# 15. Assessment of the shortraker rockfish stock in the Bering Sea and Aleutian Islands

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# Executive Summary

The Bering Sea and Aleutian Islands (BSAI) shortraker rockfish (*Sebastes borealis*) stock is currently managed in Tier 5 and is assessed on an even year schedule to coincide with new survey data from the Aleutian Islands (AI) bottom trawl survey. For this on-cycle year, we include new survey biomass from the 2023 AI bottom trawl survey, new relative population weights (RPWs) from the 2023 longline surveys, and updated auxiliary data sources. We continue to use a random effects multi-area model with an additional survey (REMA) model fit to survey data to estimate exploitable biomass and determine the recommended acceptable biological catch (ABC; Hulson et al. 2021, Sullivan et al. 2022a).

## Summary of Changes in Assessment Inputs

*Changes in the input data:*

1) Catch data have been revised and updated through October 22, 2024.
2) 2024 AI bottom trawl survey biomass estimate (BTS).
3) 2023 AFSC longline survey (LLS) relative population weights (RPWs) on the eastern Bering Sea (EBS) slope. The EBS slope is sampled by the LLS in odd years.
4) Length compositions from the 2023 fishery.
5) Length compositions from the 2023 and 2024 AI bottom trawl survey and the 2023 longline survey.

This is an update operational stock assessment, there are no changes to assessment methodology.

## Summary of Results

The summarized results of the risk table exercise for shortraker rockfish are presented below. We rated most scores as Level 1, with the exception of the assessment-related considerations which we rated at Level 2, increased concern. This increased level was due to unresolved issues in the ability of the base model to estimate region-specific process errors. While we plan for future improvements to the model structure, we do not recommend setting the ABC below the maximum permissible. Further details for each category of this risk table are provided in the *Projections and Harvest Recommendations* section.

| *Assessment-related considerations* | *Population dynamics considerations* | *Environmental/ ecosystem considerations* | *Fishery-informed stock considerations* |
|---|---|---|---|
| **Level 2:** Increased concern | **Level 1:** Normal | **Level 1:** Normal | **Level 1:** Normal |

Reference values for shortraker rockfish are summarized in the following table. The recommended 2025 acceptable biological catch (ABC) and overfishing limit (OFL) for BSAI shortraker rockfish are 473 t and 631 t, respectively. This ABC is an 11% decrease compared to the 2024 ABC and 2025 projected ABC of 530 t. The stock is not being subjected to overfishing.

| **Quantity** | As estimated or *specified last* year for: 2024 | 2025 | As estimated or *recommended this* year for: 2025 | 2026 |
|---|---|---|---|---|
| *M* (natural mortality rate) | 0.03 | 0.03 | 0.03 | 0.03 |
| Tier | 5 | 5 | 5 | 5 |
| Biomass (t) | 23,547 | 23,547 | 21,018 | 21,018 |
| $F_{OFL}$ | 0.03 | 0.03 | 0.03 | 0.03 |
| $maxF_{ABC}$ | 0.0225 | 0.0225 | 0.0225 | 0.0225 |
| $F_{ABC}$ | 0.0225 | 0.0225 | 0.0225 | 0.0225 |
| OFL (t) | 706 | 706 | 631 | 631 |
| maxABC (t) | 530 | 530 | 473 | 473 |
| ABC (t) | 530 | 530 | 473 | 473 |
| **Status** | As determined *last* year for: 2022 | 2023 | As determined *this* year for: 2023 | 2024 |
| Overfishing | | n/a | | n/a |

## Summaries for the Plan Team

The following table gives the recent biomass estimates, catch, harvest specifications, and projected biomass, OFL and ABC for 2023-2026.

| Year | Biomass | OFL | ABC | TAC | Catch |
|---|---|---|---|---|---|
| 2023 | 23,547 | 706 | 530 | 500 | 243 |
| 2024 | 23,547 | 706 | 530 | 541 | 132[1] |
| 2025 | 21,018 | 631 | 473 | | |
| 2026 | 21,018 | 631 | 473 | | |

[1] Catch as of October 22, 2024. Source: NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database (http://www.akfin.org).

## Responses to Comments

### *Responses to Plan Team and SSC Comments on Assessment in General*

"*SSC suggests the GPT assessment authors coordinate with Dr. Larson to determine if there are results relevant to their species and how any new information might impact the assessment and management of these species.*" (SSC, October 2023)

We provide a short summary regarding the results from the re-evaluation of shortraker rockfish genetic stock structure (W. Larson, *pers. commun.*, Echave et al., 2023) in the *Evidence of Stock Structure* section in the *Introduction* below.

"*The Team recommended as a best practice that appendices be linked in the front of the document (as with the sablefish assessment) to allow for an easier review of the appendices.*" (Plan Team, November 2023)

The only appendix for BSAI shortraker rockfish is the Supplemental Catch Appendix and this is included at the end of the report so there is no additional link to track. The appendix can be quickly accessed through the document navigation window.

Combined recommendations on the risk table:

"*The SSC continues to support a three-category risk table with categories normal, increased, and extreme, and requests that the category descriptions be revised to cover the range covered by the original table.*"

"*The SSC reiterates that only fishery performance indicators that provide some inference regarding biological status of the stock should be used.*"

"*The SSC recommends that the risk tables consider potential future risks when these can be anticipated.*"

"*When risk scores are reported, the SSC requests that a brief justification for each score be provided, even when that score indicates no elevated risk.*"

(SSC, December 2023)

We use the newly updated risk table with three categories and updated descriptions for developing the risk table for this assessment. The new table is included in the SAFE introduction for reference we also repeat it here for ease of use. The "fishery performance" category has been renamed to "fishery-informed stock considerations" and we only use the indicators that were listed by the SSC, namely "CPUE, fishery spatial and temporal patterns, and catches of thin or unhealthy fish (i.e., poor condition)" (SSC Minutes, December 2023, pg. 3). We also consulted with the Alaska regional office on any trends that we identified through this risk table evaluation.

Regarding a potential future risk to this assessment. We did not identify additional risk this year in the risk table categories outside of the assessment model concerns that were detailed because we received all the available survey and fishery information that we would normally have received in an even year. However, the AFSC longline survey did not occur this year and future surveys or the extent of sampling for this survey are currently unknown. If the Bering Sea section of this survey does not occur next year (or in the future), then we will not have any data on the shortraker population in the Bering Sea as the bottom trawl slope survey is not planned to continue in the future. This could pose an elevated risk for this stock in the future.

We provide justification for our risk table scores in the "*Risk Table and ABC Recommendation*" section below.

### *Responses to Plan Team and SSC Comments Specific to this Assessment*

"*The BSAI GPT encouraged the author to simplify and combine the SBS stratum with the AI in the future. Before implementing this change, the SSC requests that the authors provide the background on why the original stratification was used, whether the authors recommend a change in stratification, and a justification for changing the stratification.*" (SSC, December 2022)

We followed the SSC recommendation to first determine why the original stratification was used in this assessment. The 2012 assessment (Spencer and Rooper, 2012) used only the AI bottom trawl survey data within a surplus production model to estimate the ABC and OFL for shortraker rockfish as the majority of the biomass for shortraker was in the AI. In this assessment the authors also evaluated area-specific exploitation rates because of 1) previous management that established separate Total Allowable Catch (TAC) for the eastern Bering Sea (EBS) and AI management areas and 2) information on genetic population structure that suggested geographic scale consistent with current management regions of the EBS, AI, and Gulf of Alaska (GOA) (Matala et al., 2004). The areas evaluated were the three 3 AI subareas (541, 542, 543), the southern Bering Sea (SBS, 518 and 519) and the EBS (the remainder of the EBS management area minus the SBS). At the time of this assessment, the exploitation rates in the EBS and SBS exceeded the estimate of natural mortality (M, 0.03) in the most recent years. In the next assessment (Spies et al., 2014), there was a change in the assessment methodology to use the random effects model instead of the surplus production model to estimates the ABC and OFL. The sub-area exploitation rates were again examined, and had decreased in all areas but were still near M in the EBS and SBS. Also, the biomass estimates of the SBS had been steadily decreasing since the late 1990s and was at an all-time low in 2014. The random effects model appears to have been run on the AI including the SBS and the eastern Bering Sea slope bottom trawl survey. In the next assessment (Spies et al., 2016), the random effects model was run on the AI (with SBS) and the EBS surveys and then sub-area model runs were created for the EBS slope, the SBS, and the three AI regions to investigate the exploitation rates by sub-area. The data gaps and research priorities section of the 2016 SAFE discusses the need to investigate whether the shortraker rockfish in the SBS represented a distinct population from the eastern AI and the EBS slope since fishing pressure is higher in the SBS than in other regions and shortraker rockfish population sizes have continued to decline in that area. The 2018 and 2020 assessments (Spies et al., 2018, Shotwell et al., 2020) continued the 2014 methodology. The 2022 assessment (Shotwell et al., 2022) used the new random effects multi-area model with an additional survey (REMA) modeling framework to allow for the addition of the longline survey and also estimated the SBS separately from the AI and EBS slope survey following the area-specific methodology of the historical assessments.

There does not seem to be a recommendation for or against the stratification and we do not consider a separation between the AI and EBS management areas for this stock (managed at the FMP level). Additionally, recent whole genome sequencing was recently conducted of the shortraker stock comparing Oregon/Washington samples to the BSAI and no genetic structure was documented suggesting high gene flow across the entire species range (Echave et al., 2023). As originally discussed in the 2012 assessment, the original intent of tracking the area-specific exploitation rates was due to potential stock structure. Based on the most recent genetic studies, this structure does not seem to hold. It may be useful to consider localized depletion in the short term, but for rockfish with no structure, locally depleted areas will be replenished by larval transport over time (Echave et al., 2023, W. Larsen, *pers. commun.*). Additionally, the SBS region has several major currents that flow along shortraker adult habitat on the continental slope. Originating from the Alaskan Stream in the GOA, these currents flow through the deep passes in the Aleutian Islands (Amchitka and Buldir) and become the eastern boundary Aleutian North Slope Current (ANSC). The ANSC flows along the Bering Sea side of the AI and northward toward the SBS to eventually turn northwest along the slope as the Bering Slope Current. These currents could potentially provide a constant source of larval transport from the GOA to the BSAI slope environments and could be the mechanism for the lack of stock structure in shortraker rockfish. Given these reasons, we recommend that in future assessments the AI and the SBS strata be combined in the REMA model. We plan to test the sensitivity of this adjustment in future assessments and present it as an alternative model.

"*The SSC appreciates the authors' tracking and careful consideration of previous SSC comments. The SSC recommends the authors re-evaluate the current estimate of natural mortality for the next full assessment in light of the recent technical memo containing updated life history information for Alaska rockfishes (Sullivan et al. 2022*[b]*). The SSC also supports the research priorities listed, including the authors' listed primary research priorities of validating aging techniques and obtaining ages from archived samples.*" (SSC, December 2022)

This assessment is an operational update assessment so no new model changes were conducted this year. The rockfish assessment authors are working together as a group to determine how best to include the new information from the recent technical memo that updated the natural mortality estimates for many rockfish stocks. There are a variety of tiers involved for these assessments and the decision on how best to move forward is non-trivial and will require further discussion. We hope to provide some best practices guidance for future rockfish assessments and plan to incorporate in future shortraker rockfish assessments.

"*Now that the BSAI slope LL survey is included in the assessment, the SSC also recommends continued research to better quantify the effects of hook competition and computing adjustment factors for shortraker survey catch rates as a long-term research priority.*" (SSC, December 2022)

We agree and will incorporate any future research on effects of hook competition in future assessments.

# Introduction

The Bering Sea and Aleutian Islands (BSAI) shortraker rockfish complex is currently managed in Tier 5 and is assessed on a biennial basis to coincide with the Aleutian Islands (AI) bottom trawl survey. Please refer to the last full operational stock assessment and fishery evaluation (SAFE) report for more details on shortraker distribution and life history information (Shotwell et al., 2022).

## Evidence of Stock Structure

Please refer to the last full operational SAFE report for more details on shortraker stock structure (Shotwell et al., 2022). The following paragraph on genetic population structure has been updated due to the relevance for the SSC recommendation listed in the *Responses to Plan Team and SSC Comments on Assessment in General* section in the *Executive Summary*.

Population structure for shortraker rockfish has been observed in microsatellite data (Matala et al. 2004), with the geographic scale consistent with current management regions (i.e., GOA, AI, and EBS). The most efficient partitioning of the genetic variation into non-overlapping sets of populations identified three groups: a southeast Alaska group, a group extending from southeast Alaska to Kodiak Island, and a group extending from Kodiak Island to the central AI (the western limit of the samples). The available data are consistent with a neighborhood genetic model, suggesting that the expected dispersal of a particular specimen is much smaller than the species range. A parallel study with mtDNA revealed weaker stock structure than that observed with the microsatellite data. It is not known how shortraker in the EBS or western AI relate to the large population groups identified by Matala et al. (2004) due to a lack of samples in these areas. Preliminary results from a new study re-evaluating shortraker genetic stock structure used low coverage whole genome resequencing (3.9 million markers) to compare samples from Oregon/Washington (n =20) with samples from the BSAI (n = 28) (W. Larsen, *pers. commun*., Echave et al., 2023). They found no genetic stock structure which indicates that there is high gene flow in this species across most of their range which is likely due to long distance larval dispersal. Indeed, the eastern boundary Alaska Current flows into the fast-flowing western boundary Alaskan Stream right along most of the slope habitat in the GOA and into the Bering Sea through the deep-water Aleutian passes in Amchitka and Buldir. Once through the passes, the current takes a turn east and becomes the Aleutian North Slope Current that feeds right along the slope habitat of the southern Bering Sea (SBS) (Stabeno and Reed, 1992, Stabeno et al., 2009). This mechanism of current transport would allow for replenishing larval to locally depleted areas over time and explain the lack of stock structure for this species.

# Fishery and Management History

Please refer to the last full operational SAFE report for more details on the shortraker fishery history and management measures (Shotwell et al., 2022). The following tables are maintained to provide updated information on shortraker rockfish catches:

- The ABCs, TACs, and catches by management complex from 2004-2024 are shown in Table 15.1 (please refer to Shotwell et al., 2022 for 1988-2004).
- Catches from the domestic fishery prior to the domestic observer program were obtained from PACFIN records. Catches of shortraker rockfish since 1977 are shown in Table 15.2.
- By area, catches average 18% in the western AI (WAI), 20% in the central AI (CAI), 12% in the eastern AI (EAI), 6% in the SBS, and 44% in the EBS from 2003-2023. Catch as of October 22, 2024 was down in all areas and 132 t overall (Table 15.3).
- Estimates of discarding by species complex are shown in Table 15.4. In general, the discard rates of EBS SR/RE are less than the discard rates of EBS other red rockfish in most years, likely

reflecting the relatively higher value of rougheye and shortraker rockfish over other members of the complex. Discard rates of BSAI shortraker rockfish from 2004-2021 have ranged from 12% to less than 54%, and were 15.9% in 2023 and 23.7% in 2024 (catch taken through October 22, 2024).

# Data

## Fishery

The length composition from observer sampling of the domestic fishery (Figure 15.1), indicate relatively consistent length distributions with the bulk of the sampled fish generally between 33 and 77 cm. There are no consistent trends in the size distribution but there does appear to be more smaller fish in 2019 and 2021 that could be indicative of potential new recruitment of the stock. The number of length observations taken by fishery observers in the BSAI is shown in the following table.

| Year | Number of fishery length observations | Year | Number of fishery length observations |
|---|---|---|---|
| 1990 | 373 | 2010 | 2,156 |
| 1991 | 576 | 2011 | 1,158 |
| 1992 | 413 | 2012 | 709 |
| 1993 | 736 | 2013 | 835 |
| 1994 | 125 | 2014 | 1,137 |
| 1999 | 306 | 2015 | 1,260 |
| 2000 | 114 | 2016 | 493 |
| 2001 | 138 | 2017 | 234 |
| 2002 | 226 | 2018 | 434 |
| 2003 | 2,000 | 2019 | 600 |
| 2004 | 1,630 | 2020 | 238 |
| 2005 | 1,352 | 2021 | 523 |
| 2006 | 1,464 | 2022 | 412 |
| 2007 | 1,730 | 2023 | 262 |
| 2008 | 702 | 2024* | 0 |
| 2009 | 1,346 | | |

*Length samples as of October 22, 2024

The catch data are the estimates of single species catch described above and shown in Table 15.2. Removals from sources other than those that are included in the Alaska Region's official estimate of catch are presented in Appendix 1. Non-commercial removals averaged 2.3 t between 2005 and 2023.

## Survey

### *AFSC Bottom Trawl Surveys*

Biomass estimates for other red rockfish were produced from cooperative U.S.-Japan bottom trawl surveys (BTS) from 1979-1985 on the EBS slope, and from 1980-1986 in the AI. U.S domestic bottom trawl surveys were conducted in 1988, 1991, 2002, 2004, 2008, 2010, 2012, and 2016 on the EBS slope, and in 1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2016, 2018, 2022, and 2024 in the AI and southern Bering Sea (SBS), which is defined by the International North Pacific Fisheries Commission (INPFC) and sampled in the AI BTS (Table 15.5). The 2008 AI survey and 2006, 2010, and 2018 EBS slope surveys were canceled. The 2020 AI survey and EBS slope survey were cancelled due to the COVID-19 pandemic. The spatial distribution of the BTS stratum are provided in Figure 15.2.

The AI BTS is a multi-species survey and biomass estimates are based on a stratified random design of habitat stratified by management area, sub-region, and depth zones (0-100 m, 101-200 m, 201-300 m and 301-500 m). However, the AI BTS is based on a stratified random design of previously successful stations and is therefore an index survey. Design-based biomass estimates may be more appropriately viewed as weighted mean catch-per-unit-effort expanded by strata over the survey area. The AI BTS time series began in 1980 but gear was not standardized until the 1991 survey when the Poly'Noreastern (PNE) bottom trawl was uniformly implemented. Before then, a mix of large, fortified nets and a similar net to the PNE were used. Also haul duration was generally 30 minutes prior to 1997 when haul duration was reduced to 15 minutes. Based on recommendations from the Groundfish Assessment Program (GAP), we start the AI BTS biomass time series in 1991 for shortraker rockfish. The spatial distribution of shortraker catch-per-unit-effort from the three most recent surveys is provided in Figure 15.3 and shows the patchy distribution of catches over time with some particularly large catches in single tows in the western and central AI.

The EBS slope BTS is a multi-species survey with sampling effort distributed in proportion to the survey surface area by sub-region and depth (200-400 m, 400-600 m, 600-800 m, 800-1000 m, and 1000-1200 m; Hoff 2013). The biennial EBS slope survey was initiated in 2002. The most recent slope survey prior to 2002, excluding some preliminary tows in 2000 intended for evaluating survey gear, was in 1991. The survey used a standardized PNE with a tow duration of 30 minutes and towing speed of 2.5 knots. Although the EBS slope BTS only occurred six times and ended in 2016, it is likely our best depiction of deepwater rockfish species (e.g., shortaker rockfish, shortspine thornyhead) in this region.

EBS shelf BTS is conducted annually using fixed stations at the center of a 20 x 20 nautical mile grid (Lauth and Nichol 2013). Design-based estimates of EBS shelf BTS biomass are based on 12 strata that include four sub-regions and 3 depth strata (<50 m, 50-100 m, and 101-200 m). The survey design has been standardized since 1982 and uses a tow duration of 30 minutes and a 3 knot towing speed. The EBS shelf BTS uses a standard 83-112 Eastern otter trawl employing a 25.3 m head rope and 34.1 m footrope. Although the standard sampling trawl for the EBS shelf started in 1982, the survey was expanded in 1987 to include two more strata in the northwest area and the expanded survey area has been the standard sampling area to present.

The largest survey biomass for shortraker is found on the AI BTS, and there was a decreasing trend over the survey time period from 2000-2016 (Table 15.5, Figure 15.4) with an increase in the 2018 estimate back to near average levels and then a decrease in the 2022 and 2024 estimates. The SBS, an area defined by the INPFC northeast of Samalga Pass that is sampled in the AI BTS, has the smallest survey biomass of any of the areas (Table 15.5, Figure 15.4). Biomass in the SBS has shown a consistent decline in biomass estimated by the survey since 1991, although there was an increase in 2022 from the previous survey, but no shortraker were caught in the SBS in 2024. Shortraker rockfish are primarily caught in the 301-500 m stratum in the AI BTS, which is the deepest stratum in that survey. Estimates of deep-water species such as shortraker rockfish are likely underestimated in the AI BTS, because it does not sample <500 m and recent surveys have reduced sampling effort in the deeper stations (S. McDermott, *pers. commun.*). AI surveys from 1991 to 2018 indicated higher abundances in the western (543) and central (542) than in the eastern AI (541) (Table 15.5), with the SBS area having the lowest abundance (Figure 15.4). However, the 2022 and 2024 surveys show higher abundances in the eastern AI and very low abundance in the western AI. The survey biomass estimates of shortraker rockfish from the 2002-2016 EBS slope surveys have ranged between 2,621 t (2004) and 9,303 t (2012), with CVs between 0.22 and 0.57. The EBS slope survey estimates were updated with new survey stratum areas in 2024 by the GAP program and the biomass estimates changed slightly. There are no shortraker rockfish on the EBS shelf survey.

In contrast to the fishery length compositions, the survey length compositions reveal fewer large fish (Figure 15.1), with the exception of the more recent EBS slope surveys of 2012 and 2016. In surveys from 1994 to 2018, fish lengths from survey samples generally occurred between 30 cm and 65 cm.

### *AFSC Longline Survey*

The domestic longline survey is conducted annually by the AFSC over the continental slope region of the BS/AI and the GOA. The GOA stations are sampled each year while the Bering Sea is sampled on odd years and the Aleutian Islands in even years. This survey provides data on the relative abundance of shortraker rockfish and computes relative population numbers (RPNs) and relative population weights (RPWs) for fish on the continental slope as indices of stock abundance. Relative population abundance indices are computed annually using survey catch per unit of effort (CPUE) rates that are multiplied by the area size of the stratum within each geographic area. These relative population indices are available by numbers (RPN) and weights (RPW) for a given species (Rodgveller et al. 2011a). The survey is primarily directed at sablefish, but also catch considerable numbers of shortraker rockfish. Results for this survey concerning rockfish, however, should be viewed with some caution, as the RPNs and RPWs do not take into account possible effects of competition for hooks with other species caught on the longline, especially sablefish. An analysis of the survey data indicated there was a negative correlation between catch rates of sablefish and shortraker rockfish in the GOA, and that there was likely competition for hooks between species in the surveys (Rodgveller et al. 2008). The study concluded that further research and experiments are needed to better quantify the effects of hook competition and to compute adjustment factors for the survey catch rates. Recently, another study compared catch rates of shortraker and rougheye rockfish on survey longline gear with observed densities of these fish around the longline from a manned submersible also in the GOA (Rodgveller et al. 2011b). Results for shortraker and rougheye combined showed a catchability coefficient (q) of 0.91. There was a tendency for longline catch rates of the two species to be related to the observed densities, but this relationship was not significant. Again, this study concluded that additional research is needed on the longline catching process for shortraker rockfish to better determine the suitability of using longline survey results for assessment of this species.

The AFSC longline survey has been conducted annually since 1988, and RPNs and RPWs have been computed for each year and are available since 1997 for shortraker rockfish (Table 15.6). RPNs in the Aleutian Islands have ranged from a low of ~9,800 t in 2022 to a high of ~35,700 t in 2006 and in the Bering Sea from a low of ~4,100 t in 2009 to a high of ~28,700 t in 2003. The Aleutian Islands time series appears to exhibit a strong saw tooth pattern up until about 2016 when the series seems to stabilize somewhat (Table 15.6) and has decreased in recent years. The Bering Sea time series seems to be somewhat stable after about 2005. Definite trends in these data over the years are difficult to discern, and the BSAI values of RPN fluctuate considerably between adjacent years. This same pattern is evident in the GOA time series for shortraker rockfish. Some of the fluctuations may be related to changes in the abundance of sablefish, as discussed in the previous paragraph regarding competition for hooks among species. The 2023 longline survey RPN value for shortraker rockfish is down about 13% from 2021. Longline survey results show that the abundance of shortraker rockfish was generally higher in the Aleutians than the Bering Sea until about 2016 when they are similar in magnitude (Table 15.6).

Length data are also collected for shortraker rockfish during longline surveys and compositions are available since 1997. A clear difference in size between the Aleutian Islands (sampled in even years) and the Bering Sea (sampled in odd years) exists with larger fish sampled in the Bering Sea. However, in surveys from 1996 to 2023, fish lengths from both regions were similar to the fishery samples and generally occurred between 50 cm and 80 cm in the Bering Sea and between 30 cm and 70 cm in the AI with the exception of 2022 that seemed to have larger fish resembling the distribution in the Bering Sea.

The habitat between the two regions is quite different and the biomass estimates on the bottom trawl survey and the RPNs on the longline survey are larger for the Aleutian Islands than the Bering Sea.

The inclusion of LLS relative population weights (RPWs) for shortraker in the EBS slope region in the 2022 assessment was prompted by concerns over the cessation of the EBS slope BTS in 2016. We continue to include the EBS slope LLS RPWs to inform abundance trend information in recent years, thus reducing reliance on the 2016 bottom trawl slope survey estimate of biomass in that region. The potential use of LLS RPWs in the AI was explored; however, we did not recommend using the AI RPWs at this time due to a mismatch in the spatial extent and resolution of the AI BTS and LLS (Figure 15.2). The LLS only samples the eastern AI, and the LLS area boundaries would need to be manually redefined in order to make them comparable with the BTS strata (Figure 15.2).

### *International Pacific Halibut Commission Survey*

The International Pacific Halibut Commission (IPHC) conducts a longline survey each year to assess Pacific halibut. This survey differs from the AFSC longline survey in gear configuration and sampling design, but also catches shortraker rockfish. More information on this survey can be found in Soderlund et al. (2009). A major difference between the two surveys is that the IPHC survey samples the shelf consistently from 1-500 meters, whereas the AFSC longline survey samples the slope and select gullies from 200 to 1000 meters. Because the majority of effort occurs on the shelf in shallower depths, the IPHC survey may catch smaller and younger shortraker rockfish than the AFSC longline survey and similar to the AFSC bottom trawl surveys; however, lengths of shortraker rockfish are not taken on the IPHC survey.

RPNs have been computed for each year of the IPHC survey and are available since 1998 to 2019 for shortraker rockfish (see Table 15.9 in Shotwell et al., 2022). However, there have been recent changes to the sampling protocol and coverage of the IPHC longline survey. As such, we do not recommend using this survey as these changes will limit the survey utility moving forward.

## Analytic Approach

Exploitable biomass is estimated using a state-space random walk model, referred to broadly as the random effects (RE) model. The RE model is fit to design-based estimates of survey biomass and observation error. Population biomass is modeled as a series of random effects, and the overall smoothness of the population relative to survey biomass is governed by the process error variance, the only fixed effect parameter estimated in the model. There are two extensions to the RE model, a multivariate version that can be used to fit to multiple strata simultaneously and share process error across one or more strata (REM), and another version that can fit to an additional relative abundance index called the random effects multi-area model with an additional survey (REMA; Hulson et al. 2021). Equations for the RE, REM, and REMA models, and a guide to fitting these models in TMB using the REMA R package is provided in Sullivan et al. (2022a).

We present two models this year:

### *Model 22_2022*

This is the base model and is the accepted model from the last full assessment (Shotwell et al. 2022). This model is run in TMB using the multivariate version of the random effects model to fit three regions (AI, SBS, and EBS slope) simultaneously with a separate process error parameter in each region and includes the NMFS longline survey (LLS) relative population weights (RPW) in the eastern Bering Sea (EBS) slope region. This was accomplished through the REMA R package and resulted from recent concerns over the lack of abundance information for shortraker rockfish and other species in the EBS slope region following the cessation of the EBS slope BTS in 2016 (Shotwell et al. 2020, Sullivan et al. 2020).

*Model 22_2024*

This is the base model with any new survey data since 2022. And includes the 2024 AI bottom trawl survey biomass and the 2023 LLS RPW on the EBS slope.

## Reference points

Shortraker rockfish in the BSAI are managed under Tier 5, where OFL = $M$ * average survey biomass, where $M$ represents natural mortality, and $F_{ABC}$ is estimated by 0.75 * $M$. The acceptable biological catch (ABC) is obtained by multiplying $F_{ABC}$ by the estimated biomass, ABC ≤ 0.75 * $M$ * biomass.

## Parameter Estimates

Shortraker rockfish are assumed to have a natural mortality rate ($M$) of 0.03. This estimate of natural mortality is consistent with estimates for north Pacific shortraker rockfish using the gonad somatic index, which ranged from 0.027 to 0.042 (McDermott 1994). Recently, a group of stock assessment authors collaborated on a technical memo to revisit available life history data and M for several rockfish species in Alaska (Sullivan et al. 2022b). The rockfish assessment authors are working together as a group to determine how best to include the new information from the technical memo that updated the natural mortality estimates for many rockfish stocks. Following these discussions, we hope to provide some best practices guidance for future rockfish assessments and plan to incorporate the new information on M in the future.

# Results

Shortraker biomass is on average greatest in the AI (83% on average), followed by the EBS slope (14% on average) and then the SBS portion of the AI survey (3% on average). Both the base (Model 22_2022) and the updated Model (Model 22_2024) perform well for shortraker rockfish in all survey regions (Figure 15.4) with very few estimates falling outside the confidence bounds. The fit to shortraker survey biomass shows a decrease from 1997-2006, then stable until present in the AI, stable in the EBS slope from 2002-2016, and a decrease in the southern Bering Sea since 1997. The 2023 decline in the LLS RPWs, 2024 decline in the AI BTS survey, and the decrease in GOA shortraker stock in 2023 RPWs suggest there may be continued changes to the dynamics of this stock (Echave et al., 2023).

The LLS RPWs and BTS biomass estimates of shortraker on the EBS slope follow a similar trend where estimates overlap, therefore long-term predicted biomass trajectories are similar between the base model and the update model (Figure 15.4). Fixed effects parameters for Model 22_2022 and Model 22_2024 are presented in Table 15.7. The estimate of process error is lower in Model 22_2024 for the Bering Sea slope, resulting in slightly less inter-annual variability in biomass. Notably, the standard error for process error in this region is quite high, resulting in confidence intervals that approach zero (Table 15.7). This issue is discussed in the assessment considerations of the risk table.

The BSAI biomass estimates of shortraker rockfish from both models are very similar and are provided in Table 15.8 and Figure 15.5. More shortraker rockfish are present in the AI than the EBS. The random effects model results estimated 4,807 t in the EBS and 16,211 t in the AI in 2024. These were calculated by combining the SBS area from the AI BTS with the EBS slope BTS estimates of biomass.

The biomass estimates from the survey in the SBS region are very clustered and sporadic and may not be representative of the shortraker population in this area (Figure 15.3). Little is known about shortraker rockfish preferred habitat but they often co-occur with rougheye and blackspotted rockfish (*Sebastes aleutianus* and *S. melanostictus*, respectively) that inhabit steep, rocky areas along the continental slope. Much of this habitat is considered untrawlable by survey gear and so the AI BTS may underestimate their abundance in this habitat. It should be noted that the SBS survey estimates have very high CVs and are based on very small catches of shortraker. For example, the 2022 SBS biomass estimate has a CV of 60% and comes from the catch of 4 fish in 2 hauls. The majority of the catch in the SBS region occurs in the rockfish, flatfish, and pollock fisheries. The rockfish fishery commonly uses “rockhopper” trawl gear that can move around rocks and boulders that are common to shortraker habitat. Additionally, the catch that is recorded in the SBS defined area (518 and 519) may not overlap consistently with the location of the sampled area on the AI BTS. Due to the differences in gear and the potential spatial mismatch between the fishery and the survey, it is not clear what the exploitation rate at this small of an area size means for the shortraker population as a whole.

More notably, since we do not apportion the stock at the subarea level, the exploitation rate for the entire BSAI has remained below $F_{ABC}$ and $F_{OFL}$ since 2004. The cyclical nature may be related to the opening of directed fishing for Pacific ocean perch (POP) since 2010. Most of the BSAI shortraker catch is taken as incidental catch in the BSAI POP fishery, so any increase in POP catch in the POP target could contribute to the increases in incidental catch for shortraker rockfish (M. Furuness, *pers. commun.*). Also, in 2024 the catch is very low in all areas, particularly in the Bering Sea. The Bering Sea POP fishery is still open with more available TAC so there may be more shortraker caught by the end of the year. However, the Bering Sea POP fishery is trying to avoid blackspotted rougheye (BSRE) rockfish. Since BSRE rockfish often co-occur with shortraker rockfish, the reduction in effort to avoid BSRE may also result in reduced catch of shortraker (S. Whitney, *pers. commun.*)

## Projections and Harvest Recommendations

Shortraker rockfish are currently managed under Tier 5 of Amendment 56 of the NPFMC BSAI Groundfish FMP, which requires a reliable estimate of stock biomass and natural mortality rate. The estimate of $M$ for shortraker rockfish was obtained from Heifetz and Clausen (1991), and for Tier 5 stocks, $F_{OFL}$ and $F_{ABC}$ are defined as $M$ and 0.75$M$, respectively:

| 2024 | Shortraker Rockfish |
|---:|---:|
| $M$ | 0.03 |
| Biomass | 21,018 |
| $F_{OFL}$ | 0.03 |
| max$F_{ABC}$ | 0.0225 |
| $F_{ABC}$ | 0.0225 |
| OFL | 631 |
| maxABC | 473 |
| ABC | 473 |

### *Risk Table and ABC Recommendation*

The SSC in its December 2018 minutes recommended that all assessment authors use the risk table when determining whether to recommend an ABC lower than the maximum permissible. The SSC also requested the addition of a fourth column on fishery performance, which has been included in the table below. In the December 2023 minutes, the SSC continues to support a three-category risk table and revised descriptions to cover the range of the original table. The updated table is provided below:

## Risk Table Levels of Concern

| | *Assessment-related considerations* | *Population dynamics considerations* | *Ecosystem considerations* | *Fishery-informed stock considerations* |
|---|---|---|---|---|
| Level 1: Normal | Typical to moderately increased uncertainty/minor unresolved issues in assessment. | Stock population dynamics (e.g., recruitment, growth, natural mortality) are typical for the stock and recent trends are within normal range. | No apparent ecosystem concerns related to biological status (e.g., environment, prey, competition, predation), or minor concerns with uncertain impacts on the stock. | No apparent concerns related to biological status (e.g., stock abundance, distribution, fish condition), or few minor concerns with uncertain impacts on the stock. |
| Level 2: Increased concern | Substantially increased assessment uncertainty/ unresolved issues, such as residual patterns and substantial retrospective patterns, especially positive ones. | Stock population dynamics (e.g., recruitment, growth, natural mortality) are unusual; trends increasing or decreasing faster than has been seen recently, or patterns are atypical. | Indicator(s) with adverse signals related to biological status (e.g., environment, prey, competition, predation). | Several indicators with adverse signals related to biological status (e.g., stock abundance, distribution, fish condition). |
| Level 3: Extreme Concern | Severe assessment problems; very poor fits to important data; high level of uncertainty; very strong retrospective patterns, especially positive ones. | Stock population dynamics (e.g., recruitment, growth, natural mortality) are extremely unusual; very rapid changes in trends, or highly atypical patterns compared to previous patterns. | Indicator(s) showing a combined frequency (low/high) and magnitude(low/high) to cause severe adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock) that are likely to impact the stock. | Multiple indicators with strong adverse signals related to biological status (e.g., stock abundance, distribution, fish condition), a) across different sectors, and/or b) different gear types. |

The table is applied by evaluating the severity of four types of considerations that could be used to support a scientific recommendation to reduce the ABC from the maximum permissible. These considerations are stock assessment considerations, population dynamics considerations, ecosystem considerations, and fishery performance. Examples of the types of concerns that might be relevant include the following:

1. "Assessment-related considerations - data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data; model fits: poor fits to fits to fishery or survey data, inability to simultaneously fit multiple data inputs; model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds; estimation uncertainty: poorly-estimated but influential year classes; retrospective bias in biomass estimates.
2. "Population dynamics considerations - decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.
3. "Ecosystem considerations - adverse trends in environmental/ecosystem indicators, ecosystem model results, decreases in ecosystem productivity, decreases in prey abundance or availability, increases or increases in predator abundance or productivity.
4. "Fishery-informed stock considerations - fishery CPUE is showing a contrasting pattern from the stock biomass trend, unusual spatial pattern of fishing, changes in the percent of TAC taken, changes in the duration of fishery openings

### *Assessment-related considerations*

The BSAI shortraker stock is a Tier 5 species, meaning only reliable biomass estimates are available to calculate ABCs. The BSAI shortraker assessment is one of few Tier 5 assessments in Alaska that is fit to multiple abundance indices (AI BTS biomass, EBS slope BTS biomass, LLS RPWs). Model 22 estimates a separate process error parameter for each region (the AI using the AI BTS biomass, the SBS using the AI BTS biomass, and the EBS slope using the EBS slope BTS biomass and the LLS RPWs). However, standard error estimates for the process error on the EBS slope are approaching zero on the arithmetic scale and 95% confidence intervals are large (Table 15.7). In the REMA model, process error is estimated in log space and therefore cannot include zero. Additionally, a process error of zero is equivalent to taking the mean of the time series (i.e., the biomass has no trend), which appear to be what is happening on the EBS slope in Model 22_2024, indicating there is no information in the data to estimate this parameter (Figure 15.4). We ran a sensitivity analysis comparing the region-specific process error in Model 22 to an alternative model with pooled process error. We found that, while the pooled process error performed better in terms of model fit and estimation of fixed effects (Figure 15.6), it resulted in a similar estimate of total biomass in the terminal year (decreased by 7.3%; Table 15.9). We do not manage at the sub-area level for this stock, and new whole genome sequencing studies do not detect stock structure for the entire species range. Given this new information and new diagnostics available in Balstad et al. (2024), we plan to revisit the stratification and process error structure for this assessment in the next cycle. In the interim, we do not recommend a stop-gap for 2024 but rather rate the assessment considerations a Level 2, increased concerns.

### *Population dynamics considerations*

In general, very little is known regarding the life history of shortraker rockfish, and current techniques do not produce reliable age estimates for the species. We are unable to estimate recruitment, and very few specimens of shortraker rockfish <35 cm have ever been caught in the BSAI. Any data collected during larval cruises lump all rockfish species together. Exploration of the fishery and longline length compositions suggest that there may be some recruitment in this stock that the bottom trawl surveys are not picking up due to low sampling in slope shortraker habitat. The length compositions show a slight increase in fish <35 cm in the 2021 fishery and 2022 LLS AI samples and in the 2021, 2022 fishery and 2023 LLS EBS samples, which suggests a potential increase in recruitment in the Aleutian Islands where the biomass is highest and also in the Bering Sea which was not sampled in 2024. Overall, we rated the population-dynamic concern as level 1, normal, due to the fact that little to no information exists on the population dynamics of this species but that estimated biomass is relatively steady and there is presence of potential recruitment through the length compositions.

### *Ecosystem* considerations

Environment: The average bottom temperature from the Aleutian Islands bottom trawl survey (AIBTS, (165°W – 172°E, 30-500 m) was close to the 20-year mean (1991–2012) for all subareas but still above the long term mean. This is in contrast with the four survey years prior, which were generally warmer than average for bottom temperatures. The bottom temperature means are similar across all four regions (Howard and Laman, 2024) and values close to the long-term mean are considered a positive indicator. Satellite sea surface temperatures show a step increase in 2014 with higher temperatures both in summer and winter (Xiao and Ren 2023). Sea surface temperatures were above the mean through winter across all subregions. Over the eastern Aleutian Islands, there were few days of marine heatwave (MHW) status relative to the mean over the last decade, which was also the case in 2021 and 2022. At times during late summer over 75% of the western Aleutians were in MHW status. While there were also warm anomalies and MHWs over 25% of the central and eastern Aleutians in summer, these were not sufficient to register in the spatial mean (Lemagie and Callahan, 2024). In the Bering Sea slope, temperature from the longline survey had a step increase in 2015 with the average of temperatures before 2015 around 3.5°C and temperature above 4°C after 2015; in 2023 the temperature from the longline survey was 4.4°C. Temperature profiles of depths between 100-300 in the eastern Aleutians show temperature at 150 to 250 m around 5.5°C in 2023. In the Aleutians, there appears to be an expansion in shortraker distribution into shallower habitats in the Aleutian Islands over time but it is unclear whether this is driven by interaction with other populations, internal population dynamics or habitat preference. These results may also be impacted by the contraction of survey operations into shallower waters over the past several surveys with fewer deep-water stations available for catching deep-water rockfishes and therefore more of the observed fish distribution located in shallower stations (Conrath and Dowlin 2024).

Shortraker are typically found in the Aleutians at temperatures between 3.6 - 4.6°C, at depths between 200 and 450 m. They hatch internally and their larvae remain pelagic before settling in deeper water. This period is potentially when they are most vulnerable to marine heatwaves. Despite its distribution in deep waters, the warming trend in bottom waters means shortraker are still potentially vulnerable. In general, higher ambient temperatures incur bioenergetic costs for ectothermic fish such that, all else being equal, consumption must increase to maintain fish condition. The bottom and sea surface temperatures closer to their corresponding long term mean in 2024 may be considered a positive indicator for shortaker, although potential impacts of sustained warmer temperatures are unknown for shortraker.

Prey: Increased bioenergetic demands in past years may be mitigated by the shortraker's generalist diet. As a generalist, shortraker feeds on a variety of fish including myctophids and sculpins, squids, shrimp and benthic amphipods among others; no consistent prey item dominates their diet. Based on survey data, sculpin biomass remained the same compared to 2022 (Ortiz, 2024), however shrimp continued an ongoing decline across the entire chain (Friedman et al. 2024). There is no information on other prey.

Competitors and predators: As shortraker do not rely on copepods or euphausiids, it does not compete with POP for prey. They share similar prey items and depth distribution with rougheye rockfish and shortspine thornyheads which also consume general fish, myctophids and shrimp (rougheye) as well as sculpins, squid and shrimps (shortspine thornyheads). Similar to shortraker, other fish feeding on fish and invertebrates (Pacific cod, arrowtooth flounder, skates) also decreased and have remained below the long-term average biomass estimate. There are no recorded fish predators of shortraker in the Aleutian Islands and given their depth distribution it is unlikely that shortraker are included among the Sebastes species eaten by Steller sea lions (Sinclair et al., 2002), harbor seals (London et al, 2021) and or tufted puffins at Buldir (Rojek, et al 2024).

The indicator most relevant to reflecting habitat disturbance is the estimated area disturbed by trawls from the fishing effects model (Olson et al, 2021). Trends in potential habitat disturbance are relevant for adult shortraker, although their primary habitat is steep slopes which are generally not targeted by bottom trawlers. The fishing effects model has not indicated large changes in habitat disturbance trends, and has remained below 3% for the Aleutian Islands (EAI, CAI and WAI) since 2009, so we assume that the level of habitat disturbance for shortraker has been stable. Rooper et al (2019) concluded the removal of deep coral and sponges is likely to reduce the overall density of rockfishes.

Taken together, these indicators suggest Level 1, no apparent environmental and/or ecosystem concerns for the shortraker stock aside from the recent stretch of increased temperatures. However, both the lack of ecological data relevant to the stock as well as lack of data in 2024 limits our assessment of potential recent ecosystem impacts on this stock.

### *Fishery-informed stock considerations*

There is no directed fishing of shortraker rockfish, and they can only be retained as “incidentally-caught.” Catch of shortraker rockfish fluctuates moderately by gear type and year, but catch has nearly always remained below the ABC (exception 2013). Due to their moderately high value, discard rates of shortraker rockfish have generally been low and stable since 2014. Since 2004, the catch trend is somewhat cyclic which, since 2010, could be related to the opening of the POP target fishery as shortraker are often caught as incidental catch in the POP fishery. The catch has decreased since 2021 to very low levels in 2024, similar to 2016. Although the fishery is still ongoing, most of the catch (~90%) has been caught by this time in the year and typically taken in the rockfish fisheries but more recently in the Atka mackerel and sablefish fisheries. The decrease in 2024 may be due to the EBS POP fishery still fishing or their avoidance of BSRE that often co-occur with shortraker. Overall, we rated the fishery performance concern as Level 1, normal, since the catch is well below ABC and mostly taken in the rockfish fisheries.

| *Assessment-related considerations* | *Population dynamics considerations* | *Environmental/ ecosystem considerations* | *Fishery Performance considerations* |
|---|---|---|---|
| **Level 2:** Increased concerns | **Level 1:** Normal | **Level 1:** Normal | **Level 1:** Normal |

We rated most scores as Level 1, with the exception of the assessment-related considerations which we rated at Level 2, increased concern. This elevated score was due to Model 22’s inability to well-estimate process error on the EBS Slope. Despite this, the Tier 5 controls rules are sufficiently conservative and we do not recommend reducing the ABC below the maximum permissible.

### *Status Determination*

The official total catch for 2023 is 243 t, which is less than the 2023 OFL of 706 t; therefore, this stock is not being subjected to overfishing.

*F limit*

Fishing mortality rate above which the stock is considered to be overfishing = M = 0.03.

# Ecosystem Considerations

In general, a determination of ecosystem considerations for shortraker rockfish is hampered by the lack of biological and habitat information.

## Ecosystem Effects on the Stock

*Prey availability/abundance trends:*

Similar to other rockfish species, stock condition of shortraker rockfish is probably influenced by periodic abundant year classes. Availability of suitable zooplankton prey items in sufficient quantity for larval or post-larval rockfish may be an important determining factor of year-class strength. Unfortunately, there is no information on the food habits of larval or post-larval rockfish to help determine possible relationships between prey availability and year-class strength. Moreover, visual identification to the species level for field-collected larval or post-larval rockfish is generally not reliable, although genetic techniques allow identification for larvae/post-larvae of many rockfish, including shortraker (Gharrett *et. al* 2002; Kondzela *et al.* 2007). Very few juvenile shortraker rockfish have ever been caught in Alaska, and therefore there is no information on their food items. Adult shortraker rockfish are apparently opportunistic feeders that in Alaska prey on shrimp, deepwater fish such as myctophids, and squid (Yang and Nelson 2000; Yang 2003; Yang *et al.* 2006). Little if anything is known about abundance trends of these rockfish prey items.

*Predator population trends:*

Rockfish are preyed on by a variety of other fish at all life stages, and to some extent by marine mammals during late juvenile and adult stages. Whether the impact of any particular predator is significant or dominant is unknown. Predator effects would likely be more important on larval, post-larval, and small juvenile shortraker rockfish, but information on these life stages and their predators is unknown. Due to their large size, older shortraker rockfish likely have few potential predators other than very large animals such as sleeper sharks or sperm whales.

*Changes in physical environment:*

Strong year classes corresponding to the period around 1976-77 have been reported for many species of groundfish in the GOA, including Pacific ocean perch, northern rockfish, sablefish, and Pacific cod. Therefore, it appears that environmental conditions may have changed during this period in such a way that survival of young-of-the-year fish increased for many groundfish species, including slope rockfish. The environmental mechanism for this increased survival remains unknown. Changes in water temperature and currents could have an effect on prey item abundance and success of transition of rockfish from the pelagic to demersal stage. Rockfish in early juvenile stage have been found in floating kelp patches which would be subject to ocean currents.

Changes in bottom habitat due to natural or anthropogenic causes could affect survival rates by altering available shelter, prey, or other functions. Associations of juvenile rockfish with biotic and abiotic structure have been noted by Carlson and Straty (1981), Love *et al.* (2002), and Freese and Wing (2004). A study in the GOA based on observations from a manned submersible found that adult “large” rockfish had a strong association with *Primnoa* spp. coral growing on boulders: less than 1 percent of the observed boulders had coral, but 85 percent of the “large” rockfish were next to boulders with coral (Krieger and

Wing 2002). Although the “large” rockfish could not be positively identified, it is likely based on location and depth that many were shortraker rockfish. The Essential Fish Habitat Environmental Impact Statement (EFH EIS) for groundfish in Alaska (NMFS 2005) concluded that the effects of commercial fishing on the habitat of groundfish is minimal or temporary based largely on the criterion that stocks were above the Minimum Stock Size Threshold (MSST). However, a review of the EFH EIS suggested that this criterion was inadequate to make such a conclusion (Drinkwater 2004). The trend in shortraker abundance suggests that any adverse effect has not prevented the stock from increasing since 1990.

### Fishery Effects on the Ecosystem

Most of the catch in the Aleutian Islands is taken incidentally in trawl and longline fisheries, specifically the rockfish trawl fishery for Pacific ocean perch and for Atka mackerel, and the longline fisheries for sablefish and flatfish. Thus, the reader is referred to the discussions on “Fishery Effects” in those assessment chapters in this SAFE report.

Bottom trawl fisheries for shortraker and rougheye rockfish accounted for very little bycatch of habitat areas of particular concern (HAPC) biota. This low bycatch is likely explained by the fact that little targeted fishing occurs for these fish. Fishery-specific concentration of target catch in space and time relative to predator needs in space and time relative to spawning components are unknown. Fishery-specific effects on amount of large size target fish are unknown. Annual fishery discard rates since 2004 have been 20-50% for shortraker rockfish. The discard amount of species other than shortraker rockfish in hauls targeting shortraker rockfish is unknown. Fishery-specific effects on age-at-maturity and fecundity of the target fishery are unknown. Fishery-specific effects on EFH non-living substrate are unknown, but the heavy-duty “rockhopper” trawl gear commonly used in the rockfish fishery can move around rocks and boulders on the bottom.

## Data Gaps and Research Priorities

Validating aging techniques of shortraker rockfish, and obtaining ages from archived samples are the primary research priorities for this stock and are required for age-structured population modeling. More information on the genetic population structure within the BSAI area is needed. Also, much additional research is needed on other aspects of shortraker rockfish biology and assessment. There is little to no information on larval, post-larval, or early stage juveniles of shortraker rockfish. In particular, information is lacking on juvenile shortraker rockfish, which are very seldom caught in any sampling gear. Habitat requirements for larval, post-larval, and early stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are mostly anecdotal or conjectural. While recent work has improved our understanding greatly (Du Preez and Tunnicliffe 2011, Laman et al. 2015), further research needs to be done on the bottom habitat of the fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on the grounds. Investigation is needed on the distribution and abundance of shortraker rockfish in areas of rough bottom that cannot be sampled by trawl surveys. Little is known regarding the reproductive biology and given the relatively unusual reproductive biology of rockfish and its importance in establishing management reference points, data on reproductive capacity should be collected on a periodic basis.

In the future, using bycatch composition of commercial and non-commercial species in hauls where shortraker rockfish are caught may be potentially used as a way to evaluate changes in the biodiversity or community composition. Newer stomach samples might also inform changes in diet.

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# Tables

Table 15.1 Total allowable catch (TAC), acceptable biological catch (ABC), overfishing limit (OFL), and catch (t) of shortraker rockfish from 2004 to present in the Bering Sea and Aleutian Islands management area. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System. *Estimated removals through October 22, 2024.

| Year | OFL | ABC | TAC | Catch |
|---|---|---|---|---|
| 2004 | 701 | 526 | 526 | 242 |
| 2005 | 794 | 596 | 596 | 169 |
| 2006 | 774 | 580 | 580 | 215 |
| 2007 | 564 | 424 | 424 | 324 |
| 2008 | 564 | 424 | 424 | 133 |
| 2009 | 516 | 387 | 387 | 184 |
| 2010 | 516 | 387 | 387 | 300 |
| 2011 | 524 | 393 | 393 | 346 |
| 2012 | 524 | 393 | 393 | 353 |
| 2013 | 493 | 370 | 370 | 429 |
| 2014 | 493 | 370 | 370 | 250 |
| 2015 | 690 | 518 | 250 | 211 |
| 2016 | 690 | 518 | 200 | 127 |
| 2017 | 666 | 499 | 125 | 188 |
| 2018 | 666 | 499 | 150 | 258 |
| 2019 | 722 | 541 | 358 | 399 |
| 2020 | 722 | 541 | 375 | 299 |
| 2021 | 722 | 541 | 500 | 496 |
| 2022 | 722 | 541 | 541 | 284 |
| 2023 | 706 | 530 | 530 | 243 |
| 2024* | 706 | 530 | 530 | 132 |

Table 15.2 Catches of shortraker rockfish (t) in the Bering Sea and Aleutian Islands management area, obtained from the North Pacific Groundfish Observer Program, NMFS Alaska Regional Office, AKFIN, and PACFIN, 1977-2024 (*estimated removals through October 22, 2024).

| | Eastern Bering Sea | | | Aleutian Islands | | | |
|---|---|---|---|---|---|---|---|
| Year | Foreign | Joint Venture | Domestic | Foreign | Joint Venture | Domestic | Total |
| 1977 | 0 | 0 | | 27 | 0 | | 27 |
| 1978 | 1,069 | 0 | | 874 | 0 | | 1,943 |
| 1979 | 279 | 0 | | 3,008 | 0 | | 3,286 |
| 1980 | 649 | 0 | | 185 | 0 | | 833 |
| 1981 | 441 | 0 | | 381 | 0 | | 821 |
| 1982 | 242 | 0 | | 379 | 0 | | 621 |
| 1983 | 145 | 0 | | 89 | 1 | | 235 |
| 1984 | 54 | 0 | | 28 | 0 | | 83 |
| 1985 | 19 | 0 | | 1 | 0 | | 21 |
| 1986 | 2 | 2 | 14 | 0 | 0 | 12 | 30 |
| 1987 | 0 | 0 | 28 | 0 | 0 | 36 | 64 |
| 1988 | 0 | 0 | 31 | 0 | 0 | 37 | 69 |
| 1989 | 0 | 0 | 58 | 0 | 0 | 130 | 188 |
| 1990 | | | 116 | | | 546 | 662 |
| 1991 | | | 205 | | | 251 | 456 |
| 1992 | | | 79 | | | 289 | 368 |
| 1993 | | | 221 | | | 216 | 437 |
| 1994 | | | 46 | | | 176 | 223 |
| 1995 | | | 49 | | | 164 | 213 |
| 1996 | | | 87 | | | 143 | 230 |
| 1997 | | | 36 | | | 90 | 126 |
| 1998 | | | 52 | | | 159 | 211 |
| 1999 | | | 66 | | | 129 | 195 |
| 2000 | | | 130 | | | 200 | 330 |
| 2001 | | | 57 | | | 172 | 229 |
| 2002 | | | 93 | | | 206 | 299 |
| 2003 | | | 105 | | | 118 | 223 |
| 2004 | | | 118 | | | 123 | 242 |
| 2005 | | | 108 | | | 61 | 169 |
| 2006 | | | 47 | | | 168 | 215 |
| 2007 | | | 114 | | | 211 | 324 |
| 2008 | | | 41 | | | 91 | 133 |
| 2009 | | | 69 | | | 116 | 184 |
| 2010 | | | 160 | | | 140 | 300 |
| 2011 | | | 113 | | | 233 | 346 |
| 2012 | | | 123 | | | 230 | 353 |
| 2013 | | | 138 | | | 291 | 429 |
| 2014 | | | 132 | | | 118 | 250 |
| 2015 | | | 113 | | | 98 | 211 |
| 2016 | | | 60 | | | 67 | 127 |
| 2017 | | | 109 | | | 78 | 188 |
| 2018 | | | 172 | | | 87 | 258 |
| 2019 | | | 309 | | | 90 | 399 |
| 2020 | | | 188 | | | 111 | 299 |
| 2021 | | | 368 | | | 128 | 496 |
| 2022 | | | 197 | | | 87 | 284 |
| 2023 | | | 150 | | | 93 | 243 |
| 2024* | | | 70 | | | 63 | 132 |

Table 15.3 Area-specific catches of shortraker rockfish (t) in the BSAI area from 1994-present (*October 22, 2024). Abbreviations are: Western Aleutian Islands (WAI), Central Aleutian Islands (CAI), Eastern Aleutian Islands (EAI), Southern Bering Sea (SBS), and Bering Sea (BS). Since 2002, Bering Sea catch reporting has been between the Southern Bering Sea and the remainder of the Bering Sea, which includes all remaining NMFS areas not reported in the other categories. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

| Year | WAI (543) | CAI (542) | EAI (541) | SBS (518+519) | BS | Total |
|---|---|---|---|---|---|---|
| 1994 | 2 | 84 | 91 | | 46 | 223 |
| 1995 | 7 | 44 | 113 | | 49 | 213 |
| 1996 | 33 | 48 | 63 | | 87 | 230 |
| 1997 | 47 | 14 | 29 | | 36 | 126 |
| 1998 | 27 | 100 | 32 | | 52 | 211 |
| 1999 | 23 | 63 | 43 | | 66 | 195 |
| 2000 | 20 | 85 | 95 | | 130 | 330 |
| 2001 | 58 | 87 | 27 | | 57 | 229 |
| 2002 | 78 | 62 | 66 | | 93 | 299 |
| 2003 | 27 | 60 | 31 | 54 | 51 | 223 |
| 2004 | 32 | 76 | 15 | 5 | 114 | 242 |
| 2005 | 27 | 17 | 18 | 5 | 102 | 169 |
| 2006 | 39 | 106 | 23 | 2 | 45 | 215 |
| 2007 | 23 | 145 | 44 | 6 | 108 | 324 |
| 2008 | 40 | 35 | 17 | 12 | 30 | 133 |
| 2009 | 34 | 41 | 41 | 15 | 53 | 184 |
| 2010 | 48 | 39 | 53 | 6 | 154 | 300 |
| 2011 | 161 | 43 | 30 | 23 | 90 | 346 |
| 2012 | 168 | 33 | 28 | 40 | 83 | 353 |
| 2013 | 164 | 75 | 52 | 17 | 122 | 429 |
| 2014 | 25 | 37 | 56 | 12 | 120 | 250 |
| 2015 | 15 | 46 | 37 | 14 | 99 | 211 |
| 2016 | 15 | 28 | 24 | 17 | 43 | 127 |
| 2017 | 13 | 35 | 31 | 8 | 102 | 188 |
| 2018 | 27 | 32 | 28 | 7 | 165 | 258 |
| 2019 | 22 | 55 | 12 | 11 | 298 | 399 |
| 2020 | 52 | 28 | 30 | 3 | 185 | 299 |
| 2021 | 50 | 37 | 41 | 25 | 344 | 496 |
| 2022 | 32 | 32 | 23 | 30 | 167 | 284 |
| 2023 | 35 | 41 | 17 | 17 | 133 | 243 |
| 2024* | 31 | 21 | 11 | 2 | 67 | 132 |

Table 15.4 Estimated catch retained (t), discarded (t), and percent discarded of other red rockfish (ORR) and shortraker/rougheye (SR/RE) from the eastern Bering Sea (EBS) and Aleutian Islands (AI) regions, 1993-present (through October 15, 2024*). Prior to 2001, ORR in the EBS was managed as a single complex. Between 2001-2003, it was managed as a SR/RE complex. Source: AKFIN NMFS AKRO BLEND/Catch Accounting System.

| Area | Species Group | Year | Catch Retained | Discard | Total | Percentage |
|---|---|---|---|---|---|---|
| BSAI | Shortraker | 2004 | 143 | 99 | 242 | 41.0% |
| | | 2005 | 129 | 40 | 169 | 23.9% |
| | | 2006 | 130 | 85 | 215 | 39.5% |
| | | 2007 | 163 | 162 | 324 | 49.9% |
| | | 2008 | 102 | 31 | 133 | 23.3% |
| | | 2009 | 136 | 48 | 184 | 26.2% |
| | | 2010 | 228 | 72 | 300 | 24.0% |
| | | 2011 | 303 | 43 | 346 | 12.4% |
| | | 2012 | 295 | 58 | 353 | 16.4% |
| | | 2013 | 267 | 162 | 429 | 37.8% |
| | | 2014 | 116 | 134 | 250 | 53.5% |
| | | 2015 | 117 | 94 | 211 | 44.6% |
| | | 2016 | 78 | 50 | 127 | 39.1% |
| | | 2017 | 103 | 85 | 188 | 45.3% |
| | | 2018 | 182 | 76 | 258 | 29.6% |
| | | 2019 | 289 | 110 | 399 | 27.6% |
| | | 2020 | 252 | 47 | 299 | 15.6% |
| | | 2021 | 342 | 154 | 496 | 31.1% |
| | | 2022 | 236 | 48 | 284 | 17.0% |
| | | 2023 | 204 | 39 | 243 | 15.9% |
| | | 2024* | 101 | 31 | 132 | 23.7% |

Table 15.5 Estimated biomass (t) of shortraker rockfish from the NMFS bottom trawl survey estimates, with the coefficient of variation (CV) in parentheses. Regions presented are the western Aleutian Islands (WAI), central Aleutian Islands (CAI), eastern Aleutian Islands (EAI), the southern Bering Sea (SBS), and the eastern Bering Sea (EBS) slope. The SBS is surveyed as part of the Aleutian Islands survey.

| Year | WAI | CAI | EAI | SBS | AI survey (total) | EBS Slope survey |
|---|---|---|---|---|---|---|
| 1979 | | | | | | 1,391 |
| 1980 | 0 | 2,665 | 4,165 | 45 (1.00) | 6,829 (0.55) | |
| 1981 | | | | | | 3,571 |
| 1982 | | | | | | 5,176 |
| 1983 | 7,249 | 7,239 | 11,787 | 9,477 (0.43) | 26,276 (0.20) | |
| 1985 | | | | | | 4,010 |
| 1986 | 1,821 | 4,291 | 5,554 | 6,485 (0.64) | 11,667 (0.25) | |
| 1988 | | | | | | 1,260 (0.43) |
| 1991 | 17,558 | 3,225 | 1,053 | 1,925 (0.66) | 21,836 (0.69) | 2,758 (0.38) |
| 1994 | 6,493 | 8,164 | 11,627 | 1,959 (0.78) | 26,285 (0.22) | |
| 1997 | 6,658 | 21,560 | 7,840 | 2,428 (0.97) | 36,058 (0.27) | |
| 2000 | 17,746 | 13,543 | 5,863 | 645 (0.73) | 37,152 (0.45) | |
| 2002 | 3,906 | 8,639 | 2,797 | 1,463 (0.65) | 15,342 (0.20) | 4,877 (0.43) |
| 2004 | 16,333 | 8,779 | 7,499 | 630 (0.60) | 32,612 (0.37) | 2,621 (0.22) |
| 2006 | 2,471 | 5,335 | 3,975 | 1,180 (0.52) | 11,781 (0.25) | |
| 2008 | | | | | | 7,308 (0.32) |
| 2010 | 6,729 | 7,424 | 4,071 | 15 (1.00) | 18,224 (0.23) | 4,370 (0.28) |
| 2012 | 4,455 | 7,182 | 4,031 | 562 (0.71) | 15,668 (0.26) | 9,303 (0.57) |
| 2014 | 1,579 | 12,678 | 2,144 | 28 (0.71) | 16,401 (0.38) | |
| 2016 | 5,846 | 3,149 | 6,030 | 74 (1.00) | 15,025 (0.32) | 6,267 (0.29) |
| 2018 | 11,970 | 2,933 | 11,417 | 13 (1.00) | 26,320 (0.56) | |
| 2022 | 750 | 12,587 | 6,168 | 127 (0.60) | 19,505 (0.36) | |
| 2024 | 395 | 9,522 | 1,961 | 0 (NA) | 11,878 (0.42) | |

Table 15.6 Shortraker rockfish relative population numbers (RPN) and relative population weight (RPW) estimates, with the coefficient of variation (CV) in parentheses from the AFSC longline survey by region for 1997-most recent survey.

| | Aleutian Islands | | Bering Sea | |
|---|---|---|---|---|
| | RPN | RPW | RPN | RPW |
| 1997 | | | 6,278 (0.31) | 12,478 (0.34) |
| 1998 | 19,897 (0.15) | 22,278 (0.15) | | |
| 1999 | | | 13,472 (0.46) | 29,202 (0.41) |
| 2000 | 28,842 (0.16) | 24,993 (0.16) | | |
| 2001 | | | 9,913 (0.35) | 21,571 (0.36) |
| 2002 | 18,424 (0.15) | 16,780 (0.15) | | |
| 2003 | | | 28,722 (0.45) | 74,645 (0.47) |
| 2004 | 24,385 (0.14) | 21,142 (0.15) | | |
| 2005 | | | 9,108 (0.39) | 14,453 (0.39) |
| 2006 | 35,669 (0.15) | 35,267 (0.14) | | |
| 2007 | | | 10,735 (0.41) | 20,088 (0.40) |
| 2008 | 18,474 (0.19) | 16,247 (0.19) | | |
| 2009 | | | 4,129 (0.29) | 7,513 (0.28) |
| 2010 | 29,957 (0.14) | 22,832 (0.13) | | |
| 2011 | | | 12,559 (0.53) | 27,065 (0.58) |
| 2012 | 24,073 (0.10) | 21,779 (0.10) | | |
| 2013 | | | 7,747 (0.24) | 12,588 (0.24) |
| 2014 | 29,208 (0.18) | 27,503 (0.19) | | |
| 2015 | | | 10,730 (0.17) | 19,316 (0.19) |
| 2016 | 17,732 (0.16) | 14,629 (0.16) | | |
| 2017 | | | 13,502 (0.47) | 23,006 (0.48) |
| 2018 | 19,543 (0.16) | 17,746 (0.16) | | |
| 2019 | | | 17,125 (0.47) | 34,046 (0.47) |
| 2020 | 19,380 (0.25) | 17,905 (0.25) | | |
| 2021 | | | 10,728 (0.34) | 18,660 (0.34) |
| 2022 | 9,844 (0.15) | 9,894 (0.14) | | |
| 2023 | | | 9,368 (0.41) | 16,549 (0.46) |

Table 15.7 Parameter estimates with standard errors (SE) and lower/upper 95% confidence intervals (LCI/UCI) for the random effects (*re*) models fit for shortraker rockfish. Estimates are shown on the natural (i.e., arithmetic scale) for ease of interpretation but are estimated in log-space. Process error is pooled across all survey regions for both species groups. Results are shown for Model 22_2022, the base model, and Model 22_2024, the updated author-recommended model. Both models fit to the EBS slope longline survey relative population weights for shortraker and thus have a scaling parameter (*q*).

| Model | Parameter | Estimate | SE | LCI | UCI |
|---|---|---|---|---|---|
| Model 22_2022 | Aleutian Islands process error | 0.09 | 0.06 | 0.03 | 0.32 |
| Model 22_2022 | Bering Sea Slope process error | 0.07 | 0.16 | 0.00 | 4.76 |
| Model 22_2022 | Southern Bering Sea process error | 0.73 | 0.31 | 0.32 | 1.67 |
| Model 22_2022 | Scaling parameter q | 3.79 | 0.70 | 2.64 | 5.44 |
| Model 22_2024 | Aleutian Islands process error | 0.09 | 0.05 | 0.03 | 0.29 |
| Model 22_2024 | Bering Sea Slope process error | 0.03 | 0.12 | 0.00 | 136.25 |
| Model 22_2024 | Southern Bering Sea process error | 0.73 | 0.31 | 0.32 | 1.67 |
| Model 22_2024 | Scaling parameter q | 3.87 | 0.68 | 2.75 | 5.45 |

Table 15.8 Estimated biomass and 95% confidence intervals (CI) for shortraker rockfish from the Model 22_2022 (base) and Model 22_2024 (author recommended model).

| Year | Model 22_2022 | | | Model 22_2024 | | |
|---|---|---|---|---|---|---|
| | Biomass (t) | Lower CI | Upper CI | Biomass (t) | Lower CI | Upper CI |
| 1991 | 31,783 | 22,067 | 45,776 | 31,631 | 22,217 | 45,036 |
| 1992 | 31,867 | 22,479 | 45,175 | 31,705 | 22,584 | 44,510 |
| 1993 | 31,952 | 23,062 | 44,268 | 31,779 | 23,117 | 43,686 |
| 1994 | 32,037 | 23,865 | 43,007 | 31,853 | 23,862 | 42,519 |
| 1995 | 31,968 | 23,376 | 43,719 | 31,755 | 23,387 | 43,118 |
| 1996 | 31,900 | 23,123 | 44,009 | 31,659 | 23,144 | 43,307 |
| 1997 | 31,833 | 23,070 | 43,923 | 31,563 | 23,099 | 43,129 |
| 1998 | 30,413 | 22,326 | 41,428 | 30,134 | 22,377 | 40,579 |
| 1999 | 29,128 | 21,770 | 38,973 | 28,834 | 21,873 | 38,009 |
| 2000 | 27,875 | 21,384 | 36,337 | 27,631 | 21,517 | 35,483 |
| 2001 | 26,533 | 20,895 | 33,692 | 26,378 | 21,084 | 33,002 |
| 2002 | 25,264 | 20,251 | 31,518 | 25,224 | 20,488 | 31,054 |
| 2003 | 24,681 | 19,648 | 31,003 | 24,671 | 19,836 | 30,685 |
| 2004 | 23,970 | 19,108 | 30,070 | 24,142 | 19,409 | 30,028 |
| 2005 | 23,112 | 18,095 | 29,521 | 23,306 | 18,449 | 29,441 |
| 2006 | 22,324 | 17,196 | 28,981 | 22,522 | 17,594 | 28,830 |
| 2007 | 21,986 | 16,903 | 28,596 | 22,115 | 17,229 | 28,386 |
| 2008 | 21,806 | 16,857 | 28,207 | 21,893 | 17,137 | 27,970 |
| 2009 | 21,599 | 16,745 | 27,860 | 21,753 | 17,184 | 27,537 |
| 2010 | 21,676 | 17,258 | 27,225 | 21,705 | 17,484 | 26,945 |
| 2011 | 21,714 | 17,210 | 27,398 | 21,618 | 17,312 | 26,995 |
| 2012 | 21,756 | 17,292 | 27,373 | 21,565 | 17,303 | 26,877 |
| 2013 | 21,710 | 17,046 | 27,650 | 21,440 | 17,001 | 27,039 |
| 2014 | 21,864 | 17,081 | 27,986 | 21,394 | 16,840 | 27,180 |
| 2015 | 22,120 | 16,991 | 28,798 | 21,422 | 16,617 | 27,616 |
| 2016 | 22,358 | 16,902 | 29,574 | 21,442 | 16,486 | 27,888 |
| 2017 | 22,727 | 16,769 | 30,802 | 21,582 | 16,318 | 28,545 |
| 2018 | 23,084 | 16,695 | 31,918 | 21,722 | 16,226 | 29,080 |
| 2019 | 23,243 | 16,430 | 32,882 | 21,668 | 15,950 | 29,435 |
| 2020 | 23,332 | 16,348 | 33,300 | 21,606 | 15,788 | 29,569 |
| 2021 | 23,427 | 16,307 | 33,657 | 21,551 | 15,683 | 29,613 |
| 2022 | 23,547 | 16,247 | 34,127 | 21,503 | 15,635 | 29,573 |
| 2023 | | | | 21,258 | 15,198 | 29,735 |
| 2024 | | | | 21,018 | 14,781 | 29,888 |

Table 15.9 Sensitivity analysis comparing total biomass in the terminal year and reference points between the recommended Model 22_2024 to a model with a single pooled process error (MpoolPE_2024).

| Model | Year | Biomass | *M* | OFL | maxABC |
|---|---|---|---|---|---|
| M22_2024 | 2024 | 21,018 | 0.03 | 631 | 473 |
| MpoolPE_2024 | 2024 | 19,494 | 0.03 | 585 | 439 |

# Figures

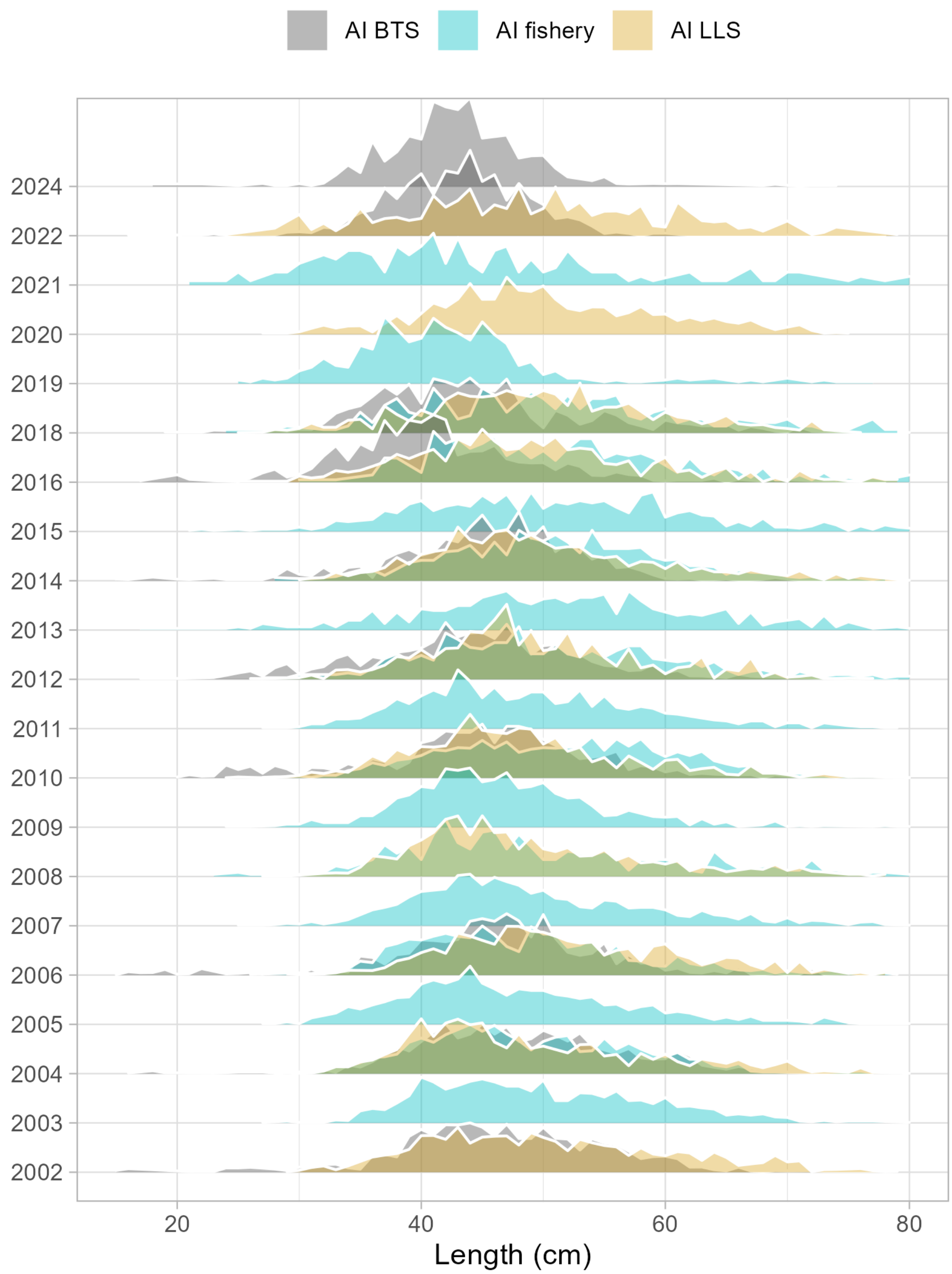


Figure 15.1a Length frequency data from the Aleutian Islands (AI) bottom trawl survey (BTS; grey), fishery (teal), and the Aleutian Islands longline survey (AI LLS; goldenrod) from 2002-present. Fishery data source: NMFS AFSC FMA Observer Debriefed Haul and Length tables. BTS data source: NMFS AFSC RACE AI Biomass and Length tables. LLS data source: NMFS AFSC ABL AI Area RPN tables.

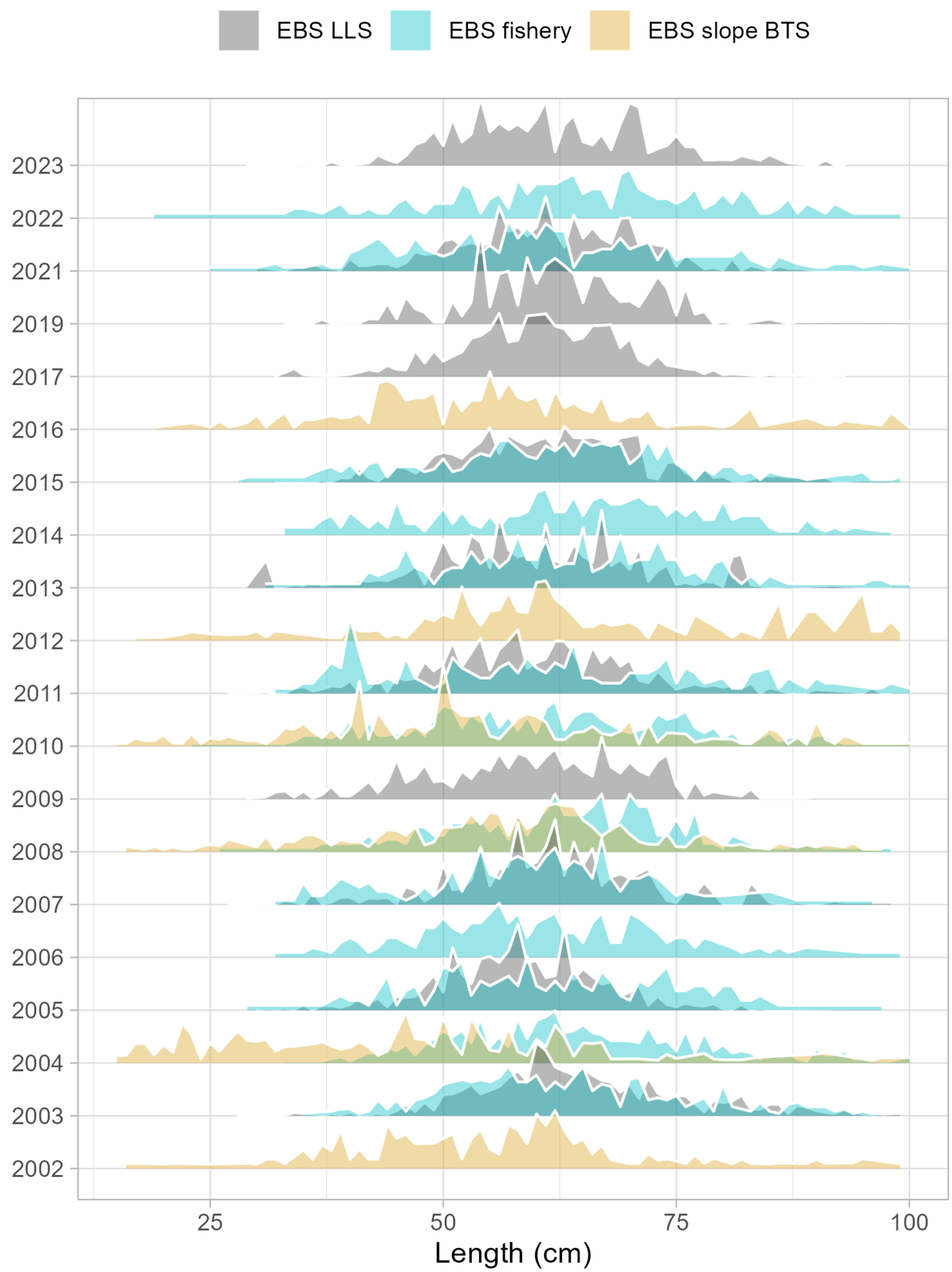


Figure 15.1b Length frequency data from the eastern Bering Sea longline survey (EBS LLS; grey), fishery (teal), and eastern Bering Sea slope bottom trawl survey (EBS slope BTS; goldenrod) from 2002-present. Fishery data source: NMFS AFSC FMA Observer Debriefed Haul and Length tables. BTS data source: NMFS AFSC RACE EBS slope Biomass and Length tables. LLS data source: NMFS AFSC ABL EBS slope Area RPN tables.

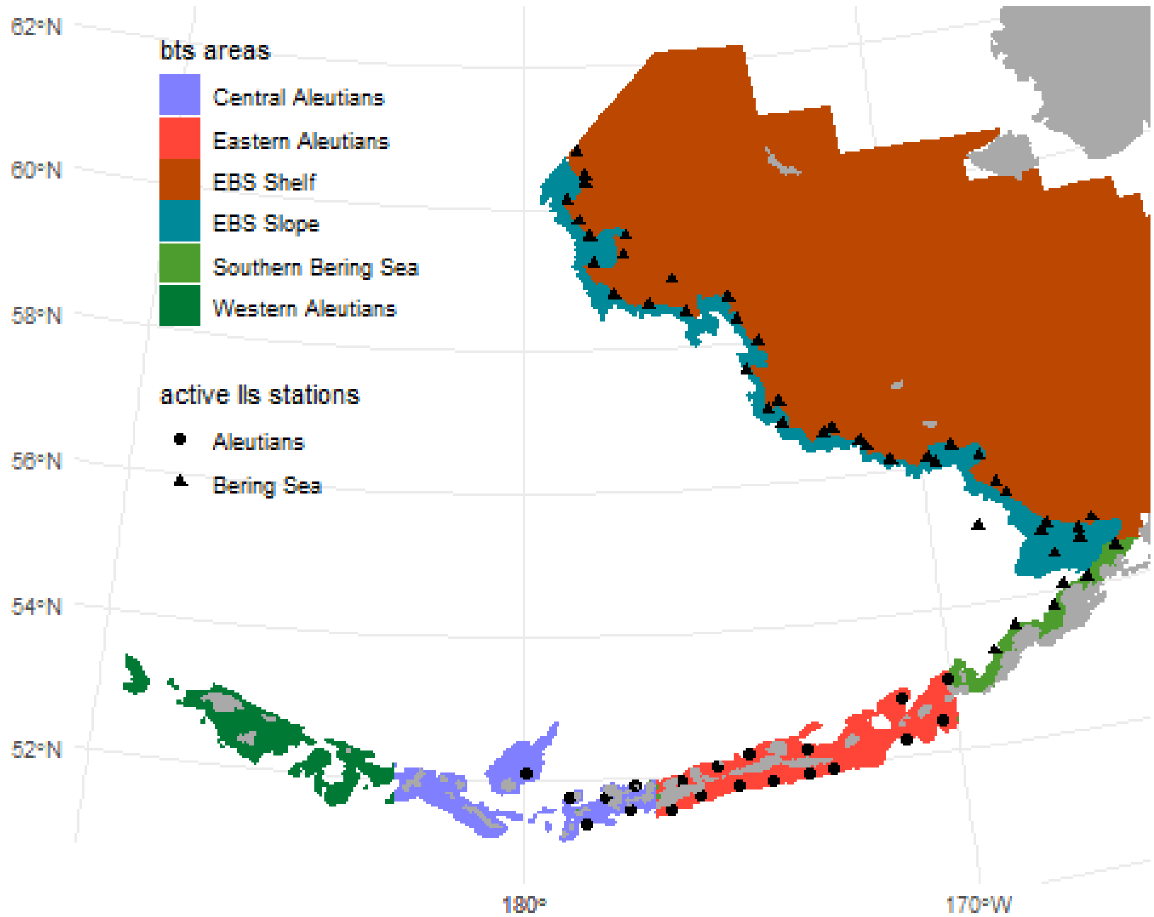


Figure 15.2 Bottom trawl surveys (BTS) strata and active longline survey (LLS) stations in the Aleutian Islands and eastern Bering Sea.

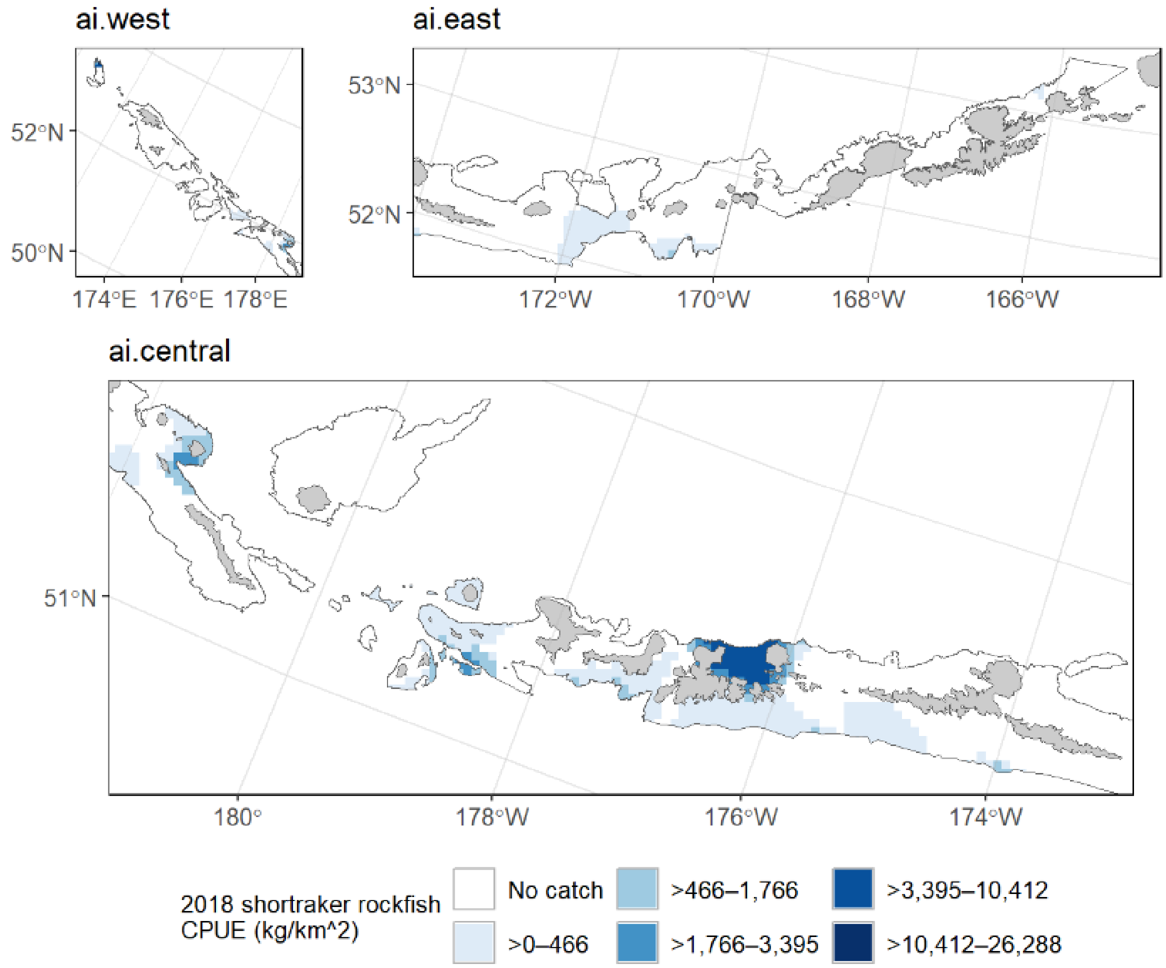


Figure 15.3 Spatial distribution map of catch-per-unit-effort (CPUE) for shortraker rockfish from the Aleutian Islands bottom trawl survey for the three most recent surveys.

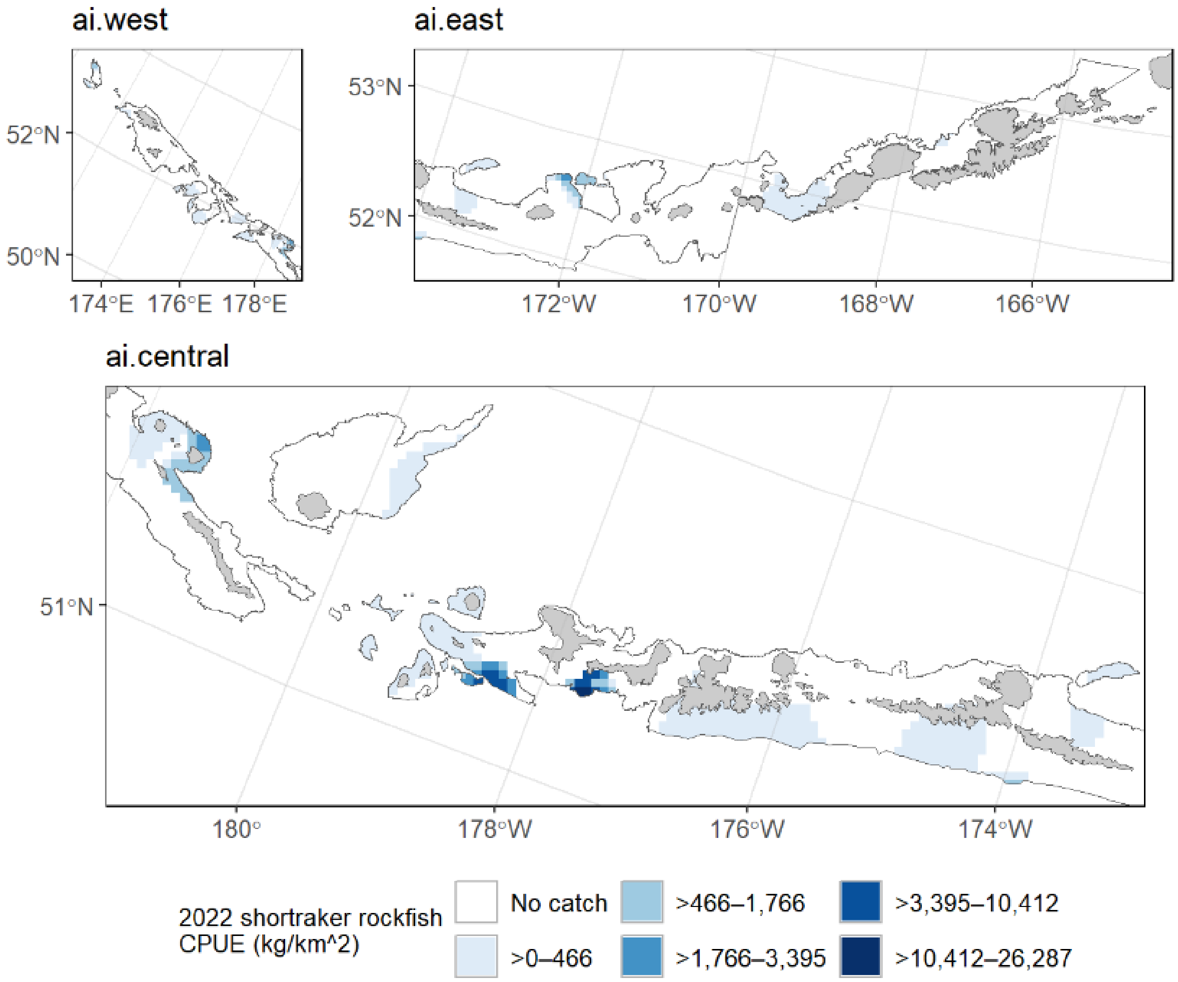


Figure 15.3 (cont.) Spatial distribution map of catch-per-unit-effort (CPUE) for shortraker rockfish from the Aleutian Islands bottom trawl survey for the three most recent surveys.

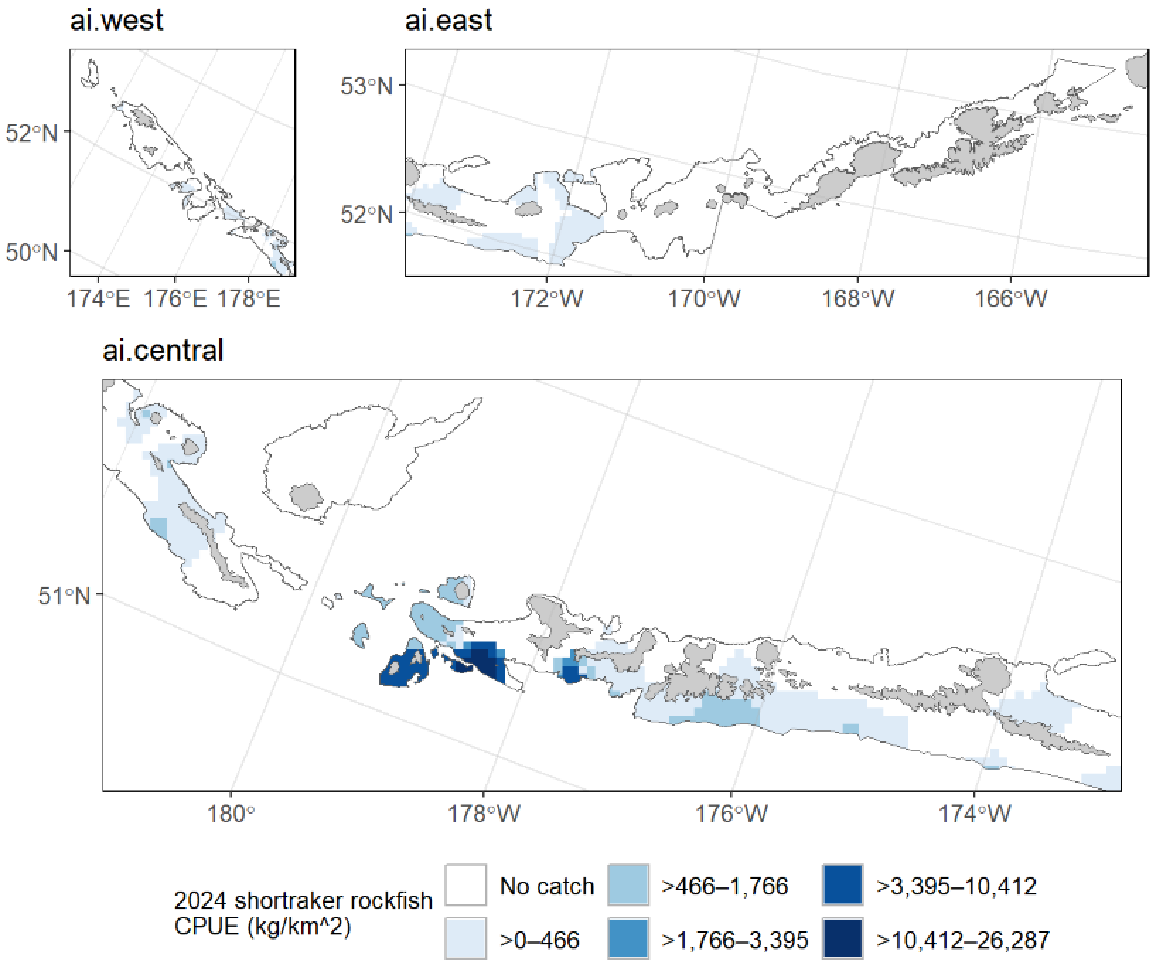


Figure 15.3 (cont.) Spatial distribution map of catch-per-unit-effort (CPUE) for shortraker rockfish from the Aleutian Islands bottom trawl survey for the three most recent surveys.

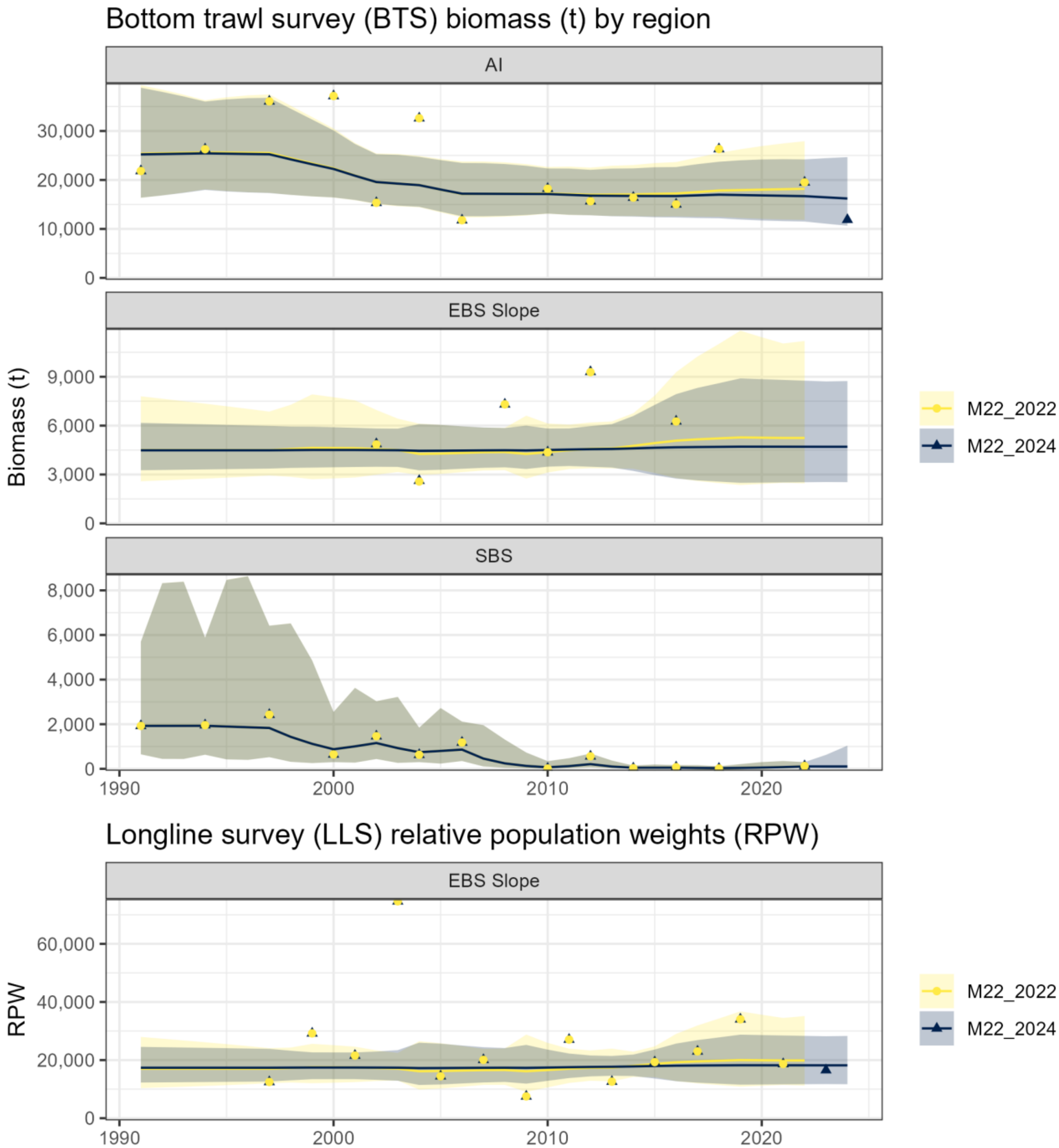


Figure 15.4 Observed biomass estimates and model fits to the Aleutian Islands (AI), eastern Bering Sea (EBS) slope, southeastern Bering Sea (SBS) bottom trawl surveys (BTS) by region (top three plots), fits to the EBS slope longline survey relative population weights (RPWs; bottom) for shortraker rockfish. Lines are the model predictions and shaded areas are the 95% confidence intervals from the random effects multi-area model with an additional survey (REMA) model. Results are shown for Model 22_2022 (yellow), the base model, and the Model 22_2024 (blue), the updated author-recommended model.

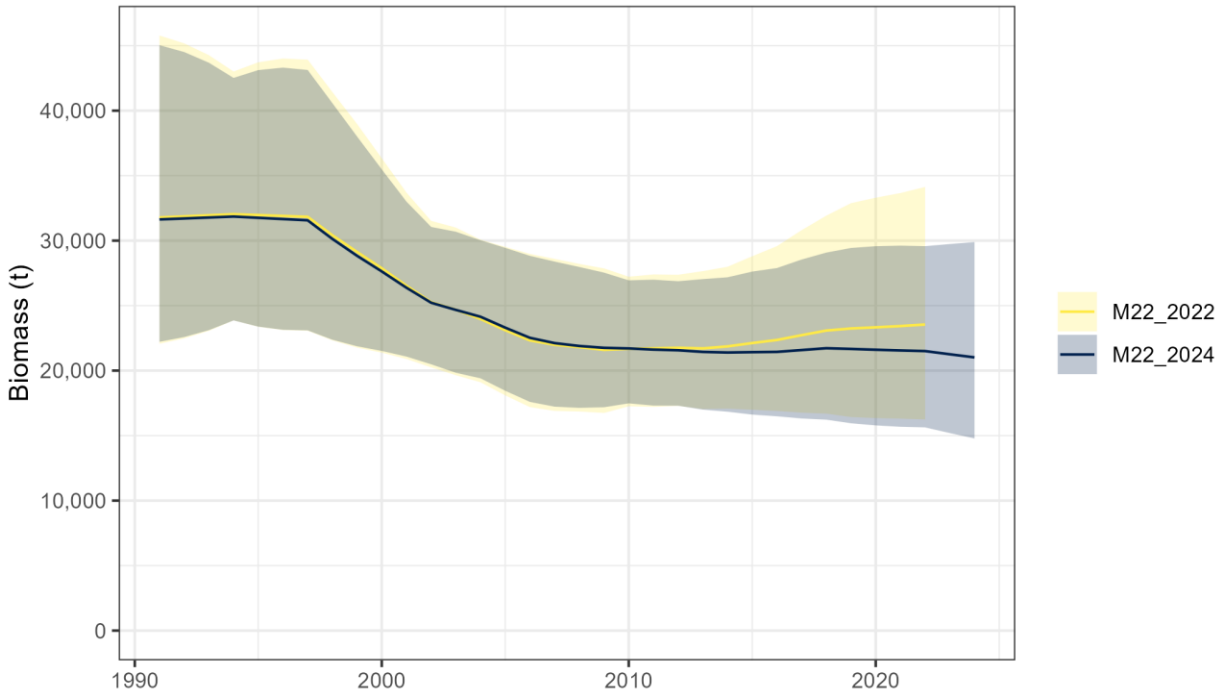


Figure 15.5 Total predicted biomass estimates for shortraker rockfish. Lines are the model predictions and shaded areas are the 95% confidence intervals from the random effects multi-area model with an additional survey (REMA) model. Results are shown for Model 22_2022 (yellow), the base model, and the Model 22_2024 (blue), the updated author-recommended model.

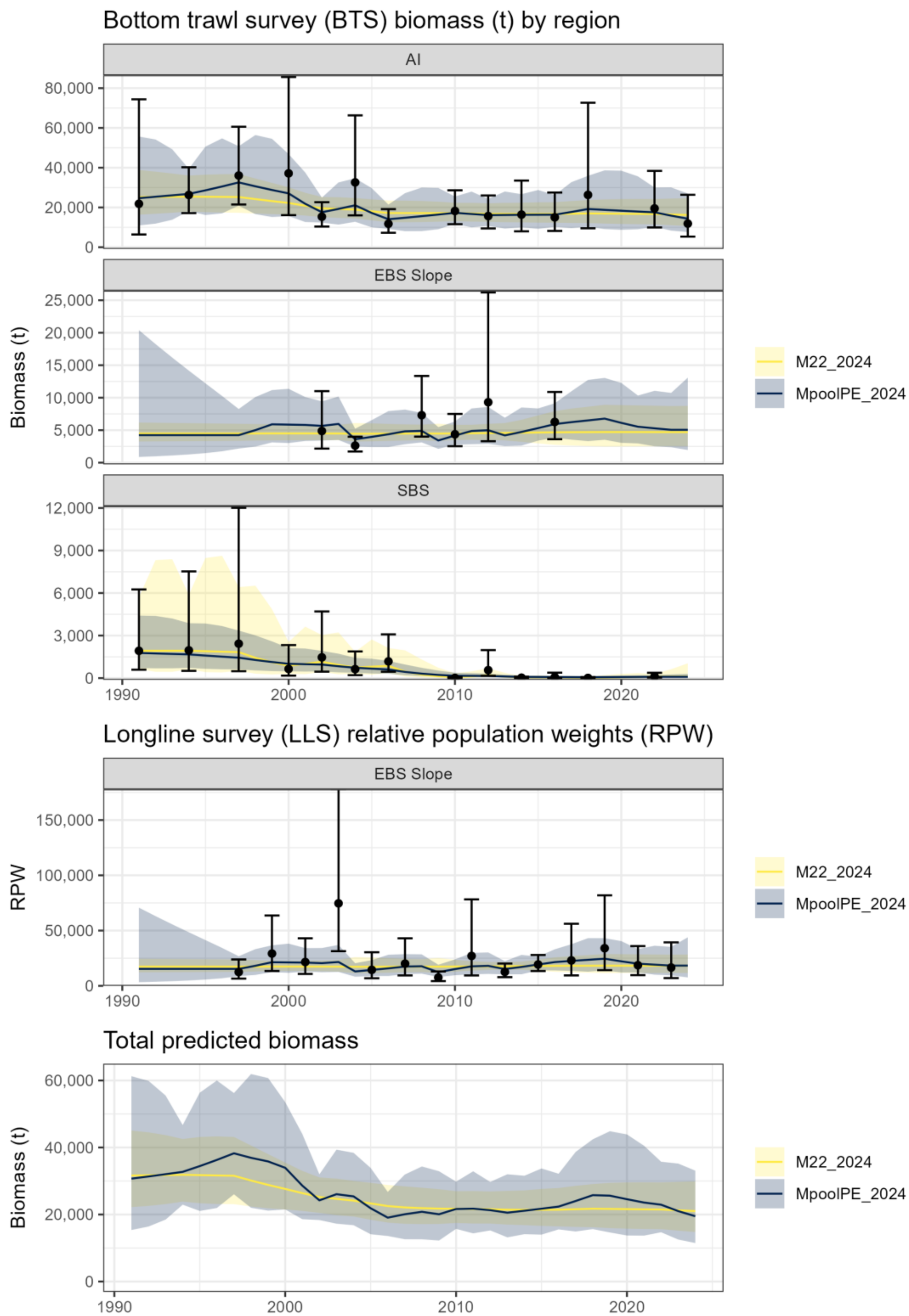


Figure 15.6 Sensitivity analysis comparing fits to the data and total predicted biomass between the recommended Model 22_2024 and a model with a single pooled process error (MpoolPE_2024).

## Appendix 1. Supplemental Catch Data

Here we present non-commercial removals, estimates of total removals that do not occur during directed groundfish fishing activities, in order to comply with the Annual Catch Limit (ACL) requirements (Tables A1.1 and A1.2). Data are not available for 2024; therefore, data is presented through 2023. This includes removals incurred during research, subsistence, personal use, recreational, and exempted fishing permit activities, but does not include removals taken in fisheries other than those managed under the groundfish FMP. These estimates represent additional sources of removals to the existing Catch Accounting System estimates. For Bering Sea/Aleutian Islands (BSAI) shortraker rockfish, these estimates can be compared to the trawl research removals reported in previous assessments. Shortraker rockfish research removals are small relative to the fishery catch. The majority of removals are taken by the Alaska Fisheries Science Center's (AFSC) biennial bottom trawl survey which is the primary research survey used for assessing the population status of BSAI shortraker rockfish. Other research activities that harvest shortraker rockfish include other trawl research activities and minor catches occur in longline surveys conducted by the International Pacific Halibut Commission and the AFSC. Some catches in the AFSC longline survey are reported as shortraker/rougheye and we only report shortraker catches here. Total removals of shortraker rockfish were around than 2 t and 1 t in 2022 and 2023, respectively, which represent less than 1% of the ABC in these years. Research harvests in even years beginning in 2000 (excluding 2008, when the Aleutian Islands (AI) trawl survey was canceled) are higher due to the biennial cycle of the AFSC bottom trawl survey in the AI. These catches have varied between 1 and 15 t (in 1983). Additionally, in 2020, several research surveys were cancelled due to the COVID-19 pandemic. Total removals for 2023 were approximately 1 t, which is about half of the removals in 2022.

Table 15.A.1 Removals (t) of BSAI shortraker rockfish from activities other than groundfish fishing, 1977-2004. Trawl and longline include research survey and occasional short-term projects. “Other” is recreational, personal use, and subsistence harvest.

| | | Shortraker | | | Shortraker/Rougheye | |
|---|---|---|---|---|---|---|
| Year | Source | Trawl | Longline | Other | Trawl | Longline |
| 1977 | NMFS-AFSC survey databases | | | | | |
| 1978 | | | | | | |
| 1979 | | 0.933 | | | | |
| 1980 | | 5.707 | | | | |
| 1981 | | 4.972 | | | | |
| 1982 | | 7.646 | | | | |
| 1983 | | 15.496 | | | | |
| 1984 | | | | | | |
| 1985 | | 9.246 | | | | |
| 1986 | | 9.151 | | | | |
| 1987 | | | | | | |
| 1988 | | 0.336 | | | | |
| 1989 | | | | | | |
| 1990 | | | | | | |
| 1991 | | 3.437 | | | | |
| 1992 | | | | | | |
| 1993 | | 0.008 | | | | |
| 1994 | | 4.604 | | | | |
| 1995 | | | | | | |
| 1996 | | | | | | |
| 1997 | | 5.824 | | | | |
| 1998 | | | 0.830 | | | 2.174 |
| 1999 | | 0.017 | 1.198 | | | 0.494 |
| 2000 | | 6.348 | 0.973 | | | 2.066 |
| 2001 | | 0.010 | 1.258 | | | 0.422 |
| 2002 | | 3.875 | 0.785 | | | 1.649 |
| 2003 | | | 2.138 | | | 0.376 |
| 2004 | | 5.367 | 0.691 | | | 1.680 |

Table 15.A.2 Removals (kg) of BSAI shortraker rockfish from activities other than groundfish fishing, 2005-2023. Data from 2024 are not yet available for shortraker rockfish.

| Year | Aleutian Islands Survey | AFSC Longline Survey | Bering Sea slope survey | IPHC Longline survey | Total |
|---|---|---|---|---|---|
| 2005 | 0 | 1,300 | 0 | 0 | 1,300 |
| 2006 | 0 | 1,154 | 0 | 0 | 1,154 |
| 2007 | 0 | 1,323 | 0 | 0 | 1,323 |
| 2008 | 0 | 647 | 0 | 0 | 647 |
| 2009 | 0 | 1,708 | 0 | 0 | 1,708 |
| 2010 | 1,397 | 974 | 1,367 | 1,595 | 5,333 |
| 2011 | 0 | 1,424 | 0 | 1,120 | 2,544 |
| 2012 | 2,009 | 690 | 1,176 | 561 | 4,436 |
| 2013 | 0 | 1,239 | 0 | 509 | 1,748 |
| 2014 | 1,571 | 904 | 0 | 851 | 3,326 |
| 2015 | 0 | 1,496 | 0 | 1,062 | 2,558 |
| 2016 | 1,564 | 700 | 967 | 541 | 3,772 |
| 2017 | 0 | 2,260 | 0 | 972 | 3,232 |
| 2018 | 1,318 | 709 | 0 | 303 | 2,331 |
| 2019 | 0 | 1,000 | 0 | 1,007 | 2,007 |
| 2020 | 0 | 880 | 0 | 197 | 1,077 |
| 2021 | 0 | 1,283 | 0 | 348 | 1,631 |
| 2022 | 1,398 | 453 | 0 | 162 | 2,012 |
| 2023 | 0 | 1,063 | 0 | 0 | 1,063 |