11. Assessment of the Shortraker Rockfish Stock in the Gulf of Alaska

Katy B. Echave, Kevin A. Siwicke, Peter-John F. Hulson, Ellen Yasumiishi, and Bridget Ferriss

November 2023

# Executive Summary

Gulf of Alaska (GOA) shortraker rockfish, *Sebastes borealis*, is assessed on a biennial schedule in odd years and is managed as a Tier 5 stock. For this on-cycle year, we incorporate new survey biomass from the 2023 bottom trawl survey, new Relative Population Weights (RPWs) from the 2022 and 2023 longline surveys, and update 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, Monnahan et al. 2021, and Sullivan et al. 2022a). The REMA model was fit to the time series of the Alaska Fisheries Science Center (AFSC) bottom trawl survey estimated shortraker rockfish biomass including uncertainty by region and the AFSC longline survey estimated shortraker rockfish RPW including uncertainty by region. These regional biomass estimates from the REMA model were summed to obtain Gulfwide biomass. Two models are presented, where Model 19\* is an error-corrected version of the 2019 accepted model (Model 19.2a; Echave and Hulson 2019) which estimates a single process error, three scaling coefficients (one for each management area), and fixes the weight of the longline survey at 0.5 relative to the bottom trawl survey at 1.0. Model 23.3 is a new model which has equal weights of 1.0 for each survey and estimates an additional observation error term for the AFSC longline survey (Sullivan et al. 2022a). Apportionment is also updated such that area proportions are calculated as an average of the predicted biomass and predicted RPWs from Model 23.3.

## Summary of Changes in Assessment Inputs

### Changes in the Input Data

1. Total catch was updated with partial 2023 data through 6 October 2023.
2. Length compositions from the 2022 and 2021 longline and trawl fisheries were added.
3. Length compositions from the 2023 GOA bottom trawl survey data were added.
4. Length compositions from the 2022 and 2023 AFSC annual longline surveys were added.
5. RPWs from 1992 to 2023 GOA longline survey were updated for use in the REMA model. Note that slight changes to RPWs in the eastern GOA resulted from updating all area sizes for extrapolating RPWs using Echave et al. (2013).
6. Biomass estimated from the 1984 and 1987 GOA trawl surveys were removed from input to the REMA model, and values from 1990 to 2023 were updated.

### Changes in Assessment Methodology

The methodology used to estimate exploitable biomass to calculate ABC and OFL (Over Fishing Limit) values for the 2024 fishery has changed. Both models presented are fit using TMB in the *rema* R library, while the previous accepted model (M19.2a) was fit using AD Model Builder (ADMB; Fournier et al. 2012). Detailed REMA model methods are available in Sullivan et al. (2022) and Hulson et al. (2021). Both models estimate a single process error and three scaling coefficients (one for each management area). Model 19\* gives the AFSC longline survey a weight of 0.5. Justification for down weighting this survey was included in the 2021 SAFE:

*By region, the estimated uncertainty in the longline survey RPW index is consistently smaller than the uncertainty in the bottom trawl survey biomass…By reducing the weight of the longline survey to 0.5 what the model is inherently doing is equalizing the relative contribution of these two indices to the model estimates…Granted, we recognize that the choice of 0.5 is subjective.*

The *rema* R library introduced in 2022 includes the option for the model to estimate additional observation error for each survey (Sullivan et al. 2022). As such, we wanted to see if the model could estimate additional observation error for the longline survey as an alternative to subjectively assigning it a weight of 0.5, so Model 23.3 uses a weight of 1.0 for the longline survey and estimates additional observation error for the longline survey. Additional models were investigated (Siwicke et al. 2023), but only Model 23.3 is being brought forward here.

The two-survey random effects model presented use the following naming conventions:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **Software** | **Model years** | **LLS weight** | **Scaling parameters (**q**)** | **Additional Obs. Error** |
| M19.2a | ADMB | 1984-2023 | 0.5 | Area-specific q |  |
| M19\* | TMB | 1990-2023 | 0.5 | Area-specific q |  |
| M23.3 | TMB | 1990-2023 | 1.0 | Area-specific q | AFSC Longline Survey |

*Changes in Apportionment Methodology*

We propose an alternative method for apportionment that is based on the mean proportions of predicted biomass and predicted RPW by area (“Biomass + RPW”). This approach is contrasted with the standard method of basing apportionment on the proportion of predicted biomass by area (“Biomass”).

## Summary of Results

For the 2024 fishery, we recommend the maximum allowable ABC of 647 t for shortraker rockfish. This ABC is an 8.3% decrease from the 2023 ABC of 705 t. The OFL is 863 t. Reference values for shortraker rockfish are summarized in the following table, with the recommended ABC and OFL values in bold. The stock was not being subjected to overfishing 2022.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Quantity** | As estimated or  *specified last* year for: | | As estimated or  *recommended this* year for: | |
| 2023 | 2024 | 2024 | 2025 |
| *M* (natural mortality rate) | 0.03 | 0.03 | 0.03 | 0.03 |
| Tier | 5 | 5 | 5 | 5 |
| Biomass (t) | 31,331 | 31,331 | 28,768 | 28,768 |
| *FOFL* | *F*=*M*=0.03 | *F*=*M*=0.03 | *F*=*M*=0.03 | *F*=*M*=0.03 |
| *maxFABC* | 0.75*M*=0.0225 | 0.75*M*=0.0225 | 0.75*M*=0.0225 | 0.75*M*=0.0225 |
| *FABC* | 0.0225 | 0.0225 | 0.0225 | 0.0225 |
| OFL (t) | 940 | 940 | **863** | 863 |
| maxABC (t) | 705 | 705 | 647 | 647 |
| ABC (t) | 705 | 705 | **647** | 647 |
| **Status** | As determined *last* year for: | | As determined *this* year for: | |
| 2021 | 2022 | 2022 | 2023 |
| Overfishing | No | n/a | No | n/a |

Updated catch data (t) for shortraker rockfish in the GOA as of October 3, 2021 (NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database, <http://www.akfin.org>) are summarized in the following table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | Western | Central | Eastern | GOA  Total | GOA  ABC | GOA  TAC |
| 2022 | 6 | 186 | 299 | 492 | 705 | 705 |
| 2023 | 5 | 164 | 248 | 417 | 705 | 705 |

### Area Apportionment

For apportionment of ABC/OFL, the random effects model was fit to area-specific biomass and RPWs, and the mean proportions of predicted biomass and predicted RPW by area were calculated. The following table shows the recommended apportionment, estimated biomass, and ABC value by regulatory area for 2024.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Regulatory area | | |  |
|  | Western | Central | Eastern | Total |
| Area Apportionment | 8.3% | 20.7% | 71.0% | 100% |
| Estimated Area Biomass (t) | 1,508 | 8,426 | 18,834 | 28,768 |
| Area ABC (t) | 54 | 134 | 459 | 647 |
| OFL (t) |  |  |  | 863 |

## Summaries for Plan Team

All values are in tons.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Species** | **Year** | **Biomass** | **OFL** | **ABC** | **TAC** | **Catch1** |
| Shortraker rockfish | 2022 | 28,768 | 863 | 647 | 647 | 492 |
| 2023 | 28,768 | 863 | 647 | 647 | 417 |
| 2024 | 28,768 | 863 | 647 | 647 |  |
| 2025 | 28,768 | 863 | 647 | 647 |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Stock/** |  | **2023** | | | | **2024** | | **2025** | |
| **Assemblage** | **Area** | **OFL** | **ABC** | **TAC** | **Catch1** | **OFL** | **ABC** | **OFL** | **ABC** |
| Shortraker rockfish | W |  | 54 | 54 | 5 |  | 54 |  | 54 |
| C |  | 134 | 134 | 164 |  | 134 |  | 134 |
| E |  | 459 | 459 | 248 |  | 459 |  | 459 |
| Total | 863 | 647 | 647 | 417 | 863 | 647 | 863 | 647 |

1Current as of October 3, 2021. Source: NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database (<http://www.akfin.org>).

## Responses to SSC and Plan Team Comments on Assessments in General

*The SSC agreed with the JGPT recommendation that Risk Tables should not be mandatory for Tiers 4-6; however, stock assessments must include compelling rationale for why a Risk Table would not be informative.* (SSC, October 2021)

1. **We continue to include the risk table in the current assessment.**

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

*SSC requests the authors provide a time series of the longline survey length compositions for comparison with the trawl survey time series currently in the assessment.* (SSC, December 2019)

**We present a time series of both the longline survey and trawl survey length compositions for comparison.**

*In addition, the SSC requests the authors provide the regional catchability coefficients used in the assessment.* (SSC, December 2019)

**We provide a table of the regional catchability coefficients used in the random effects model (19.2a) to estimate exploitable biomass in the Parameter Estimates section. We will also note that to avoid confusion we will stop using the term ‘catchability coefficient’ but rather use the term ‘scaling coefficient’. This is because the estimated coefficient simply scales biomass to RPW and isn’t the same as what we normally refer to as ‘catchability’ in the survey sampling or Tier 3 assessment sense.**

*The SSC requests further clarification on the justification of the weightings used in the assessment. To the extent feasible, the authors should concisely describe differences in the type of information that each survey index provides about regional components of the shortraker population, and whether this is informative to the weighting of indices.* (SSC, December 2019)

**By region, the estimated uncertainty in the longline survey RPW index is consistently smaller than the uncertainty in the bottom trawl survey biomass. The ratio of coefficient of variation (CV) of the longline survey RPW compared to the bottom trawl survey biomass is 0.8 in the western and central GOA, and 0.5 in the eastern GOA, indicating that we estimate the RPW index to be more precise on average than the bottom trawl survey. However, as we note when describing these data sources they both suffer from sampling error that makes it difficult to consider one source to be more accurate or reliable than the other when determining the population size of shortraker rockfish. By reducing the weight of the longline survey to 0.5 what the model is inherently doing is equalizing the relative contribution of these two indices to the model estimates. By means of comparison, the relative CVs between biomass and RPWs is much more similar for shortspine thornyheads, the other Tier 5 assessment that uses these two indices. Granted, we recognize that the choice of 0.5 is subjective, but with this relative weighting we noted in the 2019 assessment that the model is slightly more responsive to the bottom trawl survey biomass index, although, these differences in estimates between a weight of 1 or 0.5 for the longline survey was small. We will also note that in the October 2021 SSC minutes it was recommended that a working group be formed to develop standard practices for data weighting. We will closely monitor the progress of this working group and implement any pertinent recommendations into this assessment.**

*Additionally, the SSC looks forward to continued exploration of alternative apportionment methods and believes this should remain a high priority.* (SSC, December 2019)

1. **We agree with this comment and will continue exploration of alternative apportionment methods.**

*The SSC notes the large increase in the 2019 exploitation rate for the hook and line fleet in the Western GOA, which is over triple than what occurred in 2018. The SSC highlights that new regulations will require full retention of rockfish for hook and line fisheries in the GOA, and important impacts from this regulatory change should be considered in the next full assessment.* (SSC, December 2019)

**We continue to monitor exploitation and discard rates. While exploitation rates have decreased significantly in the western GOA, discard rates continue to remain high, particularly in the sablefish fleet. The reasons behind these increases, particularly following new regulations requiring full retention of rockfish by HAL catcher vessels, is unknown and will continue to be explored.**

# Introduction

### General Distribution

Shortraker rockfish, *Sebastes borealis*, range from Hokkaido Island, Japan, north into the Sea of Okhotsk and the Bering Sea, and through the Aleutian Islands and Gulf of Alaska south to southern California. The center of abundance for this species appears to be in Alaskan waters. In the GOA, adults of this species inhabit a narrow band along the upper continental slope at depths of 300-500 m; outside of this depth interval, abundance decreases considerably (Ito 1999). Much of this habitat is steep and difficult to trawl in the GOA, and observations from a manned submersible also indicated that shortraker rockfish seemed to prefer steep slopes with frequent boulders (Krieger and Ito 1999). Adult shortraker rockfish may also be associated with *Primnoa* spp. corals that are used for shelter (Krieger and Wing 2002). Research focusing on non-trawlable habitats found rockfish species often associate with biogenic structure (Du Preez and Tunnicliffe 2011, Laman *et al*. 2015), and that shortraker rockfish are often found in both trawlable and untrawlable habitats (Rooper and Martin 2012, Rooper *et al*. 2012). Several of these studies are notable as results indicate adult shortraker biomass may be underestimated by traditional bottom trawl surveys because of issues with extrapolating survey catch estimates to untrawlable habitat (Jones *et al*. 2012, Rooper *et al*. 2012).

### Life History Information

Life history information on shortraker rockfish is extremely sparse. The fish are presumed to be viviparous, as are other *Sebastes* spp. (Mecklenburg *et al.* 2002), with internal fertilization and development of embryos, and with the embryos receiving at least some maternal nourishment. There have been no fecundity studies on shortraker rockfish. One study on reproductive biology of the fish in the northeastern Pacific (most samples were from the GOA) indicated they had a protracted reproductive period, and that parturition (larval release) may take place from February through August (McDermott 1994). Another study indicated the peak month of parturition in Southeast Alaska was April (Westrheim 1975). Most recently, the reproductive development stage of shortraker rockfish was examined from samples collected opportunistically in the GOA throughout the year in 2008-2014 (Conrath 2017). Similar to McDermott’s (1994) findings, shortraker rockfish were found to be seasonal synchronous spawners, with the onset of development occurring in the late summer months and parturition taking place from March through May. There is no information on when males inseminate females or if migrations occur for spawning/breeding. Genetic techniques have been used to identify a small number of post-larval shortraker rockfish from samples collected in epipelagic waters far offshore in the GOA, which is the only documentation of habitat for this life stage (Kondzela *et al*. 2007). No data exist on when juvenile fish become demersal in the GOA; in fact, few specimens of juvenile shortraker rockfish <35-cm fork length have ever been caught in this region, so information on this life stage is virtually absent. Off Kamchatka, juvenile shortraker are reported to become demersal starting at a length of about 10 cm (Orlov 2001). Orlov (2001) has also suggested that shortraker rockfish may undergo extensive migrations in the north Pacific. In his theory, which is mostly based on size compositions of shortraker rockfish in various regions, larvae/post-larvae of this species are transported by currents from the GOA to nursery areas in the Aleutian Islands, where they grow and subsequently migrate back to the GOA as young adults. More research is needed to substantiate this scenario. As mentioned previously, adults are particularly concentrated in a narrow band along the 300-500 m depth interval of the continental slope. Within the slope habitat, shortraker rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of many other rockfish such as Pacific ocean perch (POP, *Sebastes alutus*; Clausen and Fujioka 2007). Shortraker rockfish attain the largest size of all *Sebastes* spp., with a maximum reported total length of 120 cm (Mecklenburg *et al*. 2002).

### Evidence of Stock Structure

The stock structure of the GOA shortraker rockfish was examined and presented to the GOA Groundfish Plan Team in November 2016 (Echave *et al.* 2016). There are few data available to differentiate stocks across regions, and with such little information on growth and reproduction, what is available is insufficient for evaluating comparisons within the spatial extent of the species. The limited genetic information available have indicated evidence of stock structure in the GOA (Gharrett *et al.* 2003; Matala *et al*. 2004), but additional research is needed to better define this structure. Although not conclusive, the genetic studies do not support Orlov’s theory of extensive migrations for shortraker rockfish. Please see Appendix 11.A of the 2016 GOA shortraker rockfish assessment for a more thorough evaluation of the potential stock structure for GOA shortraker rockfish (Echave *et al.* 2016).

# Fishery

### Fishery History

Throughout the 1991-2004 period during which shortraker/rougheye rockfish existed as a management category in the GOA, directed fishing was not allowed, and the fish could only be retained as an “incidentally-caught” species. This incidental catch status has continued for shortraker rockfish since it became a separate category in 2005. In the years since 2005, shortraker rockfish have been taken mostly in fisheries targeting rockfish, sablefish, *Anoplopoma fimbria,* and Pacific halibut, *Hippoglossus stenolepis,* with lesser amounts taken in the walleye Pollock, *Gadus chalcogrammus,* and other groundfish fisheries (Table 11-1). In 2021, the percentage of shortraker catch taken in rockfish directed fisheries reached a time-series high (58%, Table 11-1).

Shortraker rockfish can be caught with both trawls and longlines. The percent caught in each gear type is listed in the Table 11-1 for the years 2005-2021. Since 2005, shortraker catch has generally been caught in equal amounts on both trawl (pelagic and nonpelagic combined but the majority are caught by nonpelagic trawl) and longline gear, with the exception of 2010, 2011, 2016, and 2018. A higher percentage (62.3%) of total shortraker catch was taken in trawl gear in 2021 (Table 11-1).

Nearly all of the longline catch of shortraker rockfish appears to have come as “true” incidental catch in the sablefish or halibut longline fisheries. Historically, some of the shortraker catch in rockfish trawl fisheries was taken by actual targeting that some fishermen called “topping off” (Ackley and Heifetz 2001). “Topping off” worked in this way: fishery managers assign all vessels in a directed fishery a maximum retainable amount (MRA) for certain species that may be encountered as incidental catch. If a vessel manages to not catch its MRA during the course of a directed fishing trip, or the MRA is set overly high (as data presented in Ackley and Heifetz [2001] suggest), before returning to port the vessel may be able to make some target hauls on the incidental species and still not exceed its MRA. Such instances of “topping off” for shortraker rockfish appeared to have taken place in the POP,trawl fishery. Fisherman may have been motivated to “top off” because shortraker rockfish is the most valuable trawl-caught *Sebastes* spp. in terms of landed price. However, this practice is generally no longer thought to occur, and all shortraker catch is truly incidental.

In 2007, the Central GOA Rockfish Pilot Program was initiated to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central GOA rockfish fishery. In 2012 this pilot program was permanently put into place as the Central GOA Rockfish Program. This is a rationalization program that established cooperatives among trawl vessels that receive exclusive harvest privileges for rockfish management groups (for details, see North Pacific Fishery Management Council, 2008). The primary rockfish management groups for the program are POP, northern rockfish, *Sebastes polyspinis,* and pelagic shelf rockfish, but there is a small allocation for shortraker rockfish. Catches of shortraker rockfish taken by trawlers in the Central GOA decreased in 2007 (North Pacific Fishery Management Council 2008), and the catches have remained relatively low in the Central GOA in subsequent years with the exception of 2016 and 2018. Other effects of the pilot program include: 1) mandatory at-sea and plant observer coverage for vessels participating in the program, which has greatly improved catch data for rockfish in the Central GOA; and 2) extending the fishery season when most trawl-caught shortraker rockfish are taken. Previously, most shortrakers were taken as incidental catch during the directed “derby-style” trawl fisheries for POP, northern rockfish, and pelagic shelf rockfish, which mostly occurred during July. In the Central GOA Rockfish Program, trawling can occur anytime between May 1 and November 15, and catches are now spread over this period.

### Management Measures and History

The NPFMC established shortraker rockfish as a separate management category in the GOA in 2005. Previously, shortraker rockfish had been grouped from 1991 to 2004 with rougheye rockfish, *Sebastes aleutianus,* in the “shortraker/rougheye” management category because the two species are similar in appearance, share the same habitat on the upper continental slope, and often co-occur in hauls. Both species were assigned a single overall ABC (acceptable biological catch) and TAC (total allowable catch), and fishermen were free to harvest either species within this TAC. However, evidence from the NMFS Alaska Groundfish Observer Program indicated that shortraker rockfish were being harvested disproportionately within the shortraker/rougheye group, which raised the possibility that shortraker could become overexploited (Clausen 2004). Because of this concern, the NPFMC decided to establish separate management categories for shortraker and rougheye rockfish starting with the 2005 fishing season.

From 2005 to 2010, the assessment for shortraker rockfish was combined with that for another management group of rockfish in the GOA, “other slope rockfish.” Although shortraker rockfish and “other slope rockfish” were distinct management entities, their assessments were presented in a single SAFE chapter because each group was assessed using a similar methodology based on the NPFMC’s “tier 5” definition of overfishing. However, in 2010 both the GOA Groundfish Plan Team and the NPFMC SSC recommended that future assessments for shortraker rockfish and “other slope rockfish” be presented in separate SAFE chapters.

In practice, the NPFMC apportions the ABCs and TACs for shortraker rockfish in the GOA into three geographic management areas: the Western, Central, and Eastern GOA. This apportionment is to disperse the catch across the GOA and prevent possible depletion in one area.

A timeline of management measures that have affected shortraker rockfish, along with the corresponding GOA annual catch and ABC/TAC/OFL levels are listed Table 11-2.

### Catch History

Official fishery catch statistics for shortraker rockfish in the GOA are only available for 2005-2021, when the species catch was first reported separately for management purposes (Table 11-3). However, catch statistics are available for shortraker and rougheye rockfish combined for the years 1991-2004, when both species were classified together into one management group, and these are also listed in Table 11-3. Previous to 1991, shortraker rockfish was classified into larger management groups that included POP and other *Sebastes* spp., and it is generally not possible to separate out the shortraker catches.

Although official catch statistics for shortraker rockfish started in 2005, unofficial estimates of the GOA catch of shortraker rockfish were computed in Clausen (2004) for the years 1993-2003 (Table 11-4). The estimates are based on a combination of data from the observer program and the NMFS Alaska regional office, and they take into account differences in catch by area and gear type. The estimates indicate that annual shortraker catch was generally around 1,000-1,500 t during these years. Annual TACs for the shortraker/rougheye group were the major determining factor of these catch amounts. The total GOA catch of shortraker/rougheye for a given year was generally very similar to the corresponding TAC (Table 11-3). The 2005-2021 shortraker rockfish official catches have been consistently lower than any of the unofficial estimates in previous years. These low catches in the last sixteen years correspond to the years when shortraker rockfish has been in its own management category separate from rougheye rockfish.

Catch of shortraker rockfish varies greatly by area, gear type, and year, but has trended downward in the last two years (Figure 11-1). Before the prohibition of trawling east of 140°W longitude in the eastern GOA in 1999, shortraker rockfish were predominately caught in trawl gear (average 67% of catch). Note that for 1993-2004, information on catch by gear is only available for the shortraker/rougheye category and not for shortraker alone. Since 1999, trawl and longline gear have generally each comprised about half the annual catch in the GOA; however, the dominant gear type for shortraker catch varies significantly by region. Since 2010, the majority of shortraker catch in the central GOA has been in nonpelagic trawl gear (Figure 11-2), while the amount of shortraker catch with longline gear has decreased significantly since 2018. This can likely be attributed to the increased use of traditional pots and collapsible slinky pots by the sablefish fleet in this area. While shortraker rockfish are generally caught in trawl gear in the rockfish fishery, the recent spike in the central GOA in 2016 was the result of the anomalously large amount of shortraker catch in the pollock fishery (Table 11-5). Historically, shortraker rockfish have predominantly been caught in longline gear in both the western and eastern GOA, but in recent years, shortraker catch in longline gear has decreased and catch has been similar in both gear types (Figure 11-2). Again, this trend can likely be attributed to increased use of pot and slinky pot gear. In the western GOA, shortrakers have been caught in equal amount in both gear types since 2020 (Figure 11-2).

Exploitation rates of shortraker rockfish also vary annually by area and gear type, but in recent years have generally been low and relatively stable within the trawl fisheries, and trending downward in the hook and line fleet (Figure 11-3). Exploitation rates in 2021 decreased or remained stable in all areas and for all gear types (Figure 11-3).

Survey research catches of shortraker rockfish are a very small component of overall removals and recreational and other catches are assumed negligible. Non-commercial (research and sport) catches of shortraker rockfish are reported and discussed in Appendix 11A.

### Bycatch

The only analysis of bycatch in shortraker/rougheye rockfish fisheries of the GOA is that of Ackley and Heifetz (2001), in which they examined data for 1994-1996. In the hauls identified as targeting shortraker/rougheye (most of which were presumably “topping off” hauls as described previously), the major bycatch was arrowtooth flounder, sablefish, and shortspine thornyhead, in descending order by weight (Ackley and Heifetz 2001).

### Discards

Discard rates of shortraker rockfish are higher than those for the three species of *Sebastes* in the GOA that have directed fisheries, (POP, northern rockfish, and dusky rockfish, *Sebastes ciliates)*, but are less than the “Other rockfish” management category in this region (see chapters in this SAFE report for POP, northern rockfish, dusky rockfish, and other rockfish). The GOA total discard rate for shortraker rockfish increased for the first time in 2021 (rate of 32.9%) since reaching a historical high of 53.8% in 2018 (Table 11-5). The 2021 discard rate is similar to the time series mean (33%). In addition, discard rates continue to be disproportionate between gear types. For example, the 2021 GOA discard rate is, on average, ~17% in the trawl rockfish fisheries and ~63% in the hook and line sablefish fishery (Table 11-5). The increased discard rate in 2021, as well as the continued disproportionate discard rate in the sablefish fleet is unexpected, as full retention of rockfish by catcher vessels using pot, hook-and-line, and jig gear while fishing for groundfish or halibut is now required as of March 23, 2020 per Amendment 107 to the Fishery Management Plan for Groundfish of the Gulf of Alaska (<https://www.fisheries.noaa.gov/action/amendment-119-fmp-groundfish-bering-sea-and-aleutian-islands-and-amendment-107-fmp>).

Discard rates for fixed gear under full retention mandates are higher than expected, and an overall review has not yet been conducted on how well this new regulation was implemented. Alaska Regional Office staff comment that changes such as these take time and outreach to educate the fleet, so discarding remains common. Additionally, the estimate of the amount of catch that is discarded at sea for each species encountered in the haul is based on the observer’s best professional judgment, and is challenging because it can occur at many places in a fishing and processing operation (Cahalan et al. 2010). These estimates are then applied to the unobserved fleet, and if data is limited or based on a small number of hauls with large catch, these numbers have the potential of being extrapolated to inaccurate values (M. Furuness, pers. comm.). These methods and extrapolations apply to observed data collected via electronic monitoring (EM) as well. As of 13 October 2021, 31 mt of discards were from GOA hook-and-line catcher vessels (CVs) and 64 mt were from hook-and-line catcher processors (CPs; M. Furuness, pers. comm. AKRO CAS). The CPs aren't in the full retention regulations like the CVs, and may be discarding to not exceed the maximum retainable amounts.

# Data

## Fishery Data

### Catch

Detailed catch information for shortraker/rougheye and shortraker rockfish is listed in Table 11-3.

### Size and Age Composition

While the number of lengths sampled by observers for shortraker rockfish in the GOA commercial fishery are few, we are able to use available data to compare length frequencies by gear type (Figure 11- 4). Unimodal length frequency distributions and average length caught are similar between both gear types in the commercial fishery: the average length of shortraker caught in the longline fishery is 57.6 cm, and 59.3 cm in the nonpelagic trawl fishery. Few age samples for this species have been collected from the fishery, and none have been aged.

## Survey Data

### Longline Surveys in the Gulf of Alaska

Two longline surveys of the continental slope of the GOA have provided data on the relative abundance of shortraker rockfish: the Japan-U.S. cooperative longline survey (1979-1994) and the Alaska Fisheries Science Center (AFSC) longline survey (1988-present). Data from these surveys are used to compute relative population numbers (RPNs) and relative population weights (RPWs) for use as indices of stock abundance. The surveys were primarily designed to sample sablefish but also catch considerable numbers of shortraker rockfish. Rockfish catch rates should be viewed with some caution, however, as the RPNs and RPWs do not take into account possible effects of competition for hooks with other species, especially sablefish. An analysis of survey data indicated there was a negative correlation between catch rates of sablefish and shortraker rockfish in the GOA, and there was likely competition for hooks between species (Rodgveller *et al*. 2008). The study concluded that further research was needed to better quantify the effects of hook competition and to compute adjustment factors for the surveys’ catch rates. Another study compared longline survey catch rates of shortraker and rougheye rockfish with observed densities of fish around the longline from a manned submersible (Rodgveller *et al*. 2011). 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 was needed to better determine the suitability of using longline survey results for assessment of this species.

The Japan-US cooperative longline survey was conducted annually during 1979-94, but RPNs for rockfish are only available for the years 1979-87 (Sasaki and Teshima 1988). These data are highly variable and difficult to interpret, but suggest that abundance of shortraker rockfish remained stable in the GOA (Clausen and Heifetz 1989). The data also indicate that shortraker rockfish are most abundant in the eastern GOA.

The AFSC longline survey has been conducted annually since 1988, and RPNs and RPWs have been computed each year (Table 11-6). For shortraker rockfish, GOA RPNs have ranged from a low of ~10,381 in 1992 to a high of ~28,670 in 2000 (Table 11-6). Meaningful trends in these data over the years are difficult to discern, and GOA RPNs and RPWs can fluctuate considerably between adjacent years. For example, the RPW in 2009 was 36,839 t, dropped to 23,738 t in 2010, and increased to 34,460 t in 2011. Some of the fluctuations may be related to hook competition among species, but it may also indicate substantial sampling error, similar to what occurs in the bottom trawl survey. For the 2023 longline survey the GOA RPW for shortraker rockfish was down 2.1% from 2022, while the RPN was up 8.9%.

Similar to the Japan-US cooperative longline survey, the AFSC longline survey results show that abundance of shortraker rockfish is highest in the eastern GOA; the Yakutat area consistently has the greatest RPN and RPW values for shortraker rockfish (Figure 11-7).

### Longline Survey Size Compositions

Size compositions for shortraker rockfish from the 1992–2023 AFSC longline surveys were all unimodal with a relatively constant mean length (Figures 11-5 & 11-6). The AFSC longline survey has a long term average fork length of 60.8 cm, with the 2023 longline survey mean fork length (60.3 cm) having decreased slightly from 2022 (62.5 cm).

### AFSC Trawl Survey Biomass Estimates

Bottom trawl surveys were conducted on a triennial basis in the GOA in 1984 through 1999, and these surveys became biennial starting in 2001 (Table 11-7). The surveys provide much information on shortraker rockfish, including estimates of absolute abundance (biomass) and population length compositions. The trawl surveys have covered all areas of the GOA out to a depth of 500 m (in some surveys to 1,000 m), but the 2001 survey did not sample the eastern GOA. The random effects model is fit by region, which is able to compensate for the missing eastern GOA survey in 2001. This model is also able to compensate for depth strata that were not sampled by the bottom trawl survey (e.g., Hulson et al. 2021), however, the majority of biomass for shortraker occurs at depths less than 500 m, so we do not account for the missing depth strata in this assessment.

Total GOA biomass estimates for shortraker rockfish have sometimes shown rather large fluctuations between surveys; for example, biomass was 62,317 t in 2015, decreased by 49% to 31,534 t in 2017, increased 42% to 44,773 t in 2019, and decreased again by 39% to 27,182 t in 2021 (Table 11-7). However, the confidence intervals have usually overlapped (Table 11-7 and Figure 11-9). In 2021, all GOA areas show a decrease in biomass with the exception of an increase in the Shumagin area (WGOA) (Table 11-7). This is the opposite of what was seen in 2019, in which all GOA areas increased in biomass with the exception of Shumagin and a small decrease in Kodiak (Table 11-7).

Spatial distribution of catches of shortraker rockfish in the last three GOA trawl surveys indicate the fish are rather evenly spread in a band along the continental slope (Figure 11-6). The 2021 survey continues the trend seen in 2019 and 2017 with fewer large catches but an increase in near shore catch of shortraker rockfish (Figure 11-6). In the Yakutat area in 2013, there was a very large catch of over 1,900 kg in a single haul, and again in 2015 there was a single haul of over 1,200 kg in the Yakutat area and over 1,110 kg in the Southeast area. In contrast, the largest haul in 2021 was 430 kg in the Yakutat Area, and the second highest was 177 kg in the Kodiak Area. This absence of large catches in 2021 are responsible at least in part for the narrow confidence bounds of the 2021 biomass estimate and the lowered coefficient of variation (CV) of 21.5%. Compared with many other *Sebastes* spp., the biomass estimates for shortraker rockfish have historically shown relatively moderate confidence intervals and low CVs (compare CVs for shortraker in Table 11-7 vs. those for sharpchin*, S. zacentrus*, redstripe, *S. proriger,* harlequin, *S. variegatus,* and silvergray, *S. brevispinis***,** rockfish in the “Other Rockfish” chapter of this SAFE report). The low CVs are an indication of the generally even distribution of shortraker rockfish that was noted in the introduction of this chapter.

Despite the relative precision of the biomass estimates historically, assessment authors have been uncertain whether the trawl surveys are accurately assessing abundance of shortraker rockfish. Nearly all the catch of these fish is found on the upper continental slope at depths of 300-500 m. Much of this area in the GOA is not trawlable by the survey’s gear because of the area’s steep and rocky bottom, except for gully entrances where the bottom is more gradual. Consequently, biomass estimates for shortraker rockfish are mostly based on the relatively few hauls in gully entrances, and are variable when estimating abundance or abundance trends. One possible problem in the trawl survey results can be seen when longline survey RPWs for shortraker rockfish are compared with corresponding statistical area biomass estimates from trawl surveys. Historically, the longline survey has consistently indicated that shortraker rockfish are most abundant in the Yakutat area, and catches in this area often comprise >50% of the GOA RPW for this species. In contrast, the trawl survey results by area have been much more variable, and the Yakutat area, with few exceptions, has never stood out as a particular area of high abundance. This example highlights the differences between the ability of the trawl survey and longline survey to sample and assess abundance of shortraker rockfish. Although, as we note above, the longline survey also can have a large amount of sampling error for shortraker rockfish.

### Trawl Survey Size Compositions

Size compositions for shortraker rockfish from the 1990–2007 and 2011–2021 trawl surveys were all unimodal, with almost no fish < 35 cm in length (Figure 11-7). However, results from the 2009 trawl survey were different because there was a modest catch of small fish that ranged in size between 10 and 35-cm long. The reason these small fish occurred in 2009, and not in the other surveys, is unknown. The 2001 results may be biased by the fact that they do not include fish from the eastern GOA because this area was not sampled that year. Shortraker rockfish are generally larger in the eastern GOA (e.g., Martin and Clausen 1995; Martin 1997; von Szalay et al. 2008 and 2010) and the 2001 survey seems to be missing many fish >70 cm in length compared to the other surveys. Based on trawl survey samples the mean length of the shortraker rockfish population in the GOA progressively declined from 61.2 cm in 1990 to 53.9 cm in 2003, followed by increases in 2005, 2007, 2011, 2013, 2015, and 2017 with a mean for the latter year of 62.8 cm. The AFSC bottom trawl survey has a long term average fork length of 59.3 cm, with the 2023 trawl survey mean fork length (62.9 cm) having increased slightly from 2021 (59.0 cm).

Trawl Survey Age Compositions

Shortraker rockfish have long been considered among the most difficult rockfish species to age. The usual method for determining rockfish ages, i.e., counting annular growth zones on otoliths, did not appear to work because the growth pattern of shortraker otoliths is so unclear. However, Hutchinson (2004) developed a new aging method for this species based on using thin sections of otoliths and on applying an innovative set of aging criteria to determine which growth bands correspond to annuli. A comparison between his results and those of a previous radiometric study of shortraker rockfish age (Kastelle *et al.* 2000) indicated general agreement and provided a limited degree of validation. This new aging methodology was used to determine the age compositions of shortraker rockfish in the 1996, 2003, and 2005 GOA trawl surveys (Figure 11-10). Ages ranged from 5 to 146 years, and the results indicate the shortraker rockfish population in the GOA is quite old (mean age varied between 32 and 44 years, depending on the survey). To provide direct validation of the new aging method, in 2008 a validation study was conducted based on carbon 14 levels in shortraker rockfish otoliths from nuclear bomb testing in the 1960s. Results were unsuccessful, however, because carbon 14 could not be found in sufficient quantities in the otoliths[[1]](#footnote-1). Thus, alternative validation techniques will be necessary to verify the aging methodology. One possibility is to conduct an updated and more detailed radiometric study than the previously mentioned Kastelle *et al.* (2000) study, which was done before Hutchison (2004) and was somewhat problematic because it was based on using length of the fish as a proxy for age.

Because of the lack of direct validation for the aging method, and the consequent uncertainty about the ages, production aging for shortraker rockfish has now been put on hold. Due to this uncertainty, use of an age-structured model to assess GOA shortraker rockfish is not recommended at present. Although we hope to move to an age-structured assessment at some time in the future, better validation of the shortraker rockfish aging methodology is needed before we do so.

# **Analytic Approach**

## General Model Structure

Due to the lack of biological information for shortraker rockfish (especially an absence of validated age data), recent assessments used a biomass-based approach to estimate ABCs. Both trawl and longline survey data affect the trends used to estimate the ABCs. The application of the REMA model smooths trends in survey estimates. The process errors (step changes) from one year to the next are the random effects that are integrated over, and the process error variance terms are freely estimated. The observations can be irregularly spaced, so for years where data are missing estimates can be made. Specified survey observation error terms (provided each year) effectively weights the survey estimates and can affect the predictions.

In 2019, Model 19.2a was selected which is a multivariate version of the random effects model that was fit to an additional relative abundance index, the AFSC longline survey RPWs (Hulson et al. 2021). In 2022, the R package *rema* was developed that is version-controlled online and includes a set of utility functions for visualizing results and conducting model comparisons (Sullivan et al. 2022a). The *rema* package provides a flexible and extensible framework for users to fit REMA models, and the models have been recoded using Template Model Builder (TMB; Kristensen et al. 2016). The *rema* package also introduces a method to estimate additional observation error, which is utilized in this year’s author recommended model.

The Tier 5 estimate of the OFL is simply M multiplied by the estimated exploitable biomass and under the FMP the maximum permissible ABC is 75% of OFL. Here we assume 0.03 as a value for M (see the Parameters Estimates section for how this estimate was derived). For all models considered, input data starts in 1990.

### Modeling Selection

Several models were presented to the GOA Plan Team in September of 2023 ([PT presentation](https://meetings.npfmc.org/CommentReview/DownloadFile?p=4d698035-49d6-40ba-8ef7-61155c9848ad.pdf&fileName=GOAshortraker_September2023_KAS.pdf)), and following their recommendation, only two models are included here. The following table provides the model case name and description of the changes made to the model.

|  |  |
| --- | --- |
| **Model case** | **Description** |
| 19\* | Model 19.2a accepted in 2019 with coding error corrected. Estimates 1 process error, 3 area-specific scaling coefficients, fixed longline survey weight to 0.5 and run using the *rema* package |
| 23.3 | Estimates 1 process error, 3 area-specific scaling coefficients, both surveys (bottom trawl and longline survey) have equal weights (1.0), estimates an additional observation error for the longline survey and run using *rema* package |

A brief description of each model case is provided below.

#### 19\* – Corrected Model 19.2a

A coding error was found in Model 19.2a, the status quo model which was accepted in 2019 and used in 2021, and that version has now been discontinued. Model 19\* is Model 19.2a (described in Echave and Hulson 2019) with that error corrected and run using the newly developed *rema* package (Sullivan et al. 2022a).

Model 19\* is a REMA model that can be represented as a state-space random walk model with added noise. Two surveys are combined in this model, with the AFSC bottom trawl survey providing biomass estimates and uncertainty, and the AFSC longline survey providing RPW estimates and uncertainty. The RPWs contribute trend information to the model, while the trawl biomass contributes both scale and trend information to the model. Each survey contributes an observation error component to the likelihood. The RPWs are scaled to the biomass estimated by three area-specific scaling coefficients ( for the WGOA, for the CGOA, and for the EGOA), and an estimated single process error component which is shared across areas and surveys (). This model fixes the weight of the longline survey at 0.5, meaning the negative log likelihood contribution to the objective function is halved. This model has three likelihood components: 1) the bottom trawl survey biomass estimate observation error component 2) the longline survey RPW index observation error component, and 3) the process error component (which represents the amount of variation across time of the random effect parameters).

The first observation model is comprised of regional log-transformed annual bottom trawl survey biomass data with associated standard deviations , where *y* is year, *r* is region (WGOA, CGOA, or EGOA), and is approximated using the coefficient of variation of the annual survey biomass by region (), such that:

The biomass survey measurement or observation equation, which describes the relationship between the observed log-transformed survey biomass and the latent state variable, estimated log-transformed population biomass , is expressed as:

, where .

The state equation and associated process error is defined as:

, where , and

.

The second observation model using the annual/regional longline survey RPW index ( is similarly structured with associated standard deviations approximated using the coefficient of variation of the annual survey RPW (), such that:

The longline survey measurement or observation equation is similarly expressed as:

, where ,

where the estimated index () is scaled to the estimated population biomass using an estimated region-specific scaling coefficient () such that:

The state equation for the longline survey shares a process error with the trawl survey:

, where

The parameters estimated are , , , and , in addition to the unobserved population biomass estimated as a vector of random effects.

#### 23.3 – Longline survey weight = 1.0 and additional observation error term for the longline survey

Model 23.3 is setup similarly to Model 19\*, but the longline survey is given equal weight to the bottom trawl survey (1.0) and an additional observation error for the longline survey is estimated. Based on experience gained using alternative observed index estimates (e.g. relative CPUE indices), there appears to be cases where the estimates of observation error for the biomass and/or CPUE survey are lower than expected. That is, there is a mismatch between biologically reasonable inter-annual variability and the precision of index estimates. In these instances, the model estimates of the sum of observation errors from the bottom trawl and longline surveys divided by the estimated process error, (+ / , may be lower than what should be expected based on an individual species’ life history traits. For example, if the ratio of observation to process error variation is low, model predictions of population biomass may exhibit high inter-annual variability. This behavior would be unexpected in low productivity species, such as shortraker rockfish, which should exhibit low inter-annual variation in biomass (i.e., a small process error), especially in situations when fishing exploitation is low.

One approach to address this issue is to estimate additional observation error. This method is commonly implemented in Alaskan crab stock assessments and has been explored in several groundfish assessment models as well. The biomass survey coefficient of variation is generally larger than the longline survey (Tables LLS/BTS with CV), so an extra estimated observation error () is specified as an additional coefficient of variation component:

|  |  |  |
| --- | --- | --- |
|  |  |  |

The parameters estimated are , , , ,and , in addition to the unobserved population biomass estimated as a vector of random effects.

Shortraker rockfish in the GOA are managed under Tier 5, where OFL = *M* \* exploitable biomass, where *M* represents natural mortality, and *FABC* is estimated by 0.75 \* *M*. The acceptable biological catch (ABC) is obtained by multiplying *FABC* by the estimated biomass, ABC ≤ 0.75 \* *M* \* biomass. *M* is assumed equal to 0.03 and is discussed further in the following section.

## Apportionment methods

Two alternative apportionment methods were examined (“Biomass” = standard method based on proportion of predicted biomass by area; “Biomass + RPW” = proposed method for GOA RE/BS based on the mean proportions of predicted biomass and predicted RPW by area). The results from each method for the two models described are shown in the following apportionment percentages by management area for 2024 and 2025 (author-recommended model and apportionment method in bold):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **REMA model names** | **Apportionment Method** | **WGOA** | **CGOA** | **EGOA** |
| M19\* | Biomass | 5.3% | 29.5% | 65.2% |
| M19\* | Biomass + RPW | 8.4% | 20.7% | 70.9% |
| M23.3 | Biomass | 5.2% | 29.3% | 65.5% |
| **M23.3** | **Biomass + RPW** | **8.3%** | **20.7%** | **70.0%** |

## Parameter Estimates

#### Mortality, Maximum Age, Female Age- and Length-at-50% Maturity:

Estimates of mortality, maximum age, and female age- and size-at-50% maturity for shortraker rockfish are listed as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mortality  rate | Mortality | Maximum  age | Age at | Length at | Area | References |
| rate method | Maturity | Maturity |
| - | - | 120 | - | - | BC | 1 |
| 0.027-0.042 | GSI | - | 21.4 | 44.9 | WC,GOA,AI,EBS | 2,3 |
| - | - | 157 | - | - | GOA | 4 |
| - | - | 146 | - | - | GOA | 5 |
| - | - | - | - | 49.9 | GOA | 6 |

Area indicates location of study: British Columbia (BC), West Coast of U.S. (WC), Gulf of Alaska (GOA), Aleutians (AI), and eastern Bering Sea (EBS).

GSI: gonad somatic index (Gunderson and Dygert (1988).

References: 1) Chilton and Beamish 1982; 2) McDermott 1994: 3) Hutchinson 2004; 4) Munk 2001; 5) this report; 6) Conrath 2017.

The two values for maximum age of shortraker rockfish in the GOA (146 and 157), if true, would make this species one of the longest-lived fishes. McDermott (1994) determined that length-at-50% maturity for female shortraker rockfish was 44.9 cm based on samples collected in several regions of the northeast Pacific, including the GOA, while Conrath’s (2017) more recent study based on specimens collected solely from the GOA was slightly larger, at 49.9 cm. Hutchinson’s (2004) experimental aging study of shortraker rockfish computed von Bertalanffy growth parameters for females, and he used these parameters to convert McDermott’s length-of-maturity to an age-of-50% maturity of 21.4 years. Because it was based on experimental aging, however, and was also determined indirectly, the estimate needs to be confirmed by additional study.

When the shortraker/rougheye category was created in 1991, there was no estimate at that time of *M* or *Z* for shortraker rockfish. Therefore, the SSC suggested the following computation for a proxy estimate of *M*: use the ratio of maximum age of rougheye to shortraker (140/120) from British Columbia and then multiply this value by the mid-point of the range of *Z* for rougheye rockfish in British Columbia (mid-point = 0.025) to yield an *M* of 0.03 for shortraker rockfish. In a later study, *M* for shortraker rockfish was estimated to range between 0.027 and 0.042 (McDermott 1994), so the original estimate of 0.03 for *M* seems reasonable.

#### Length- and Weight-at-Age:

Length-weight coefficients and von Bertalanffy parameters for shortraker rockfish are listed below. Length-weight coefficients are from the formula W = aLb where W = weight in kg and L = length in cm (based on data from the 1996 GOA trawl survey in Martin 1997):

|  |  |  |  |
| --- | --- | --- | --- |
| Sex | a | b | # sampled |
| combined | 9.85 x 10-6 | 3.13 | 620 |
| males | 1.26 x 10-5 | 3.07 | 302 |
| females | 1.02 x 10-5 | 3.12 | 318 |

Von Bertalanffy parameters for shortraker rockfish (GOA = Gulf of Alaska; AI = Aleutian Islands: EBS = Eastern Bering Sea):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Area | Sex | t0 | K | Linf (cm) |
| GOA/AI/EBS | female | -3.62 | 0.030 | 84.60 |

The von Bertalanffy parameters are based on the previously discussed Hutchinson (2004) study which has been only partially validated, so they should be used with caution. Although the analysis combined samples from the GOA, Aleutian Islands, and eastern Bering Sea, most were from the GOA.

# Results

## Model Results

The alternative REMA models explored in September gave equal weights to the longline and bottom trawl surveys. We feel this is justified by the quantity and quality of the data from longline survey. The longline survey catches several thousand shortraker rockfish each year compared to several hundred in the biennial (formerly triennial) bottom trawl survey. The resulting length compositions show similarities in the EGOA, with an increasing divergence to the west with the longline survey lengths indicating larger fish being sampled (Figure 3). The longline survey has relatively consistent mean lengths by region, while the bottom trawl survey lengths have more interannual variability (Figure 4). One reason that sample sizes differ so much is likely due to the amount of effort each survey has in the habitat (trawlable vs. untrawlable) and depths (between 250 and 500 m) that shortraker are found (Figure 5). As such, we recommend fixing both survey weights to 1, but as before, we acknowledge that the longline survey observation error is quite small relative to the bottom trawl survey.

Several alternative models were presented to the GOA Groundfish Plan Team in September 2023 (e.g., additional observation error for the trawl survey only, additional observation error for the longline survey only, and only including the bottom trawl survey with an additional observation error). However, the additional observation error estimated for the trawl survey was quite large and greatly diminished the contribution of this survey to the biomass estimates. As such, Model 23.3 provided the only reasonable option, and it included an additional observation error on the longline survey. Model fits for 19\* and 23.3 can be compared at the regional level by survey (Figure 15-7), and at the Gulfwide level (Figure 15-8).

Additionally, the change from M19\* to M23.1 does result in a larger process error (Table 1), so we do not recommend using M23.1.

The biomass trajectories in Model 19\* are very similar to those predicted by Model 23.3, so the choice of model does not markedly influence the ABC or apportionment. Because Model 23.3 objectively estimates additional uncertainty in the longline survey, we prefer this option to Model 19\* which subjectively selected to downweight the longline survey. Parameter estimates, standard errors (SE), and corresponding lower (LCI) and upper (UCI) 95% confidence intervals from Models 19 \* and 23.3 are below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Model 19\* | | | |  | Model 23.3 | | | | | |
| Parameter | | | Parameter Estimate | SE | LCI | | UCI |  | Parameter Estimate | SE | LCI | UCI |
| Process error | | | 0.172 | 0.033 | 0.117 | | 0.251 |  | 0.174 | 0.040 | 0.111 | 0.272 |
| WGOA scaling parameter | | | 2.215 | 0.316 | 1.674 | | 2.930 |  | 2.205 | 0.287 | 1.708 | 2.846 |
| CGOA scaling parameter | | | 0.417 | 0.043 | 0.340 | | 0.511 |  | 0.424 | 0.042 | 0.350 | 0.515 |
| EGOA scaling parameter | | | 1.203 | 0.106 | 1.012 | | 1.429 |  | 1.189 | 0.102 | 1.004 | 1.407 |
| Extra LLS RPW observation error | | |  |  |  | |  |  | 0.135 | 0.076 | 0.043 | 0.375 |

## Harvest Recommendations

### Amendment 56 Reference Points

In previous assessments, shortraker rockfish were always classified as “tier 5” in the NPFMC definitions for ABC and Overfishing Level (OFL) based on Amendment 56 to the Gulf of Alaska FMP. The population dynamics information available for Tier 5 species consists of reliable estimates of biomass and natural mortality *M*, and the definitions state that for these species, the fishing rate that determines ABC (i.e., *F*ABC) is ≤0.75*M* . Because age and maturity data are available for shortraker rockfish (Hutchinson 2004), theoretically this species could be moved into tier 4, where *FABC* ≤*F*40%. However, because of the uncertainty of the present aging method and the lack of age validation, we recommend keeping shortraker rockfish in tier 5 for the present. Thus, the recommended *F*ABC for shortraker rockfish is 0.0225 (i.e., 0.75 \* *M*, where *M* = 0.03). The overfishing limit for Tier 5 species is defined to occur at a harvest rate of *F*=*M*.

As described in the previous section, the recommended RE model was fit to the 1990–2023 AFSC GOA trawl survey time-series of biomass values and estimates of uncertainty by region to account for missing survey data and regional RPW indices from the 1992–2023 AFSC longline survey (with associated estimates of uncertainty). These regional biomass estimates from the RE model were then summed to obtain total GOA biomass of 28,768 t (95% CI between 20,282 and 40,804; Table 11-8) for shortraker rockfish (Figure 11-11).

The random effects methodology has been recommended for all tier 5 stocks managed by the NPFMC.

### Specification of OFL and Maximum Permissible ABC

Applying the *F*ABC to the estimate of current exploitable biomass (using the random effects methodology) of 31,331 t (+/- CI of 26,742 and 36,707; Table 11-8) for shortraker rockfish results in a total GOA ABC of 705 t and OFL of 940 t for the 2022 fishery. This ABC is slightly lower than the 2020 ABC of 708 t.

### Risk Table and ABC Recommendation

The following table is to be used to complete the risk table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Assessment-related considerations* | *Population dynamics considerations* | *Environmental/ecosystem considerations* | *Fishery Performance* |
| Level 1: Normal | Typical to moderately increased uncertainty/minor unresolved issues in assessment. | Stock trends are typical for the stock; recent recruitment is within normal range. | No apparent environmental/ecosystem concerns | No apparent fishery/resource-use performance and/or behavior concerns |
| Level 2: Substantially increased concerns | Substantially increased assessment uncertainty/ unresolved issues. | Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical. | Some indicators showing an adverse signals relevant to the stock but the pattern is not consistent across all indicators. | Some indicators showing adverse signals but the pattern is not consistent across all indicators |
| Level 3: Major Concern | Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias. | Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns. | Multiple indicators showing consistent 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) | Multiple indicators showing consistent adverse signals a) across different sectors, and/or b) different gear types |
| Level 4: Extreme concern | Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable. | Stock trends are unprecedented; More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns. | Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock; Potential for cascading effects on other ecosystem components | Extreme anomalies in multiple performance indicators that are highly likely to impact the stock |

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, environmental/ecosystem considerations, and fishery performance. Examples of the types of concerns that might be relevant include the following:

1. Assessment considerations—
2. Data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data
3. Model fits: poor fits to fishery or survey data, inability to simultaneously fit multiple data inputs
4. Model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds
5. Estimation uncertainty: poorly-estimated but influential year classes
6. Retrospective bias in biomass estimates.
7. Population dynamics considerations—decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.
8. Environmental/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.
9. Fishery performance—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 considerations:

The GOA shortraker stock is a Tier 5 species, meaning only biomass estimates are available to calculate ABCs. The GOA shortraker assessment is one of a few Tier 5 assessments in Alaska that is fit to multiple abundance indices (trawl survey biomass estimates and longline survey RPWs) using the RE model. While these two surveys have often shown opposing trends (trawl survey biomass decreased in 2021 while longline survey RPWs increased), which is not unexpected due to the differing habitats sampled, the inclusion of these two data sources in the RE model has allowed for increased stability of biomass estimates (Table 11-8) and more consistent regional apportionments across time. Historically, the biomass estimates for shortraker rockfish have shown relatively moderate confidence intervals and low CVs. We rated the assessment-related concern as level 1, normal. While survey biomass estimates have historically shown large changes from year to year (typical of several rockfish assessments), the CVs have generally remained low.

#### 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 GOA. Any data collected during larval cruises lump all rockfish species together. Even with large annual survey variability, recent biomass estimates have generally been stable. 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 and survey biomass estimates have shown normal variability for this species.

#### Environmental/Ecosystem considerations:

Shortraker rockfish are benthic continental slope (300-500m) dwellers as adults (Krieger and Ito 1999), with post-larval rockfish documented in epipelagic waters in offshore waters of the GOA (Kondzela et al. 2007). While optimal spawning and larval survival temperature ranges are not known for shortraker rockfish, it is reasonable to expect that the 2021 and predicted 2022 average deeper ocean temperatures will provide good spawning habitat, and average to cooler surface temperatures contribute to good pelagic conditions for age-0 rockfish during a time when they are growing to a size that promotes over winter survival. Sea temperatures at the surface and at depth on the shelf were around the long-term average in 2021 (not a marine heatwave year, Watson and Callahan 2021; AFSC Bottom Trawl Survey, Laman 2021; AFSC EcoFOCI survey, Rogers *et al*. 2021; Seward Line Survey, Danielson and Hopcroft 2021), although the western GOA started the year with warmer surface waters (satellite data; Watson 2021) and there was above average warmth (5.2°C) at 200m depth along the outer edge of the shelf during the summer (AFSC Longline Survey; Siwicke 2021). Numerous temperature time series showed signs of cooling from previous surveys (returning to average from recent marine heatwave years 2014-2016, 2019) at the surface and at depth, and 2022 surface temperatures are predicted to continue cooling, in alignment with La Niña conditions and a negative Pacific Decadal Oscillation. Additional epifauna habitat and rockfish distribution data show a continued decline in sponges since 2015, particularly in the Shumagin and Kodiak areas (AFSC Bottom Trawl Survey; Palsson 2021b) and no change in relative abundance of soft corals (AFSC Bottom Trawl Survey; Palsson 2021b). In general, no changes have been observed over the AFSC Bottom Trawl catch time series (1989-2021) in the distribution of shortraker rockfish catch relative to depth, temperature, or east/west position in the GOA (AFSC Bottom Trawl Survey; Palsson 2021a).

Larval rockfish are planktivorous and the primary prey items of adult shortraker rockfish are shrimp, squid, and deepwater fish in the GOA (Yang 2000). For larval rockfish, zooplankton productivity was moderate and regionally variable across the GOA in 2021. The western GOA had lower spring biomass of large copepods and approximately average biomass of smaller copepods was around Kodiak, characteristics of previous warm, less productive years (e.g., 2019). Planktivorous seabird reproductive success, an indicator of zooplankton availability and nutritional quality, was below average just north of Kodiak (E. Amatuli Island; Drummond 2021). Around the eastern edge of the central GOA (Seward Line, Middleton Island) the biomass of large copepods was average to above-average (Seward Line Survey, Hopcroft and Coyle 2021) and planktivorous seabirds had better reproductive success (Middleton Island, Hatch 2021), indicating improved forage conditions. The eastern GOA inside waters of Icy Strait, northern southeast Alaska, had higher than average large copepods and euphausiids (AFSC SECM Survey, Icy Strait, Fergusson 2021), however planktivorous seabirds had mixed reproductive success. Little is known about the adult prey base (shrimp, squid, deepwater fish).The body condition of other adult rockfish species (northern and southern rockfish) was below average (lower weight for a given length) continuing a seven year trend, but increased closer to the long-term average from the low in 2019 (AFSC Bottom Trawl Survey, O’Leary *et al*. 2021). Shrimp have been increasing around Chirikof, Yakutat, and southeastern GOA regions, but declining around Kodiak over the past 5 years (AFSC Bottom Trawl Survey, Palsson 2021c). While we have no data on squid abundance, 2021 is having large adult returns of pink salmon, which predate heavily on squid and some research points to competitive effects in the marine environment (Shaul *et al*. 2021, Aydin 2000). The large 2016 year class of sablefish is shifting to the edge of the GOA shelf as they mature, potentially increasing the overlap in distribution and potential for competition with slope rockfish.

Little is known about the impacts of predators, such as fish and marine mammals, on adult shortraker rockfish. Juvenile rockfish could be preyed upon by cod, arrowtooth flounder, halibut, sablefish, and seabirds. In general, apex fish predators in the GOA are at relatively low abundances (including cod and arrowtooth flounder, although sablefish are abundant) (Whitehouse and Aydin 2021) and we do not have seabird population abundance data. There is no cause to suspect increased predation pressure on larval or adult shortraker rockfish.

We scored this category as level 1, normal concern for adult shortraker rockfish, given approximately average physical environmental conditions, mixed trends/unknown foraging conditions (mixed trends in shrimp abundance, negative body condition of other rockfish), potential for competition with pink salmon and sablefish but the actual effect is unknown, and unknown predation pressure.

#### Fishery performance:

There is no directed fishing of shortraker rockfish, and they can only be retained as “incidentally-caught.” Catch of shortraker rockfish varies greatly by area, gear type, and year, but catch has always remained below the TAC. Shortraker catch has generally been stable, but has decreased in recent years. This decrease is likely due in part to the increased use of traditional pot gear and slinky pots in the sablefish fishery. Due to their high value, discard rates of shortrakers have generally been low, however, discard rates in the longline fisheries have been increasing in recent years for unknown reasons, even after regulations requiring mandatory retention by fixed gear CVs were passed. Overall, we rated the fishery performance concern as level 1, normal, due to the low stable catch of this non-directed fishery species that historically has always remained below the TAC.

The overall score of level 1 suggests no need to set the ABC below the maximum permissible.

### Area Allocation of Harvests

Since 1991, the GOA ABC for shortraker/rougheye rockfish or shortraker rockfish alone has been allocated amongst the western, central, and eastern GOA regulatory areas based on the geographic distribution of the species’ exploitable biomass in the trawl surveys. We used area-specific survey biomass estimates and a random-walk smoother (the ‘random effects’ model) to apportion ABCs among regions. The fit of this model is shown in Figure 11-12 (for bottom trawl survey biomass) and Figure 11-13 (for longline survey RPWs). The result is responsive to both the bottom trawl and longline survey indices which may reflect different components of the population. For 2024, the estimated distribution of biomass is shown as:

|  |  |  |  |
| --- | --- | --- | --- |
| GOA Area | 2024 Biomass (t) | Percent of Total Biomass | Area ABC Apportionment (t) |
| Western | 1,508 | 8.3% | 54 |
| Central | 8,426 | 20.7% | 134 |
| Eastern | 18,834 | 71.0% | 459 |
| GOA Total | 28,768 | 100% | 647 |

The 2024 recommended apportionment values shift biomass from the CGOA to EGOA, which is a result of shifting biomass estimates and the new apportionment method which takes into account the different area proportions by survey (“Biomass + RPW”).

### Status determination

Based on Amendment 56 in the Gulf of Alaska FMP, overfishing for a Tier 5 species such as shortraker rockfish is defined to occur at a harvest rate of *F*=*M*. Therefore, applying the estimate of *M* for shortraker rockfish (0.03) to the estimate of current exploitable biomass (28,768 t) yields an overfishing catch limit of 863 t for 2024. This stock is not being subjected to overfishing.

# Ecosystem Considerations

In general, a determination of ecosystem considerations for shortraker rockfish is hampered by the lack of biological and habitat information. A summary of the ecosystem considerations presented in this section is listed in Table 11-9.

## Ecosystem Effects on the Stock

#### Prey availability/abundance trends:

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. Although few juvenile shortraker rockfish have ever been caught in Alaska, precluding species-specific information on their food items, generally zooplankton productivity was moderate and regionally variable across the GOA. In the western GOA there was lower spring biomass of large copepods and approximately average biomass of smaller copepods around Kodiak, characteristics of previous warm, less productive years (e.g., 2019). Planktivorous seabird reproductive success, an indicator of zooplankton availability and nutritional quality, was below average just north of Kodiak (E. Amatuli Island). Around the eastern edge of the central GOA (Seward Line, Middleton Island), the biomass of large copepods was average to above-average (Danielsen and Hopcroft 2021), and planktivorous seabirds had better reproductive success indicating improved forage conditions (Middleton Island, Hatch 2021). The eastern GOA inside waters of Icy Strait, northern southeast Alaska, had higher than average large copepods and euphausiids (Fergusson 2012), however planktivorous seabirds had mixed reproductive success.

Adult shortraker rockfish in Alaska are opportunistic feeders that prey on shrimp, deepwater fish (e.g., myctophids), and squid (Yang and Nelson 2000; Yang 2003; Yang *et al.* 2006). Shrimp have been increasing around Chirikof, Yakutat, and southeastern GOA regions, but declining around Kodiak over the past 5 years (AFSC Bottom Trawl Survey). While we have no data on squid abundance, adult returns of pink salmon, which prey heavily on squid, were high in 2021. The large 2016 year class of sablefish is shifting to the edge of the GOA shelf as they mature, potentially increasing the overlap in distribution and potential for competition with slope rockfish.

#### 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 sparse. 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 POP, 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.

While optimal spawning and larval survival temperature ranges are not known for shortraker rockfish, it is reasonable to expect that the 2021 and predicted 2022 average deeper ocean temperatures will provide good spawning habitat and average to cooler surface temperatures contribute to favorable pelagic conditions for age-0 rockfish during a time when they are growing to a size that promotes overwinter survival. Sea temperatures at the surface and at depth on the shelf were around the long-term average in 2021 (not a marine heatwave year; AFSC Bottom Trawl Survey, AFSC EcoFOCI survey, Seward Line Survey). Numerous temperature time series showed signs of cooling from previous surveys (returning to average from recent marine heatwave years 2014-2016, 2019) at the surface and at depth, and 2022 surface temperatures are predicted to continue cooling, in alignment with La Niña conditions and a negative Pacific Decadal Oscillation.

Epifauna habitat and rockfish distribution data show a continued decline in sponges since 2015, particularly the Shumagin and Kodiak areas (AFSC Bottom Trawl Survey; Palsson 2021), and no change in relative abundance of soft corals (AFSC Bottom Trawl Survey; Palsson 2021). 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), Pearcy *et al.* (1989), Love *et al.* (1991), and Freese and Wing (2003). A study in the GOA based on observations from a manned submersible found that adult “large” rockfish had a strong association with *Primnoa* spp. 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 GOA is taken incidentally in longline fisheries for sablefish and Pacific halibut or in the rockfish trawl fishery for POP. Thus, the reader is referred to the discussions on “Fishery Effects” in the sablefish and POP chapters in this SAFE report.

#### Fishery-specific contribution to bycatch of HAPC biota:

In the GOA, bottom trawl fisheries for shortraker and rougheye rockfish accounted for very little bycatch of HAPC biota (Table 11-10). 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 (if known) and relative to spawning components:

Unknown.

#### Fishery-specific effects on amount of large size target fish:

Unknown.

#### Fishery contribution to discards and offal production:

Annual fishery discard rates since 2011 have been 22-54% 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:

Unknown.

#### Fishery-specific effects on EFH non-living substrate:

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

Currently, validation of aging methods for shortraker rockfish is the most important research priority so that an age-structured model can be used for assessment. Additional research is needed on other aspects of shortraker rockfish biology and assessment. There is little information on larval, post-larval, or early stage juveniles of shortraker rockfish. In particular, juvenile shortraker rockfish are very seldom caught in any sampling gear. 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 on the fishing grounds needs to be done on the bottom habitat, HAPC biota , and impacts from bottom trawling. Investigation is needed on the distribution and abundance of shortraker rockfish in untrawlable habitat.

# Literature Cited

Ackley, D. R. and J. Heifetz. 2001. Fishing practices under maximum retainable bycatch rates in Alaska’s groundfish fisheries. Alaska Fish. Res. Bull. 8: 22-44.

Cahalan, J., J. Mondragon, and J. Gasper. 2010. Catch sampling and estimation in the federal groundfish fisheries off Alaska. U.S Dept. Commer. NOAA Tech. Memo. NMFS-AFSC-205. 51 p.

Carlson, H. R., and R. R. Straty. 1981. Habitat and nursery grounds of Pacific rockfish, *Sebastes* spp., in rocky coastal areas of Southeastern Alaska. Mar. Fish. Rev. 43: 13-19.

Chilton, D. E. and R. J. Beamish. 1982. Age determination methods for fishes studied by the groundfish program at the Pacific Biological Station. Can. Spec. Pub. Fish. Aquat. Sci. 60.

Clausen, D. M. 2004. Alternative ABCs for shortraker/rougheye rockfish in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, Appendix 9A, p. 416–428. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501.

Clausen, D. M. 2007. Shortraker and other slope rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 735–780. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501. Available on-line: http://www.afsc.noaa.gov/refm/docs/2007/GOAshortraker.pdf

Clausen, D. M., and J. T. Fujioka. 2007. Variability in trawl survey catches of Pacific ocean perch, shortraker rockfish, and rougheye rockfish in the Gulf of Alaska. In J. Heifetz, J. Dicosimo, A. J. Gharrett, M. S. Love, V. M. O’Connell, and R. D. Stanley (editors), Biology, assessment, and management of North Pacific rockfishes, p. 411-428. Alaska Sea Grant, Univ. of Alaska Fairbanks.

Clausen, D. M. and J. Heifetz. 1989. Slope rockfish. In T.K. Wilderbuer (editor), Condition of groundfish resources of the Gulf of Alaska in 1988, p. 99-149. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-165.

Conrath, C. L. 2017. Maturity, spawning omission, and reproductive complexity of deepwater rockfish. Tran. Amer. Fish. Soc. 146:495-507.

Danielson, S., and R. Hopcroft. 2021. Ocean temperature synthesis: Seward line may temperatures . In Ferriss, B., and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Drinkwater, K. 2004. Summary report: review on evaluation of fishing activities that may adversely affect Essential Fish Habitat (EFH) in Alaska. Center of Independent Experts Review (CIE) June 2004, Alaska Fisheries Science Center, Seattle, Washington.

Du Preez, C. and V. Tunnicliffe. 2011. Shortspine thornyhead and rockfish (Scorpaenidae) distribution in response to substratum, biogenic structures and trawling. Mar. Ecol. Prog. Ser. 425:217-231.

Echave, K., C. Rodgveller, and S.K. Shotwell. 2013. Calculation of the geographic area sizes used to create population indices for the Alaska Fisheries Science Center longline survey. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-253, 93 p.

Echave, K. B., S. K. Shotwell, and P. J. F. Hulson. 2016. Shortraker rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 525 - 550. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Echave, K.B. and P.J.F Hulson. 2019. Assessment of shortraker rockfish stock in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish fisheries of the Gulf of Alaska. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 9950-2252.

Echave, K.B., K.A. Siwicke, P.J.F Hulson, E. Yasumiishi, and B. Ferriss. 2021. Assessment of shortraker rockfish stock in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish fisheries of the Gulf of Alaska. North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 9950-2252.

Fergusson, E. 2021. Long-term trends in zooplankton densities in Icy Strait, Southeast Alaska. In Ferriss, B., and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Fournier D. A., H. J. Skaug , J. Ancheta , J. Ianelli , A. Magnusson, M. N. Maunder , A. Nielsen, and J. Sibert. 2012. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models, Optimization Methods and Software, 27:2, 33-249, doi: 10.1080/10556788.2011.597854

Freese, J. L., and B. L. Wing. 2003. Juvenile red rockfish, *Sebastes* sp., associations with sponges in the Gulf of Alaska. Mar. Fish. Rev. 65(3): 38-42.

Gharrett, A. J., E. L. Peterson, A. K. Gray, Z. Li, and J. Heifetz. 2003. Population structure of Alaska shortraker rockfish, *Sebastes borealis*, inferred from mitochondrial DNA variation. Fisheries Division, School of Fisheries and Ocean Sciences, Univ. of Alaska Fairbanks, Juneau AK 99801 Unpublished contract report. 21 p.

Gunderson, D. R., and P. H. Dygert. 1988. Reproductive effort as a predictor of natural mortality rate. J. Cons. Int. Explor. Mer. 44: 200-209.

Heifetz, J.,

Heifetz, J., D. M. Clausen, and J. N. Ianelli. 1994. Slope rockfish. In Stock assessment and fishery evaluation report for the 1995 Gulf of Alaska groundfish fishery, p. 5-1 - 5-24. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Hopcroft, R., and K. Coyle. 2021. Seward Line: Large Copepod & Euphausiid Biomass. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Hulson, P.-J. F., K. B. Echave, P. D. Spencer, and J. N. Ianelli. 2021. Using multiple Indices for biomass and apportionment estimation of Alaska groundfish stocks. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-414, 28 p.

Hutchinson, C. E. 2004. Using radioisotopes in the age determination of shortraker (*Sebastes borealis*) and canary (*Sebastes pinniger*) rockfish. Masters Thesis. Univ. Washington, Seattle. 84 p.

Ito, D. H. 1999. Assessing shortraker and rougheye rockfishes in the Gulf of Alaska: addressing a problem of habitat specificity and sampling capability. Ph. D. Thesis. Univ. Washington, Seattle. 204 p.

Jones, D. T., C. D. Wilson, A. De Robertis, C. N. Rooper, T. C. Weber, and J. L. Butler. 2012. Evaluation of rockfish abundance in untrawlable habitat: combining acoustic and complementary sampling tools. Fish. Bull. 110(3):332-343.

Kastelle, C. R., D. K. Kimura, and S. R. Jay. 2000. Using 210Pb/226Ra disequilibrium to validate conventional ages in Scorpaenids (genera *Sebastes* and *Sebastolobus*). Fish. Res. 46: 299-312.

Kondzela, C. M., A. W. Kendall, Z. Li, D. M. Clausen, and A. J. Gharrett. 2007. Preliminary identification of pelagic juvenile rockfishes collected in the Gulf of Alaska. In J. Heifetz, J. DiCosimo, A.J. Gharrett, M.S. Love, V.M. O’Connell, and R.D. Stanley (editors), Biology, assessment, and management of North Pacific rockfishes, p. 153-166. Alaska Sea Grant, Univ. of Alaska Fairbanks.

Krieger, K. J., and D. H. Ito. 1999. Distribution and abundance of shortraker rougheye, *Sebastes borealis*, and rougheye rockfish, *S. aleutianus*, determined from a manned submersible. Fish. Bull. 97: 264-272.

Krieger, K. J., and B. L. Wing. 2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the Gulf of Alaska. Hydrobiologia 471: 83-90.

Kristensen K., A. Nielsen, C. W. Berg, H. Skaug, B. M. Bell. 2016. TMB: automatic differentiation and Laplace approximation. J Stat Softw 70(5):1–21. doi:10.18637/jss.v070.i05

Skaug H. and D. Fournier. 2013. Random effects in AD Model Builder: ADMB-RE User Guide. http://ftp.admb-project.org/admb-11.2pre/admbre-11.2pre.pdf

Laman, N. 2021. Ocean temperature synthesis: Bottom trawl survey. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Laman, E.A., S. Kotwicki, and C. N. Rooper. 2015. Correlating environmental and biogenic factors with abundance and distribution of Pacific ocean perch (*Sebastes alutus*) in the Aleutian Islands, Alaska. Fish. Bull. 113(3): 270-289.

Love, M .S, M. H. Carr, and L. J. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. Environmental Biology of Fishes 30:225-243.

Martin, M. H. 1997. Data report: 1996 Gulf of Alaska bottom trawl survey. U.S Dept. Commer. NOAA Tech. Memo. NMFS-AFSC-82. 235 p.

Martin, M. H., and D. M. Clausen. 1995. Data report: 1993 Gulf of Alaska bottom trawl survey. U.S Dept. Commer. NOAA Tech. Memo. NMFS-AFSC-59. 217 p.

Matala, A. P., A. K. Gray, J. Heifetz, and A. J. Gharrett. 2004. Population structure of Alaska shortraker rockfish, *Sebastes borealis*, inferred from microsatellite variation. Environ. Biol. Fishes. 69: 201-210.

McDermott, S. F. 1994. Reproductive biology of rougheye and shortraker rockfish, *Sebastes aleutianus* and *Sebastes borealis.* Masters Thesis. Univ. Washington, Seattle. 76 p.

Mecklenburg, C. W., T. A. Mecklenburg, and L. K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, Maryland. 1,037 p.

Munk, K. M. 2001. Maximum ages of groundfishes in waters off Alaska and British Columbia and considerations of age determination. Alaska Fish. Res. Bull. 8(1): 12-21.

National Marine Fisheries Service. 2005. Final environmental impact statement for essential fish habitat identification and conservation in Alaska. Available on-line: http://www.fakr.noaa.gov/habitat/seis/efheis.htm.

North Pacific Fishery Management Council. 2008. Gulf of Alaska rockfish pilot program review. Unpubl. report, 35 p. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306 Anchorage, AK 99501. Available on-line: http://www.fakr.noaa.gov/npfmc/current\_issues/groundfish/RPPreview508.pdf

O’Leary, C, N. Laman, and S. Rohan. 2021. Gulf of Alaska groundfish condition. In Ferriss, B., and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Orlov, A. M. 2001. Ocean current patterns and aspects of life history of some northwestern Pacific scorpaenids. In: G. H. Kruse, N. Bez, A. Booth, M. W. Dorn, A. Hills, R. N. Lipcius, D. Pelletier, C. Roy, S. J. Smith, and D. Witherell (editors), Spatial processes and management of marine populations. Pub. No. AK-SG-01-02. Univ. Alaska Sea Grant College Program, Fairbanks AK.

Palsson, W. 2021a. Distribution of rockfish species along environmental gradients in the Gulf of Alaska bottom trawl survey. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Palsson, W. 2021b. Structural Epifauna – Gulf of Alaska. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Palsson, W. 2021c. Miscellaneous species-Gulf of Alaska. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Pearcy, W. G., D. L. Stein, M. A. Hixon, E. K. Pikitch, W. H. Barss, and R. M. Starr. 1989. Submersible observations of deep-reef fishes of Heceta Bank, Oregon. Fish. Bull. 87: 955-965.

Rodgveller, C. J., C. R. Lunsford, and J. T. Fujioka. 2008. Evidence of hook competition in longline surveys. Fish. Bull. 106: 364-374.

Rodgveller, C. J., M. F. Sigler, D. H. Hanselman, and D. H. Ito. 2011. Sampling efficiency of longlines for shortraker and rougheye rockfish using observations from a manned submersible. Mar. Coast. Fish: Dynamics, Management, and Ecosystem Sci. 3: 1-9.

Rogers, L., M. Wilson, and S. Porter. 2021. Ocean temperature synthesis: EcoFOCI spring survey. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Rooper, C. N. and M. H. Martin. 2012. Comparison of habitat-based indices of abundance with fishery-independent biomass estimates from bottom trawl surveys. Fish. Bull. 110(1):21-35.

Rooper, C. N., M. H. Martin, J. L. Butler, D. T. Jones, and M. Zimmerman. 2012. Estimating species and size composition of rockfishes to verify targets in acoustic surveys of untrawlable areas. Fish. Bull. 110(3):317-331.

Sasaki, T., and K. Teshima. 1988. Data report of abun­dance indices of flatfishes, rockfishes, and shortspine thornyhead and grenadiers based on results from Japan-U.S. joint longline surveys, 1979-1987. Unpubl. manuscr., 5 p. (Document submitted to the annual meeting of the International North Pacific Fisheries Commission, Tokyo, Japan, October 1988.) Fisher­ies Agency of Japan, Far Seas Fisheries Research Laboratory, 5-7-1 Orido, Shimizu, Japan 424.

Shaul, L.D., Ruggerone, G.T., and Justin T. Priest, J.T. 2021.. Maturing Coho Salmon Weight as an Indicator of Offshore Prey Status in the Gulf of Alaska. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Siwicke, K. 2021. Ocean temperature synthesis: Longline survey. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Siwicke, K. A., K. B. Echave, and J. Y. Sullivan. 2023. Updated model for the 2023 stock assessment of Shortraker rockfish in the Gulf of Alaska. Plan Team Report, Joint Groundfish Plan Teams, North Pacific Fishery Management Council. 605 W 4th Ave, Suite 306 Anchorage, AK 99501. https://meetings.npfmc.org/CommentReview/DownloadFile?p=4d698035-49d6-40ba-8ef7-61155c9848ad.pdf&fileName=GOAshortraker\_September2023\_KAS.pdf

Sullivan, J. Y., C. Monnahan, P. Hulson, J. Ianelli, J. Thorson, and A. Havron. 2022a. REMA: a consensus version of the random effects model for ABC apportionment and Tier 4/5 assessments. Plan Team Report, Joint Groundfish Plan Teams, North Pacific Fishery Management Council. 605 W 4th Ave, Suite 306 Anchorage, AK 99501. https://meetings.npfmc.org/CommentReview/DownloadFile?p=eaa760cf-8a4e-4c05-aa98-82615da1982a.pdf&fileName=Tier%204\_5%20Random%20Effects.pdf

Sullivan, J., J. A. Dimond, and P. Malecha. 2022b. Slinky pot and hook-and-line comparison project during the experimental leg of the 2021 AFSC sablefish longline survey. AFSC Processed Rep. 2022-02, 18 p. Alaska Fish. Sci. Cent., NOAA, Natl. Mar. Fish. Serv., Auke Bay Laboratories,17109 Pt. Lena Loop Road, Juneau, AK, 99801.

Sullivan, J. Y., C. A. Tribuzio, and K. B. Echave. 2022c. A review of available life history data and updated estimates of natural mortality for several rockfish species in Alaska. U. S. Dept. Comm., NOAA Tech. Memo. NMFS-AFSC-443, 45 p.

von Szalay, P. G., M. E. Wilkins, and M. M. Martin. 2008. Data report: 2007 Gulf of Alaska bottom trawl survey. U.S Dept. Commer. NOAA Tech. Memo. NMFS-AFSC-189. 247 p.

von Szalay, P. G., N. W. Raring, F. R. Shaw, M. E. Wilkins, and M. M. Martin. 2010. Data report: 2009 Gulf of Alaska bottom trawl survey. U.S Dept. Commer. NOAA Tech. Memo. NMFS-AFSC-208. 245 p.

Watson, J.T. and M.W. Callahan. 2021. Ocean temperature synthesis: Satellite Data and Marine Heat Waves. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Westrheim, S.J. 1975. Reproduction, maturation, and identification of larvae of some *Sebastes* (Scorpaenidae) species in the northeast Pacific Ocean. J. Fish. Res. Board Can. 32:2399-2411.

Whitehouse, A. and Aydin, K. 2021. Foraging guild biomass-Gulf of Alaska. In Ferriss, B. and Zador, S., 2021. Ecosystem Status Report 2021: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Yang, M-S., and M. W. Nelson. 2000. Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-112, 174 p.

Yang, M-S. 2003. Food habits of the important groundfishes in the Aleutian Islands in 1994 and 1999. AFSC Proc. Rep 2003-07. 233 p. (Available from National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle WA 98115).

Yang, M-S., K. Dodd, R. Hibpshman, and A. Whitehouse. 2006. Food habits of groundfishes in the Gulf of Alaska in 1999 and 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-164, 199 p.

**Tables**

Table 11-1.--Estimated catch (%) of shortraker rockfish in the Gulf of Alaska by target fishery and gear type, 2005-2023.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Target Fishery | | | | |  | Gear Type | |  |
| Year | Rockfish | Sablefish | Halibut | Pollock | Pacific Cod | Total\* | Trawl | Longline | Total\* |
| 2005 | 51 | 39 | 6 | 3 | <1 | 100 | 54.8 | 45.2 | 100 |
| 2006 | 38 | 28 | 22 | 10 | 1 | 100 | 49.2 | 50.8 | 100 |
| 2007 | 44 | 35 | 13 | 8 | <1 | 100 | 54.0 | 46 | 100 |
| 2008 | 39 | 35 | 15 | 11 | 1 | 100 | 53.2 | 46.8 | 100 |
| 2009 | 47 | 29 | 19 | 4 | 1 | 100 | 56 | 44 | 100 |
| 2010 | 27 | 56 | 14 | 2 | 1 | 100 | 39.4 | 60.6 | 100 |
| 2011 | 52 | 28 | 13 | 5 | 1 | 100 | 65.1 | 34.9 | 100 |
| 2012 | 45 | 45 | 7 | 3 | 1 | 100 | 49 | 51 | 100 |
| 2013 | 43 | 39 | 16 | 2 | 1 | 100 | 48.7 | 51.3 | 100 |
| 2014 | 42 | 40 | 17 | <1 | 1 | 100 | 50.6 | 49.4 | 100 |
| 2015 | 43 | 45 | 10 | 1 | <1 | 100 | 49.2 | 50.8 | 100 |
| 2016 | 38 | 29 | 8 | 24 | <1 | 100 | 64 | 36 | 100 |
| 2017 | 50 | 36 | 13 | <1 | 2 | 100 | 53 | 47 | 100 |
| 2018 | 37 | 51 | 12 | <1 | 1 | 100 | 42.7 | 57.3 | 100 |
| 2019 | 40 | 50 | 9 | 1 | <1 | 100 | 43.5 | 56.5 | 100 |
| 2020 | 47 | 42 | 6 | 5 | <1 | 100 | 54.6 | 45.4 | 100 |
| 2021 | 58 | 31 | 10 | <1 | <1 | 100 | 62.3 | 37.7 | 100 |
| 2022 |  |  |  |  |  | 100 |  |  | 100 |
| 2023 |  |  |  |  |  | 100 |  |  | 100 |

Source: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 3, 2021. \* Numbers may not sum to 100 due to rounding.

Table 11-2.--A summary of key management measures and the time series of catch (t), ABC, TAC, and OFL for shortraker rockfish in the Gulf of Alaska (GOA). Source: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 2, 2021.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | GOA  Total | GOA  ABC | GOA  TAC | GOA  OFL | Management Measures |
| 1988 |  |  |  |  | The NPFMC implements the slope rockfish assemblage, which includes shortraker rockfish and the species that will become “other slope rockfish”, together with Pacific ocean perch, northern rockfish, and rougheye rockfish. Previously, *Sebastes* in Alaska were managed as the “Pacific ocean perch complex” or “other rockfish”. Apportionment of ABC among management areas in the Gulf (Western, Central, and Eastern) for slope rockfish assemblage is determined based on average percent biomass in previous NMFS trawl surveys. |
| 1989 |  | 2,092 | 2,092 |  |  |
| 1990 |  |  |  |  |  |
| 1991 | 702 | 2,000 | 2,000 |  | Slope rockfish assemblage is split into three management subgroups with separate ABCs and TACs: Pacific ocean perch, shortraker/rougheye rockfish, and “other slope rockfish”. |
| 1992 | 2,165 | 1,960 | 1,960 |  |  |
| 1993 | 1,932 | 1,960 | 1,764 |  |  |
| 1994 | 1,832 | 1,960 | 1,960 |  |  |
| 1995 | 2,250 | 1,910 | 1,910 |  |  |
| 1996 | 1,661 | 1,910 | 1,910 |  |  |
| 1997 | 1,609 | 1,590 | 1,590 |  | Area apportionment procedure for shortraker/rougheye is changed. Apportionment is now based on 4:6:9 weighting of biomass in the most recent three NMFS trawl surveys. |
| 1998 | 1,734 | 1,590 | 1,590 |  |  |
| 1999 | 1,311 | 1,590 | 1,590 |  | Trawling is prohibited in the Eastern Gulf east of 140 degrees W longitude. Eastern Gulf trawl closure becomes permanent with the implementation of FMP Amendments 41 and 58 in 2000 and 2001, respectively. |
| 2000 | 1,745 | 1,730 | 1,730 | 2,513 |  |
| 2001 | 1,976 | 1,730 | 1,730 | 2,513 |  |
| 2002 | 1,323 | 1,620 | 1,620 | 2,343 |  |
| 2003 | 1,402 | 1,620 | 1,620 | 2,343 |  |
| 2004 | 997 | 1,318 | 1,318 | 2,512 |  |

Table 11-2.--(continued)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | GOA  Total | GOA  ABC | GOA  TAC | GOA  OFL | Management Measures |
| 2005 | 501 | 753 | 753 | 982 | Shortraker rockfish is split as a separate management entity from rougheye rockfish and now has its own ABC and TAC. |
| 2006 | 747 | 843 | 843 | 1,124 |  |
| 2007 | 680 | 843 | 843 | 1,124 | Amendment 68 creates the Central Gulf Rockfish Pilot Program, which affects trawl catches of rockfish in this area. |
| 2008 | 607 | 898 | 898 | 1,197 |  |
| 2009 | 562 | 898 | 898 | 1,197 |  |
| 2010 | 498 | 914 | 914 | 1,219 |  |
| 2011 | 546 | 914 | 914 | 1,219 |  |
| 2012 | 687 | 1,081 | 1,081 | 1,441 | The Central Gulf Rockfish Program is permanently put into place. |
| 2013 | 697 | 1,081 | 1,081 | 1,441 |  |
| 2014 | 664 | 1,323 | 1,323 | 1,764 |  |
| 2015 | 571 | 1,323 | 1,323 | 1,764 |  |
| 2016 | 782 | 1,286 | 1,286 | 1,715 |  |
| 2017 | 537 | 1,286 | 1,286 | 1,715 |  |
| 2018 | 747 | 863 | 863 | 1,151 | Estimation of exploitable biomass and area apportionment procedures for shortraker is changed. Apportionment is now based on applying the time series of trawl survey data to a random effects model. |
| 2019 | 697 | 863 | 863 | 1,151 | Longline survey RPWs are added to the random effects model used to estimate exploitable biomass and apply apportionment. |
| 2020 | 492 | 708 | 708 | 944 | Amendment 107 requires GOA wide full retention of rockfish by catcher vessels using pot, hook-and-line, and jig gear while fishing for groundfish or halibut. |
| 2021 | 417 | 705 | 705 | 940 |  |
| 2022 |  |  |  |  |  |
| 2023 |  |  |  |  |  |

Table 11-3.--Commercial catch (t) of fish in the shortraker/rougheye rockfish and shortraker rockfish management categories in the Gulf of Alaska, with total GOA values of acceptable biological catch (ABC) and total allowable catch (TAC), 1991-2023. Updated through October 3, 2021.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Area of Gulf | | | GOA | GOA | GOA |
| Year | Western | Central | Eastern | Total | ABC | TAC |
| Shortraker/Rougheye Rockfish | | | | | | |
| 1991 | 123 | 408 | 171 | 702 | 2,000 | 2,000 |
| 1992 | 115 | 1,367 | 683 | 2,165 | 1,960 | 1,960 |
| 1993 | 85 | 1,197 | 650 | 1,932 | 1,960 | 1,764 |
| 1994 | 114 | 996 | 722 | 1,832 | 1,960 | 1,960 |
| 1995 | 216 | 1,222 | 812 | 2,250 | 1,910 | 1,910 |
| 1996 | 127 | 941 | 593 | 1,661 | 1,910 | 1,910 |
| 1997 | 137 | 931 | 541 | 1,609 | 1,590 | 1,590 |
| 1998 | 129 | 870 | 735 | 1,734 | 1,590 | 1,590 |
| 1999 | 194 | 580 | 537 | 1,311 | 1,590 | 1,590 |
| 2000 | 137 | 887 | 721 | 1,745 | 1,730 | 1,730 |
| 2001 | 126 | 998 | 852 | 1,976 | 1,730 | 1,730 |
| 2002 | 263 | 631 | 429 | 1,323 | 1,620 | 1,620 |
| 2003 | 225 | 856 | 321 | 1,402 | 1,620 | 1,620 |
| 2004 | 277 | 337 | 383 | 997 | 1,318 | 1,318 |
| Shortraker Rockfish | | | | | | |
| 2005 | 71 | 224 | 205 | 501 | 753 | 753 |
| 2006 | 91 | 336 | 320 | 747 | 843 | 843 |
| 2007 | 194 | 214 | 272 | 680 | 2020843 | 843 |
| 2008 | 134 | 238 | 235 | 607 | 898 | 898 |
| 2009 | 152 | 189 | 221 | 562 | 898 | 898 |
| 20202010 | 72 | 131 | 295 | 498 | 914 | 914 |
| 2011 | 81 | 237 | 228 | 546 | 914 | 914 |
| 2012 | 90 | 304 | 293 | 687 | 1,081 | 1,081 |
| 2013 | 37 | 423 | 237 | 697 | 1,081 | 1,081 |
| 2014 | 76 | 325 | 263 | 664 | 1,323 | 1,323 |
| 2015 | 46 | 259 | 266 | 571 | 1,323 | 1,323 |
| 2016 | 52 | 433 | 298 | 782 | 1,286 | 1,286 |
| 2017 | 43 | 219 | 275 | 537 | 1,286 | 1,286 |
| 2018 | 30 | 310 | 407 | 747 | 863 | 863 |
| 2019 | 57 | 231 | 410 | 697 | 863 | 863 |
| 2020 | 6 | 186 | 299 | 492 | 708 | 708 |
| 2021 | 5 | 164 | 248 | 417 | 708 | 708 |
| 2022 |  |  |  |  |  |  |
| 2023 |  |  |  |  |  |  |

Sources: Catch: 1991-2021: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 3, 2021. ABC and TAC: 1991-2007, Clausen (2007); 2008-2023, North Pacific Fishery Management Council website (http://www.fakr.noaa.gov/npfmc/Council0910specs.pdf).Table 11-4.--Estimated commercial catch (t) of shortraker rockfish in the Gulf of Alaska, 1993-2003, based on data from the NMFS Alaska Observer Program database and from the NMFS Alaska Regional Office. See Clausen (2004) for an explanation of how these numbers were estimated.

|  |  |
| --- | --- |
| Year | Catch (t) |
| 1993 | 1,348 |
| 1994 | 1,254 |
| 1995 | 1,545 |
| 1996 | 1,102 |
| 1997 | 1,065 |
| 1998 | 1,069 |
| 1999 | 992 |
| 2000 | 1,214 |
| 2001 | 1,385 |
| 2002 | 1,051 |
| 2003 | 1,010 |

Table 11-5.--Gulf of Alaska (GOA) shortraker rockfish retained (t) and discarded (t) by target fishery, and total GOA discard rate, 2005–2021; approximate percentage of total discards in parentheses. 2005-2021: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 3, 2021.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Halibut | | Pollock-nonpelagic | | Rockfish | | Sablefish | | Total GOA |
| Year | Retained | Discarded | Retained | Discarded | Retained | Discarded | Retained | Discarded | Discard Rate |
| 2005 | 30 | 1 (4%) | 1 | 0 (0%) | 239 | 10 (4%) | 126 | 64 (34%) | 15.9% |
| 2006 | 52 | 109 (68%) | 6 | 0 (0%) | 266 | 8 (3%) | 112 | 91 (45%) | 32.3% |
| 2007 | 61 | 26 (30%) | 1 | 0 (0%) | 283 | 8 (3%) | 98 | 130 (57%) | 27% |
| 2008 | 77 | 9 (10%) | 17 | 0 (0%) | 219 | 13(6%) | 120 | 83 (41%) | 19.4% |
| 2009 | 73 | 29 (29%) | 14 | 0 (0%) | 207 | 41(16%) | 83 | 72 (46%) | 27.3% |
| 2010 | 69 | 2 (2%) | 1 | 0 (0%) | 121 | 10 (8%) | 119 | 154 (56%) | 34.9% |
| 2011 | 45 | 15 (25%) | 15 | 0 (0%) | 213 | 28 (12%) | 77 | 54 (41%) | 21.8% |
| 2012 | 38 | 9 (20%) | 3 | 0 (0%) | 276 | 25 (8%) | 129 | 175 (58%) | 32% |
| 2013 | 40 | 70 (63%) | 2 | 0 (0%) | 247 | 42 (15%) | 93 | 169 (65%) | 42.3% |
| 2014 | 32 | 66 (67%) | 1 | 0 (0%) | 238 | 5 (2%) | 92 | 136 (60%) | 36.2% |
| 2015 | 34 | 19 (37%) | 2 | 0 (0%) | 235 | 3 (1%) | 95 | 154 (62%) | 32.6% |
| 2016 | 30 | 32 (52%) | 2 | 154 (99%) | 276 | 18 (6%) | 63 | 161 (72%) | 49.6% |
| 2017 | 25 | 40 (61%) | <1 | 0 | 227 | 29 (11%) | 62 | 125 (67%) | 38.2% |
| 2018 | 27 | 59 (69%) | <1 | 0 | 244 | 25 (9%) | 64 | 307 (83%) | 53.8% |
| 2019 | 27 | 32 (54%) | <1 | 0 | 248 | 21 (8%) | 91 | 247 (73%) | 45.1% |
| 2020 | 24 | 5 (16%) | 6 | <1 (2%) | 221 | 4 (2%) | 100 | 102 (50%) | 23.8% |
| 2021 | 26 | 12 (32%) | 1 | <1 (7%) | 194 | 41 (17%) | 47 | 78 (63%) | 32.9% |
| 2022 | 24 | 5 (16%) | 6 | <1 (2%) | 221 | 4 (2%) | 100 | 102 (50%) | 23.8% |
| 2023 | 26 | 12 (32%) | 1 | <1 (7%) | 194 | 41 (17%) | 47 | 78 (63%) | 32.9% |

Table 11-6.--Relative population number (RPN) and relative population weight (RPW) with the associated coefficient of variation (CV) for Gulf of Alaska (GOA) shortraker rockfish in the Alaska Fishery Science Center longline survey, 1992-2023. Data are shown by for the GOA and by management area (western – WGOA, central – CGOA, and eastern – EGOA). RPN and RPW values are calculated using the most recent calculated geographic area sizes for the AFSC longline survey (Echave *et al.* 2013).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | WGOA | CGOA | EGOA | GOA | WGOA |  | CGOA |  | EGOA |  | GOA |
| Year | RPN | RPN | RPN | RPN | RPW | CV | RPW | CV | RPW | CV | RPW |
| 1992 | 1,291 | 1,653 | 7,188 | 10,381 | 1,735 | 30% | 3,212 | 42% | 15,342 | 21% | 20,289 |
| 1993 | 3,266 | 3,781 | 6,471 | 11,038 | 2,103 | 29% | 5,297 | 79% | 14,021 | 18% | 21,420 |
| 1994 | 4,129 | 2,976 | 10,184 | 9,608 | 3,718 | 29% | 3,346 | 38% | 11,987 | 16% | 19,051 |
| 1995 | 5,272 | 1,591 | 7,480 | 15,139 | 7,288 | 34% | 2,924 | 28% | 16,155 | 14% | 26,366 |
| 1996 | 3,745 | 2,577 | 8,600 | 15,885 | 5,428 | 37% | 5,036 | 29% | 20,213 | 16% | 30,677 |
| 1997 | 2,675 | 2,680 | 12,515 | 18,693 | 4,143 | 36% | 4,933 | 34% | 29,767 | 19% | 38,843 |
| 1998 | 4,325 | 3,020 | 13,415 | 21,886 | 6,268 | 34% | 5,814 | 36% | 28,642 | 13% | 40,723 |
| 1999 | 4,616 | 3,385 | 11,674 | 20,751 | 6,380 | 27% | 5,883 | 26% | 23,956 | 14% | 36,218 |
| 2000 | 8,775 | 3,634 | 14,911 | 28,670 | 13,795 | 37% | 6,218 | 17% | 33,433 | 13% | 53,446 |
| 2001 | 4,732 | 4,217 | 13,321 | 23,178 | 6,699 | 39% | 8,263 | 30% | 29,309 | 26% | 44,270 |
| 2002 | 3,159 | 2,687 | 9,800 | 16,726 | 4,693 | 28% | 4,460 | 21% | 21,820 | 20% | 30,973 |
| 2003 | 3,344 | 2,098 | 8,754 | 14,743 | 5,525 | 38% | 4,167 | 38% | 19,666 | 17% | 29,359 |
| 2004 | 6,079 | 1,636 | 8,948 | 17,478 | 9,282 | 57% | 2,716 | 16% | 18,886 | 20% | 30,884 |
| 2005 | 1,852 | 1,899 | 7,524 | 12,131 | 3,126 | 59% | 3,214 | 24% | 16,831 | 17% | 23,171 |
| 2006 | 3,749 | 3,496 | 7,700 | 15,552 | 5,650 | 43% | 6,233 | 18% | 14,894 | 18% | 26,776 |
| 2007 | 3,344 | 4,428 | 12,486 | 21,473 | 4,629 | 51% | 8,224 | 34% | 26,436 | 10% | 39,289 |
| 2008 | 3,598 | 4,076 | 11,921 | 20,545 | 5,684 | 43% | 6,590 | 19% | 23,261 | 15% | 35,535 |
| 2009 | 3,980 | 6,491 | 10,148 | 21,249 | 5,608 | 37% | 12,407 | 42% | 18,824 | 18% | 36,839 |
| 2010 | 4,309 | 2,858 | 6,732 | 14,379 | 6,328 | 43% | 4,664 | 25% | 12,746 | 15% | 23,738 |
| 2011 | 7,512 | 4,671 | 7,544 | 20,918 | 10,808 | 39% | 8,135 | 30% | 15,516 | 20% | 34,460 |
| 2012 | 3,471 | 3,684 | 8,739 | 16,448 | 5,212 | 29% | 6,024 | 27% | 18,267 | 18% | 29,504 |
| 2013 | 3,661 | 3,023 | 5,689 | 12,832 | 5,136 | 32% | 4,726 | 20% | 11,447 | 21% | 21,310 |
| 2014 | 2,718 | 4,515 | 10,947 | 18,883 | 3,955 | 32% | 7,698 | 21% | 23,514 | 17% | 35,167 |
| 2015 | 3,057 | 3,601 | 10,614 | 18,193 | 4,456 | 35% | 5,497 | 27% | 23,601 | 16% | 33,554 |
| 2016 | 3,196 | 4,073 | 5,607 | 13,185 | 5,505 | 41% | 6,456 | 26% | 12,810 | 20% | 24,772 |
| 2017 | 5,269 | 4,715 | 6,462 | 16,899 | 7,426 | 33% | 7,676 | 20% | 12,399 | 15% | 27,501 |
| 2018 | 3,431 | 3,821 | 6,496 | 14,291 | 4,432 | 34% | 6,042 | 36% | 13,146 | 24% | 23,620 |
| 2019 | 4,325 | 3,640 | 6,974 | 15,163 | 6,848 | 58% | 5,696 | 19% | 14,401 | 26% | 26,945 |
| 2020 | 1,746 | 2,749 | 9,703 | 14,849 | 2,557 | 56% | 4,174 | 20% | 21,239 | 30% | 27,969 |
| 2021 | 3,208 | 3,324 | 11,041 | 18,313 | 4,894 | 38% | 5,967 | 42% | 25,241 | 15% | 36,102 |
| 2022 | 1,746 | 2,749 | 9,703 | 15,222 | 1,434 | 46% | 5,172 | 39% | 22,556 | 22% | 29,163 |
| 2023 | 3,208 | 3,324 | 11,041 | 16,584 | 3,682 | 40% | 3,171 | 13% | 21,702 | 25% | 28,556 |

Table 11-7.--Annual biomass estimates (t) and coefficient of variation (CV) for shortraker rockfish in the Gulf of Alaska (GOA) and by management area (western – WGOA, central – CGOA, and eastern – EGOA) based on bottom trawl surveys conducted between 1990 and 2023.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | WGOA |  | CGOA |  | WGOA |  | GOA |
| Year | Biomass | CV | Biomass | CV | Biomass | CV | Biomass |
| 1990 | 284 | 60% | 4,756 | 48% | 7,642 | 25% | 12,681 |
| 1993 | 2,775 | 66% | 7,055 | 38% | 9,642 | 23% | 19,472 |
| 1996 | 1,905 | 38% | 10,132 | 38% | 8,222 | 27% | 20,258 |
| 1999 | 2,208 | 38% | 12,390 | 41% | 13,676 | 14% | 28,275 |
| 2001\* | 4,313 | 33% | 13,102 | 22% |  |  | 17,415 |
| 2003 | 11,166 | 43% | 17,288 | 33% | 13,569 | 37% | 42,023 |
| 2005 | 5,946 | 45% | 17,083 | 33% | 19,546 | 28% | 42,575 |
| 2007 | 2,492 | 35% | 10,186 | 23% | 22,447 | 35% | 35,125 |
| 2009 | 8,810 | 76% | 16,749 | 26% | 18,626 | 21% | 44,185 |
| 2011 | 2,464 | 63% | 32,896 | 53% | 29,877 | 43% | 65,237 |
| 2013 | 2,248 | 35% | 8,727 | 35% | 56,395 | 41% | 67,370 |
| 2015 | 1,064 | 46% | 14,071 | 28% | 47,181 | 42% | 62,317 |
| 2017 | 2,542 | 71% | 13,792 | 48% | 15,200 | 35% | 31,534 |
| 2019 | 431 | 39% | 17,666 | 45% | 26,677 | 36% | 44,773 |
| 2021 | 2,270 | 55% | 10,231 | 35% | 14,682 | 30% | 27,182 |
| 2023 | 1,958 | 62% | 7,401 | 33% | 21,736 | 42% | 31,096 |

\*The 2001 survey did not sample the EGOA.

Table 11-8.--Time series of predicted exploitable biomass using the random effects model (M23.3) for the Gulf of Alaska (GOA) and by management area (western – WGOA, central – CGOA, and eastern – EGOA), with 95 % lower (LCI) and upper confidence intervals (UCI).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | WGOA | CGOA | EGOA | GOA | LCI | UCI |
| 1990 | 850 | 6,794 | 9,171 | 16,815 | 12,237 | 23,106 |
| 1991 | 947 | 7,155 | 10,016 | 18,117 | 13,502 | 24,310 |
| 1992 | 1,054 | 7,534 | 10,939 | 19,527 | 15,336 | 24,865 |
| 1993 | 1,280 | 7,926 | 11,008 | 20,215 | 16,440 | 24,856 |
| 1994 | 1,600 | 8,325 | 11,486 | 21,411 | 17,253 | 26,571 |
| 1995 | 1,967 | 8,837 | 13,110 | 23,914 | 19,520 | 29,298 |
| 1996 | 2,131 | 10,178 | 14,527 | 26,837 | 22,068 | 32,635 |
| 1997 | 2,296 | 11,187 | 18,499 | 31,983 | 25,020 | 40,883 |
| 1998 | 2,587 | 12,183 | 19,773 | 34,543 | 27,154 | 43,943 |
| 1999 | 2,849 | 12,933 | 17,801 | 33,583 | 28,141 | 40,076 |
| 2000 | 3,305 | 13,492 | 21,628 | 38,425 | 30,075 | 49,095 |
| 2001 | 3,350 | 13,324 | 20,756 | 37,430 | 29,903 | 46,852 |
| 2002 | 3,220 | 11,867 | 18,669 | 33,756 | 27,549 | 41,361 |
| 2003 | 3,554 | 11,231 | 16,939 | 31,724 | 26,157 | 38,477 |
| 2004 | 3,423 | 9,617 | 16,440 | 29,479 | 23,670 | 36,715 |
| 2005 | 3,227 | 10,903 | 16,258 | 30,389 | 24,993 | 36,950 |
| 2006 | 2,975 | 12,597 | 16,301 | 31,872 | 26,277 | 38,659 |
| 2007 | 2,810 | 13,204 | 19,112 | 35,126 | 29,176 | 42,290 |
| 2008 | 2,838 | 14,658 | 18,276 | 35,772 | 29,455 | 43,444 |
| 2009 | 2,913 | 15,747 | 16,574 | 35,235 | 29,446 | 42,161 |
| 2010 | 2,861 | 14,803 | 14,298 | 31,962 | 25,785 | 39,619 |
| 2011 | 2,808 | 15,679 | 15,284 | 33,771 | 27,497 | 41,478 |
| 2012 | 2,510 | 14,317 | 15,767 | 32,593 | 26,418 | 40,212 |
| 2013 | 2,284 | 13,108 | 16,530 | 31,923 | 25,930 | 39,301 |
| 2014 | 2,077 | 14,518 | 17,863 | 34,458 | 28,056 | 42,320 |
| 2015 | 1,965 | 14,330 | 18,085 | 34,381 | 28,220 | 41,887 |
| 2016 | 2,036 | 14,759 | 14,299 | 31,093 | 25,222 | 38,331 |
| 2017 | 2,033 | 15,027 | 13,098 | 30,159 | 24,711 | 36,808 |
| 2018 | 1,757 | 14,026 | 13,653 | 29,436 | 23,641 | 36,651 |
| 2019 | 1,470 | 13,047 | 15,526 | 30,043 | 24,444 | 36,925 |
| 2020 | 1,492 | 11,362 | 16,909 | 29,764 | 23,952 | 36,986 |
| 2021 | 1,555 | 10,685 | 18,116 | 30,357 | 24,799 | 37,160 |
| 2022 | 1,444 | 9,703 | 18,569 | 29,716 | 23,676 | 37,297 |
| 2023 | 1,508 | 8,426 | 18,834 | 28,768 | 22,433 | 36,891 |
| 2024 | 1,508 | 8,426 | 18,834 | 28,768 | 20,282 | 40,804 |
| 2025 | 1,508 | 8,426 | 18,834 | 28,768 | 18,767 | 44,098 |

Table 11-9.--Analysis of ecosystem considerations for shortraker rockfish.

| ***Indicator*** | ***Observation*** | ***Interpretation*** | ***Evaluation*** |
| --- | --- | --- | --- |
| ***ECOSYSTEM EFFECTS ON STOCK*** |  |  |  |
| ***Prey availability or abundance trends*** | important for larval and post-larval survival, but no information known | may help to determine  year class strength | possible concern |
| ***Predator population trends*** | Unknown |  | little concern for adults |
| ***Changes in habitat quality*** | Variable | variable recruitment | possible concern |
| ***FISHERY EFFECTS ON ECOSYSTEM*** |  |  |  |
| ***Fishery contribution to bycatch*** |  |  |  |
| Prohibited species | Unknown |  |  |
| Forage (including herring, Atka mackerel, cod, and pollock) | Unknown |  |  |
| HAPC biota (sea pens/whips, corals, sponges, anemones) | fishery disturbing hard-bottom biota, i.e., corals, sponges | could harm the ecosys-  tem by reducing shelter  for some species | concern |
| Marine mammals and birds | probably few taken |  | little concern |
| Sensitive non-target species | Unknown |  |  |
| ***Fishery concentration in space and time*** | little overlap between fishery and reproductive activities | fishery does not hinder  reproduction | little concern |
| ***Fishery effects on amount of large size target fish*** | Unknown |  |  |
| ***Fishery contribution to discards and offal production*** | discard rates moderate | some unnatural input of  food into the ecosystem | some concern |
| ***Fishery effects on age-at-maturity and fecundity*** | Unknown |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 11-10.--Average bycatch (kg) and bycatch rates during 1997 - 99 of living substrates in the Gulf of Alaska; POT - pot gear; BTR - bottom trawl; HAL - Hook and line (source - Draft Programmatic SEIS). | | | | | | | | | | |
|  |  |  | Bycatch (kg) | |  | Target catch (t) |  | Bycatch rate (kg/t target) | | |
| Target fishery | Gear | Coral | Anemone | Sea whips | Sponge | Coral | Anemone | Sea whips | Sponge |
| Arrowtooth flounder | POT | 0 | 0 | 0 | 0 | 4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Arrowtooth flounder | BTR | 58 | 99 | 13 | 24 | 2,097 | 0.0276 | 0.0474 | 0.0060 | 0.0112 |
| Deep water flatfish | BTR | 1,626 | 481 | 5 | 733 | 2,001 | 0.8124 | 0.2404 | 0.0024 | 0.3663 |
| Rex sole | BTR | 321 | 306 | 11 | 317 | 2,157 | 0.1488 | 0.1417 | 0.0053 | 0.1468 |
| Shallow water flatfish | POT | 0 | 0 | 0 | 0 | 5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Shallow water flatfish | BTR | 53 | 4,741 | 115 | 403 | 2,024 | 0.0261 | 2.3420 | 0.0567 | 0.1993 |
| Flathead sole | BTR | 3 | 267 | 1 | 136 | 484 | 0.0071 | 0.5522 | 0.0019 | 0.2806 |
| Pacific cod | HAL | 28 | 4,419 | 961 | 33 | 10,765 | 0.0026 | 0.4105 | 0.0893 | 0.0030 |
| Pacific cod | POT | 0 | 14 | 0 | 1,724 | 12,863 | 0.0000 | 0.0011 | 0.0000 | 0.1340 |
| Pacific cod | BTR | 34 | 5,767 | 895 | 788 | 37,926 | 0.0009 | 0.1521 | 0.0236 | 0.0208 |
| Pollock | BTR | 1,153 | 55 | 0 | 23 | 2,465 | 0.4676 | 0.0222 | 0.0000 | 0.0092 |
| Pollock | PTR | 41 | 110 | 0 | 0 | 97,171 | 0.0004 | 0.0011 | 0.0000 | 0.0000 |
| Demersal shelf rockfish | HAL | 0 | 0 | 0 | 141 | 226 | 0.0000 | 0.0000 | 0.0000 | 0.6241 |
| Northern rockfish | BTR | 25 | 90 | 0 | 103 | 1,938 | 0.0127 | 0.0464 | 0.0000 | 0.0532 |
| Other slope rockfish | HAL | 0 | 0 | 0 | 0 | 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other slope rockfish | BTR | 0 | 0 | 0 | 0 | 193 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Pelagic shelf rockfish | HAL | 0 | 0 | 0 | 0 | 203 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Pelagic shelf rockfish | BTR | 324 | 176 | 3 | 245 | 1,812 | 0.1788 | 0.0969 | 0.0017 | 0.1353 |
| Pacific ocean perch | BTR | 549 | 90 | 5 | 1,968 | 6,564 | 0.0837 | 0.0136 | 0.0007 | 0.2999 |
| Pacific ocean perch | PTR | 7 | 0 | 0 | 55 | 1,320 | 0.0052 | 0.0000 | 0.0000 | 0.0416 |
| Shortraker/rougheye | HAL | 6 | 0 | 0 | 0 | 19 | 0.3055 | 0.0000 | 0.0000 | 0.0000 |
| Shortraker/rougheye | BTR | 0 | 18 | 0 | 0 | 21 | 0.0000 | 0.8642 | 0.0000 | 0.0000 |
| Sablefish | HAL | 156 | 154 | 68 | 27 | 11,143 | 0.0140 | 0.0138 | 0.0061 | 0.0025 |
| Sablefish | BTR | 0 | 0 | 0 | 0 | 27 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Shortspine thornyhead | HAL | 0 | 0 | 0 | 0 | 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Shortspine thornyhead | BTR | 0 | 9 | 0 | 1 | 2 | 0.0000 | 4.8175 | 0.0000 | 0.4069 |

**Figures**

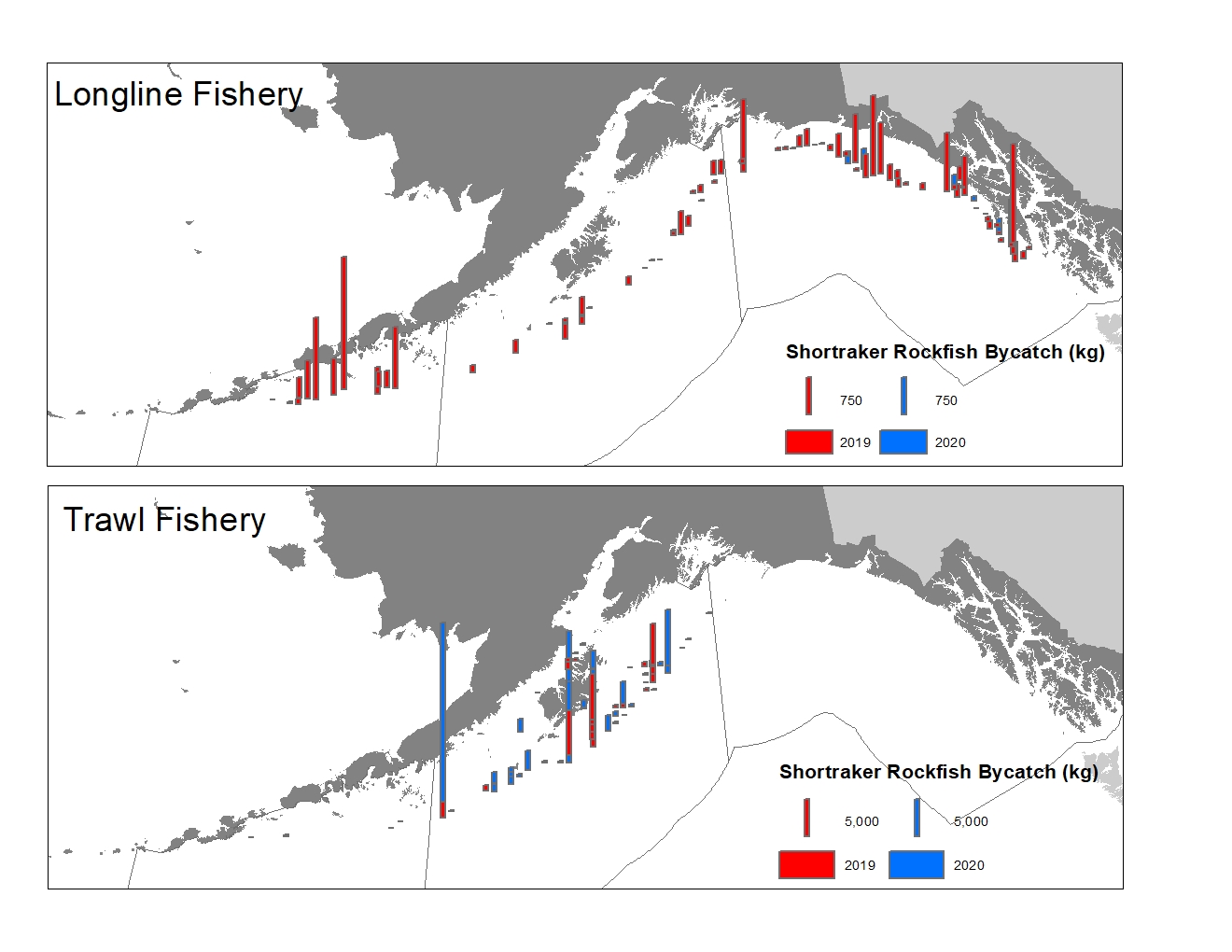


Figure 11-1.--Spatial distribution of observed shortraker rockfish catch in the Gulf of Alaska from 2019 (red bars) and 2020 (blue bars) in the longline fishery (top panel) and trawl fishery (bottom panel). Height of the bar represents the catch in kilograms. Each bar represents non-confidential catch data summarized into 400 km2 grids. Grid blocks with zero catch were not included for clarity. Data provided by the Fisheries Monitoring and Analysis division website, queried October 15, 2021 (https://www.fisheries.noaa.gov/resource/map/spatial-data-collected-groundfish-observers-alaska).

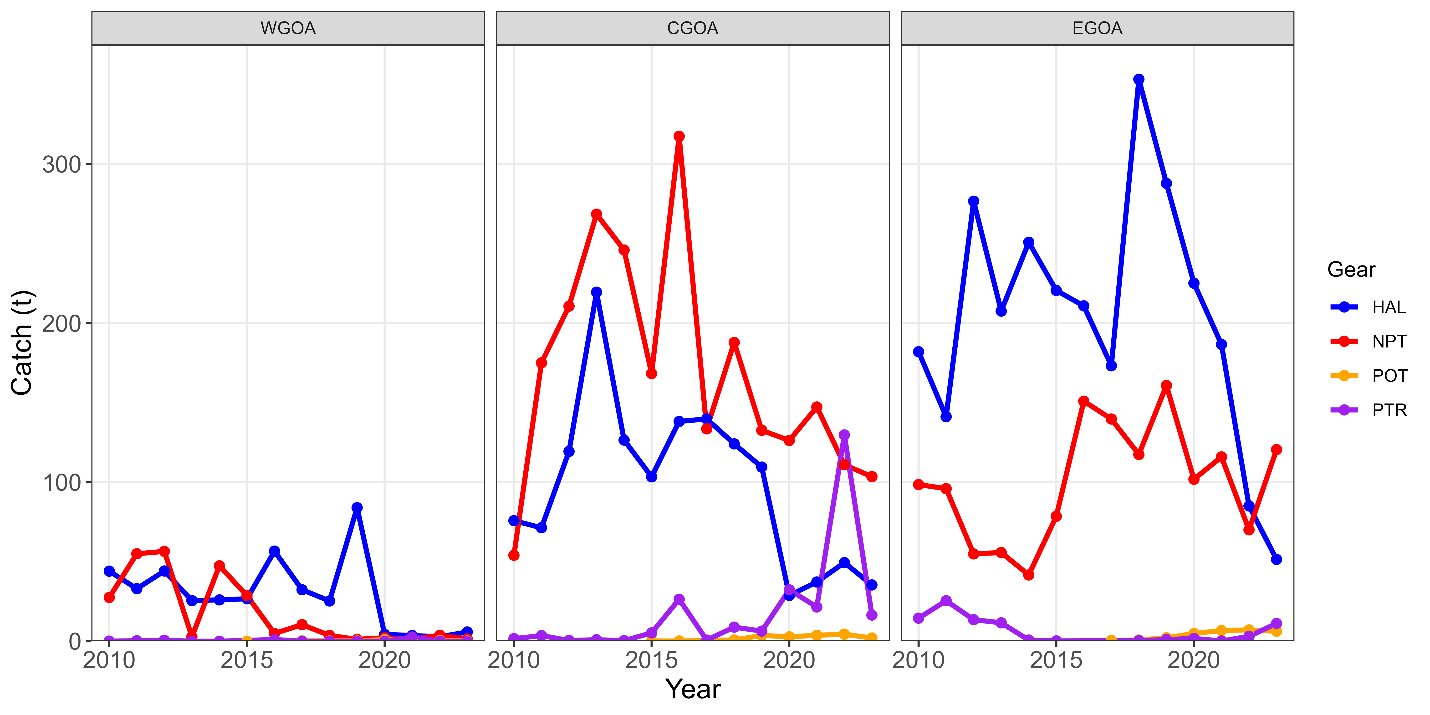


Figure 11-2--Catch (t) of shortraker rockfish by gear type, area and year. Gear type: hook and line (HAL) and nonpelagic trawl (NPT). Area: western Gulf of Alaska (WGOA), central Gulf of Alaska (CGOA), and eastern Gulf of Alaska (EGOA).

Figure 11-3.--Time series of the exploitation rates of shortraker rockfish in the observed hook and line (HAL) fishery (top panel) and the nonpelagic trawl (NPT) fishery (bottom panel), by area [central Gulf of Alaska (CG), eastern Gulf of Alaska (EG), and western Gulf of Alaska (WG)].

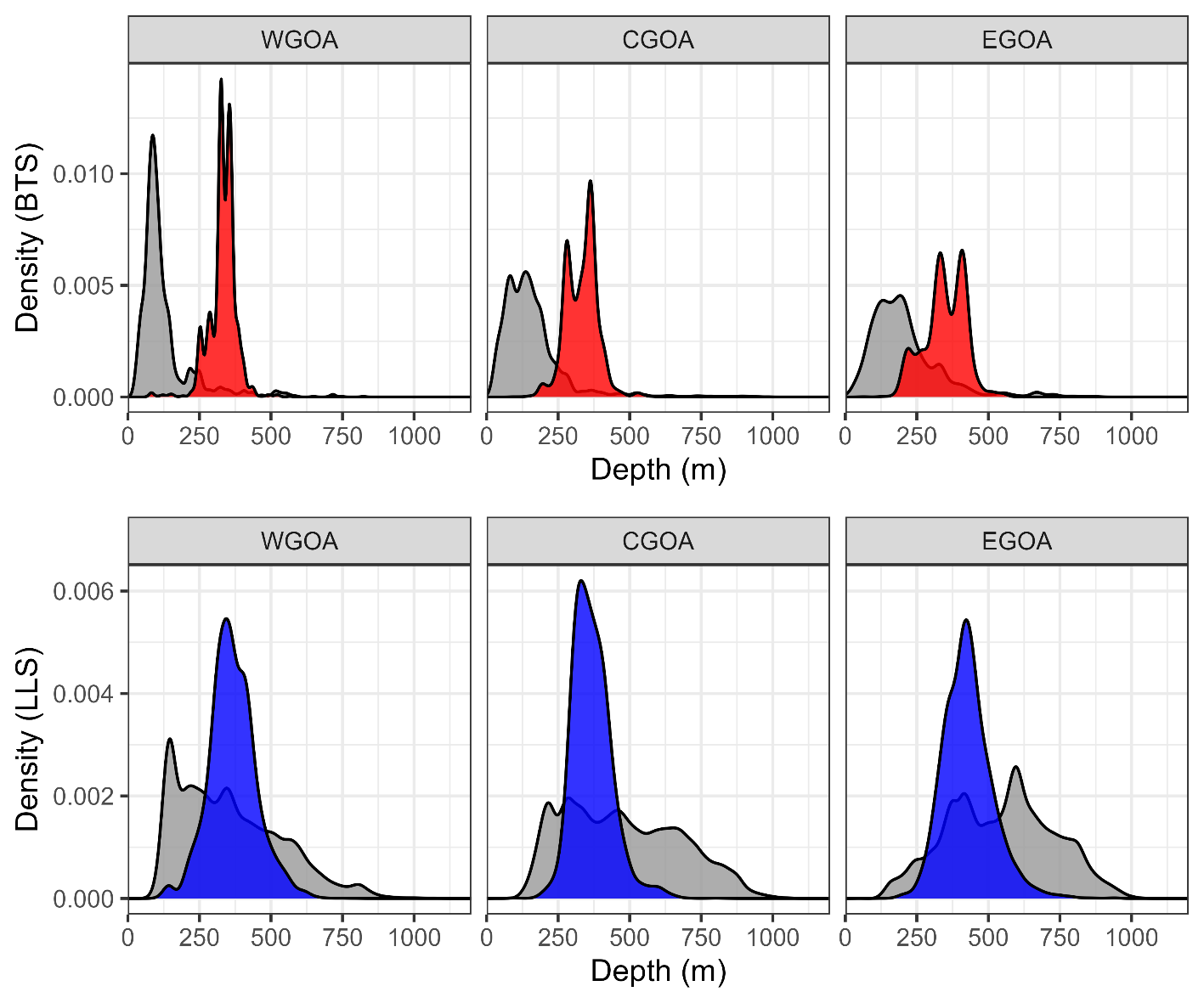


Figure 11-4.--Survey effort (grey in both panels) relative to catch of shortraker rockfish by depth in the Gulf of Alaska (GOA) from the bottom trawl survey (BTS, top panel, red) and longline survey (LLS, bottom panel, blue) by central, eastern, and western GOA (WGOA, CGOA, and EGOA) management area.

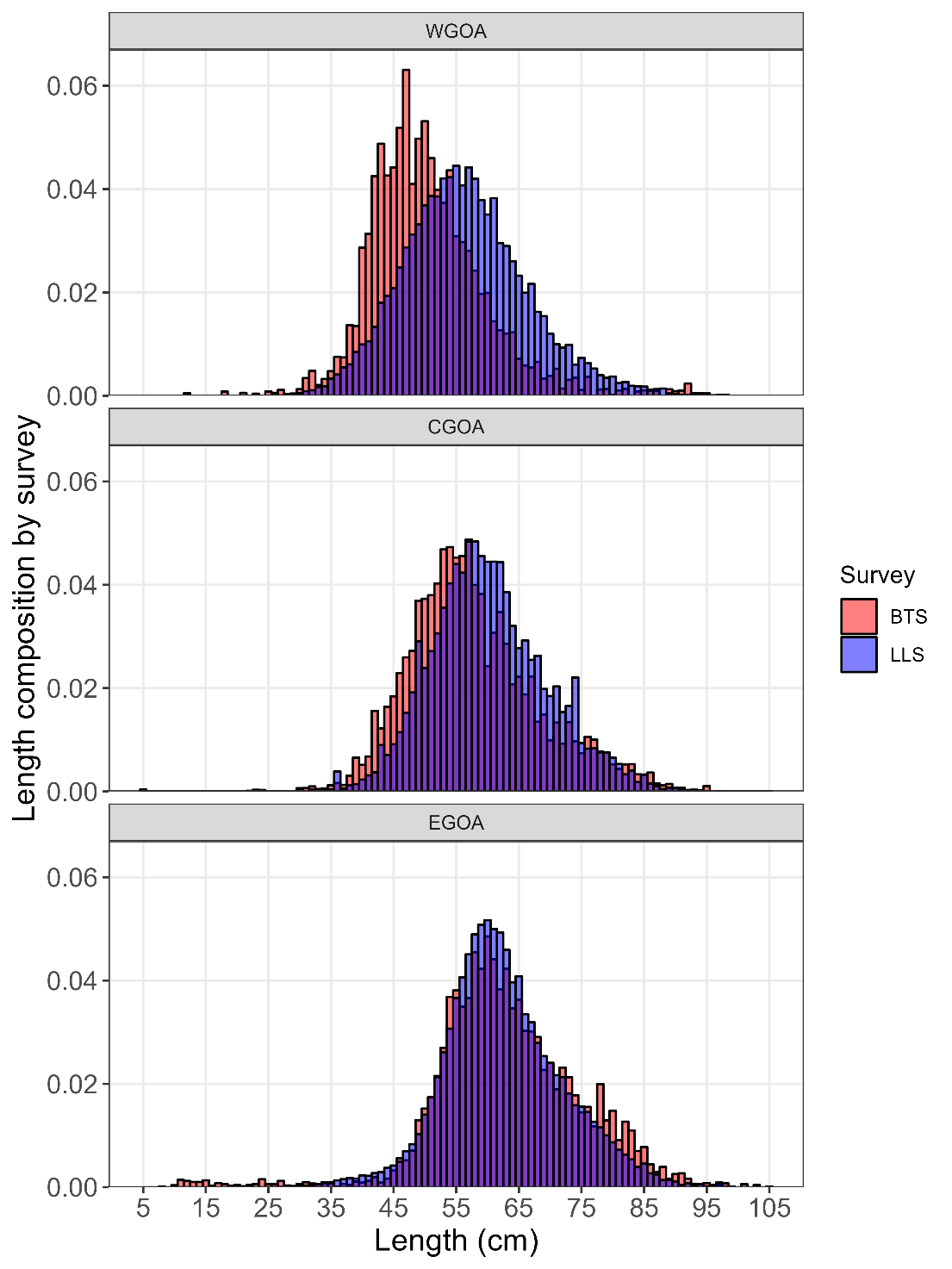


Figure 11-5.--Length compositions for Gulf of Alaska (GOA) shortraker rockfish by bottom trawl survey (BTS, red) and longline survey (LLS, blue) by central, eastern, and western GOA (WGOA, CGOA, and EGOA) management area.

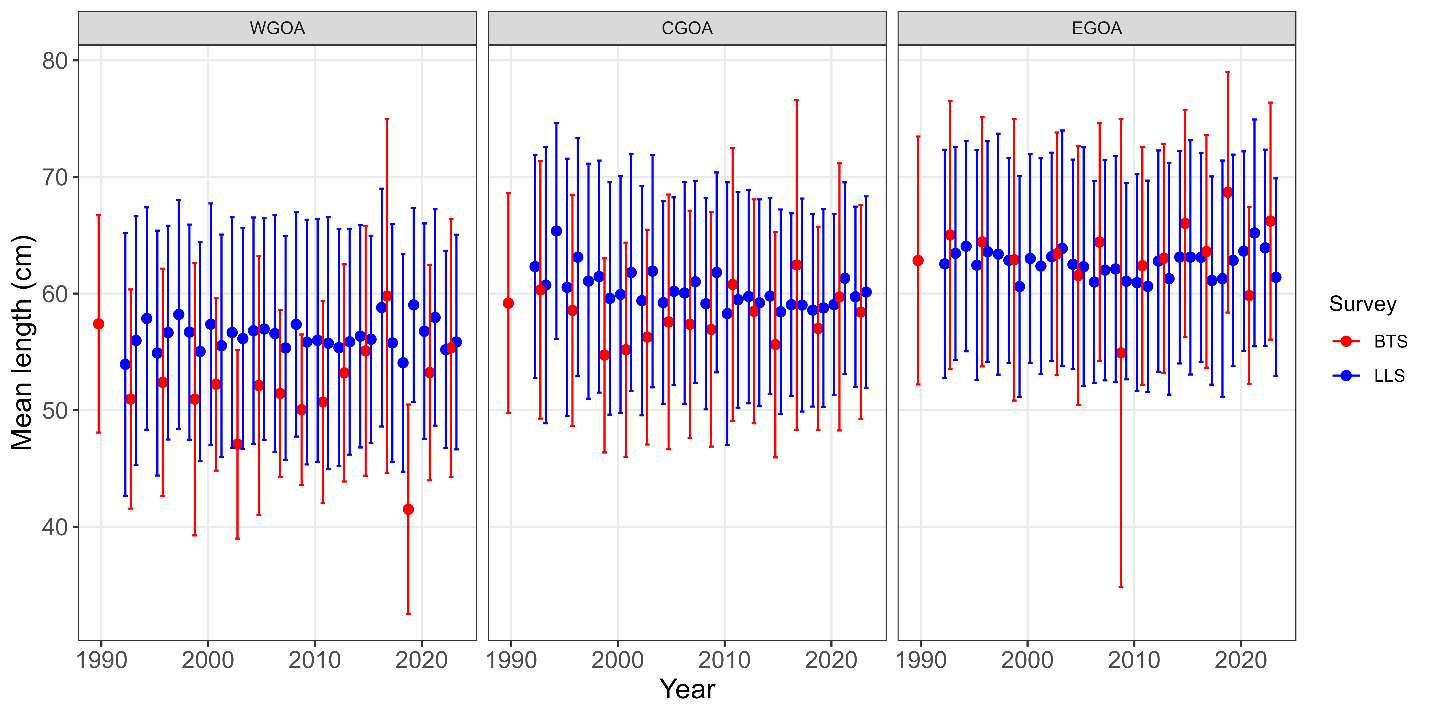


Figure 11-6.--Mean length (error bars = ± 1 SD) through time for Gulf of Alaska (GOA) shortraker rockfish by bottom trawl survey (BTS, red) and longline survey (LLS, blue) by central, eastern, and western GOA (WGOA, CGOA, and EGOA) management area.

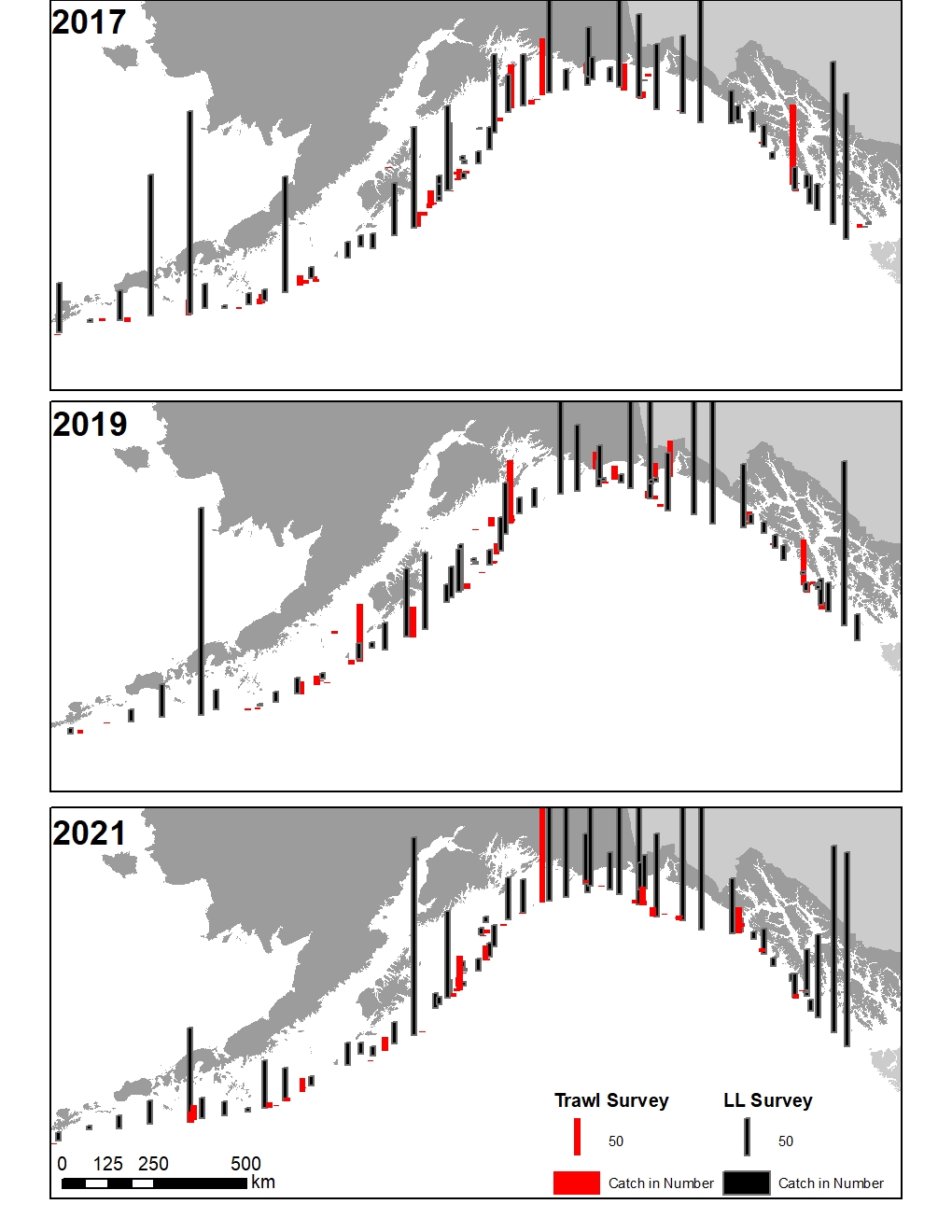


Figure 11-7.--Spatial distribution of shortraker rockfish catches (in number caught) in the Gulf of Alaska during the 2017, 2019, and 2021 NMFS bottom trawl surveys (red bars) and longline surveys (black bars).

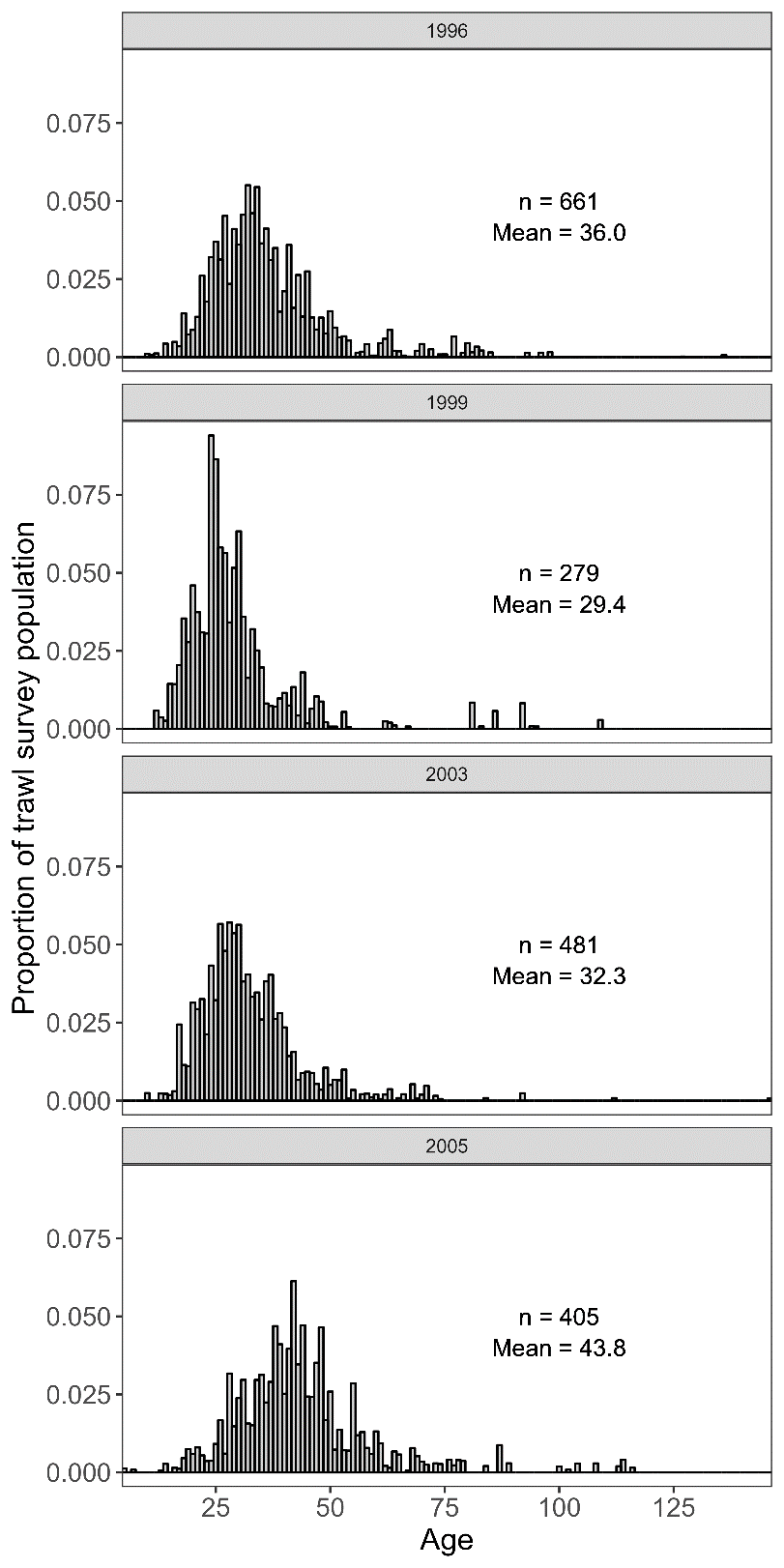


Figure 11-8.--Age composition of the estimated population of shortraker rockfish in the 1996, 1999, 2003, and 2005 Gulf of Alaska bottom trawl surveys.

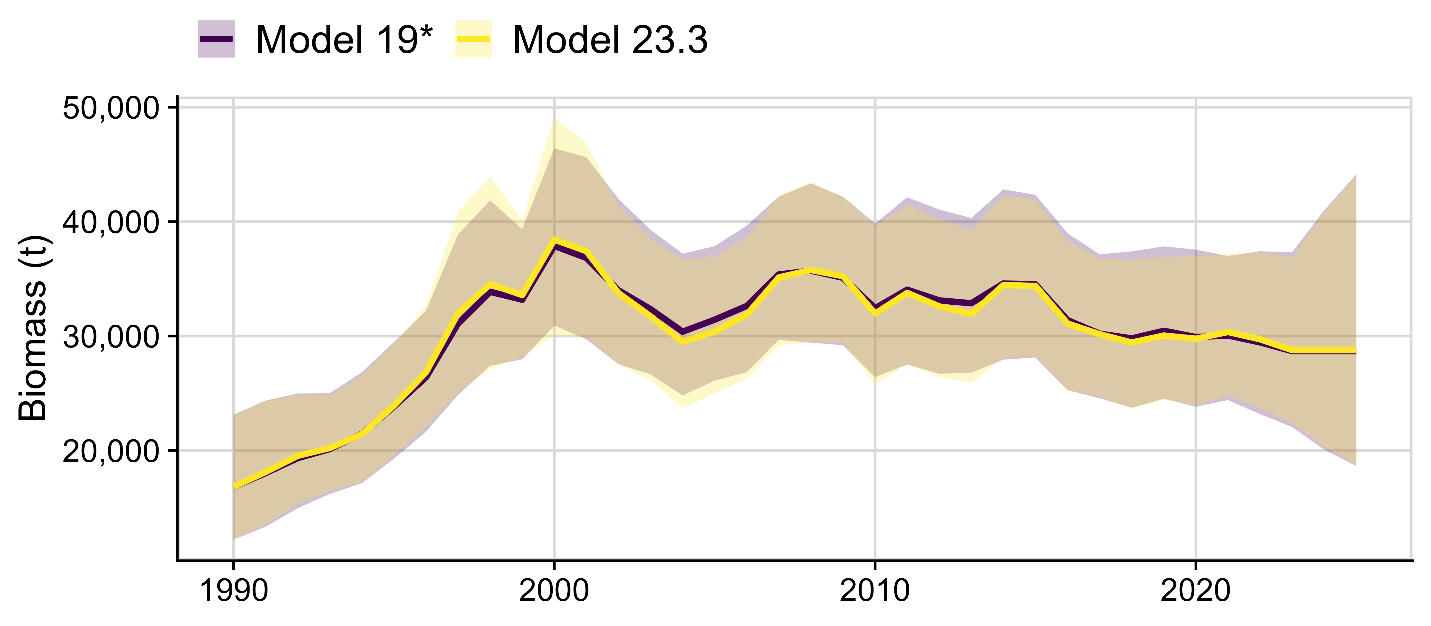


Figure 11-9.--Two-survey random effects (REMA) model fits to Gulf of Alaska (GOA) shortraker rockfish bottom trawl survey (BTS) biomass and longline survey (LLS) relative population weights, where the shaded regions are the model predictions and 95% confidence intervals from the REMA model. Results are shown for Model 19\* (LLS weight = 0.5) in purple and Model 23.3 (LLS weight = 1.0 with extra LLS observation error) in yellow.

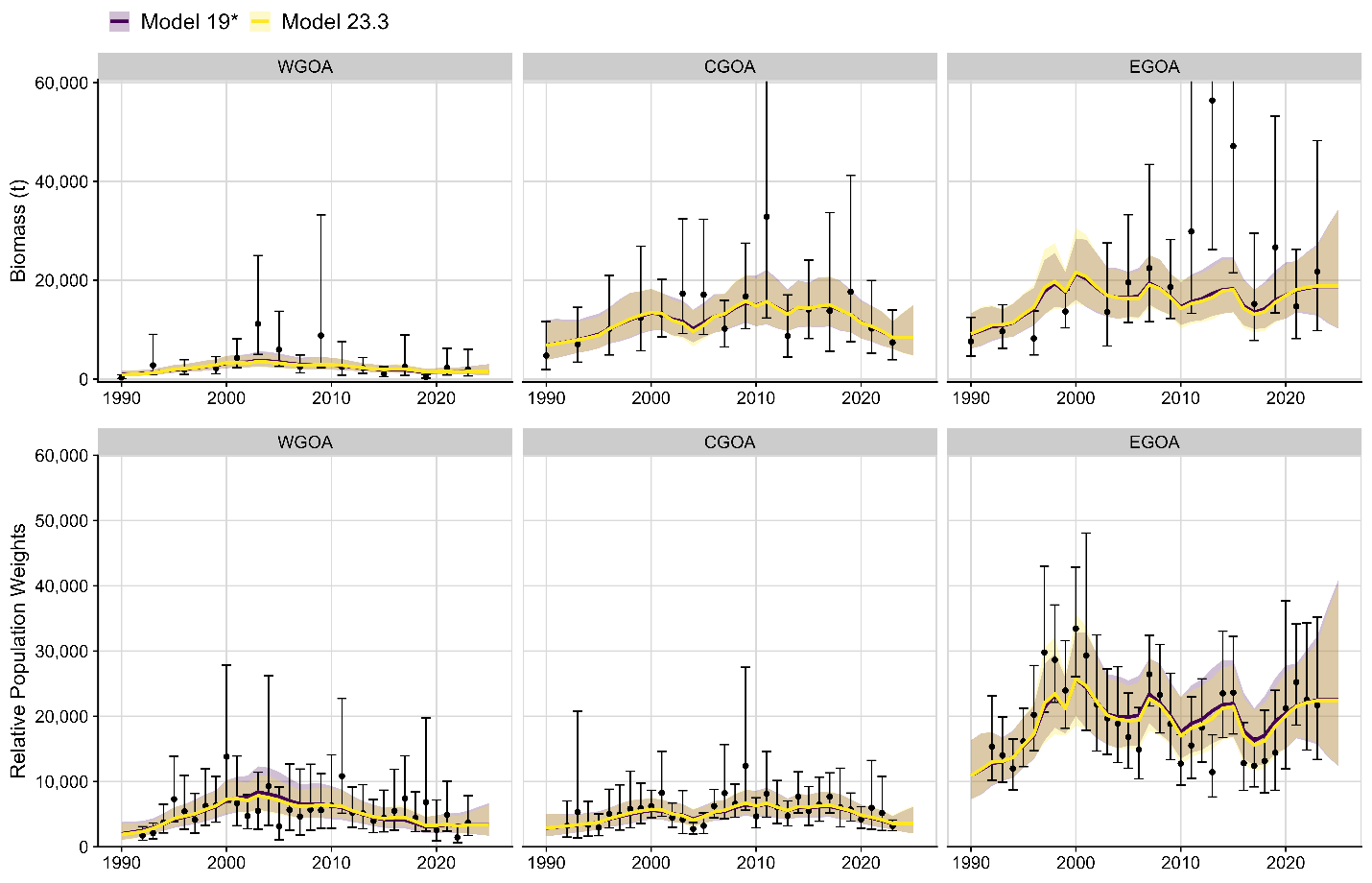


Figure 11-10.--Two-survey random effects (REMA) model fits to Gulf of Alaska (GOA) shortraker rockfish bottom trawl survey (BTS) biomass (top panels) and longline survey (LLS) relative population weights (bottom panels) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area, where the points and error bars are the design-based survey estimates and the lines with shaded regions are the model predictions and 95% confidence intervals from the REMA model. Results are shown for Model 19\* (LLS weight = 0.5) in purple and Model 23.3 (LLS weight = 1.0 with extra LLS observation error) in yellow.

**Appendix 11A – Supplemental Catch Data**

In order to comply with the Annual Catch Limit (ACL) requirements, non-commercial removals in the Gulf of Alaska (GOA) are presented. Non-commercial removals are estimated total removals that do not occur during directed groundfish fishing activities (Table 11A-1). 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.

Research catches of shortraker rockfish for the years 1977-2020 are listed in Table 11A-2. Although data are not available for a complete accounting of all research catches, the values in the table indicate that generally these catches have been modest. The one exception is 1999, when a total of almost 110 t was taken, mostly by research trawling. The majority of research removals of shortraker rockfish are taken by the Alaska Fisheries Science Center’s (AFSC) annual longline survey and the biennial bottom trawl survey, which are the primary research surveys used for assessing the population status of GOA shortraker rockfish. Other research activities that harvest minor amounts of shortraker rockfish include other trawl research activities conducted by the Alaska Department of Fish and Game (ADFG) and the International Pacific Halibut Commission’s (IPHC) longline survey. Recorded recreational harvest or harvest that was non-research related in 2011-2020 have varied between 1 and 6.5 t , surpassing AFSC longline survey research catch for the first time in 2018, and then decreasing again in both 2019 and 2020 to values below 1.5 t. The non-commercial removals show that a little over 14.9 t of shortraker rockfish was taken in 2020 during research cruises and in sport fisheries (Table 11A-1). Nearly equal amounts (between 5 – 6 t) have been taken in longline surveys by either the International Pacific Halibut Commission or the NMFS Alaska Fishery Science Center, and the NMFS trawl survey since 2011. This total was ~3% of the reported commercial catch of 492 t for shortraker rockfish in 2020 (see Table 11-2 in the main document). Therefore, this presents no risk to the stock especially because commercial catches in recent years have been much less than ABCs.

Table 11A-1.--Estimated research and sport catches (t) of shortraker rockfish in the Gulf of Alaska in 2022, based on data provided by the NMFS Alaska Regional Office (AK R.O.). AFSC trawl = NMFS Alaska Fishery Science Center bottom trawl survey; IPHC longline = International Pacific Halibut Commission longline survey; AFSC longline = NMFS Alaska Fishery Science Center longline survey; ADFG PWS = Alaska Department of Fish and Game Prince William Sound sablefish tagging survey.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Source | AFSC trawl | IPHC longline | AFSC longline | ADFG PWS | Sport | Total |
| AK R.O. | - | 7.62 | 5.95 | - | 1.36 | 14.94 |

Table 11A-2.--Catch (t) of shortraker rockfish taken during NMFS research cruises in the Gulf of Alaska, 1977-2022. Longline data refers only to catches in the AFSC longline survey and does not include the International Pacific Halibut Commission longline survey. (n.a.=not available; tr=trace).

|  |  |  |  |
| --- | --- | --- | --- |
|  | Gear | |  |
| Year | Trawl | Longline | Total |
| 1977 | 0.1 | 0.0 | 0.1 |
| 1978 | 0.6 | n.a. | 0.6 |
| 1979 | 0.5 | n.a. | 0.5 |
| 1980 | 1.0 | n.a. | 1.0 |
| 1981 | 6.2 | n.a. | 6.2 |
| 1982 | 2.4 | n.a. | 2.4 |
| 1983 | 0.2 | n.a. | 0.2 |
| 1984 | 6.8 | n.a. | 6.8 |
| 1985 | 3.5 | n.a. | 3.5 |
| 1986 | 0.9 | n.a. | 0.9 |
| 1987 | 15.5 | n.a. | 15.5 |
| 1988 | 0.0 | n.a. | 0.0 |
| 1989 | 0.1 | n.a. | 0.1 |
| 1990 | 2.4 | n.a. | 2.4 |
| 1991 | tr | n.a. | tr |
| 1992 | 0.1 | n.a. | 0.1 |
| 1993 | 3.0 | n.a. | 3.0 |
| 1994 | 0.1 | n.a. | 0.1 |
| 1995 | tr | n.a. | tr |
| 1996 | 4.3 | 5.9 | 10.2 |
| 1997 | 0.0 | 11.1 | 11.1 |
| 1998 | 20.7 | 9.7 | 30.4 |
| 1999 | 101.5 | 8.1 | 109.6 |
| 2000 | 0.0 | 10.0 | 10.0 |
| 2001 | 1.0 | 7.1 | 8.1 |
| 2002 | 0.5 | 6.1 | 6.6 |
| 2003 | 4.3 | 5.5 | 9.8 |
| 2004 | 0.0 | 4.7 | 4.7 |
| 2005 | 4.1 | 4.5 | 8.6 |
| 2006 | 0.0 | 6.0 | 6.0 |
| 2007 | 4.7 | 7.9 | 12.6 |
| 2008 | 0.0 | 8.4 | 8.4 |
| 2009 | 8.3 | 6.7 | 15.0 |
| 2010 | 0.0 | 4.2 | 4.2 |
| 2011 | 4.6 | 6.7 | 11.3 |
| 2012 | 0.0 | 5.3 | 5.3 |
| 2013 | 5 | 4.1 | 9.1 |
| 2014 | 0.0 | 6.8 | 6.83 |
| 2015 | 6.1 | 5.9 | 12 |
| 2016 | 0.0 | 5.0 | 5.0 |
| 2017 | 2.9 | 5.8 | 8.7 |
| 2018 | 0.0 | 5.1 | 5.1 |
| 2019 | 2.8 | 5.5 | 8.3 |
| 2020 | 0.0 | 5.9 | 5.9 |
| 2021 |  |  |  |
| 2022 |  |  |  |

1. C. Hutchinson, National Marine Fisheries Service, Alaska Fisheries Science Center, REFM Division, 7600 Sand Point Way NE, Seattle WA 98115. Pers. commun. Jan. 2009. [↑](#footnote-ref-1)