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

Katy B. Echave, Kevin A. Siwicke, Jane Sullivan, and Bridget Ferriss
November 2023

This report may be cited as:
Echave, K. B., K. A. Siwicke, J. Sullivan, and B. Ferriss, 2023. Assessment of the Shortraker Rockfish stock in the Gulf of Alaska. North Pacific Fishery Management Council, Anchorage, AK. Available from https://www.npfmc.org/library/safe-reports/

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 include new survey biomass from the 2023 bottom trawl survey, new Relative Population Weights (RPWs) from the 2022 and 2023 longline surveys, and updated auxiliary data sources.

We continue to use a Random Effects Multi-area model with an Additional survey (REMA) model fit to survey data to estimate exploitable biomass and determine the recommended Acceptable Biological Catch (ABC; Hulson *et al.* 2021, Sullivan *et al.* 2022a). The REMA model was fit to the time series of the Alaska Fisheries Science Center (AFSC) bottom trawl survey estimated shortraker rockfish biomass (1990–2023) including uncertainty by region and the AFSC longline survey estimated shortraker rockfish RPW (1992–2023) 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 2 October 2023.
2. Length compositions from the 2022 and 2023 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*. (2022a) 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*. 2022a). 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*. 2023b), 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"). In the case of GOA shortraker rockfish, there is data conflict between the bottom trawl and longline survey indices. Specifically, the longline survey RPWs suggest higher proportions of biomass in the eastern and western GOA compared to the bottom trawl survey biomass. The proposed alternative approach has the benefit of utilizing information from the RPWs to inform relative scale of biomass among regions, thus striking a balance between the conflicting survey indices. 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 in 2022.

Quantity	As estimated or *specified last* year for: 2023	2024	As estimated or *recommended this* year for: 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
F_{OFL}	$F=M=0.03$	$F=M=0.03$	$F=M=0.03$	$F=M=0.03$
$maxF_{ABC}$	$0.75M=0.0225$	$0.75M=0.0225$	$0.75M=0.0225$	$0.75M=0.0225$
F_{ABC}	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: 2021	2022	As determined *this* year for: 2022	2023
Overfishing	No	n/a	No	n/a

Updated catch data (t) for shortraker rockfish in the GOA as of October 2, 2023 (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	7	294	165	467	705	705
2023	7	157	189	354	705	705

Area Apportionment

For apportionment of ABC, 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 and ABC value by regulatory area for 2024.

	Regulatory Area Western	Central	Eastern	Total
Area Apportionment	8.3%	20.7%	71.0%	100%
Area ABC (t)	54	134	459	647
OFL (t)				863

Furthermore, the authors acknowledge the possibility of overages in area specific ABCs that may constrain fisheries. For several reasons, the authors have little biological concerns about area-specific depletions. See “Area Allocation of Harvests” section below for further details. The authors suggest area apportionment alternatives be investigated for future management considerations.

Summaries for Plan Team

All values are in tons.

Species	Year	Biomass	OFL	ABC	TAC	Catch[1]
Shortraker rockfish	2022	31,331	940	705	705	467
	2023	31,331	940	705	705	354
	2024	28,768	863	647		
	2025	28,768	863	647		

Stock/ Assemblage	Area	2023				2024		2025	
		OFL	ABC	TAC	Catch[1]	OFL	ABC	OFL	ABC
Shortraker rockfish	W		51	51	7		54		54
	C		280	280	157		134		134
	E		374	374	189		459		459
	Total	940	705	705	354	863	647	863	647

[1]Current as of October 2, 2023. 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

SSC suggests the GPT assessment authors coordinate with Dr. Larson to determine if there are results relevant to their species and how any new information might impact the assessment and management of these species. (SSC, October 2023)
Authors have updated the Stock Structure section with new findings provided by Dr. Wes Larson and his lab. Genetic structure of shortraker was reevaluated with low coverage whole genome resequencing using data from 3.9 million markers. No genetic structure was documented, indicating high gene flow in this species across nearly their full species range. It is hypothesized that this gene flow is due to long distance larval dispersal. For rockfish with no structure, it is likely that areas that are locally depleted will be replenished by larval transport over longer timescales (decades, 100s of years), but in the short term local depletion could cause reduced abundance because adult movement is likely low

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)
We continue to include the risk table in the current assessment.

Responses to SSC and Plan Team Comments Specific to this Assessment

The SSC looks forward to continued exploration of alternative apportionment methods and believes this should remain a high priority. (SSC, December 2019)
We present an alternative apportionment method in this assessment cycle. We propose using the average of the proportions of predicted biomass (trawl survey) and predicted RPWs (longline survey) by area to inform apportionment instead of using only the standard proportion of predicted biomass. In the case of GOA shortraker rockfish, there are data conflicts between the bottom trawl and longline survey indices. Specifically, the longline survey RPWs suggest higher proportions of biomass in the eastern and western GOA compared to the bottom trawl survey biomass. The proposed alternative approach has the benefit of utilizing information from the RPWs to inform relative scale of biomass among regions, thus striking a balance between the conflicting survey indices.

Additionally, the authors suggest alternative management strategies be considered for shortraker rockfish. Area-specific apportionment is meant to discourage geographic over-concentration of harvest across the GOA that may result in localized depletion of specific stocks. However, shortraker rockfish are a non-target rockfish that are not well sampled by existing surveys and can have highly variable catches. Biologically, several reasons exist that may warrant consideration of alternative apportionment strategies that are less restrictive: 1) rockfish species are poorly sampled in existing surveys, 2) there is no evidence of area-specific genetic stock structure, 3) there are minimal biological concerns based on the available life history data and historical fishery removals, and 4) there has been a decrease in shortraker catch due to the recent shift to pot gear in the sablefish fishery, and effective catch accounting systems with species-specific catch data are in place that closely monitor and respond if an increase in localized regional catches occurs (noting that no localized depletion is evident in historical fishery removals). While there may be minimal biological concerns for sub-area ABCs as described above, other non-biological factors may need to be evaluated before gulfwide ABCs are adopted. Further explanation can be found in the Area Allocation section.

Discard rates for fixed gear under full retention mandates remain high, particularly in sablefish fleet, and an overall review is pending to determine how well this new regulation has been implemented and communicated with industry. The SSC looks forward to the results of this review. (SSC, December 2021)
We continue to report discard rates, which have declined in the sablefish fleet since 2021. The overall review is still pending and results will be shared once complete.

The SSC suggests that GOA shortraker rockfish is a good candidate to examine for the working group the SSC requested to develop standard practices for data weighting (see October 2021 SSC Report). (SSC, December 2021)
The authors will continue to follow the progress of this working group and will consider its usefulness for shortraker once results are available.

SSC noted study by Rodgveller et al. (2011) that compared longline survey catch rates of shortraker and rougheye rockfish with observed densities of fish around the longline from a manned submersible that showed a catchability coefficient of 0.91, and requests the authors consider whether or not this would be appropriate for inclusion in assessment. (SSC, December 2021)
Authors will investigate the inclusion of a catchability coefficient in this assessment in the future.

The SSC supports the GOA GPT recommendation that the authors reexamine natural mortality, as this is critical for setting the fishing mortality rate for this long-lived species. The SSC also asks the authors to consider the confidence in the estimates of M, compared to other species without reliable age estimates and with consideration of the longevity of this species, when they evaluate risk levels in the risk tables in the next full assessment. (SSC, December 2021)
The authors have followed the improved methods and resultant natural mortality estimates that have been proposed in recent years by various GOA rockfish species (GOA 'other rockfish') and GOA rougheye/blackspotted. Shortraker rockfish and blackspotted/rougheye rockfish share similar life history characteristics, and current estimates of *M* are determined similarly for both these species. As such, we will continue to follow the progress and outcome for GOA rougheye/blackspotted, in addition to utilizing recent developments in literature on natural mortality (Sullivan *et al*. 2022b).

The SSC is looking forward to seeing the results of research into untrawlable habitat for GOA POP rockfish and encourages the authors to consider whether results are useful for shortraker as well. (SSC, December 2021)

The authors will continue to follow the progress of this project and will consider its usefulness for shortraker once results are available.

The SSC noted that the authors' justification for a level 1 ranking of assessment considerations in the Risk Table was that the CVs of the surveys have remained low and encourages the authors to consider potential bias, in addition to estimated uncertainty. For instance, as untrawlable habitat is preferred by shortraker, perhaps the trawl survey index is biased low. Similarly, if there is hook competition (this would certainly vary over time), the longline survey index might also be biased low. Finally, a submersible study (Rodgveller et al. 2011) showed that the catchability of shortraker and rougheye to the longline was 0.91. While a negative bias may not be justification for a reduction from max ABC, the SSC suggests the authors consider such factors in the risk table rankings. (SSC, December 2021)
The authors thank the SSC for recognizing the potential bias found within both surveys and the ultimate effect it may have on model results. Authors thank the SSC for recommending an appropriate location to address these concerns and will incorporate text regarding this uncertainty in the Risk Table.

The SSC recommends exploring, in an alternative model for December, the author and GOA GPT recommendations to weight the longline survey and bottom trawl survey equally within the rema model and to estimate additional observation error for the longline survey only. (SSC, October 2023)
Authors present two models, 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).

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 based on demographics, and with such little information on growth and reproduction, what is available is insufficient for evaluating comparisons within the spatial extent of the species. Previous genetic studies using eight microsatellite markers indicated evidence of stock structure in the GOA (Gharrett *et al.* 2003; Matala *et al*. 2004). More recently, genetic structure of shortraker was reevaluated with low coverage whole genome resequencing using data from 3.9 million markers. Samples from Oregon and Washington (N=20) were compared with samples from the Aleutian Islands and Bering Sea (N=28). No genetic structure was documented, indicating high gene flow in this species across nearly their full species range. It is hypothesized that this gene flow is due to long distance larval dispersal. For rockfish with no structure, it is likely that areas that are locally depleted will be replenished by larval transport over longer timescales (decades, 100s of years). But in the short term local depletion could cause reduced abundance because adult movement is likely low[2]. 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 managed stock 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 2023, the percentage of shortraker catch taken in rockfish directed fisheries reached a time-series high (63%), while the percentage of shortraker catch taken in sablefish directed fisheries was at a time series low (16%, Table 11-1).

Shortraker rockfish can be caught with both trawls and longlines. Historically, shortraker catch has generally been caught in equal amounts on both trawl (both pelagic and nonpelagic with the majority are caught by nonpelagic trawl) and longline gear (Table 11-1). However, a shift occurred in 2021, with a higher percentage of catch occurring in trawl gear: over 80% of total shortraker catch was taken in trawl gear in both 2022 and 2023 (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 it's 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

[2]W. Larsen, National Marine Fisheries Service, Alaska Fisheries Science Center, ABL Division, 17905 Pt. Lena Loop Rd. Juneau AK 99801. Pers. commun. Oct. 2023.

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 (Table 11-2). 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 in Table 11-2.

Catch History

Official fishery catch statistics for shortraker rockfish in the GOA are only available for 2005–2023, when the species catch was first reported separately for management purposes (Table 11-2). 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 11-2. Prior 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 (Echave et al. 2021). 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 11-2). The 2005–2023 shortraker rockfish official catches have been consistently lower than any of the unofficial estimates in previous years. These low catches in the last eighteen 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 (Figures 11-1 & 11-2), but has generally been trending downward in longline fisheries while increasing slightly in trawl fisheries (Figure 11-2). Catch of shortraker rockfish in the central GOA (294 t) exceeded the apportioned ABC of this region (central GOA ABC = 280 t) in 2022, but the current level of 2023 catch in the central GOA (157 t) remains well below the ABC. 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 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 spikes in the central GOA in 2016 and 2022 was the result of the anomalously large amount of shortraker catch in the pollock fishery (Table 11-3, Figure 11-2). 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. Beginning in 2023, shortraker catch in trawl gear surpassed catch in longline gear in the eastern GOA for the first time (Figure 11-2). Again, this trend can likely be attributed to increased use of pot and slinky pot gear.

Exploitation rates (catch/estimated exploitable biomass) of shortraker rockfish also vary annually by area and gear type, but have generally remained low in 2023 (Figure 11-3). The continued decrease seen in the hook and line fisheries in all areas since 2018 can likely be attributed to a shift to pot gear in the sablefish fishery.

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 variabilis)*, 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 discard rate for shortraker rockfish in the GOA continues in a decreasing trend: the 2023 discard rate for shortraker rockfish in the GOA (14.7%) is currently below the time series mean (35.6%; Table 11-3). Discard rates in sablefish targeted fisheries continue to decrease since the implementation of Amendment 107 to the Fishery Management Plan for Groundfish of the Gulf of Alaska requiring full retention of rockfish by catcher vessels using pot, hook-and-line, and jig gear while fishing for groundfish or halibut (https://www.fisheries.noaa.gov/action/amendment-119-fmp-groundfish-bering-sea-and-aleutian-islands-and-amendment-107-fmp).

Data

Fishery Data

Catch

Detailed catch information for shortraker/rougheye and shortraker rockfish is listed in Table 11-2.

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 and management area (Figure 11-4). Both fisheries show unimodal length frequency distributions, with slightly smaller sized shortrakers caught in trawl gear and similar average length caught between both gear types in the commercial fishery: the average length of shortraker caught in the longline fishery is 57.6 cm, and 59.4 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 to 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 1979–1994, but RPNs for rockfish are only available for the years 1979–1987 (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 RPWs have been computed each year (Table 11-4). For shortraker rockfish, GOA RPWs have ranged from a low of ~19,051 in 1994 to a high of ~53,446 in 2000 (Table 11-4). Meaningful trends in these data over the years are difficult to discern, and GOA 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 catches of shortraker rockfish (Figure 11-5).

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 11-6 & 11-7). 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 11-5). 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. Also, in 1984 a different, non-standard survey design was used in the eastern GOA; furthermore, much of the survey effort in the western and central GOA in 1984 and 1987 was by Japanese vessels that used a very different net design than what has been the standard used by U.S. vessels throughout the surveys. For these reasons, we follow the NPFMC Groundfish Plan Team and SSC recommendations (September, October 2022) to exclude the bottom trawl survey data from 1984 and 1987. This data will no longer be reported in the SAFE report and will not be used in the estimation of shortraker rockfish exploitable biomass.

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 11-5). In 2023, the gulfwide biomass increased by 14.4% from 2021 due to a large increase in the eastern GOA (Table 11-5). Biomass decreased in both the western GOA and central GOA (Table 11-5).

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 11-5). The 2023 survey continues the trend seen in 2021 and 2019 with fewer large catches but an increase in near shore catch of shortraker rockfish (Figure 11-5). 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 11-5 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. With this in mind, it is very likely that biomass estimates provided by the bottom trawl survey are biased low. 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 2011–2023 trawl surveys were all unimodal, with almost no fish <35 cm in length (Figure 11-6). However, results from the 2009 trawl survey included 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. 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 this is seen in both surveys (Figure 11-7). 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, 1999, 2003, and 2005 GOA trawl surveys (Figure 11-8). 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]. 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

[1]C. Hutchinson, Alaska Fisheries Science Center, REFM Division, 7600 Sand Point Way NE, Seattle WA 98115. Pers. commun. Jan. 2009.

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 natural mortality *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), 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 (q_W for the western GOA, q_C for the central GOA, and q_E for the eastern GOA), and an estimated single process error component which is shared across areas and surveys (σ_{PE}). 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 $ln(B_{y,r})$ with associated standard deviations $\sigma_{ln\,(B_{y,r})}$, where y is year, r is region (western GOA, central GOA, or eastern GOA), and $\sigma_{ln\,(B_{y,r})}$ is approximated using the coefficient of variation of the annual survey biomass by region ($\sigma_{B_{y,r}}/B_{y,r}$), such that:

$$\sigma_{ln(B_{y,r})} = \sqrt{ln\left(\left(\frac{\sigma_{B_{y,r}}}{B_{y,r}}\right)^2 + 1\right)}.$$

The biomass survey measurement or observation equation, which describes the relationship between the observed log-transformed survey biomass $ln(B_{y,r})$ and the latent state variable, estimated log-transformed population biomass $ln(\hat{B}_{y,r})$, is expressed as:

$$ln(B_{y,r}) = ln(\hat{B}_{y,r}) + \epsilon_{y,r}, \text{ where } \epsilon_{y,r} \sim N(0, \sigma^2_{ln(B_{y,r})}).$$

The state equation and associated process error σ^2_{PE} is defined as:

$$ln(\hat{B}_{y,r}) = ln(\hat{B}_{y-1,r}) + \eta_{y-1,r}, \text{ where } \eta_{y,r} \sim N(0, \sigma^2_{PE}), \text{ and}$$

$$\hat{B}_y = \sum_R e^{ln(\hat{B}_{y,r})}.$$

The second observation model using the annual/regional longline survey RPW index ($I_{y,r}$) is similarly structured with associated standard deviations $\sigma_{ln(I_{y,r})}$ approximated using the coefficient of variation of the annual survey RPW ($\sigma_{I_{y,r}}/I_{y,r}$), such that:

$$\sigma_{ln(I_{y,r})} = \sqrt{ln\left(\left(\frac{\sigma_{I_{y,r}}}{I_{y,r}}\right)^2 + 1\right)}$$

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

$$ln(I_{y,r}) = ln(\hat{I}_{y,r}) + \omega_{y,r}, \text{ where } \omega_{y,r} \sim N(0, \sigma^2_{ln(I_{y,r})}),$$

where the estimated index ($\hat{I}_{y,r}$) is scaled to the estimated population biomass using an estimated region-specific scaling coefficient (q_r) such that:

$$\hat{I}_{y,r} = e^{ln(\hat{I}_{y,r})} = q_r \hat{B}_{y,r}.$$

The state equation for the longline survey shares a process error σ^2_{PE} with the trawl survey:

$$ln(\hat{I}_{y,r}) = ln(\hat{I}_{y-1,r}) + \eta_{y-1,r}, \text{ where } \eta_{y,r} \sim N(0, \sigma^2_{PE})$$

The parameters estimated are q_W, q_C, q_E, and σ_{PE}, in addition to the unobserved population biomass $ln(\hat{B}_y)$ 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, ($\sigma^2_{B_{y,r}}$+ $\sigma^2_{I_{y,r}}$) / $\sigma^2_{PE,r}$, 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 11-4 & 11-5), so an extra estimated observation error ($\sigma_{\tau,I}$) is specified as an additional coefficient of variation component:

$$\sigma_{ln(I_{y,r})} = \sqrt{ln\left(\left(\frac{\sigma_{B_{y,r}}}{B_{y,r}}\right)^2 + \sigma^2_{\tau,I} + 1\right)}.$$

The parameters estimated are q_W, q_C, q_E, σ_{PE}, and $\sigma_{\tau,I}$, in addition to the unobserved population biomass $ln(\hat{B}_y)$ 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 F_{ABC} is estimated by 0.75 * *M*. The acceptable biological catch (ABC) is obtained by multiplying F_{ABC} by the estimated biomass, ABC ≤ 0.75 * *M* * biomass. *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 shortraker 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%**	**71.0%**

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 rate method	Maximum Age	Age at Maturity	Length at Maturity	Area	References
-	-	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 the study 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* (total instantaneous mortality) 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 $W = aL^b$ 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	9.85×10^{-6}	3.13	620
males	1.26×10^{-5}	3.07	302
females	1.02×10^{-5}	3.12	318

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

Area	Sex	t_0	K	L_{inf} (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 the 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 eastern GOA, with an increasing divergence to the west with the longline survey lengths indicating larger fish being sampled (Figure 11-6). The longline survey has relatively consistent mean lengths by region, while the bottom trawl survey lengths have more interannual variability (Figure 11-7). 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 11-9). As such, we recommend fixing both survey weights to 1, but as before, we acknowledge that the longline survey observation error is small relative to the bottom trawl survey (Tables 11-4 & 11-5).

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; Siwicke *et al.* 2023). 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 11-10), and at the gulfwide level (Figure 11-11).

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 down weight 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 (σ_{PE})	0.172	0.033	0.117	0.251	0.174	0.040	0.111	0.272
WGOA scaling parameter (q_W)	2.215	0.316	1.674	2.930	2.205	0.287	1.708	2.846
CGOA scaling parameter (q_C)	0.417	0.043	0.340	0.511	0.424	0.042	0.350	0.515
EGOA scaling parameter (q_E)	1.203	0.106	1.012	1.429	1.189	0.102	1.004	1.407
Extra LLS RPW observation error ($\sigma_{\tau,I}$)					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 $\leq 0.75M$. Because age and maturity data are available for shortraker rockfish (Hutchinson 2004), theoretically this species could be moved into tier 4, where $F_{ABC} \leq F_{40\%}$. 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 REMA model 23.3 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 REMA model were then summed to obtain total GOA biomass of 28,768 t (95% CI between 20,282 and 40,804 Table 11-6) for shortraker rockfish (Figure 11-11).

Specification of OFL and Maximum Permissible ABC

Applying the F_{ABC} to the estimate of current exploitable biomass (using the random effects methodology) of 28,768 t (95% CI of 20,282 and 40,804; Table 11-6) for shortraker rockfish results in a total GOA ABC of 647 t and OFL of 863 t for the 2024 fishery. This ABC is a drop from the 2023 ABC of 705 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: No Concern	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: 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 3: 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—
    a. Data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data
    b. Model fits: poor fits to fishery or survey data, inability to simultaneously fit multiple data inputs
    c. Model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds
    d. Estimation uncertainty: poorly-estimated but influential year classes
    e. Retrospective bias in biomass estimates.
2. Population dynamics considerations—decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.
3. 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.
4. 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.

<u>Assessment considerations</u>*:*

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 REMA model. While these two surveys have often shown opposing trends (trawl survey biomass increased in 2023 while longline survey RPWs decreased), which is not unexpected due to the differing habitats sampled, the inclusion of these two data sources in the REMA model has allowed for increased stability of biomass estimates (Table 11-6) and more consistent regional apportionments across time. While survey indices for shortraker rockfish have historically shown relatively moderate confidence intervals and low CVs, authors do recognize the potential bias and uncertainty that may be found in both of these survey indices. For instance, the trawl survey index may be biased low as untrawlable habitat is preferred by shortraker. Similarly, if there is hook competition (which would vary over time), the longline survey index might also be biased low: a submersible study (Rodgveller *et al*. 2011) showed that the catchability of shortraker and rougheye to the longline was 0.91. We rated the assessment-related concern as level 1, no elevated concern. While biomass estimates for shortraker rockfish have historically shown large changes from year to year (typical of several rockfish assessments) with relatively moderate confidence intervals and low CVs, authors do recognize the potential bias and uncertainty that may be found in both of these survey indices.

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. While both surveys show large annual variability, recent exploitable biomass estimates have been slowly declining: the estimated biomass is as low as it was in the mid- to late-90s and has been generally trending downward since 2007. Overall we rated the population-dynamic concern as level 1, no elevated concern, 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, but exploitable biomass estimates have been in a slow decline.

Environmental/Ecosystem considerations:

While optimal temperatures for shortraker life stages are not known, it is reasonable to expect that the 2023 average ocean temperatures at depth on the shelf edge were adequate for adult rockfish (Siwicke 2023a). Cooler (winter) to warmer (summer) surface temperatures provided good pelagic conditions for age-0 rockfish during a time when they are growing to a size that promotes over winter survival (O'Leary 2023). Shortraker are found around structural epifauna, and multiple datasets from non-target surveys show a continuous decline in sponges since 2015. These trends are observed in the western and central GOA (Sullivan pers. comm.), Shumagin and Kodiak areas (Laman and Dowlin 2023a), and in general across the GOA as part of the structural epifauna broader group (Whitehouse 2023a). We note that while these surveys are not designed for sampling epifauna and that a reduction in this habitat cannot be quantifiably connected to population-level effects on shortraker, the loss of important habitat is a note of concern.

Larval rockfish prey was below average to average on the GOA shelf in the spring and summer, while adult rockfish prey were unknown with some signs of decrease. Zooplankton biomass in the WGOA progressed from below average in the spring to improved conditions in the summer (Kimmel *et al.* 2023, Hopcroft 2023). Summer planktivorous foraging conditions were somewhat improved with above average large calanoid copepod and euphausiid biomass, but continued lower small copepod biomass (Kimmel *et al.* 2023). Planktivorous seabird reproductive success, an indicator of zooplankton availability and nutritional quality, was approximately average in the central GOA, and above average in the eastern

GOA (Drummond *et al.* 2023, Whelan *et al.* 2023). The body condition of adult shortraker rockfish was slightly below average (O'Leary and Rohan 2023) indicating approximately adequate (or slightly diminished) prey to meet their energetic needs. Shrimp decreased around Chirikof, Kodiak, and Yakutat regions (Laman and Dowlin 2023b, Worton 2023). The status of other adult shortraker prey, including squid and deep water fish, is not well known.

There is no cause to suspect increased predation pressure on larval or adult shortraker rockfish. Little is known about the impacts of predators, such as fish and marine mammals, on adult shortraker rockfish. Juvenile rockfish could be predated upon by Pacific cod, arrowtooth flounder, P. halibut, sablefish, and seabirds. In general, apex fish predators in the GOA are at relatively low abundances (including P. cod, P. halibut, and arrowtooth flounder, although sablefish are abundant) (Whitehouse 2023b) and we do not have seabird population abundance data. Potential competitors of larval rockfish include large returns of pink salmon (Whitehouse 2023c, Vulstek and Russell 2023), a relatively large population of Pacific Ocean perch (Hulson *et al.* 2023), large year classes of juvenile sablefish (Goethel *et al.* 2023), and increasing population of pollock (Monnahan *et al.* 2023). The large year classes of sablefish since 2016 are maturing and moving to adult slope habitat, potentially increasing the overlap in distribution and potential for competition with adult shortraker.

We scored this category as level 1, no elevated concern for adult shortraker rockfish, given approximately average physical environmental conditions, mixed trends/unknown status of foraging conditions, potential for increased competition for larvae, and moderate predation pressure. In general, there is a lack of a mechanistic understanding for the direct and indirect effects of ecosystem changes on the survival and productivity of shortraker rockfish.

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 has always been stable and remained below the TAC. However, catch has decreased in recent years due in part to the increased use of traditional pot gear and slinky pots in the sablefish fishery. The majority of incidental catch now occurs in the central GOA rockfish fisheries in trawl gear. Due to their high value, discard rates of shortrakers have generally been low, and continue to decrease following the passing of regulations requiring mandatory retention by fixed gear CVs. Overall, we rated the fishery performance concern as level 1, no elevated concern, due to consistent gulfwide catches below the TAC, but we acknowledge the potential for overages of ABC in the CGOA.

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 predicted biomass and predicted RPWs ("Biomass + RPW") to apportion ABCs among regions. The fit of this model is shown for bottom trawl survey biomass and longline survey RPWs (Figure 11-10). 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	Percent of Total Biomass for Apportionment	Area ABC Apportionment (t)
Western	8.3%	54
Central	20.7%	134
Eastern	71.0%	459
GOA Total	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”).

The SSC has recommended authors to explore *“alternative apportionment methods and believes this should remain a high priority”* (SSC, December 2019). While new methods were explored and implemented in this assessment, the authors acknowledge the concern of potential regional ABC overages. Shortraker species are not targeted and instead are incidentally caught in other target fisheries in both fixed and trawl gear sectors depending on the area. In general, non-target rockfish species in Alaskan waters have ~30 years of catch and survey data that indicate fishing behavior has not changed substantially and that localized depletion is unlikely for stocks that are not targeted. Historically, shortraker catch has been split evenly between trawl and longline gear (Table 11-1). With the sudden shift to pot gear in the sablefish fleet, the majority of shortraker catch now occurs in trawl fisheries. While the purpose of subarea ABCs is to reduce the risk of localized depletion/overfishing on specific stocks, authors are finding less biological justification for these subarea ABCs.

To evaluate appropriateness of sub-area apportionment, some biological and fishery considerations include: 1) there is no evidence of stock structure based on the available data (see the *Evidence of Stock Structure* section above), 2) rockfish species are poorly sampled in existing surveys (see Survey Data section above), 3) there are minimal biological concerns based on the available life history data for GOA rockfish species and historical fishery removals, 4) there has been a decrease in shortraker catch due to the recent shift to pot gear in the sablefish fishery, and effective catch accounting systems with species-specific catch data are in place that closely monitor and respond if an increase in localized regional catches occurs (noting that no localized depletion is evident in historical fishery removals), and 5) there is precedence for combining GOA subareas for non-target rockfish management (e.g., GOA Other Rockfish combining western and central subarea ABCs and GOA Demersal Shelf Rockfish complex having a single ABC for western GOA, central GOA, and West Yakutat.)

Preliminary genetics information indicates two things for many of these species: 1) larval dispersal rates imply that if depletion were to occur in an area, the species would likely re-establish themselves, and 2) lack of stock structure indicates a basin-wide population without much concern for area specific stocks. Second, management advice relies on annual longline and biennial trawl survey results to provide abundance information. Survey results are highly variable and are associated with large uncertainty. Additionally, the trawl survey is likely biased for many of these species due to non-trawlable habitat considerations. Finally, full retention mandates for rockfish in fixed gear fisheries and at-sea observer coverage in trawl fisheries both contribute to a responsive management system with accurate catch monitoring. These catch accounting systems are in place to monitor changes in catch or fishery behavior that may lead to localized harvest concerns for these non-target stocks. While there may be minimal biological concerns for these occurrences as just described, other regulatory factors may need to be considered before gulfwide ABCs are considered, such as Rockfish Program allocations of shortraker rockfish.

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 11-7.

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. Larval rockfish prey (zooplankton) was below average to average on the GOA shelf, in the spring and summer, while adult rockfish prey (shrimp, squid, and deep water fish) were unknown with some signs of decrease. In the western GOA, zooplankton biomass progressed from below average in the spring to improved conditions in the summer (Shelikof Strait; Kimmel *et al.* 2023, and Seward Line; Hopcroft 2023). Around the eastern edge of the central GOA, summer planktivorous foraging conditions were somewhat improved with above average large calanoid copepod and euphausiid biomass, but continued lower small copepod biomass (Kimmel *et al.* 2023). Planktivorous seabird reproductive success, an indicator of zooplankton availability and nutritional quality, was approximately average around in the central GOA, and above average in the eastern GOA (Drummond *et al.* 2023, Whelan *et al.* 2023).

Adult shortraker rockfish in Alaska are opportunistic feeders that prey on shrimp, deep water fish (e.g., myctophids), and squid (Yang and Nelson 2000; Yang 2003; Yang *et al.* 2006). Shrimp decreased around Chirikof, Kodiak, and Yakutat regions (Laman and Dowlin 2023b, Worton 2023). While we have no data on squid abundance, adult returns of pink salmon, which prey heavily on squid, were high in 2023. 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. The status of other adult shortraker prey, such as deep water fish, is not well known.

Predator population trends:

There is no cause to suspect increased predation pressure on larval or adult shortraker rockfish. Little is known about the impacts of predators, such as fish and marine mammals, on adult shortraker rockfish. Juvenile rockfish could be predated upon by Pacific cod, arrowtooth flounder, P. halibut, sablefish, and seabirds. In general, apex fish predators in the GOA are at relatively low abundances (including P. cod, P. halibut, and arrowtooth flounder, although sablefish are abundant) (Whitehouse 2023b) and we do not have seabird population abundance data. Potential competitors of larval rockfish include large returns of pink salmon (Whitehouse 2023c, Vulstek and Russell 2023), a relatively large population of Pacific Ocean perch (Hulson *et al.* 2023), large year classes of juvenile sablefish (Goethel *et al.* 2023), and increasing population of pollock (Monnahan *et al.* 2023). The large year classes of sablefish since 2016 are maturing and moving to adult slope habitat, potentially increasing the overlap in distribution and potential for competition with adult shortraker. 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 1976–1977 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 temperatures for shortraker life stages are not known, it is reasonable to expect that the 2023 average ocean temperatures at depth on the shelf edge were adequate for adult rockfish (Siwicke 2023). 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). Cooler (winter) to warmer (summer) surface temperatures, provided good pelagic conditions for age-0 rockfish in during a time when they are growing to a size that promotes over winter survival (O'Leary 2023). Shortraker are found around structural epifauna, and multiple datasets from non-target surveys show a continuous decline in sponges since 2015. These trends are observed in the western and central GOA (Sullivan pers. comm.), Shumagin and Kodiak areas (Laman and Dowlin 2023a) and in general across the GOA as part of the structural epifauna broader group (Whitehouse 2023a). While a reduction in this habitat cannot be quantifiably connected to population-level effects on shortraker, the loss of important habitat is a note of concern. 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).

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 11-8). 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 2005 have ranged from 16–59% 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. A project conducted by Dr. Will Patterson with the University of Florida conducting eye lens based age validation of shortraker rockfish is currently underway. This work will involve application of the bomb radiocarbon chronometer, as well as a novel approach based on amino acid racemization. Additional work led by Dr. Dave Portnoy's research team at Texas A & M – Corpus Christi will then develop draft epigenetic clocks with validated age estimates form eye lens core $\Delta^{14}C$ analysis.

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.

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., 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. 2023. Ocean temperature synthesis: Seward line may survey. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 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.

Drummond, B., A. Kettle, and H. Renner. 2023. Seabird synthesis: Alaska Maritime National Wildlife Refuge data. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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.

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.

Goethel, D., C.J. Rodgveller, K.B. Echave, K. Shotwell, K. Siwicke, D. Hanselman, P.W. Malecha. M. Williams, K. Omori, C.R. Lunsford. 2023. Assessment of the sablefish stock in Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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.

Hopcroft, R. 2023. Seward Line: Large Copepod & Euphausiid Biomass. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 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.

Hulson, P.F., B.C. Williams, B.E. Ferriss, M. Hall, E.M. Yasumiishi, and D.T. Jones. 2023. Assessment of the Pacific ocean perch stock in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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 $^{210}Pb/^{226}Ra$ disequilibrium to validate conventional ages in Scorpaenids (genera *Sebastes* and *Sebastolobus*). Fish. Res. 46: 299-312.

Kimmel, D., K. Axler, B. Cormack, D. Crouser, W. Fennie, J. Keister, J. Lamb, C. Pinger, L. Rogers, and R. Suryan. 2023. Current and Historical Trends for Zooplankton in the Western Gulf of Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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

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.

Laman, N. and A. Dowlin. 2023a. Structural Epifauna – Gulf of Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Laman, N. and A. Dowlin. 2023b. Miscellaneous Taxa – Gulf of Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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.

Monnahan, C.C., M.W. Dorn, G.M. Correa, A.L. Deary, B.E. Ferriss, M. Levine, D.W. McGowan, L. Rogers, S.K. Shotwell, A. Tyrell, and S. Zador. 2023. Assessment of the walleye pollock stock in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

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. 2023. Ocean temperature synthesis: Bottom trawl survey. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific

O'Leary, C. and S. Rohan. 2023. Gulf of Alaska Groundfish Condition. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 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.

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.

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.

Siwicke, K. 2023. Ocean temperature synthesis: Longline survey. In Ferriss, B., 2023. Ecosystem Status Report 2023: 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.Y., C.A. Tribuzio, and K.B. Echave. 2022b. 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.

Vulstek, S. and J.R. Russell. 2023. Trends in survival of coho, sockeye, and pink salmon from Auke Creek, Southeast Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 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.

Whelan, S., S.A. Hatch, M. Arimitsu, and J.F. Piatt. 2023. Seabird breeding performance on Middleton Island. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Whitehouse, G.A. 2023a. Time Trends in Non-Target Species Catch. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Whitehouse, G.A. 2023b. Forage guild biomass – Gulf of Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Whitehouse, G.A. 2023c. Trends in Alaska commercial salmon catch – Gulf of Alaska. In Ferriss, B., 2023. Ecosystem Status Report 2023: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 1007 West Third, Suite 400, Anchorage, Alaska 99501.

Worton, C. 2023. ADF&G Gulf of Alaska Trawl Survey. In Ferriss, B., 2023. Ecosystem Status Report 2023: 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.

Zenger and M. Sigler. 1992. A comparison of the catch rates of sablefish between the domestic and cooperative longline surveys. Unpubl. manuscr., 30 p. Available Alaska Fish Sc. Cent., NMFS, NOAA, 7600 Sand Point Way NE, Bin C15700, Seattle, WA 98115-0070.

Tables

Table 11-1.--Estimated catch (%) of shortraker rockfish in the Gulf of Alaska by target fishery and gear type, 2005–2023. Trawl includes both pelagic and non-pelagic trawl gear.

	Target Fishery						Gear Type		
Year	Rockfish	Sablefish	Halibut	Pollock	Pacific Cod	Total*	Trawl	Longline	Total*
2005	51	39	6	3	<1	100	58	42	100
2006	38	28	22	10	1	100	63	37	100
2007	44	35	13	8	<1	100	62	38	100
2008	39	35	15	11	1	100	62	38	100
2009	47	29	19	4	1	100	68	32	100
2010	27	56	14	2	1	100	46	54	100
2011	47	34	14	4	1	100	67	33	100
2012	39	50	8	2	<1	100	47	53	100
2013	38	44	16	2	1	100	51	49	100
2014	37	36	26	<1	1	100	59	41	100
2015	39	42	18	1	1	100	54	46	100
2016	33	35	11	21	<1	100	62	38	100
2017	42	42	14	<1	2	100	52	48	100
2018	33	56	11	<1	<1	100	43	57	100
2019	35	55	9	1	<1	100	42	58	100
2020	43	46	6	4	<1	100	54	46	100
2021	46	36	11	5	1	100	63	37	100
2022	40	20	14	25	<1	100	82	18	100
2023	63	16	12	8	<1	100	84	16	100

Source: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 2, 2023. * 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, 2023.

	Area of Gulf			Gulfwide	Gulfwide	Gulfwide	Gulfwide	
Year	Western	Central	Eastern	Total	ABC	TAC	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								
	Shortraker/Rougheye Rockfish							
1991	123	408	171	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	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		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	129	870	735	1,734	1,590	1,590		
1999	194	580	537	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	137	887	721	1,745	1,730	1,730	2,513	
2001	126	998	852	1,976	1,730	1,730	2,513	
2002	263	631	429	1,323	1,620	1,620	2,343	
2003	225	856	321	1,402	1,620	1,620	2,343	
2004	277	337	383	997	1,318	1,318	2,512	

Table 11-2.--(continued)

	Area of Gulf			Gulfwide	Gulfwide	Gulfwide	Gulfwide	
Year	Western	Central	Eastern	Total	ABC	TAC	OFL	Management Measures
		Shortraker Rockfish						
2005	71	224	205	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	91	336	320	747	843	843	1,124	
2007	194	214	272	680	843	843	1,124	Amendment 68 creates the Central Gulf Rockfish Pilot Program, which affects trawl catches of rockfish in this area.
2008	134	238	235	607	898	898	1,197	
2009	152	189	221	562	898	898	1,197	
2010	72	131	295	498	914	914	1,219	
2011	88	250	262	601	914	914	1,219	
2012	101	330	345	777	1,081	1,081	1,441	The Central Gulf Rockfish Program is permanently put into place.
2013	28	489	275	792	1,081	1,081	1,441	
2014	73	373	293	739	1,323	1,323	1,764	
2015	55	277	299	632	1,323	1,323	1,764	
2016	63	482	362	906	1,286	1,286	1,715	
2017	43	274	313	631	1,286	1,286	1,715	
2018	29	322	472	823	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	85	252	452	789	863	863	1,151	Longline survey RPWs are added to the random effects model used to estimate exploitable biomass and apply apportionment.
2020	8	190	334	531	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	8	210	309	527	708	708	944	
2022	7	294	165	467	705	705	940	
2023	7	157	189	354	705	705	940	Area apportionment procedures for shortraker is changed. For apportionment of ABC the random effects model is fit to area-specific trawl survey biomass and longline survey RPWs, and the mean proportions of predicted biomass and predicted RPW by area are calculated.

Table 11-3.--Gulf of Alaska (GOA) shortraker rockfish retained (t) and discarded (t) by target fishery, and total GOA discard rate, 2005–2023; approximate percent of total discards in parentheses. 2005–2023: National Marine Fisheries Service, Alaska Region, Catch Accounting System, accessed via the Alaska Fishery Information Network (AKFIN). Updated through October 2, 2023.

	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%)	27.0 %
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 (57%)	34.9 %
2011	44	27 (38%)	15	0 (0%)	214	28 (12%)	81	94 (54%)	29.7 %
2012	37	26 (41%)	3	0 (0%)	276	25 (8%)	135	243 (64%)	39.4 %
2013	40	87 (68%)	2	0 (0%)	247	42 (15%)	99	240 (71%)	48.8 %
2014	32	134 (81%)	1	0 (0%)	238	5 (2%)	86	147 (63%)	44.4 %
2015	34	73 (68%)	2	0 (0%)	235	3 (1%)	90	166 (65%)	40.2 %
2016	30	69 (69%)	2	154 (99%)	276	18 (6%)	64	246 (79%)	56.7 %
2017	25	63 (71%)	<1	0	227	29 (11%)	64	192 (75%)	47.3 %
2018	27	59 (69%)	<1	0	244	25 (9%)	63	390 (86%)	58.7 %
2019	27	41 (60%)	<1	0	248	21 (8%)	94	326 (78%)	51.3 %
2020	24	9 (26%)	6	<1 (2%)	221	4 (2%)	100	136 (57%)	29.6 %
2021	30	27 (47%)	16	<1 (<1%)	197	44 (18%)	71	116 (62%)	37.4 %
2022	24	41 (63%)	46	1 (2%)	175	6 (3%)	57	36 (38%)	21.7 %
2023	18	26 (60%)	18	<1 (<1%)	216	6 (3%)	39	18 (32%)	14.7 %

Table 11-4.--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 for the GOA and by management area (western – WGOA, central – CGOA, and eastern – EGOA). 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
Year	RPW	CV	RPW	CV	RPW	CV	RPW
1992	1,735	30%	3,212	42%	15,342	21%	20,289
1993	2,103	29%	5,297	79%	14,021	18%	21,420
1994	3,718	29%	3,346	38%	11,987	16%	19,051
1995	7,288	34%	2,924	28%	16,155	14%	26,366
1996	5,428	37%	5,036	29%	20,213	16%	30,677
1997	4,143	36%	4,933	34%	29,767	19%	38,843
1998	6,268	34%	5,814	36%	28,642	13%	40,723
1999	6,380	27%	5,883	26%	23,956	14%	36,218
2000	13,795	37%	6,218	17%	33,433	13%	53,446
2001	6,699	39%	8,263	30%	29,309	26%	44,270
2002	4,693	28%	4,460	21%	21,820	20%	30,973
2003	5,525	38%	4,167	38%	19,666	17%	29,359
2004	9,282	57%	2,716	16%	18,886	20%	30,884
2005	3,126	59%	3,214	24%	16,831	17%	23,171
2006	5,650	43%	6,233	18%	14,894	18%	26,776
2007	4,629	51%	8,224	34%	26,436	10%	39,289
2008	5,684	43%	6,590	19%	23,261	15%	35,535
2009	5,608	37%	12,407	42%	18,824	18%	36,839
2010	6,328	43%	4,664	25%	12,746	15%	23,738
2011	10,808	39%	8,135	30%	15,516	20%	34,460
2012	5,212	29%	6,024	27%	18,267	18%	29,504
2013	5,136	32%	4,726	20%	11,447	21%	21,310
2014	3,955	32%	7,698	21%	23,514	17%	35,167
2015	4,456	35%	5,497	27%	23,601	16%	33,554
2016	5,505	41%	6,456	26%	12,810	20%	24,772
2017	7,426	33%	7,676	20%	12,399	15%	27,501
2018	4,432	34%	6,042	36%	13,146	24%	23,620
2019	6,848	58%	5,696	19%	14,401	26%	26,945
2020	2,557	56%	4,174	20%	21,239	30%	27,969
2021	4,894	38%	5,967	42%	25,241	15%	36,102
2022	1,434	46%	5,172	39%	22,556	22%	29,163
2023	3,682	40%	3,171	13%	21,702	25%	28,556

Table 11-5.--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.

Year	WGOA Biomass	CV	CGOA Biomass	CV	EGOA Biomass	CV	GOA 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 11-6.--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 11-7.--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 11-8.--Average bycatch (kg) and bycatch rates during 1997–1999 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	Bycatch rate (kg/t target)			
Target fishery	Gear	Coral	Anemone	Sea whips	Sponge	catch (t)	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

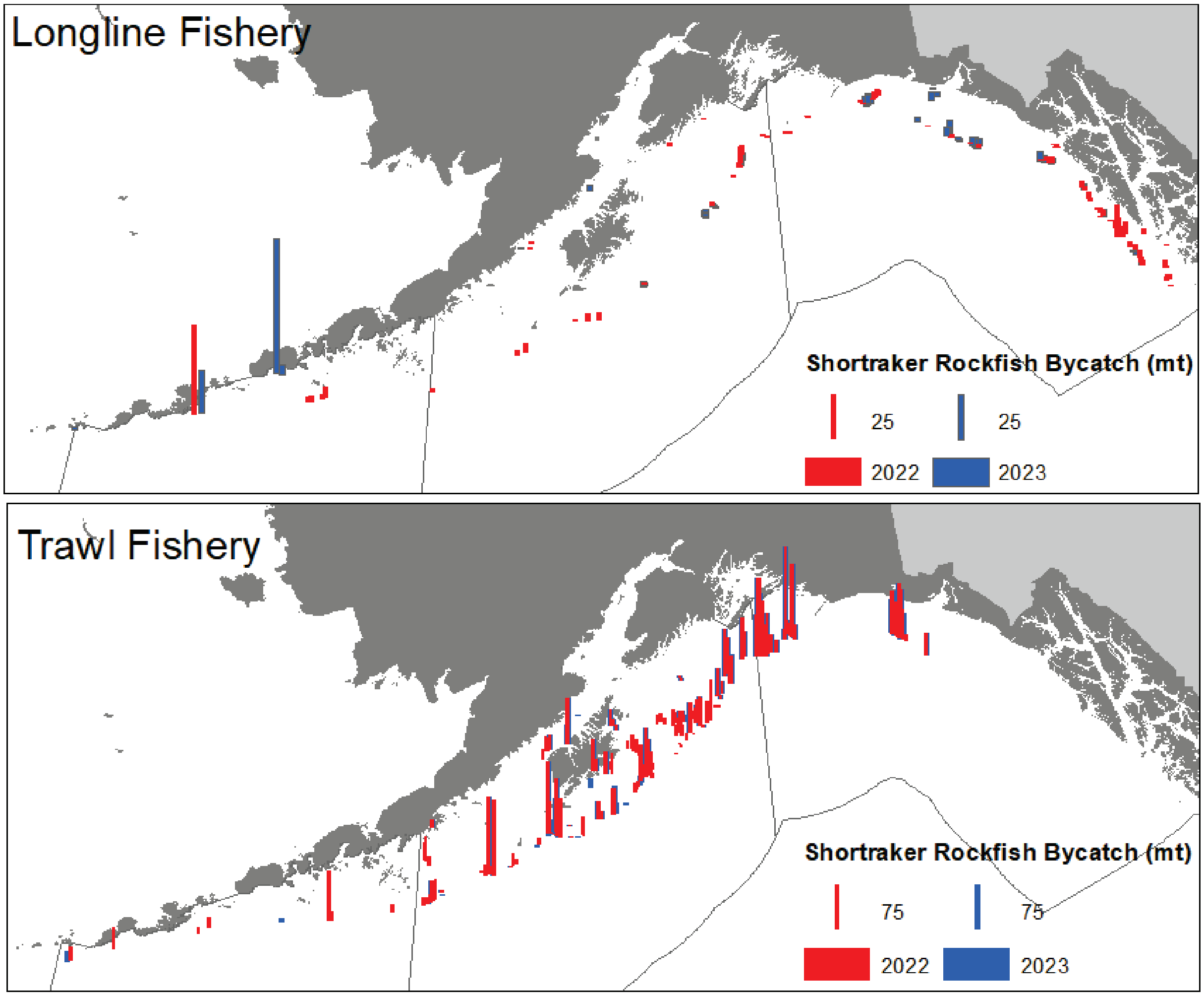

Figure 11-1.--Spatial distribution of observed shortraker rockfish catch (mt) in the Gulf of Alaska from 2022 (red bars) and 2023 (blue bars) in the longline fishery (top panel) and trawl fishery (bottom panel). Height of the bar represents the catch in metric tons. Each bar represents non-confidential catch data summarized into 20 km^2 grids. Grid blocks with zero catch were not included for clarity. Data provided by the NORPAC catch database accessed via the Alaska Fishery Information Network (AKFIN) on Oct. 4. 2023.

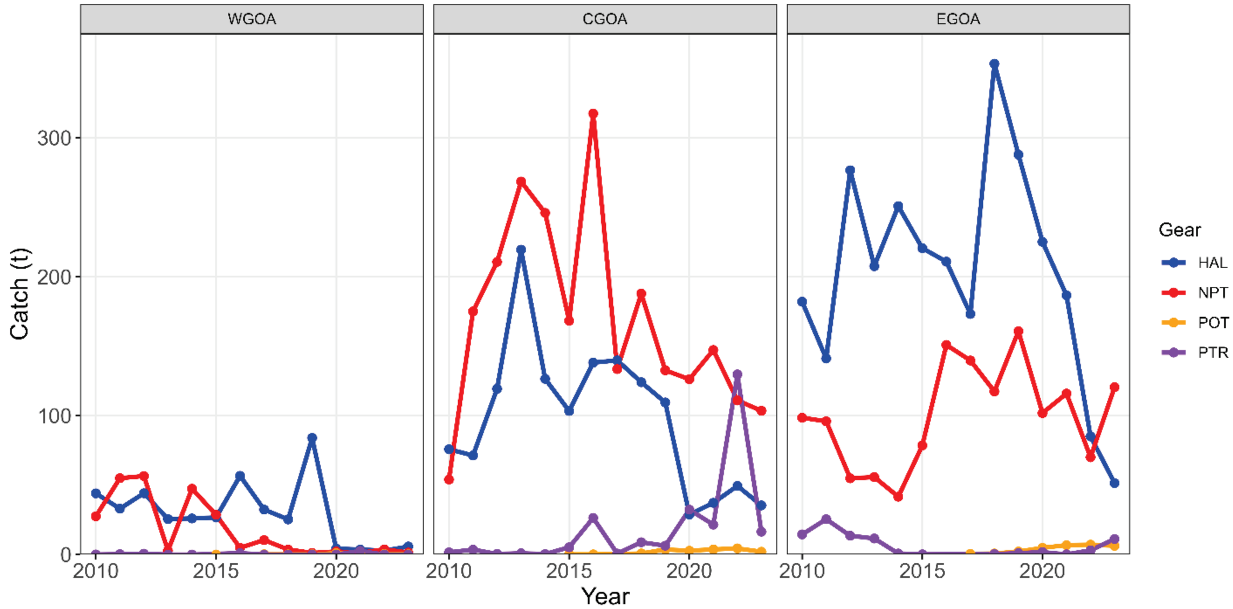

Figure 11-2--Catch (t) of shortraker rockfish by gear type, area and year. Gear type: hook and line (HAL), nonpelagic trawl (NPT), pot, and pelagic trawl (PTR). Area: western Gulf of Alaska (WGOA), central Gulf of Alaska (CGOA), and eastern Gulf of Alaska (EGOA).

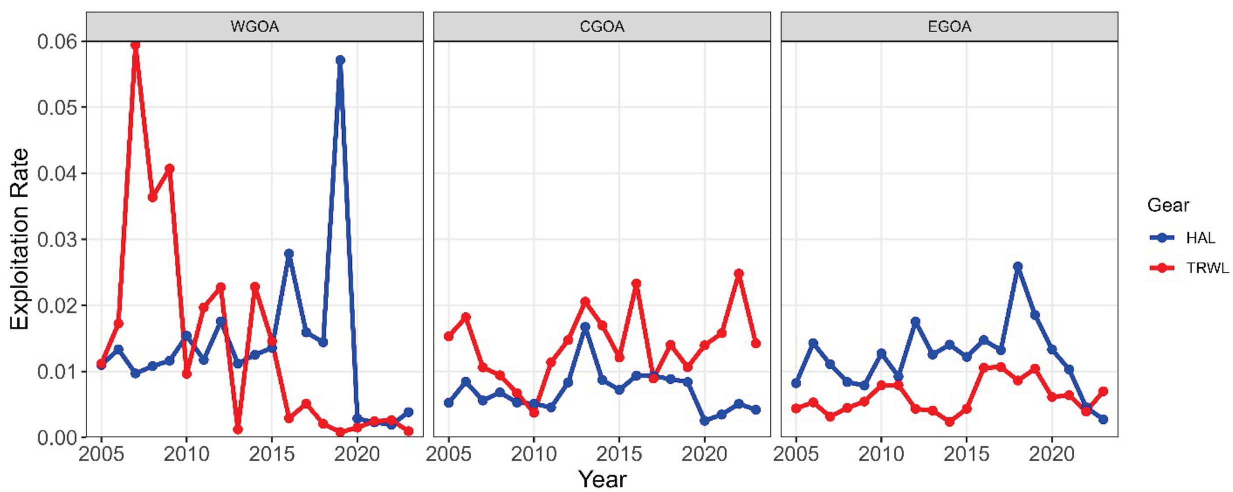

Figure 11-3.--Time series of the exploitation rates (catch/estimated exploitable biomass) of shortraker rockfish in the observed hook and line (HAL) fishery (blue) and the trawl (TRWL) fishery (red), by area [western Gulf of Alaska (WGOA), central Gulf of Alaska (CGOA), and eastern Gulf of Alaska (EGOA)].

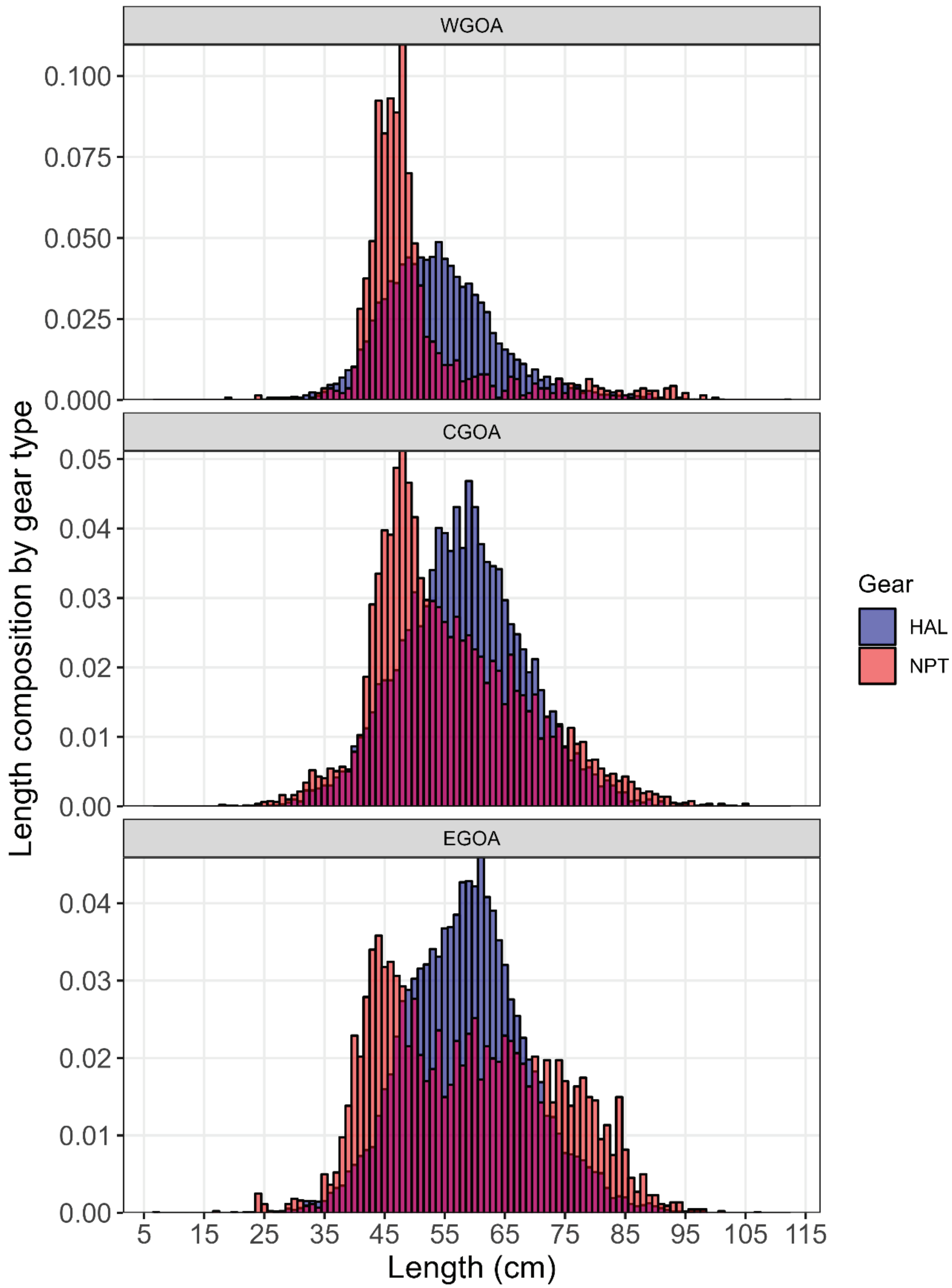

Figure 11-4.-- Length compositions for Gulf of Alaska (GOA) shortraker rockfish by hook and line fishery (HAL, blue) and non-pelagic trawl fishery (NPT, red) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area for years 1990-2023.

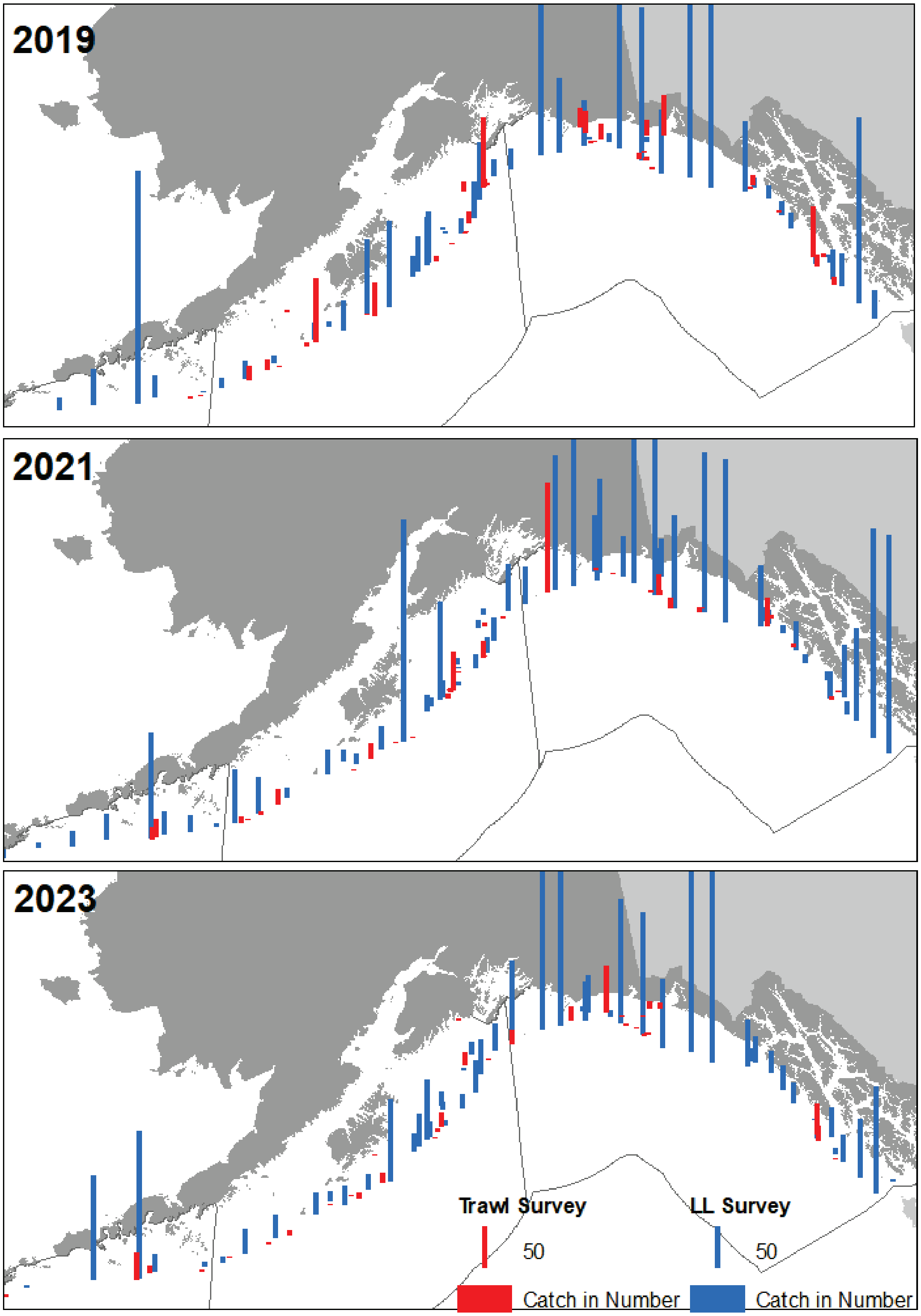

Figure 11-5.--Spatial distribution of shortraker rockfish catches (in number caught) in the Gulf of Alaska during the 2019, 2021, and 2023 NMFS bottom trawl surveys (red bars) and longline surveys (blue bars).

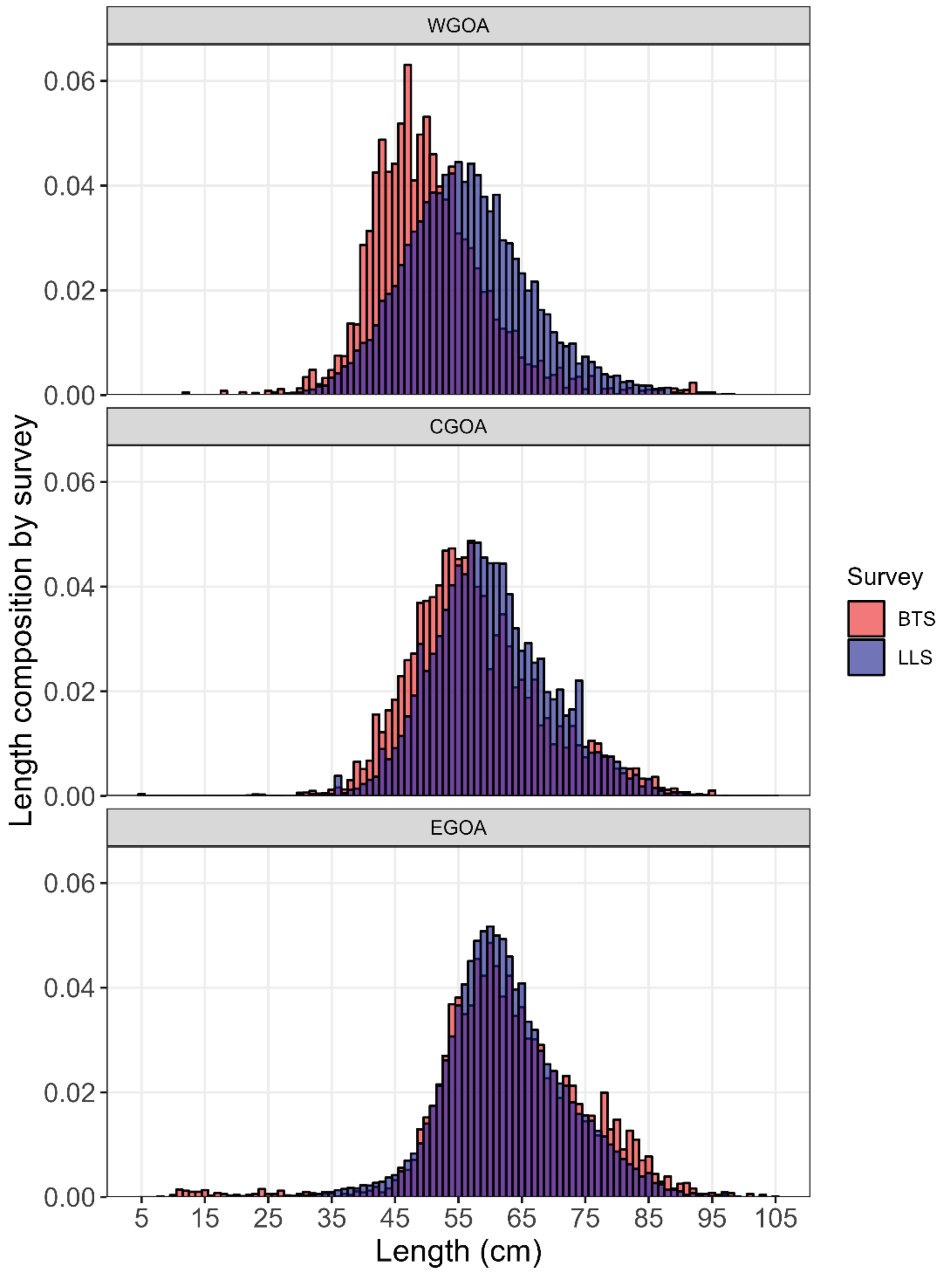

Figure 11-6.--Length compositions for Gulf of Alaska (GOA) shortraker rockfish by bottom trawl survey (BTS, red) and longline survey (LLS, blue) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area for years. Data included for trawl survey length compositions are from 1990, 1993, 1996, 1999, and odd years from 2001 – 2023. Data included for longline survey length compositions are from 1992 – 2023.

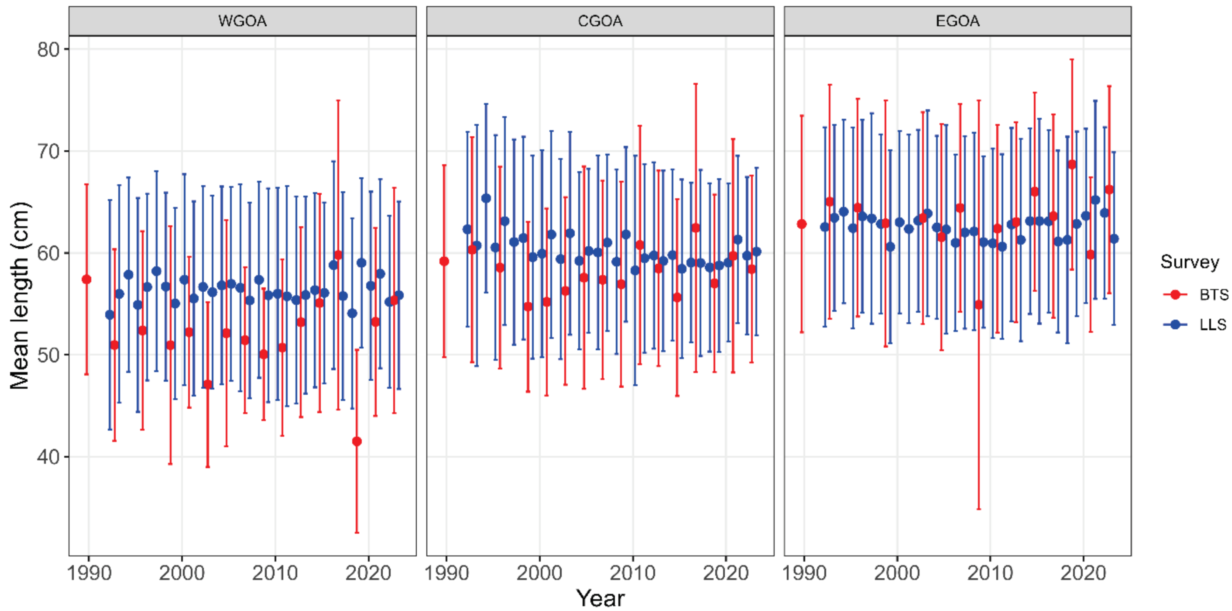

Figure 11-7.--Mean length (error bars = ± 1 SD) through time for Gulf of Alaska (GOA) shortraker rockfish by bottom trawl survey (BTS, red) and longline survey (LLS, blue) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area.

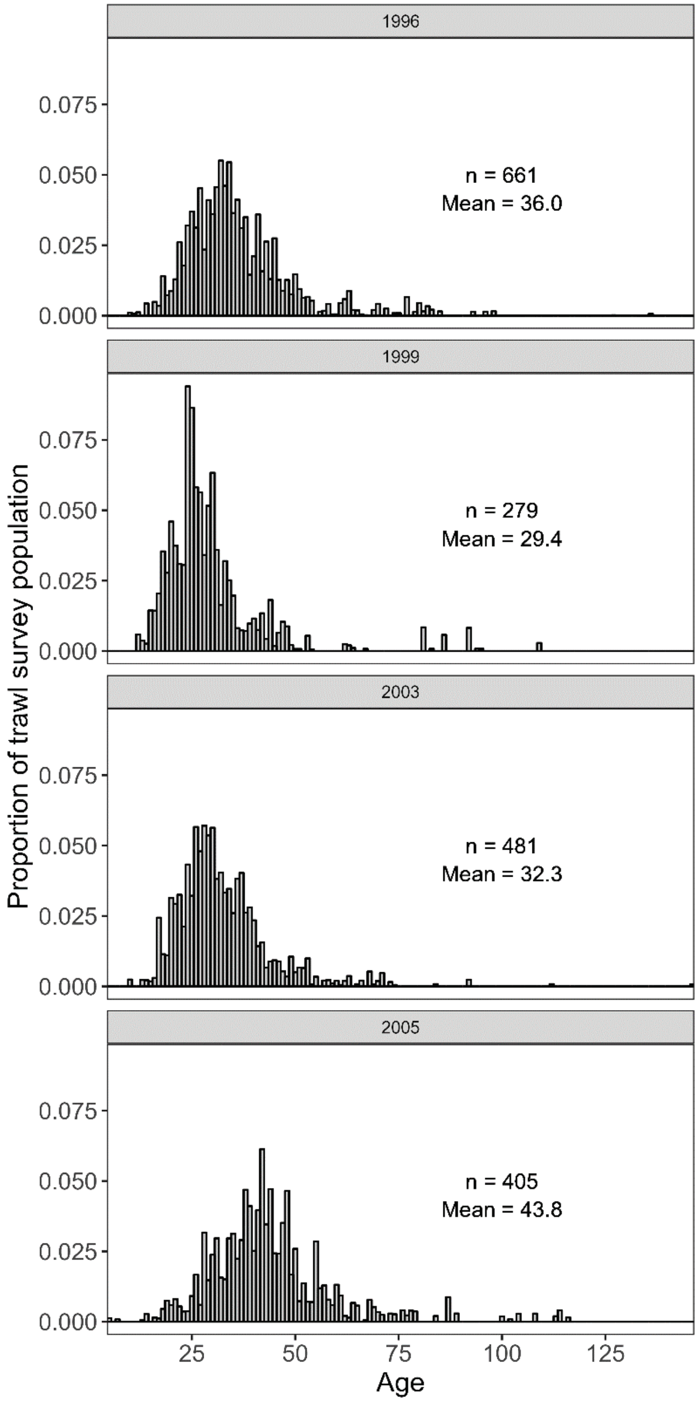

Figure 11-8.--Age composition of the estimated population of shortraker rockfish in the 1996, 1999, 2003, and 2005 Gulf of Alaska bottom trawl surveys.

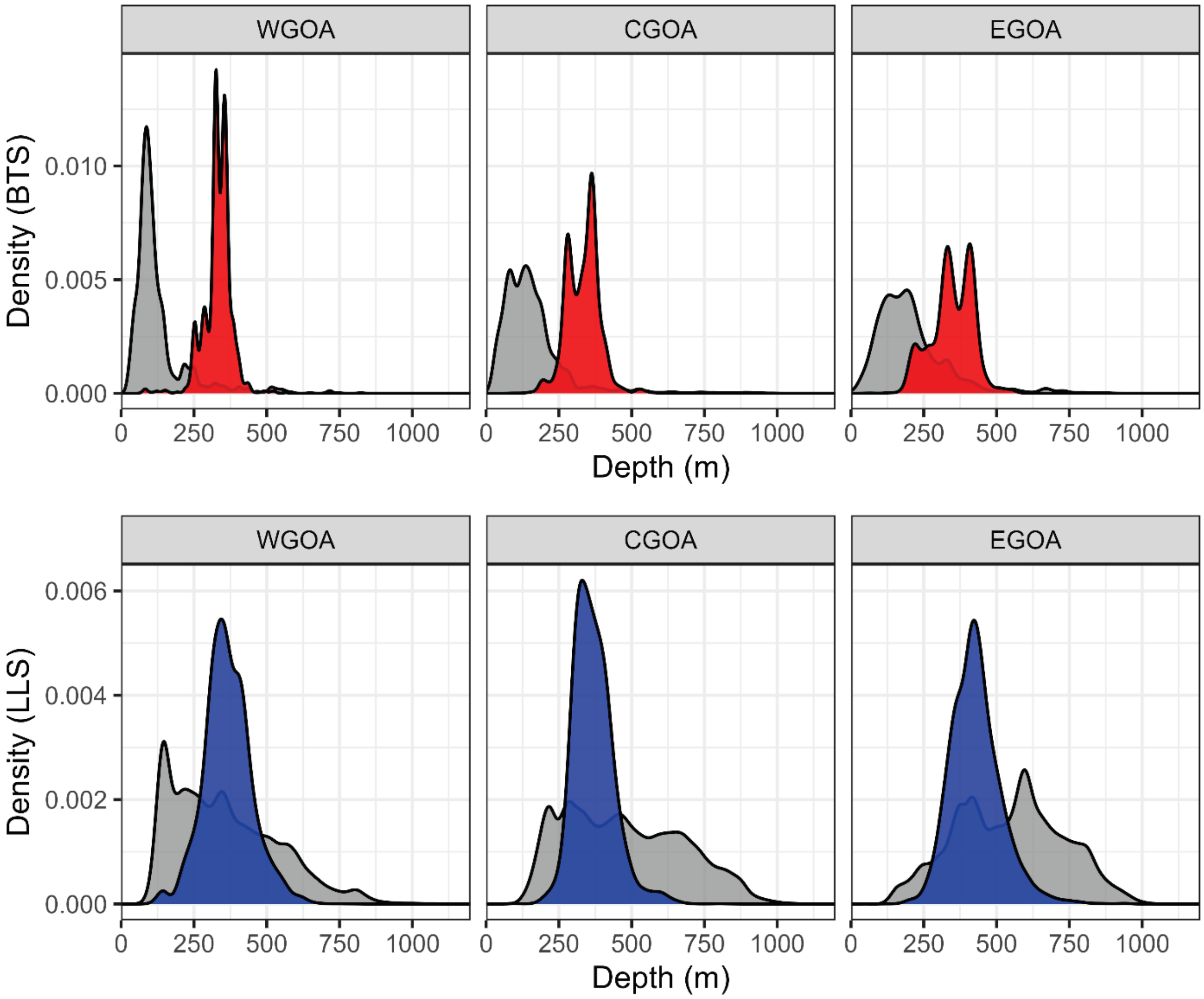

Figure 11-9.--Survey effort (grey in both panels) relative to catch of shortraker rockfish by depth in the Gulf of Alaska (GOA) from the bottom trawl survey (BTS, top panel, red) and longline survey (LLS, bottom panel, blue) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area.

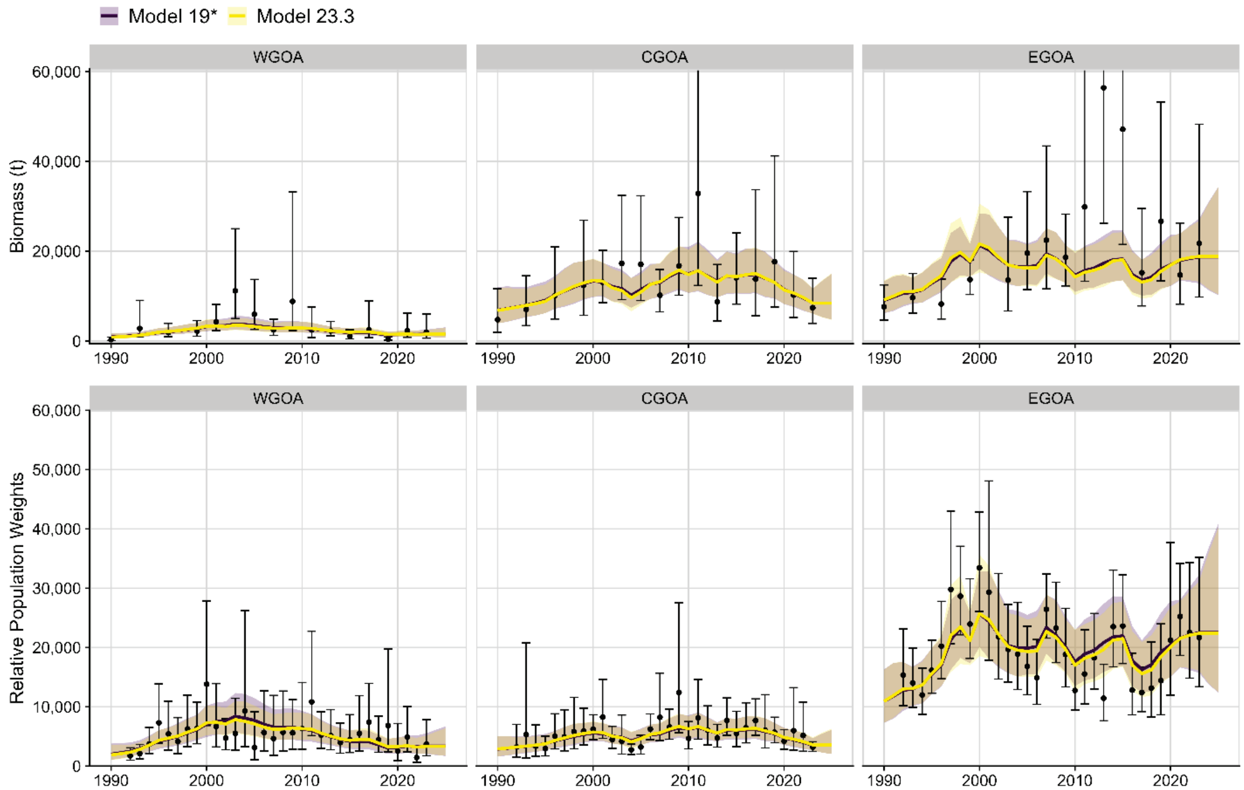

Figure 11-10.--Two-survey random effects (REMA) model fits to Gulf of Alaska (GOA) shortraker rockfish bottom trawl survey (BTS) biomass (top panels) and longline survey (LLS) relative population weights (bottom panels) by western, central, and eastern GOA (WGOA, CGOA, and EGOA) management area, where 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.

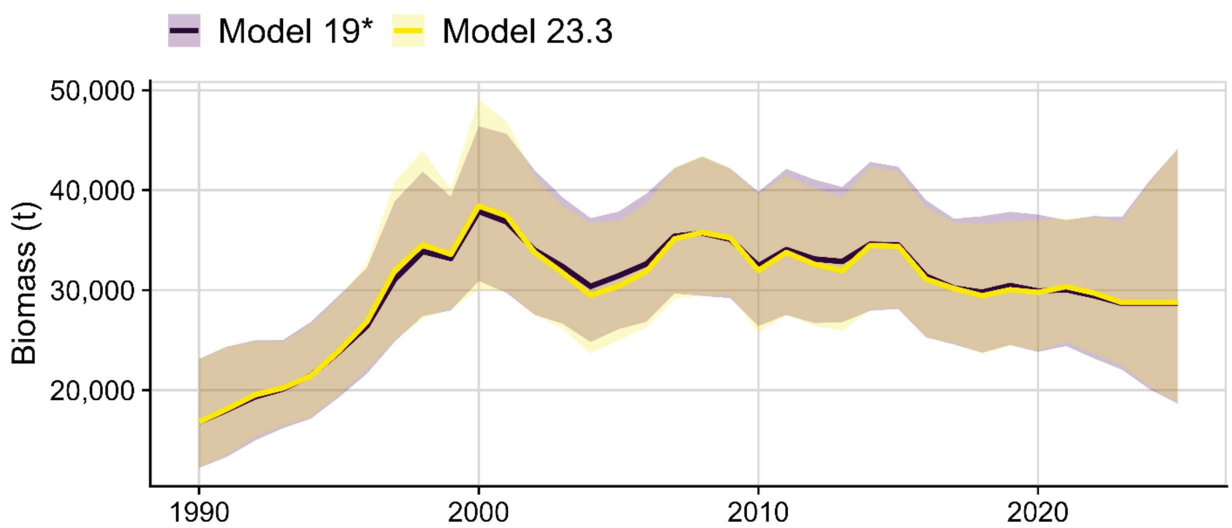

Figure 11-11.--Two-survey random effects (REMA) model fits to Gulf of Alaska (GOA) shortraker rockfish bottom trawl survey (BTS) biomass and longline survey (LLS) relative population weights, where the shaded regions are the model predictions and 95% confidence intervals from the REMA model. Results 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.

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 1977–2022 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 has generally remained low (1 – 2 t), with a notable exception in 2018 when non research catch surpassed AFSC longline survey research catch for the first time. Following 2018, non-research catch returned to average annual levels of ~1.5 t. However, the amount of recreational harvest of shortraker rockfish hit record highs in both 2021 and 2022, with total weight values of 10 and 12.8 t, respectively. The non-commercial removals show that a little over 24 t of shortraker rockfish was taken in 2022 during research cruises and in sport fisheries (Table 11A-1). This was a time series high. 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 ~5% of the reported commercial catch of 467 t for shortraker rockfish in 2022 (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 2021 and 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.

Year	AFSC trawl	IPHC longline	AFSC longline	ADFG PWS	Sport	Total
2021	1.8	8.0	7.5	-	10.0	27.3
2022	-	5.1	6.3	-	12.8	24.2

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	1.9	7.5	9.4
2022	tr	6.3	6.3