16. Assessment of the Other Rockfish stock complex in the Gulf of Alaska

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EXECUTIVE SUMMARY

The Other Rockfish complex in the Gulf of Alaska (GOA) is assessed on a biennial stock assessment schedule to coincide with the availability of new trawl survey biomass estimates. The Other Rockfish complex consists of twenty-seven non-target rockfish species (*Sebastes spp.*) that are managed in three tiers. There is one species in Tier 4, four species in Tier 5, and the remaining twenty-one species in Tier 6. The complex acceptable biological catch (ABC) and overfishing level (OFL) is the sum of the recommendations for the Tiers 4, 5, and 6 species.

Summary of Changes in Assessment Inputs

Changes to the input data

1. Total catch for GOA Other Rockfish from 2003 – 2023 has been updated (through October 10, 2023).
2. NMFS GOA bottom trawl survey data have been updated to include 2023 survey data.
3. GOA bottom trawl survey biomass estimates from 1984 and 1987 have been dropped to be consistent with advice regarding changes in the survey time series. Time series now spans from 1990-2023.

Changes in assessment methodology

1. Tier 4 Model 15.2 change from random effects (RE) to REMA model using the *rema* R package.
2. Tier 5 Model 23.1 includes:
    a. Changes from random effects (RE) model to REMA model using *rema* R package.
    b. Implementation of alternative weighted *M* approach (average 3-survey weighted *M*) as a proxy for F_{OFL} instead of single year weighted *M*.
    c. Reduction in number of species assigned to Tier 5 to a total of four species.
3. Tier 6 Model 23.1 includes:
    a. Extension of maximum catch time series from 2013-2016 to 2013-2022.
    b. Addition of twelve species that were removed from Tier 5 due to unreliable survey biomass, totally twenty-one Tier 6 species.

Summary of Results

The recommended ABC for the 2024 fishery is 3,773 t and the OFL is 4,977 t for the Other Rockfish complex. This is a 7% decrease from 2023. There is no evidence to suggest that overfishing is occurring for the Other Rockfish complex in the GOA because the OFL has not been exceeded. Total Other Rockfish catch in 2022 was 1,287 t and catch in 2023 was 941 t as of October 10, 2023, which is lower than the Gulf-wide ABC of 4,064 t for both years. The authors do not recommend reductions below the max ABC. A full risk table was completed for this assessment and can be found in the Harvest Recommendations section.

Tier 4 recommendation of ABC and OFL for sharpchin rockfish for 2024–2025.

	As estimated or specified *last* year for:		As estimated or recommended *this* year for:	
Quantity	2023	2024	2024	2025
M (natural mortality rate)	0.06	0.06	0.06	0.06
Tier	4	4	4	4
Biomass (t)	10,826	10,826	7,008	7,008
$F_{OFL} = F_{35\%}$	0.079	0.079	0.079	0.079
$maxF_{ABC} = F_{40\%}$	0.065	0.065	0.065	0.065
$F_{ABC} = F_{40\%}$	0.065	0.065	0.079	0.079
OFL (t)	855	855	554	554
*max*ABC (t)	704	704	456	456
ABC (t)	704	704	456	456
	As determined *last* year for:		As determined *this* year for:	
Status	2021	2022	2022	2023
Overfishing		n/a		n/a

Tier 5 recommendation of ABC and OFL for four Other Rockfish species for 2024–2025.

	As estimated or specified *last* year for:		As estimated or recommended *this* year for:	
Quantity	2023	2024	2024	2025
M (natural mortality rate)	0.070	0.070	0.062	0.062
Tier	5	5	5	5
Biomass (t)	59,861	59,861	63,291	63,291
F_{OFL}	0.070	0.070	0.062	0.062
$maxF_{ABC}$	0.053	0.053	0.046	0.046
F_{ABC}	0.053	0.053	0.046	0.046
OFL (t)	4,190	4,190	3,924	3,924
*max*ABC (t)	3,143	3,143	2,943	2,943
ABC (t)	3,143	3,143	2,943	2,943
	As determined *last* year for:		As determined *this* year for:	
Status	2021	2022	2022	2023
Overfishing		n/a		n/a

Tier 6 recommendation of ABC and OFL for twenty-one Other Rockfish species for 2024–2025.

	As estimated or specified *last* year for:		As estimated or recommended *this* year for:	
Quantity	2023	2024	2024	2025
Tier	6	6	6	6
OFL (t)	275	275	499[1]	499
*max*ABC (t)	206	206	374	374
ABC (t)	206	206	374	374
	As determined *last* year for:		As determined *this* year for:	
Status	2021	2022	2022	2023
Overfishing		n/a		n/a

[1]For the Tier 6 calculations, the OFL is the sum of the maximum catch from 2013 – 2022 for each species. Changes in the ABC/ OFL values are due to updates to the catch estimates provided by the NMFS Alaska Regional Office Catch Accounting System (AKRO CAS) and the update in the catch history time series.

ABC and OFL recommendations for the full Other Rockfish complex for 2024–2025.

Quantity **All Other Rockfish Combined**	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
	2023	2024	2024	2025
Tier	4/5/6	4/5/6	4/5/6	4/5/6
OFL (t)	5,320	5,320	**4,977**	4,977
*max*ABC (t)	4,053	4,053	3,773	3,773
ABC (t)	4,053	4,053	**3,773**	3,773
	As determined *last* year for:		As determined *this* year for:	
Status	2021	2022	2022	2023
Overfishing		n/a		n/a

Updated catch data (t) for the Other Rockfish stock complex in the GOA are summarized in the following table with ABCs and TACs. Source: NMFS AKRO CAS accessed through the Alaska Fisheries Information Network (AKFIN) database, http://www.akfin.org as of October 10, 2023.

Year	Western GOA	Central GOA	Eastern GOA		Gulf-wide Total	Gulf-wide ABC	Gulf-wide TAC
			West Yakutat	E. Yak/ Southeast			
2022	179	982	79	47	1,287	4,054[1]	1,610
2023	70	803	46	22	941	4,054[1]	1,610

[1]The ABCs include the transferred northern rockfish ABC to the Other Rockfish ABC. The total northern rockfish ABC is estimated in the northern rockfish assessment for the GOA, and the WY and EY/SEs ABCs are deducted from the northern rockfish ABC and added to the GOA Other Rockfish total ABC. Historically, this quantity has ranged from 1-4 t and is done during the Plan Team deliberations in November.

Area Apportionment

Area apportionment was estimated using the REMA model for Tier 4 and 5. The authors, Plan Team, and SSC have recommended that the ABCs for the Western GOA and Central GOA be combined since the 2014 fishery. The combined catch for the Western GOA and Central GOA has not exceeded the combined ABC of these areas in 2023 as of October 10, 2023, but is approaching the combined Western/Central area ABC. The authors recommend continuing to combine the Western and Central GOA ABCs, as data do not suggest any developing conservation concerns that would be alleviated by splitting the ABCs. Furthermore, the authors acknowledge the possibility of overages in area specific ABCs that may constrain the fisheries, but have little area-specific biological concerns. Further discussion on alternative apportionment considerations are provided in the "Area Allocation of Harvest" section.

The tables below show the apportionment for the Tier 4 (sharpchin rockfish), Tier 5, and Tier 6 species separately.

Tier 4 - Sharpchin	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	13.2%	13.3%	73.5%	100%
Area ABC (t)	60	61	335	456
OFL (t)				554

Tier 5 – 4 species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	15.8%	13.6%	70.6%	100%
Area ABC (t)	465	400	2,078	2,943
OFL (t)				3,924

Tier 6 – 21 species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	295	71	8	374
OFL (t)				499

Total Other Rockfish ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	820	532	2,421	3,773
OFL (t)				4,977

Summaries for Plan Team

Species	Year	Biomass[1]	OFL	ABC	TAC	Catch[2]
Other Rockfish	2022	70,687	5,320	4,054[3]	1,610	1,287
	2023	70,687	5,320	4,054[3]	1,610	941
	2024	70,299	4,977	3,773[4]		
	2025	70,299	4,977	3,773[4]		

Stock/ Assemblage	Area	2023				2024		2025	
		OFL	ABC	TAC	Catch[2]	OFL	ABC	OFL	ABC
Other Rockfish	WGOA/ CGOA		940	940	873		820		820
	EGOA								
	WY		370	370	46		532		532
	EY/SE		2,744[3]	300	22		2,421[4]		2,421[4]
	Total	5,320	4,054[3]	1,610	941	4,977	3,773[4]	4,977	3,773[4]

[1]Total biomass estimates from the random effects model for the Tier 4/5 species only.
[2]Current as of October 10, 2023. Source: NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database (http://www.akfin.org).
[3]The ABCs for past years include the transferred northern rockfish ABC to the Other Rockfish ABC. The total northern rockfish ABC is estimated in the northern rockfish assessment for the GOA, and the WY and EY/SEs ABCs are deducted from the northern rockfish ABC and added to the GOA Other Rockfish total ABC. Historically, this quantity has ranged from 1- 4 t and is done during the Plan Team deliberations in November.
[4]The recommended ABCs (in 2024-2025) are only for GOA Other Rockfish in this assessment and do not include northern rockfish ABC because the value has not been set.

Responses to SSC and Plan Team Comments on Assessments in General

Risk Table: "*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. The SSC also agreed with the JGPT recommendation to leave the decision concerning which species (or multiple species) to focus on for stock complexes up to the author*." (SSC, October 2021)

The authors appreciate the ability to determine if a risk table is necessary for this stock complex. An updated risk table was included in this assessment because it was last presented in the 2019 full assessment.

Risk Tables: "The SSC reiterates its previous recommendation that the number of levels should be collapsed from four to three to make the choices easier for the authors. Further, the SSC recommends that the PTs review previous risk scores, as well as GPT and SSC recommended reductions from maxABC across stocks, from previous years prior to beginning the process each year." (SSC, December 2022)

The risk table follows the three-level guideline that the SSC recommended.

"The Team recommends all GOA authors evaluate any bottom trawl survey information used in their assessment prior to 1990 including the 1984 and 1987 surveys and conduct sensitivity analyses to evaluate their usefulness to the assessment. This may apply for Aleutian Islands surveys but this was only raised during GOA assessment considerations." (JGPT, November 2021)

The authors followed the SSC/ PT recommendations to remove the 1984 and 1987 GOA bottom trawl survey years in the analyses for Tier 4 and 5 GOA Other Rockfish. Removing these two survey years did not impact model results.

"Random effects tier 4-5 considerations: The Teams recommended that stock assessment authors transition from the ADMB random-effects survey smoother to this package which implements the same model with several improvements." (JGPT, September 2022)

"The SSC supports the JGPT's recommendation that stock assessment authors transition from the ADMB RE variants to the rema framework, which implements the same model variants in a single framework with several improvements." (SSC, October 2022)

The authors applied the REMA model, which uses TMB, for Tier 4 and 5 methods and apportionment in place of the random effects model that used ADMB. Model comparisons presented in Appendix 16B demonstrate that no difference was found between the two models.

SSC and Plan Team Comments Specific to this Assessment

Spatial Management for DSR:

"*C-6 GOA Groundfish Specifications Council motion October 14, 2021 1. The Council supports the SSC recommendation to move to Step 2 of the Spatial Management Policy for consideration of separating DSR from the other rockfish complex Gulf-wide. An update of the 2017 discussion paper on this topic to identify economic and management implications and tools to achieve conservation and management goals should be developed to inform this process.*" (NPFMC, October 2021)

"The Council is considering a motion to change the spatial management of demersal shelf rockfish (DSR), by moving DSR species out of the other rockfish category to a GOA-wide assessment. ***The SSC supports making this change to the DSR complex in the 2024 stock assessment for implementation for the 2025 fisheries*** *and looks forward to examining the area apportionment at that time."* (SSC, October 2023)

The authors recognize the support in moving the spatial management for DSR species process forward and refer to Appendix 16C for more information.

GOA Other Rockfish

"The Team recommended rolling over harvest recommendations from 2021 due to the discrepancy between catch and survey biomass and the estimation of weighted M being influenced by a few species that have patchy distributions and survey catchability/availability issues.

The Team recommends the author further explore issues with using the current method of weighted M biomass estimates." – (NPFMC Joint Groundfish PT, November 2021)

"The SSC recommends that the authors:

1. *Revisit the tier level assignments for the species included in the other rockfish complex. (Are they appropriate given survey catchability/availability issues?)*
2. *Consider fitting a random effects model to the aggregate complex, rather than subcomponents*
3. *Re-examine the need for area-specific apportionments of ABC.*
4. *Incorporate, as appropriate, results from the pilot 2022 untrawlable grounds cooperative work, recognizing that full results will not be available for some time.*
5. *For Tier 5 stocks, evaluate the random effects weighted mortality methodology and consider alternatives such as the long-term average.*
6. *Evaluate past research and investigate estimating catchability in the next assessment, with a focus on key components such as harlequin, sharpchin and redstripe rockfish. See Jones et al. (2012, 2021) and Zimmermann (2003) for relative "trawlability" of rockfish species."*

- (SSC, December 2021)

"Leave redstripe and harlequin rockfish in Tier 5, as recommended by the author, but continue to explore these Tier 5 biomass estimates which have CVs >0.50." – (SSC, October 2023)

The authors acknowledge that some of the GOA Other Rockfish species have patchy distributions and survey catchability/availability issues that caused concerns in the last assessment, which led to rolling over the harvest recommendations. The authors explored a number of options to address these concerns listed in order of the SSC recommendations:

1. Authors explored the reliability of the GOA bottom trawl survey for Tier 4 and Tier 5 GOA rockfish species (Appendix 16B, presented at the September GOA Plan Team meeting). Based on metrics applied to determine a "reliable survey biomass", results indicated that only 5 of the Tier 4/5 GOA Other Rockfish species are caught in relatively high enough frequency, more consistent catches, and more spatially distributed in the GOA compared to some rockfish that are only caught in the Eastern GOA. As a result, the authors recommended moving 12 GOA Other Rockfish species from Tier 5 to Tier 6 and managed using Tier 6 methodologies of maximum catch in the fisheries.
2. The random effects model is fit to the aggregate tiers for the complex. The subcomponents (i.e., *M* groups) are only used for a weighted *M* estimate (as an F_{OFL} proxy) defined for NPFMC Tier 5 stocks.
3. Area-specific apportionment is meant to discourage geographic over-concentration of harvest across the GOA that may result in localized depletion of specific stocks. The Other Rockfish complex consists of only non-target rockfish that are caught incidentally in other directed fisheries. These species are not well-sampled by the trawl survey and have highly variable survey catches resulting in large fluctuations in ABC/OFL. Biologically, several reasons exist that may warrant consideration of alternative less restrictive apportionment strategies: 1) many of the Other Rockfish species inhabit both trawlable and untrawlable habitat, thus leading to underestimated and biased trawl survey results, 2) in general, rockfish tend not to have genetic stock structure within the GOA (although species-specific data for most GOA Other Rockfish do not exist) and there may be minimal stock structure concerns at existing management area levels, 3) preliminary genetic analyses indicate relatively high larval dispersal rates for most rockfish species reducing concerns for localized depletion on a long-term (i.e., evolutionary) scale, 4) the trawl fishery does not operate in areas east of 140°W longitude, while the majority of estimated biomass is found east of 140°W longitude, and 5) there has been no major changes in fishing behavior for Other Rockfish species over time, and species-specific catch data continue to be well monitored through full retention in the fixed gear fleet and at-sea observers in the trawl sector. While there may be minimal biological concerns for sub-area ABCs as described above, other non-biological factors may need to be evaluated before alternative ABCs (e.g., Gulf-wide ABCs) are adopted. Further explanation can be found in the Area Allocation section.
4. The authors are excited about two research projects that are working to identify the differences between trawlable and untrawlable habitat. These two projects are the untrawlable grounds cooperative work (Science-Industry Rockfish Research Collaboration, SIRRCA) and estimating groundfish densities in

GOA untrawlable habitat using a camera system (implemented by AFSF RACE GAP bottom trawl survey team). Data for the Other Rockfish (i.e., harlequin) are not yet available, but the authors plan to incorporate the data for harlequin and Other Rockfish species when results become available.

5. An alternative weighted *M* methodology for Tier 5 Other Rockfish was developed, which uses the average estimated biomass from the REMA model using the recent 6 years (which is estimated based on 3 survey years) instead of the terminal year estimated biomass. This weighted *M* method is less sensitive to annual variability in survey catches, thus dampening the effects of sudden shifts in species composition, while still capturing long-term trends.
6. There is an ongoing effort to address catchability issues for Other Rockfish species including species with patchy distributions and those inhabiting both trawlable and untrawlable habitat. Species of particular concern that will be further investigated in the future include: harlequin and redstripe.

Introduction

The Gulf of Alaska (GOA) Other Rockfish stock complex is a group of up to 27 non-target rockfish species (*Sebastes spp.*), depending on the management area (Table 16.1; Figure 16.1). The complex is managed in Tier 4, 5, and 6 on a biennial cycle with a single complex-wide overfishing limit (OFL) for the GOA and acceptable biological catches (ABCs) for East Yakutat/ Southeast, West Yakutat, and a combined Western/ Central management areas. This GOA complex is further complicated by eight species that occur in other assessments in some management areas.

Currently, seven species in the Demersal Shelf Rockfish (DSR) complex (canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfish) are managed separately in East Yakutat/ Southeast Outside (EY/SE) region (NMFS area 650), but belong to the GOA Other Rockfish stock complex in the other GOA management areas west of 140° W longitude (NMFS areas 610-640; Western and Central GOA and West Yakutat portion of the Eastern GOA). These demersal shelf species are denoted as the demersal sub-group when managed within the Other Rockfish complex. Catch estimates for the demersal sub-group were included in the Other Rockfish complex since 2013 for areas west of NMFS area 650. Current proposals have been made to remove the demersal sub-group into a separate DSR stock complex. The remaining 20 species in the GOA Other Rockfish complex are termed slope sub-group for the purpose of this document.

Northern rockfish technically belong to the Other Rockfish complex in the Eastern GOA (NMFS area 640 and 650) and are managed in a separate Northern rockfish stock assessment in the Western and Central GOA due to extremely low abundance of northern rockfish in the Eastern GOA. However, the overfishing limit (OFL) and acceptable biological catch (ABCs) for northern rockfish in the Eastern GOA are estimated in the species-specific Northern rockfish assessment and the ABCs from the Eastern GOA portion are added to the Other Rockfish complex harvest limits during the November Plan Team deliberations. Therefore, the Other Rockfish complex does not include the Northern rockfish in its analyses or OFL and ABC calculations in this document.

There are six species that generally comprise > 95 % of the Other Rockfish catch and/or biomass: harlequin, redbanded, redstripe, sharpchin, silvergray, and yelloweye rockfish (Figure 16.2B; Figure 16.3B). Of these six species, sharpchin is managed as Tier 4, redbanded, redstripe, sharpchin, and silvergray are assigned to Tier 5, and yelloweye, a demersal sub-group species, is assigned as Tier 6. This document focuses primarily on the Tier 4 and 5 species, with all other species being grouped into a category termed “minors”.

General Distribution of Other Rockfish

Nearly all of the Other Rockfish species are at the northern edge of their ranges; the center of abundance for most is farther south off British Columbia or the U.S. West Coast (Love et al., 2002). Within the GOA, the majority of Other Rockfish species are most abundant in Southeast GOA (Figure 16.3). One exception is harlequin rockfish, which occurs predominantly in Alaska throughout the GOA. Summarized information on the geographic distribution of each of the species can be found in the stock structure document (Tribuzio and Echave, 2015, Appendix 16B Table 16B.2).

Other Rockfish species can be found in depths up to 800m, but more commonly reside in depths from 100 to 300 m. These species inhabit a variety of different benthic substrates (e.g., high relief, low relief rocky habitats, mudflats, and mixed habitats; Tribuzio and Echave, 2015; Conrath et al., 2019). Research focusing on untrawlable habitats found that some Other Rockfish species associate with biogenic structure and tend to have patchy distributions (Du Preez and Tunnicliffe, 2011; Jones et al., 2012;), whereas others, such as harlequin rockfish, are often found in both trawlable and untrawlable habitats (Rooper and Martin, 2012; Rooper et al., 2012; Conrath et al., 2019). These studies indicate that further research is needed to address if there are differences in density between trawlable and untrawlable habitats.

Evidence of Stock Structure

The stock structure of the GOA Other Rockfish complex was examined in conjunction with the DSR complex and presented to the Plan Team in September 2015 (Tribuzio and Echave, 2015, Appendix 16B). Little data are available to address stock structure concerns across management regions for any of the Other Rockfish species. Generalizing across rockfish species, there is most commonly no or little genetic structure for rockfish within the GOA (W. Larson, pers. comm.). For rockfish with no structure, it is likely that areas that are locally depleted will be replenished by larval transport over longer time scales (i.e., evolutionary time scale) due to relatively high dispersal rates seen in rockfish (decades, 100s of years), but short-term local depletion could cause reduced abundance because adult movement is likely low. A species-specific genetics project is underway to examine the genetic stock structure of harlequin rockfish with the GOA.

Previous research was conducted to address the stock structure of the demersal sub-group species that overlap with the Other Rockfish complex. Authors of both the DSR and Other Rockfish stock assessments have proposed moving the demersal sub-group that are in the Other Rockfish complex in the Western and Central GOA and West Yakutat areas, into a Gulf-wide DSR complex (Spatial Management of DSR species groupings document). Research showed that the demersal sub-group species are caught by different fishery gear types, occupy different habitats, and have different fine-scale spatial distributions (Omori et al., 2021; Omori and Thorson, 2022). The demersal sub-group species are primarily caught in fixed-gear fisheries, while the slope sub-group are primarily caught in the trawl fisheries. The fishery catches by gear coincide with the higher relief habitat preferences of the demersal sub-group species compared to the slope sub-group species. The demersal sub-group species tend to be caught more near-shore and in shallower waters, while the slope sub-group tend to be further offshore and often deeper. Additionally, the biological differences between demersal sub-group species and slope sub-group species support the proposal to separate the two sub-groups into separate GOA-wide complexes (Ormseth and Spencer, 2011; Omori et al., 2021). Lastly, the available data suggest that there is no apparent spatial structure within each sub-group within the GOA. The Plan Team (PT) and Statistical Science Committee (SSC) both support the motion to have two GOA-wide rockfish complexes, DSR and Other Rockfish (PT Sept 2017, SSC Oct 2017, PT Nov 2019, SSC Dec 2019, PT Sept 2021, SSC Oct 2021). A document for the Council was produced to address the impacts and changes in harvest limits in response to the separation of demersal sub-group species into the GOA-wide DSR stock complex (Appendix 16C). The change to move the demersal sub-group species out of the Other Rockfish complex into a GOA-wide DSR complex is proposed to be implemented for the 2025 fisheries.

Life History Information

Life history data are limited for most Other Rockfish species, and are generally based on studies from waters in lower latitudes (British Columbia and further south). Life history data collected in waters off Alaska are available for some species (e.g., harlequin, redstripe, sharpchin, silvergray, and yelloweye rockfish). The remaining life history data are borrowed from other regions for most of the Other Rockfish species despite studies showing geographic variation for some rockfish life history data (e.g., Gertseva at al., 2010). The maximum age for species in the Other Rockfish complex ranges from 23 to 118 years, while the age at 50% maturity ranges from 2.5 to 22 years. Rockfish are ovoviviparous, with fertilization, embryonic development, and larval hatching occurring inside the female. There is limited knowledge in fecundity and parturition timing. Summarized information on the life history of the Other Rockfish species can be found in Table 16.2 and further details on species-specific life history characteristics can be found in the Appendix 16B Table 16B.3 in Tribuzio and Echave (2015).

Sharpchin rockfish is the only species in the Other Rockfish complex with sufficient GOA-specific maturity and growth data that can be considered as a Tier 4 species (Heifetz et al., 1998). The maximum observed age in the GOA is 58 years, with age at 50% maturity at 10 years (Malecha et al., 2007).

Natural mortality rates (M) are used in this assessment for the Tier 4 and Tier 5 species. Values of M are from literature and have not been computed within this assessment. The M values range from 0.05 (silvergray and

widow rockfish; Chilton and Beamish, 1982, Malecha et al., 2007) to 0.1 (redstripe rockfish, Chilton and Beamish, 1982) for the Tier 5 species. Sharpchin rockfish, the only Tier 4 species, has an estimated M ranging between 0.056 - 0.059 (Malecha et al., 2007). While not used in the assessment, yelloweye rockfish have the lowest *M* value at 0.02 (O'Connell and Funk, 1987). There have been many advances in methods to estimate *M* from life-history invariants (e.g., Hamel, 2014, Then et al., 2015). Sullivan et al. (2022a) evaluated *M* values for some of the Other Rockfish species with results that suggest that *M* values used in this assessment should be updated.

Fishery

Management History and Management Units

The history of management changes for the Other Rockfish complex is presented in Table 16.3. The North Pacific Fishery Management Council (NPFMC) established a separate management category for Other Slope Rockfish in the GOA in 1991. The group initially included northern rockfish and 15 other species, but northern rockfish was removed in 1993 to become its own separate management category. Northern rockfish have been managed as a separate species in the Central and Western GOA; however, northern rockfish were reassigned to the Other Rockfish complex in 1999 in the Eastern GOA only due to their low abundance and consequential difficulty of managing them as a single species. The species is *not* included in the calculations of ABC and OFL conducted as part of this assessment because they are already accounted for in the northern rockfish assessment. Beginning in 2012, two Pelagic Shelf Rockfish species, yellowtail and widow, were moved into the Other Slope Rockfish complex and the complex was renamed to Other Rockfish complex. Since 2005, these species have been assessed using Tier 5 methodologies.

The seven species in the demersal sub-group (canary, china, copper, quillback, rosethorn, tiger, and yelloweye rockfish) have been accounted for in the AKRO Catch Accounting System (CAS) in the Other Rockfish complex, but were not included in the Other Rockfish stock assessment prior to 2013. Thus, the demersal sub-group species were included in the assessment using Tier 6 methodologies since 2013 in Western GOA, Central GOA, and West Yakutat. Recently, recommendations have been made to separate the demersal sub-group species into a separate GOA-wide Demersal Shelf Rockfish complex (see Appendix 16C) and the motion has been approved for 2025 fisheries.

Beginning in the 2014 fishery, the ABC and total allowable catch (TAC) for the Western and Central GOA were combined. The ABC for the Other Rockfish had been exceeded in the Western GOA consistently from 2009 to 2013. The decision to combine the ABC was a response to the high proportion of harlequin catches in the fisheries, but being poorly sampled by the trawl survey. From 2009 to 2013, harlequin rockfish was on average 77% and 52% of the Other Rockfish catch in the Western and Central GOA, respectively. Harlequin rockfish biomass is likely underestimated by the trawl survey, due to the species affinity for high relief rocky habitat not sampled by the survey. Therefore, it was agreed that the overages were likely not a conservation concern and that combining the Western and Central GOA ABC/TAC was an acceptable alternative. Historical catch estimates and harvest specifications (TAC, ABC, and OFL) for the Other Rockfish complex are presented in Table 16.4.

Directed Fishery, Effort, and CPUE

Since the mid-1990s, directed fishing has not been permitted for Other Rockfish in the GOA, but they are retained as "incidental-catch". Therefore, the fishery is bycatch only and does not reflect targeted fishing behavior. Annual catches are generally less than the Gulf-wide ABC or TAC, and catches in the Southeast area of the Eastern GOA are particularly small (where these species are most abundant) since 1999, when trawling was prohibited east of the 140° W. longitude line. Other Rockfish are predominately caught in trawl fisheries (average of 77%; Table 16.5), with much of the bycatch occurring in the rockfish trawl fishery in the Central GOA (Figure 16.2A). The Other Rockfish catch from the Central GOA on average consists of 65% of

the total Gulf-wide catch, followed by 16% in the Western GOA, 15% in West Yakutat, and 5% in the Southeast. Overall, harlequin, sharpchin, and redstripe are the three most frequently caught Other Rockfish species (Figure 16.2B), and more specifically, those species comprise on average 56%, 12%, 10%, respectively, of the total Other Rockfish catch in the trawl fisheries. The overall distribution of fisheries catch throughout the GOA and by gear types does not substantially vary, but there has been some annual variability amongst species composition. For example, silvergray rockfish catch has mostly comes from the Central GOA since 2012, but in 2019 most of the catch was in the West Yakutat area (Figure 16.2B). The fixed gear (hook-and-line, jig, and pot gear) consist of 23% of total Other Rockfish catch, where mostly species belonging to the demersal sub-group are caught by the fixed gear.

There are two exception of targeted fisheries: 1) in 1993, when directed fishing was permitted for Other Rockfish, there was some targeting by trawlers in the Eastern GOA for silvergray and yellowmouth rockfish; and 2) in 2004 and 2005, a small experimental fishery was permitted in EY/SE that used modified trolling gear to attempt to catch the large amount of Pacific ocean perch quota unavailable to trawlers, but mainly was successful in catching silvergray rockfish (Clausen and Echave, 2011).

Discards

Gulf-wide discard rates (% of the total catch discarded within management categories) are provided in two time series: 1) pre – 2003, where catch and discards were estimated by species in Tribuzio and Echave (2013) by extrapolating observed species compositions to the total catch; and 2) 2003 – present from the CAS (Table 16.5). Discard rates have been on roughly 50% over the entire time series. However, since 2016 discard rates have ranged from 25-48%. This decrease in discards consists primarily of harlequin, sharpchin, and silvergrey rockfish in the rockfish target fishery in the Central GOA. The discard rate is highly variable by gear type (Table 16.5) and regulatory area. A full retention requirement went into effect for hook-and-line catcher vessels in 2020, but discard rates only notably dropped this past year. Staff at the AKRO are investigating operational reasons behind the discard rates and working with NOAA Office of Law Enforcement to increase education and outreach for better compliance with the rockfish retention regulations. (J. Keaton, pers. comm.).

Data

Time series of catch and biomass for the Other Rockfish species are obtained from the following sources:

Source	Data	Years
AKRO Catch Accounting System	Catch estimates	1991 – 2023
NMFS Bottom Trawl Surveys – GOA	Biomass Index	1984 – 1999 (triennial) 2001 – 2023 (biennial)

Fishery

Fishery catch statistics for the Other Rockfish complex are available from AKRO blend estimates and CAS beginning in 1991. Catch by species were estimated from 1991 to 2002 in Tribuzio and Echave (2013). Table 16.6 presents the time series of estimated catch of the current Other Rockfish complex by species and Table 16.4 presents catch of the full complex by area. The time series of catch estimates is subject to the following caveats: 1) catch prior to 2003 (i.e., pseudo-blend) is fixed and should be considered a separate estimation method from CAS; 2) CAS estimates of catch prior to 2010 are not available by species and are estimated based on observed species ratios from 2010 to 2019 (a ten-year time series); and 3) Observer restructuring went into effect in 2013, which expanded observer coverage to the previously unobserved Pacific halibut IFQ fleet. The CAS estimates of catch do not include state managed fisheries.

Unidentified rockfish are generally a small portion of the total Other Rockfish catch, accounting for < 30 t annually generally occurring in the hook-and-line catcher vessel fleet (~ 75%). However, there were a few high "unidentified rockfish" catch years: 1) in 2020 (230 t) vastly from the hook-and-line catcher vessel fleet mostly likely due to an observer effect, and 2) in 2022 (131 t) from both the hook-and-line catcher vessels and

catcher processors. Historically, the unidentified rockfish count against the Other Rockfish harvest limits, but are not included in the assessment. Catches of unidentified rockfish will continue to be tracked in this assessment and are combined with the "minor" species in the catch summaries.

The number of lengths sampled by observers for Other Rockfish in the GOA commercial fishery have been too small to yield meaningful data. Few age samples for any of these species have been collected from the fishery, and none have been aged.

Other Sources of Removals

In general, research catch is small relative to biomass (research catches are in Appendix 16A). Sport catch of canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfish (demersal sub-group species) was not included until 2013, and only includes catch of those species west of the 140˚ W long. (i.e., NMFS areas 610 – 640).

Beginning in 2013, estimated catches are available from fisheries occurring in federally managed fisheries (e.g., Pacific halibut IFQ) within Prince William Sound (NMFS area 649) and the Inside waters of Southeast Alaska (NMFS area 659; Table 16.7). These catches do not count against the Other Rockfish ABC/TAC. Catch occurring in these areas should be monitored, but catches in these areas remain low. The estimated catches from NMFS area 659 do not include the species within the demersal sub-group, as those species are accounted for within the DSR assessment. In NMFS area 649 the catch is composed primarily of yelloweye and quillback rockfish, while in NMFS area 659 it is mostly redbanded and "other" or unidentified rockfish.

Survey

NMFS AFSC GAP GOA bottom trawl survey biomass estimates are available for the Other Rockfish species in the GOA (1990 – 2021; Table 16.8). Bottom trawl surveys were conducted on a triennial basis in the GOA from 1984 to 1999 and biennially since 1999. The 1984 and 1987 surveys were completed using different vessels, net design, and sampling protocols, so these years have been excluded from this assessment. The GOA bottom trawl survey is based a stratified random design that is stratified by management area, sub-regions, and depth bins (six bins of depths up to 1000 m). Due to funding constraints, the survey has either eliminated stations within a regulatory area (e.g., 2001), not sampled deeper depths > 700 m, and/or reduced the total number of survey stations. Other Rockfish species are not noticeably impacted by the survey constraints because they are found in typically depths < 500 m. However, given the patchy nature of these species, it is important to note the potential for measurement error (e.g., "missing" a patchy species) and that the reduction in stations is expected to reduce precision in biomass estimates. The other important time series caveat is that the survey did not sample the Eastern GOA in 2001.

Most of the Other Rockfish biomass is in the Eastern GOA (Table 16.8 and Figure 16.3). Harlequin rockfish is the one exception; this species is primarily found in the Western and Central GOA (Table 16.8). Survey catches of many of the Other Rockfish species can be highly variable due to the patchy nature of these species and the tendency to inhabit areas that are considered untrawlable by the survey. As a result, the coefficient of variations (CVs) for the biomass estimates are generally higher for Other Rockfish species compared to many of the rockfish species in the GOA. For example, CVs for redstripe rockfish range from 36% to 87%, compared to a range of only 11% to 23% for shortraker rockfish and 11% to 48% for rougheye/blackspotted rockfish (see Echave et al., 2021 and Sullivan et al., 2021).

Additionally, many of the 2021 (and prior) assigned Tier 5 Other Rockfish species are infrequently caught by the bottom trawl survey, particularly in the Western and Central GOA, have patchy distributions that contribute to highly variable catches, and depend on a survey that is not optimized to sample these non-target rockfish species to estimate their biomass. Tier assignments were reassessed in 2023 using 'reliable survey biomass' diagnostics, which included frequency of hauls with positive catch, proportion of years with positive catch, CV, and distribution of catch in the GOA. Results indicated that survey catches of 12 species originally

assigned to Tier 5 were deemed "unreliable" (i.e., it was unsuitable to use the bottom trawl survey catches to assess these species; Appendix 16B). Thus, these 12 Other Rockfish species were moved to Tier 6 assessment methodologies in this assessment.

The total biomass from the 2023 trawl survey for Tier 4 and 5 Other Rockfish species was 137,575 t (Table 16.8). This is an 18% increase from the 2021 survey. The 2023 survey biomass of harlequin (260%) and redstripe (440%) increased from the previous survey, but sharpchin (-7%) and redbanded (-22%) decreased from the previous survey, while silvergray remained the same. These large changes in biomass estimates are likely due in part to the patchiness of the species, as suggested by the high CVs (Table 16.8; Figure 16.4). For example, in 2019 the estimated trawl survey biomass for harlequin had a CV of 0.68. Such wide fluctuations in biomass do not seem reasonable given the slow growth and low natural mortality rates of *Sebastes* species. Large catches of aggregating species, as most Other Rockfish appear to be, in just a few individual hauls can greatly influence biomass estimates and may be a source of much variability. However, there are other factors, such as behavior or environmental conditions, that can influence survey biomass catches to fluctuate that should not be disregarded as stated by previous authors (e.g., Clausen and Echave, 2011).

Little is known about the size structure for Other Rockfish species from the trawl survey, and is limited to harlequin, redbanded, redstripe, sharpchin, and yelloweye rockfish. Survey size compositions for the primary Other Rockfish species are shown in Figure 16.5. Limited survey ages are available in small sample sizes, and are aged as part of special projects, not production ageing. There are insufficient data to create informative age compositions for the species within the Other Rockfish complex.

Distribution of catch: fishery and survey

The majority of the survey biomass for Other Rockfish occurs in the Eastern GOA, whereas much of the commercial catch occurs in the Western GOA and Central GOA. One example of the discontinuity between catch and abundance is harlequin rockfish. While the estimated biomass based on the trawl survey for harlequin rockfish is substantially lower than for other species in the Other Rockfish complex, it is the primary species caught by fisheries. Harlequin rockfish are caught in 6% of survey hauls, on average, in the Central GOA and 3% of hauls in the Western GOA. Catch per haul is generally low (average of 26 kg, st. dev. = 148 kg), with 91% of the hauls being below that average, indicating that there are few hauls with large catches. This is in stark comparison to the commercial catch, where harlequin rockfish catch is more broadly spread across the shelf and the shelf break with substantially larger mean catches. Thus, fishery data may provide a better picture of certain species' distributions because fishery activity may sample some of these species more effectively than surveys. However, many of these species are primarily caught with trawl gear, and they are more abundant in the Eastern GOA where trawling is prohibited. The directed fishery for rockfish (e.g., Pacific ocean perch) in the Western GOA and Central GOA is responsible for the majority of the catch of Other Rockfish. Thus, the fishery data may provide some distribution information for the species farther west, in which untrawlable habitat may impact the survey catch. Current research is being conducted for harlequin to examine differences between untrawlable and trawlable habitat.

Analytic Approach

The Other Rockfish stock complex is assessed using three separate models: one Tier 4 (sharpchin) random effects model using the REMA model (Model 15.2), four Tier 5 species random effects model using the REMA model (Model 23.1), and twenty-one Tier 6 species using maximum catch from 2013-2022 (Model 23.1). Associated reference points are calculated based on North Pacific Fishery Management Council (NPFMC) Tier specifications.

General Model Structure

The Other Rockfish species managed as Tier 4 and Tier 5 use the bottom trawl survey biomass as the primary data input. The total biomass for the Tier 4 and 5 Other Rockfish species are estimated using a random effects survey averaging approach (model description in the 2012 Survey Average Working Group document and Hulson et al., 2021). The previous operational full assessment used the ADMB process for estimating the random effects model. For this operational full assessment, the guidance of the PT and SSC was followed (see comment section) and the random effects model using the *rema* package was implemented (REMA; Sullivan et al., 2022b). Model comparisons with the previous ADMB approach (Model 15.1) and REMA (Model 15.2) were completed in Appendix 16B for the 2023 September Plan Team and are excluded from the main document because there was no difference between the results of the two models. Model 15.2 will be used going forward. The GOA Other Rockfish Tier 4 and 5 species use the multivariate version of the REMA model where each management area (Western, Central, and Eastern GOA) is modeled with a shared process error and summed to obtain the Gulf-wide biomass estimates. Because the trawl survey did not sample the Eastern GOA in 2001, the random effects model treats the 2001 Eastern GOA biomass estimate as missing data.

Model 15.2 for Tier 4 consists of one species: sharpchin rockfish. The output of the random effects model provides a Gulf-wide biomass estimate, as well as biomass by area. The Tier 4 reference points are defined as $F_{OFL} = F_{35\%}$ and $F_{ABC} = F_{40\%}$. The OFL = F_{OFL}*Biomass from the random effects model in the terminal (current) year and ABC = F_{ABC}*Biomass from the random effect model in the terminal year.

Model 23.1 for Tier 5 consists of four species each with a natural mortality (*M*) value. The random effects model is applied to all Tier 5 species combined and to each Tier 5 species separately. The biomass estimates are obtained for the three GOA management areas and summed to get Gulf-wide estimates. The Tier 5 reference points are defined as $F_{OFL} = M$ and $F_{ABC} = 0.75 * F_{OFL}$, and are applied to the combined Tier 5 Gulf-wide biomass estimate to obtain Tier 5 the ABC and OFL. For Tier 5 stock complexes the F_{OFL} = weighted *M* (*Wt M*), where the *Wt M* is calculated by a REMA estimated biomass-weighted *M* from the proportion of each Tier 5 species (using the Tier 5 species-specific biomass estimates).

Option 1- Status quo weighted M calculation:

$$F_{OFL} = Wt\ M = \sum_i p_{i,z} * F_i,$$

where p_i is the proportion of GOA-wide biomass for each *i* species with a unique *M* value (Table 16.1 for *M* values) for survey, *z*, and F_i is the sub-group specific fishing mortality with *M* value as a proxy (i.e., $F_i \approx M_i$) as established for NPFMC Tier 5 stocks.

Option 2- Alternative weighted M:

The alternative weighted *M* ($\overline{Wt\_M}$) is based on an average biomass, where the time series shifts to accommodate new estimated biomass. The alternative weighted *M* is calculated using the average estimated biomass from the REMA model from the 6 most recent years, which is based on the previous three GOA trawl surveys (i.e., 3-surveys = 6 years):

$$F_{OFL} = \overline{Wt\_M} = \sum_i \overline{p_{i,z-2:z}} * F_i,$$

where the proportion of estimated GOA-wide biomass is now the average of the 6 most recent years, which encompasses the 3 most recent surveys (i.e., *z*-2 to *z*, representing the trawl surveys for 2019, 2021, and 2023) for each Tier 5 *i* species. Rockfish are a long-lived, later maturing species with high survey variability, thus the alternative average weighted *M* dampens the survey uncertainty, while capturing the population trends.

Model 23.1 for Tier 6 consists of twenty-one Other Rockfish species. Tier 6 Other Rockfish species are managed using the maximum catch from a 'reliable catch history' as defined by the NPFMC for Tier 6 species, where the original 'reliable catch history' spans from 1978-1995. For these non-target Other Rockfish species, the 'reliable catch history' started in 2013 when species-specific discard estimates of the non-target rockfish species were documented in CAS and when observer restructuring went into effect. Catch estimates prior to 2013 in CAS were not considered representative of the GOA Other Rockfish catch due to biases in discard rates estimated using observer data. For Tier 6 species within the Other Rockfish complex, the OFL is obtained by taking the sum of the maximum catch within each GOA management area for each species over the 'reliable catch history' time series, where the OFL = maximum catch and ABC = 0.75*OFL.

Option 1- Status quo:

Model 17.1 uses the 'reliable catch history' time series from 2013 to 2016.

Option 2- Alternative:

Model 23.1 expands the reliable catch history time series from 2013 to 2022.

Research completed for the September 2023 Plan Team on determining 'reliable survey biomass' for Tier 4/5 Other Rockfish species resulted in the recommendation to move 12 Tier 5 species to Tier 6 (Appendix 16B). Resultant tier species assignments are compared to the previous tier assignments.

Parameter Estimates

Age and maturity curves are used in a spawning biomass per recruit analysis to estimate $F_{40\%}$ and $F_{35\%}$ for Tier 4 sharpchin rockfish (Heifetz et al., 1998).

Estimates of mortality for the Tier 5 Other Rockfish species are shown in Table 16.2 with the assigned *M* groups in Table 16.1. The mortality rates are calculated outside of this assessment and are based on a variety of methods. Those that were calculated using the catch curve method are actually estimates of the total instantaneous mortality (Z) and should be considered as upper bounds for the natural mortality rate (*M*).

The weighted *M* parameter is described in the general model structure section. The time series of weighted *Ms*, both status quo and the alternative, are in Figure 16.6.

Results

Model Results

Estimated biomass is presented in Table 16.9 and Figure 16.4 for sharpchin rockfish and Table 16.10 and Figure 16.4 for the Tier 5 species. The weighted *M* status quo and alternative average weighted *M* ($\overline{Wt\_M}$) results are in Figure 16.6. Summary computations of ABC and OFL for the Tier 4 and Tier 5 Other Rockfish complex components in the GOA, using the random effects estimated exploitable biomass are in the following tables.

Status quo tier assignments (seventeen Tier 5 species) with the two weighted *M* options: status quo (*Wt M*) and alternative average weighted M ($\overline{Wt\_M}$). Status quo Tier 5 results are in grey boxes and the authors' recommendations are bolded.

Model	Group (**2021 Groups**)	Tier	2023 Est. Biomass	F_{OFL}	OFL	F_{ABC}	ABC
Model 15.2	Sharpchin	4	7,008	$F_{35\%}$ = 0.079	554	$F_{40\%}$ = 0.065	456
	M=0.05 Group	5	42,548				
	M=0.06 Group	5	8,901				
	M=0.07 Group	5	2,799				
	M=0.092 Group	5	914				
	M=0.1 Group	5	11,162				
	Tier 5 Biomass	5	70,759	F_{OFL} = *Wt M* = 0.061	4,316	F_{ABC} = 0.75*F_{OFL}	3,237
	Tier 5 Biomass	**5**	**70,759**	**F_{OFL} = $\overline{Wt\_M}$ = 0.062**	**4,387**	**F_{ABC} = 0.75*F_{OFL}**	**3,290**
Total Tier 4/5 Gulf-wide with status quo *Wt M*					4,870		3,693
Total Tier 4/5 Gulf-wide with alternative $\overline{Wt\_M}$					**4,941**		**3,746**

[1]The total Tier 5 biomass is not the sum of the *M* groups, but the random effects biomass for the combined Tier 5 species.

Alternative tier assignments (five Tier 5 species) with the two weighted *M* options: status quo (*Wt M*) and alternative average weighted M ($\overline{Wt\_M}$). Status quo Tier 5 results are in grey boxes and the authors' recommendations are bolded.

Model	Group (**2023 Groups**)	Tier	2023 Est. Biomass	F_{OFL}	OFL	F_{ABC}	ABC
Model 15.2	Sharpchin	4	7,008	$F_{35\%}$ = 0.079	554	$F_{40\%}$ = 0.065	456
	M=0.05 Group	5	42,010				
	M=0.06 Group	5	6,541				
	M=0.092 Group	5	914				
	M=0.1 Group	5	11,162				
	Tier 5 Biomass	5	63,291	F_{OFL} = *Wt M* = 0.061	3,861	F_{ABC} = 0.75*F_{OFL}	2,896
	Tier 5 Biomass	**5**	**63,291**	**F_{OFL} = $\overline{Wt\_M}$ = 0.062**	**3,929**	**F_{ABC} = 0.75*F_{OFL}**	**2,943**
Total Tier 4/5 Gulf-wide with status quo *Wt M*					4,415		3,352
Total Tier 4/5 Gulf-wide with alternative $\overline{Wt\_M}$					**4,478**		**3,399**

[1]The total Tier 5 biomass is not the sum of the *M* groups, but the random effects biomass for the combined Tier 5 species.

The below table is the summary of the maximum catch from the status quo time series, 2013 – 2016 of each of the Tier 6 species by region (Model 17.1). The ABC and OFL are calculated for each species then summed for the Tier 6 totals. The ABC is combined for the Western and Central GOA. The Tier 6 species include the original Tier 6 species (grey) and the newly assigned Tier 6 species with previous Tier assignments listed in "2021 Tier Assignment" column, with associated ABC and OFL based on the 2021 Tier 6 species assignment (grey) and new 2023 Tier 6 species assignment (bolded). Changes in value from the previous assessment are due to CAS updates.

Status quo time series (2013-2016) with status quo (9 species) and alternative (21 species) species tier assignments.

		Maximum Catch (t)			
2021 Tier Assignments	Tier 6 Model 17.1 (2013-2016)	Western GOA	Central GOA	West Yakutat	East Yak/SE
6	Aurora	0	<1	0	0
6	Canary	<1	1	<1	0
6	China	<1	<1	<1	0
6	Copper	<1	<1	<1	0
6	Quillback	<1	25	1	0
6	Rosethorn	<1	<1	<1	0
6	Shortbelly	0	0	0	0
6	Tiger	<1	4	<1	0
6	Yelloweye	57	124	40	0
5	Blackgill	0	0	0	0
5	Bocaccio	0	<1	<1	<1
5	Chilipepper	0	0	0	0
5	Darkblotched	3	4	<1	<1
5	Greenstriped	<1	<1	<1	<1
5	Pygmy	<1	<1	0	0
5	Splitnose	<1	0	0	0
5	Stripetail	0	<1	<1	0
5	Vermilion	<1	<1	0	<1
5	Widow	<1	35	5	<1
5	Yellowmouth	0	0	0	0
5	Yellowtail	0	2	<1	1
Status quo Tier Assignment	ABC		161	32	0
	OFL		257		
Alternative Tier Assignment	**ABC**		**195**	**35**	**1**
	OFL		**308**		

The following table is the same as the previous table, but showing the alternative time series (2013 – 2022) with status quo (9 species) and alternative (21 species) species tier assignments (Model 23.1).

		Maximum Catch (t)			
2021 Tier Assignments	Tier 6 Model 23.1 (2013-2022)	Western GOA	Central GOA	West Yakutat	East Yak/SE
6	Aurora	0	<1	<1	0
6	Canary	<1	1	<1	0
6	China	<1	1	<1	0
6	Copper	<1	<1	<1	0
6	Quillback	<1	25	14	0
6	Rosethorn	<1	2	2	0
6	Shortbelly	0	0	0	0
6	Tiger	<1	6	<1	0
6	Yelloweye	82	170	53	0
5	Blackgill	0	<1	0	<1
5	Bocaccio	0	<1	<1	<1
5	Chilipepper	0	<1	0	0
5	Darkblotched	3	4	<1	<1
5	Greenstriped	<1	<1	<1	<1
5	Pygmy	<1	<1	0	<1
5	Splitnose	<1	<1	3	0
5	Stripetail	0	<1	<1	0
5	Vermilion	<1	<1	<1	<1
5	Widow	<1	85	22	<1
5	Yellowmouth	<1	<1	0	8
5	Yellowtail	<1	10	<1	1
Status quo Tier Assignment	ABC	217		52	0
	OFL	359			
Alternative Tier Assignment	**ABC**	**295**		**71**	**8**
	OFL	**499**			

Harvest Recommendations

Amendment 56 Reference Points

The ABCs and OFLs for Other Rockfish are based on the NPFMC Amendment 56 definitions for Tier 4, 5, and 6 stocks. The population dynamics for Tier 4 and 5 consist of reliable estimates of biomass and reliable point estimates for $F_{35\%}$ and $F_{40\%}$ for Tier 4 or natural mortality (M) for Tier 5. Sharpchin, the Tier 4 Other Rockfish species, has sufficient maturity data available for a spawning biomass per recruit analysis to estimate $F_{35\%}$ and $F_{40\%}$, where $F_{OFL} \leq F_{35\%} = 0.079$ and $F_{ABC} \leq F_{40\%} = 0.065$. The Tier 5 reference points are defined as $F_{OFL} = M$ and $F_{ABC} = 0.75 * F_{OFL.}$ For the Tier 5 complexes, the F_{OFL} = weighted M, where the recommended weighted M is using an average of 6 years (i.e., 3-surveys) of a REMA estimated biomass-weighted M based on proportion of each Tier 5 species ($F_{OFL} = \overline{Wt\_M}$). The reference points for Other Rockfish Tier 6 species are based on the sum of maximum catch of individual species for each management area over a 'reliable catch history' time series (i.e., 2013-2022), where the OFL = sum of maximum catch and ABC = 0.75*OFL.

Specification of OFL and Maximum Permissible ABC

Resulting ABCs and OFLs based on the authors' methodology recommendations are below:

Tier - Model	2023 Biomass (with 95% CI)	F_{OFL}	OFL	F_{ABC}	ABC
4-Model 15.2	7,008 (2,964-16,583)	$F_{35\%} = 0.079$	554	$F_{40\%} = 0.065$	456
5-Model 23.1	63,291 (40,069-99,972)	$F_{OFL} = \overline{Wt\_M} = 0.062$	3,924	$F_{ABC} = 0.75*F_{OFL}$	2,943
6-Model 23.1			499		374
All Tiers Combined			4,977		3,773

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

Risk Matrix

Assessment-related considerations	Population dynamics considerations	Environmental/ ecosystem considerations	Fishery performance considerations	Overall score (highest of the individual scores)
Level 1: Typical to moderately increased uncertainty/minor unresolved issues	**Level 1:** Stock trends are typical for the stock; recent recruitment is within normal range	**Level 1**: Normal, No apparent environmental/ ecosystem concerns	**Level 1:** No apparent fishery/ resource-use performance and/or behavior concerns	**Level 1**: No elevated concern

Assessment Considerations

The tier assignments have been reassessed this year and better reflect data availability and data quality used to assess each species in the stock complex. The Tier 4 and 5 Other Rockfish species are better represented in the GOA bottom trawl survey, the primary data source for biomass estimates. However, some species, such as harlequin and redbanded, have high variability in the trawl survey (i.e., high CVs). Likewise, in general, species in this complex are highly associated with untrawlable habitat, have patchy distributions, and so it is unclear if the exploitation rates by area should be a concern. One ongoing concern is the spatial mismatch between fishery catch and the trawl survey for some rockfish species (e.g., harlequin). It is known that harlequin is not well sampled in the trawl survey, but are caught in higher frequency in the fishery despite not being targeted. Thus, it is thought that the estimated biomass for these species is being underestimated, which may result in a more conservative ABC/ OFL. Overall, the concerns are typical for these species and recent work has been completed to alleviate some of the concerns. Thus, there is no increased level of concern, so the assessment considerations are classified as Level 1.

Population dynamics considerations

Further details on the population dynamics and life histories for these Other Rockfish species are sparse. There are no data on recruitment or larval dispersal. The historical biomass estimated from the GOA bottom trawl survey are characterized by large inter-survey swings due to the patchy distributions of some rockfish species. However, large annual changes in biomass estimates are unlikely for these long-lived species. Therefore, the population dynamics are considered typical for this assessment and are classified as Level 1.

Environmental/ecosystem Considerations

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 Other Rockfish. The summary of environmental conditions for Other Rockfish is based on representatives of dominant species in the complex.

Environment: The 2023 average ocean temperatures on the shelf at depth (adults) and at the surface (larvae) were adequate and within optimal range for the small number of species/life stages that are known for Other Rockfish. Western GOA temperatures at depth on the shelf were approximately average and within the optimal adult range. Surface waters were approximately average, with cooler than average temperatures in the winter, spring, and fall and warmer than average temperatures in the summer (Ferris, 2023). Shifts in Other Rockfish species distributions due to long term temperature trends have not been observed, but distributions may shift further toward Western GOA or deeper water in the long-term.

Other Rockfish are often found around structural epifauna (e.g., corals, sponges, sea pens). Some surveys may suggest a decline in sponges, but there is no quantifiable evidence to support a population-effect on the Other Rockfish. Thus, it is noted that the loss of habitat is a concern that should be monitored.

Prey: In general, the zooplankton biomass, a common prey for larval rockfish and some adult rockfish, (e.g., sharpchin and redstripe rockfish) are generally below average to average total zooplankton biomass (average/below average copepod), while euphausiids biomass was average to above average biomass across the GOA (Ferris, 2023).

Predators & Competitors: There is no cause to suspect increased predation pressure on larval or adult Other Rockfish. Predator effects would likely be more important on larval, post-larval, and small juvenile rockfish, but information on these life stages and their predators is limited. Potential competition for zooplankton may be increased in 2023 due to number of larger population estimates including large returns of pink salmon (Whitehouse, 2023) and higher Pacific ocean perch (Hulson, 2023).

Based on the summary of average physical environmental conditions, mixed trends/ unknown status of foraging conditions, potential for increased competition for larvae, and moderate predation pressure, the most recent data suggest an ecosystem risk Level 1 – "No apparent environmental/ecosystem concerns".

Fishery Performance considerations

There is no directed fishing for species belonging to the Other Rockfish stock complex, and they can only be retained as "incidentally-caught". Other Rockfish catch varies by species, area, gear type, and year, with higher catches in the Central and Western GOA. However, the biomass distribution is highest in the Eastern GOA. The majority of Other Rockfish catch comes from the Rockfish Trawl Fishery operating in the Central GOA with a higher proportion of harlequin caught compared other Other Rockfish species. Although harlequin is not targeted, they are caught in higher frequency in the fishery compared to the bottom trawl survey, most likely due to the species occupying 'untrawlable' habitat, which is not sampled very well by the survey. While there is some concern that there may be overages in area-specific ABCs, there is little biological concern for the stock complex for localized depletion because fishing behavior patterns have not substantially changed, trawl survey results are highly variable, and the survey does not sample in the 'untrawlable' habitat. Overall, there is no increased fishery concern because has been no notable changes in fishery catches and these species are not targeted by the fisheries. Thus, fishery performance considerations are classified as Level 1.

Area Allocation of Harvests

Based on the geographic distribution of the species' exploitable biomass in the trawl surveys, the NPFMC has allocated the Gulf-wide ABC and corresponding TAC for Other Rockfish into three geographic management areas: Western GOA, Central GOA, and Eastern GOA. For apportionment of ABC, the random effects model

was fit to area-specific biomass and subsequent proportions of biomass by area were calculated. After the apportionment calculations are conducted, the ABCs and TAC for the Western and Central GOA are combined (Tribuzio and Echave, 2013, Appendix 16A; supported by PT Nov 2013; SSC Dec 2013).

Since 1999, trawling has been prohibited in the Eastern GOA east of 140° W. longitude. Because most species of the Other Rockfish complex are caught exclusively with trawl gear, this closure could have concentrated the catch of these fish in the Eastern GOA within the relatively small area between 140° and 147° W longitude that remained open to trawling. To ensure that such a geographic over-concentration of harvest would not occur, beginning in 1999 the NPFMC divided the Eastern GOA into two smaller management areas: West Yakutat (WY, area between 147° and 140° W long.) and East Yakutat/Southeast (EY/SE, area east of 140° W. long.) A proportional fraction of the biomass in the WY vs. EY/SE areas is computed for each trawl survey (termed "split fraction"). Separate ABCs and TACs are assigned to each of these smaller areas for the Other Rockfish complex as a weighted average of the split fraction in the three most recent trawl surveys. In the computations, each successive survey is given a progressively heavier weighting using factors of 4, 6, and 9, respectively.

The random effect model estimates the apportionment proportions separately for the Tier 4 and Tier 5 species. The Tier 6 ABCs were calculated by area for each species. The complex ABC by area is the sum of the Tier 4, Tier 5, and Tier 6 ABCs by area. The split fractions for delineating the biomass between WY and the EY/SE portions of the Eastern GOA are calculated at the tier and complex levels, thus the split fraction was used for Tier 4 and Tier 5 species.

The tables below show the apportionment for the Tier 4 (sharpchin rockfish), Tier 5, and Tier 6 species separately and Figure 16.7 shows the historical catch for the Other Rockfish complex with historical area ABCs and proposed 2024 area ABCs.

Tier 4 - Sharpchin	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	13.2%	13.3%	73.5%	100%
Area ABC (t)	60	61	335	456
OFL (t)				554

Tier 5 – 4 species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	15.8%	13.6%	70.6%	100%
Area ABC (t)	465	400	2,078	2,943
OFL (t)				3,924

Tier 6 – 21 species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	295	71	8	374
OFL (t)				499

Total Other Rockfish ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	820	532	2,421	3,773
OFL (t)				4,977

Alternative Apportionment:

The SSC has recommended authors "*Re-examine the need for area-specific apportionments of ABC"* (SSC, December 2021) in response to past concerns of potential regional ABC overages of the Other Rockfish complex (Figure 16.7). These specific rockfish 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. 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.

A stock structure evaluation for the Other Rockfish complex was done in 2015 (Tribuzio and Echave, 2015, Appendix 16B). At that time, the authors determined that overharvest was unlikely because multiple levels of precaution were built into the current management recommendations. No changes in area-specific apportionment were recommended, though, due to the paucity of data for this stock complex. A few biological and fishery points to consider when evaluating the appropriateness of sub-area apportionment include: 1) many of the Other Rockfish species inhabit both trawlable and untrawlable habitat, thus leading to underestimated and biased trawl survey results, 2) in general, rockfish tend not to have genetic stock structure within the GOA (although species-specific data for most GOA Other Rockfish do not exist), and the lack of evident stock structure indicates a basin-wide population rather than area specific stocks, 3) preliminary genetic analyses indicate relatively high larval dispersal rates for most rockfish species, reducing concerns for localized depletion on a long-term scale, 4) the trawl fishery does not operate in areas east of 140°W longitude, while the majority of estimated biomass is found east of 140°W longitude, 5) there has been no major changes in fishing behavior for Other Rockfish species over time, and species-specific catch data continue to be well monitored through full retention in the fixed gear fleet and at-sea observers in the trawl sector, 6) the subarea ABCs in the Central and Western GOA management areas for this complex were combined in 2014 (Tribuzio and Echave, 2013, Appendix 16A; supported by PT Nov 2013; SSC Dec 2013), and 7) there is precedence for combining GOA subareas for management, such as GOA-wide spatial management policy approved for the GOA DSR stock complex, which has a single ABC for Western GOA, Central GOA, and West Yakutat (Appendix 16C).

Subarea ABCs for the Other Rockfish complex fluctuate annually, largely due to highly variable survey results. These fluctuations can lead to ABC overages, requiring management intervention to restrain fisheries. While there may be minimal biological concerns for sub-area ABCs as described above, other non-biological factors may need to be evaluated before Gulf-wide ABCs are adopted. A spatial management evaluation was provided for GOA DSR species in Appendix 16C and could be referred to for other non-target rockfish species including the Other Rockfish complex.

Ecosystem Considerations

The ecosystem considerations for the GOA Other Rockfish stock complex are summarized in Table 16.11.

Ecosystem Effects on Stock

Prey availability/abundance trends: Little is known about species-specific food habits for Other Rockfish species in Alaska. Similar to other rockfish species, year-class strength of Other Rockfish species is likely influenced by availability of suitable zooplankton prey items in sufficient quantity for larval or post-larval rockfish. However, no direct information on food habits for larval or post-larval Other Rockfish species area available to determine the relationship between prey availability and year class strength. Some juvenile rockfish found in inshore habitat feed on shrimp, amphipods, and other crustaceans, as well as some mollusks and fish (Byerly 2001). Food habits data for Other Rockfish species in Alaska are very sparse, but adult sharpchin rockfish in the GOA feed mostly on plankton such as calanoid copepods and euphausiids and also

on pandalid shrimp (Yang et al. 2006). Redstripe rockfish in areas south of Alaska feed on euphausiids, shrimps, and small fish (Love et al. 2002). Harlequin rockfish prey on shrimp, Tanner crab, euphausiids, and deep-water fish including myctophids (Love et al. 2002).

Predator population trends: Rockfish are preyed on by a variety of other fish at all life stages, and to some extent by marine mammals during late juvenile and adult stages. Whether the impact of any particular predator is significant or dominant is unknown. Predator effects would likely be more important on larval, post-larval, and small juvenile rockfish, but information on these life stages and their predators is minimal.

Changes in physical environment: Given most of the Other Rockfish species in the GOA are at the northern edge of their ranges (with the exception of harlequin), increased ocean temperatures may result in shifts in distribution further to the Western GOA or into deeper water in the long-term. Strong year classes corresponding to the period around 1976 – 1977 have been reported for many species of groundfish in the GOA, including Pacific Ocean perch, northern rockfish, sablefish, and Pacific cod. Environmental conditions during this period were favorable for the survival of many young-of-the-year groundfish species and may have also been favorable for Other 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. Optimal temperature ranges for most species in the Other Rockfish complex are minimally researched except harlequin (4.1°C - 12.2°C).

Changes in bottom habitat due to natural or anthropogenic causes could affect survival rates by, for example, altering available shelter or prey. Associations of juvenile rockfish with biotic and abiotic structure have been noted by Carlson and Straty (1981), Pearcy et al. (1989), Love et al. (1990), and Freese and Wing (2003). 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 Ecosystem

Because there is no targeted fishing on Other Rockfish in the GOA, nearly all the catch of these species is taken incidentally in directed rockfish trawl fisheries for Pacific Ocean perch, northern rockfish, and dusky rockfish and in longline fisheries for sablefish and Pacific halibut. See the discussions on "Fishery Effects" for these targeted species in this SAFE report.

Data Gaps and Research Priorities

Data limitations are severe for Other Rockfish in the GOA, and it is difficult to determine whether current management is appropriate with the limited information available. Gaps include imprecise biomass estimates, limited and unvalidated ageing, and lack of life history information (including movement, distribution, and reproductive parameters). Regardless of future management decisions regarding the Other Rockfish complex management category, improving biological sampling of Other Rockfish in fisheries and surveys is essential. Areas of research that would utilize existing fishery or survey data include: body condition, horizontal and/or vertical changes in fishery capture depth, and alternative modelling approaches that would incorporate other data sources where appropriate for each species. Likewise, observed differences between fishery catches and the bottom trawl survey catches for some Other Rockfish species requires further investigation (e.g., harlequin), particularly when the bottom trawl survey serves as the main input in the assessment.

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Tables

Table 16.1. Species comprising the Other Rockfish management category in the Gulf of Alaska. The demersal sub-group species are included in this assessment in all areas west of East Yakutat/Southeast, but in the Demersal Shelf Rockfish assessment otherwise. Former and current Tier assignment and associated former natural mortality (*M*) group included.

Common name	Scientific name	Former (pre-2012) Management Category	Former Tier (2021)	Current Tier (2023)	*M* group
		Slope Sub-Group			
aurora rockfish	*Sebastes aurora*	Other Slope Rockfish	6	6	
blackgill rockfish	*S. melanostomus*	Other Slope Rockfish	5	6	0.06
bocaccio	*S. paucispinis*	Other Slope Rockfish	5	6	0.06
Chilipepper	*S. goodie*	Other Slope Rockfish	5	6	0.06
darkblotched rockfish	*S. crameri*	Other Slope Rockfish	5	6	0.07
greenstriped rockfish	*S. elongates*	Other Slope Rockfish	5	6	0.07
harlequin rockfish	*S. variegatus*	Other Slope Rockfish	5	5	0.092
northern rockfish[a]	*S. polyspinis*	Other Slope Rockfish			
pygmy rockfish	*S. wilsoni*	Other Slope Rockfish	5	6	0.06
redbanded rockfish	*S. babcocki*	Other Slope Rockfish	5	5	0.06
redstripe rockfish	*S. proriger*	Other Slope Rockfish	5	5	0.1
sharpchin rockfish	*S. zacentrus*	Other Slope Rockfish	4	4	SC
shortbelly rockfish	*S. jordani*	Other Slope Rockfish	6	6	
silvergray rockfish	*S. brevispinis*	Other Slope Rockfish	5	5	0.05
splitnose rockfish	*S. diploproa*	Other Slope Rockfish	5	6	0.06
stripetail rockfish	*S. saxicola*	Other Slope Rockfish	5	6	0.06
vermilion rockfish	*S. miniatus*	Other Slope Rockfish	5	6	0.06
widow rockfish	*S. entomelas*	Other Slope Rockfish	5	6	0.05
yellowmouth rockfish	*S. reedi*	Other Slope Rockfish	5	6	0.06
yellowtail rockfish	*S. flavidus*	Other Slope Rockfish	5	6	0.07
		Demersal Sub-Group			
canary rockfish [a]	*S. pinniger*	Other Rockfish	6	6	
China rockfish [a]	*S. nebulosus*	Other Rockfish	6	6	
copper rockfish [a]	*S. caurinus*	Other Rockfish	6	6	
quillback rockfish[a]	*S. maliger*	Other Rockfish	6	6	
rosethorn rockfish [a]	*S. helvomaculatus*	Other Rockfish	6	6	
tiger rockfish[a]	*S. nigrocinctus*	Other Rockfish	6	6	
yelloweye rockfish[a]	*S. ruberrimus*	Other Rockfish	6	6	

[a]Only in the West Yakutat and East Yakutat/Southeast management areas (i.e. Eastern GOA), otherwise in the northern rockfish assessment.

Table 16.2. A description of the life history of each of the species within the Other Rockfish complex along with mortality rates, maximum age, and female age and size at 50% maturity, where available. Size is fork length in cm. Area indicates location of study: California (CA), Oregon (OR), British Columbia (BC), Gulf of Alaska (GOA), Eastern Gulf of Alaska (EGOA), and Washington (WA). Mortality rates with no superscript have unknown methodology for their calculations.

Species	Mortality Rate	Max Age	Age at Maturity	Size at Maturity	Parturition timing	Area	References
blackgill rockfish		90	21	35		OR, CA	11, 24
bocaccio rockfish	0.06	45	4	45		WA, OR, CA	5, 16, 18, 22
canary rockfish	0.03-0.17	84	9	48		CA, BC	5, 16, 18, 27
chilipepper rockfish		35	2.5	26		OR, CA	7, 16
China rockfish		78	4	27		GOA, EGOA, CA	5, 18
copper rockfish		50	6	34		GOA, CA	5, 18
darkblotched rockfish	0.05[b]	105	8.4	36.5		OR, BC	2, 10, 16, 19
greenstriped rockfish	0.07	54	8.5	23		GOA, WA, OR, CA	5, 12, 16, 18
harlequin rockfish	0.092[b]	72	5	23		EGOA	17, 26
pygmy rockfish	0.06	26				BC	16, 18
quillback rockfish	0.06	90	5	26		GOA, CA	3, 5, 14, 16, 18
redbanded rockfish	0.06	106	19	42	Apr-Jul	GOA, BC, CA	2, 4, 5, 18, 27
redstripe rockfish	0.1[a]	55	8	29		BC	2, 3, 4, 18
rosethorn rockfish	0.06	87	8	21		GOA, CA	5, 16, 18, 27
sharpchin rockfish	0.056-0.059[a]	58	10	27	Jul	GOA	2, 3, 17
silvergray rockfish	0.05[b]	75	10	46		GOA, BC	3, 17, 23
splitnose rockfish	0.05	103	7	22		BC, WA, OR	5, 8, 9, 16
stripetail rockfish		38	4	20		BC, CA	16, 21, 27
tiger rockfish		116				EGOA	18
vermilion rockfish	0.1[b]	60	6	33		GOA, CA	16, 18, 21
widow rockfish	0.05[a]	60	5	37		BC, CA	5, 16, 18
yelloweye rockfish	0.02	117	22	47.5	Feb-Sep	EGOA	1, 3, 16, 20
yellowmouth rockfish	0.06[a]	99	11	38		BC	2, 6, 18, 27
yellowtail rockfish	0.07	64	9	41		BC, WA, OR, CA	4, 15, 16, 25

Mortality rate methods: [a] Total mortality (Z) as computed by catch curve analysis; [b] Natural mortality (M) as computed by a combination of the Alverson and Carney (1975) and Hoenig (1983) methods

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Table 16.3. Management history for the Other Rockfish stock complex.

Year	Management Measures
1988	The NPFMC implements the slope rockfish assemblage, which includes the species that will become "other slope rockfish", together with Pacific Ocean Perch, Northern Rockfish, Shortraker Rockfish and Rougheye Rockfish. Previously, *Sebastes* in Alaska were managed as the "Pacific Ocean Perch complex" or "Other Rockfish".
1988	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.
1991	Slope rockfish assemblage is split into three management subgroups with separate ABCs and TACs: Pacific Ocean Perch, Shortraker/Rougheye Rockfish, and "other slope rockfish".
1993	Northern Rockfish is split as a separate management entity from "other slope rockfish".
1997	Area apportionment procedure for "other slope rockfish" is changed. Apportionment is now based on 4:6:9 weighting of biomass in the most recent three NMFS trawl surveys.
1999	Trawling is prohibited in the Eastern Gulf east of 140° W long. Eastern Gulf trawl closure becomes permanent with the implementation of FMP Amendments 41 and 58 in 2000 and 2001, respectively.
1999	Northern Rockfish in the Eastern Gulf is reassigned to "other slope rockfish".
1999	Eastern Gulf is divided into West Yakutat and East Yakutat/Southeast Outside, and separate ABCs and TACs are assigned for "other slope rockfish" in these areas.
2005	Assessed using Tier 5 methodologies.
2007	Amendment 68 creates the Central Gulf Rockfish Pilot Program, which affects trawl catches of rockfish in this area.
2012	Yellowtail and Widow Rockfish are assigned to the "other slope rockfish" group, and group name is changed to "Other Rockfish" and assessed using Tier 5 methodologies
2013	Demersal Shelf Rockfish species were added to the Other Rockfish stock complex, but only Western GOA, Central GOA, and West Yakutat management areas.
2014	Merge Western and Central GOA ABCs and TACs
2023	Tier reassignment (moving 12 Tier 5 species to Tier 6)

Table 16.4. Time series of catch estimates for the Other Rockfish complex by management area and total with area specific and GOA-wide acceptable biological catch (ABC), GOA-wide overfishing level (OFL) and the total allowable catch (TAC). Catch values from 1991 – 2002 are from previous assessment estimates, while 2003 – present data are from the Alaska Regional Office Catch Accounting System queried through AKFIN on October 10, 2023.

	Gulf of Alaska Catch					ABC						
Year	Western	Central	West Yakutat	Southeast	Total Catch	Western	Central	West Yakutat	Southeast	GOA ABC	TAC	OFL
1991	20	175	81	2	278					10,100	10,100	
1992	76	854	731	14	1,675					14,060	14,060	20,710
1993[a]	342	2,423	735	1,923	5,423					8,300	5,383	9,850
1994	101	715	564	233	1,613					8,300	2,235	9,850
1995	31	883	460	23	1,397					7,110	2,235	8,395
1996	19	618	233	11	881					7,110	2,020	8,395
1997	68	941	123	85	1,217					5,260	2,170	7,560
1998	46	701	108	6	861					5,260	2,170	7,560
1999[b]	39	614	125	10	788					5,270	5,270	7,560
2000	49	363	132	33	577					4,900	4,900	6,390
2001	25	318	169	47	559					4,900	1,010	6,390
2002	223	481	45	25	774					5,040	990	6,610
2003	133	683	227	26	1,069					5,050	990	6,610
2004	275	584	78	31	968					3,900	670	5,150
2005	65	516	71	48	700					3,900	670	5,150
2006	279	604	138	79	1,100					4,152	1,480	5,394
2007	249	340	54	53	696					4,154	1,482	5,394
2008	250	439	50	29	768					4,297	1,730	5,624
2009	403	403	83	15	904					4,297	1,730	5,624
2010	366	441	131	31	969					3,749	1,192	4,881
2011	303	398	193	33	927					3,752	1,195	4,881
2012[c]	255	725	38	24	1,042	44	606	230	3,165	4,045	1,080	5,305
2013	203	477	79	51	810	44	606	230	3,165	4,045	1,080	5,305
2014[d]		890	58	29	977		1,031	580	2,470	4,081	1,811	5,347
2015		1,056	36	15	1,107		1,031	580	2,469	4,080	1,811	5,347
2016		1,185	52	36	1,273		1,534	574	3,665	5,773	2,308	7,424
2017		998	45	36	1,079		1,534	574	3,665	5,773	2,308	7,424
2018		1,037	136	48	1,221		1,737	368	3,489	5,594	2,305	7,356
2019		693	183	79	955		1,737	368	3,489	5,594	5,594[e]	7,356
2020		653	104	98	855		940	369	2,744	4,053	4,053[e]	5,320
2021		1,054	125	37	1,216		940	369	2,744	4,053	1,609	5,320
2022		1,162	79	47	1,288		940	370	2,744	4,054	1,610	5,320
2023		873	46	22	941		940	370	2,744	4,054	1,610	5,320

[a]northern rockfish removed; [b]northern rockfish catch included in EGOA; [c]widow and yellowtail included in complex; [d]apportioned ABCs for the Western and Central GOA were combined, and thus catch for those regions was combined. [e]TAC was not reduced in the East Yakutat/Southeast in 2019-2020.

Table 16.5. Estimated percentage of catch by main gear types, trawl and fixed gear (hook-and-line, jig, and pot), percent discarded by main gear types (trawl and fixed gear) and total discard for the Other Rockfish complex. Percent discarded values are provided in two time series: 1) pre – 2009, where catch and discards were estimated by species in Tribuzio and Echave (2013) by extrapolating observed species compositions to the total catch; and 2) 2009 – present from the NMFS Alaska Regional Office Catch Accounting System. Data queried through AKFIN on October 10, 2023.

	Trawl Gear		Fixed Gear				
Year	% of Catch	% Discarded	% of Catch	% Discarded	Total Discards	Total Catch	Total % Discarded
1991					169	278	61%
1992					1,019	1,675	61%
1993					2,652	5,423	49%
1994					1,058	1,613	66%
1995					1,013	1,397	73%
1996					666	881	76%
1997					634	1,217	52%
1998					571	861	66%
1999					541	788	69%
2000					305	577	53%
2001					268	559	48%
2002					449	774	58%
2003					1,445	2,188	66%
2004					1,137	1,922	59%
2005					539	1,362	40%
2006					1,306	1,943	67%
2007					482	1,335	36%
2008					851	1,531	56%
2009					952	1,770	54%
2010	78%	65%	22%	38%	571	969	59%
2011	73%	55%	27%	52%	502	926	54%
2012	88%	55%	12%	15%	521	1,042	50%
2013	64%	67%	36%	69%	549	810	68%
2014	82%	36%	18%	61%	394	978	40%
2015	82%	54%	18%	49%	590	1,108	53%
2016	81%	15%	19%	64%	315	1,273	25%
2017	76%	24%	24%	62%	355	1,079	33%
2018	82%	24%	18%	68%	388	1,221	32%
2019	75%	42%	25%	65%	455	955	48%
2020	62%	28%	38%	77%	395	855	46%
2021	82%	36%	18%	55%	480	1,216	39%
2022	72%	36%	28%	59%	547	1,288	42%
2023	79%	40%	21%	23%	340	941	36%

Table 16.6. Time series of estimated catches (t) of the species in the Other Rockfish complex. Catch estimates for the six most often caught species are shown with all remaining species combined in the "Minors" category. Catch was from the Alaska Regional Office Catch Accounting System. Data queried through AKFIN on October 10, 2023.

Year	Harlequin	Redbanded	Redstripe	Sharpchin	Silvergray	Yelloweye	Minors	Total
2003	510	50	41	250	26	150	43	1,070
2004	470	46	40	155	21	128	107	967
2005	475	63	10	51	4	89	7	699
2006	617	98	65	98	13	147	62	1,100
2007	329	72	39	97	12	131	15	695
2008	367	52	31	78	10	201	32	771
2009	518	46	34	84	23	167	32	904
2010	466	59	62	105	30	213	36	971
2011	354	60	67	114	63	228	40	926
2012	614	41	55	89	34	169	39	1,041
2013	307	84	25	46	18	214	115	809
2014	481	77	72	93	28	167	58	976
2015	580	60	50	106	43	178	91	1,108
2016	598	94	110	161	58	164	88	1,273
2017	468	83	76	123	49	194	87	1,080
2018	555	85	160	163	34	147	77	1,221
2019	361	72	133	67	68	141	114	956
2020	226	42	84	66	31	110	296	855
2021	391	64	169	119	145	180	149	1,217
2022	342	60	231	53	92	259	250	1,287
2023	175	43	228	38	48	196	213	941

Table 16.7. Estimated catch (t) of Other Rockfish from federally managed fisheries occurring in Prince William Sound (PWS, NMFS Area 649) and Southeast Alaska Inside Waters (SEI, NMFS Area 659). Catches in SE do not include the DSR sub-group.

Year	PWS	SEI
2013	19.9	15.4
2014	11.2	10.0
2015	22.5	10.8
2016	39.2	11.3
2017	9.7	14.8
2018	11.0	11.3
2019	11.0	13.4
2020	9.4	49.5
2021	14.5	9.7
2022	22.1	10.1
2023	15.2	9.6

Table 16.8. Biomass estimates (t) by NMFS regulatory area and Gulf-wide with associated coefficient of variation (CV) for the Tier 4 and 5 Other Rockfish species in the Gulf of Alaska (GOA) and for combined Tier 5 species based on the bottom trawl survey conducted between 1990 and 2023.

			Regulatory Area				
Tier	Species/Group	Year	Western GOA	Central GOA	Eastern GOA	Gulf-wide Total	CV
4	Sharpchin	1990	2	3,363	34,969	38,334	0.37
		1993	76	7,047	16,555	23,679	0.32
		1996	72	1,921	62,576	64,570	0.32
		1999	0	2,856	17,984	20,841	0.66
		2001	23	1,774	0	1,797	0.69
		2003	38	290	6,766	7,094	0.46
		2005	195	10,757	10,183	21,135	0.32
		2007	52	4,048	14,937	19,037	0.34
		2009	15	655	11,823	12,493	0.35
		2011	0	538	7,503	8,041	0.63
		2013	160	811	13,949	14,920	0.50
		2015	67	15,889	29,061	45,016	0.55
		2017	44	344	11,234	11,622	0.51
		2019	214	2,598	8,524	11,336	0.41
		2021	0	110	8,307	8,417	0.38
		2023	15	2,227	5,566	7,808	0.51
5	Redstripe	1990	0	15	27,049	27,064	0.52
		1993	6	112	29,502	29,620	0.55
		1996	152	91	14,721	14,964	0.54
		1999	0	139	8,087	8,226	0.49
		2001	2	124	0	127	0.60
		2003	5	175	7,845	8,025	0.36
		2005	2,796	12,827	6,080	21,702	0.58
		2007	15	656	10,830	11,501	0.61
		2009	1	48	1,542	1,592	0.46
		2011	0	499	18,246	18,745	0.87
		2013	18	8,722	1,132	9,871	0.87
		2015	0	11,952	4,748	16,699	0.71
		2017	73	15,710	14,378	30,161	0.54
		2019	9	6,552	11,020	17,580	0.36
		2021	0	316	2,404	2,720	0.36
		2023	0	8,466	6,297	14,763	0.62
5	Harlequin	1990	125	13,584	3,956	17,664	0.51
		1993	86	8,529	668	9,283	0.47
		1996	773	2,882	16,371	20,026	0.64
		1999	7	8,563	1,306	9,876	0.42
		2001	2,987	5,378	0	8,365	0.50
		2003	25	1,498	2,021	3,545	0.45
		2005	26,668	1,930	4,526	33,124	0.64
		2007	834	1,902	1,320	4,057	0.45
		2009	44	840	1,802	2,686	0.43
		2011	2,238	1,082	415	3,734	0.61
		2013	123	6,720	642	7,485	0.71
		2015	468	1,430	418	2,316	0.48
		2017	11,939	928	53	12,920	0.83
		2019	104	3,842	534	4,480	0.68
		2021	24	128	118	270	0.34
		2023	64	841	80	984	0.43

Table 16.8. Continued

Tier	Species/Group	Year	Regulatory Area Western GOA	Central GOA	Eastern GOA	Gulf-wide Total	CV
5	Redbanded	1990	0	220	3,066	3,285	0.35
		1993	10	434	3,230	3,675	0.29
		1996	61	200	4,333	4,594	0.34
		1999	118	403	10,420	10,941	0.41
		2001	61	354	0	415	0.24
		2003	19	889	2,532	3,441	0.22
		2005	41	1,010	4,559	5,610	0.22
		2007	52	1,164	5,982	7,198	0.25
		2009	34	2,020	4,388	6,442	0.17
		2011	12	1,304	3,726	5,042	0.23
		2013	66	2,346	3,456	5,868	0.19
		2015	52	1,901	3,504	5,457	0.18
		2017	43	1,557	4,188	5,788	0.22
		2019	0	822	3,982	4,805	0.24
		2021	43	3,864	5,071	8,978	0.35
		2023	9	1,390	5,630	7,030	0.25
5	Silvergray	1990	0	280	13,868	14,149	0.42
		1993	0	544	18,435	18,979	0.31
		1996	0	1,553	22,575	24,127	0.27
		1999	0	6,745	30,896	37,641	0.33
		2001	0	63	0	63	0.58
		2003	0	65	51,851	51,915	0.73
		2005	18	1,073	39,989	41,081	0.40
		2007	0	359	29,439	29,798	0.26
		2009	0	94	9,757	9,851	0.43
		2011	0	24,110	75,939	100,049	0.35
		2013	0	406	18,832	19,238	0.38
		2015	0	1,498	42,677	44,174	0.35
		2017	0	3,517	32,689	36,206	0.41
		2019	18	182	28,326	28,526	0.25
		2021	0	145	42,086	42,231	0.27
		2023	7	700	41,400	42,106	0.32
5	Tier 5	1990	125	14,099	47,939	62,162	0.28
		1993	102	9,618	51,836	61,556	0.29
		1996	986	4,726	57,999	63,711	0.26
		1999	126	15,849	50,710	66,685	0.22
		2001	3,050	5,919	0	8,969	0.47
		2003	49	2,627	64,250	66,926	0.57
		2005	29,523	16,840	55,154	101,517	0.29
		2007	901	4,081	47,571	52,553	0.21
		2009	79	3,003	17,489	20,571	0.22
		2011	2,250	26,995	98,326	127,570	0.30
		2013	207	18,194	24,062	42,463	0.30
		2015	520	16,781	51,346	68,647	0.29
		2017	12,055	21,712	51,308	85,076	0.29
		2019	132	11,398	43,862	55,392	0.18
		2021	68	4,452	49,679	54,199	0.22
		2023	80	11,398	53,406	64,883	0.25

Table 16.9. Estimated random effects biomass (t) by NMFS regulatory area and total Gulf-wide biomass with 95% confidence intervals for Tier 4, sharpchin rockfish.

Year	Western GOA	Central GOA	Eastern GOA	Gulf-wide Total	95% Confidence Intervals Lower	Upper
1990	5	3,701	32,985	36,691	18,968	70,972
1991	10	4,038	26,962	31,011	10,253	93,796
1992	21	4,406	22,039	26,467	9,313	75,219
1993	44	4,808	18,015	22,867	14,247	36,705
1994	49	3,705	26,027	29,781	10,199	86,962
1995	55	2,855	37,602	40,512	12,984	126,399
1996	62	2,200	54,324	56,585	31,832	100,588
1997	55	2,269	38,787	41,110	12,358	136,753
1998	48	2,340	27,693	30,081	8,453	107,051
1999	43	2,413	19,772	22,228	8,443	58,521
2000	38	1,848	15,696	17,583	4,654	66,424
2001	34	1,416	12,461	13,910	3,413	56,686
2002	39	811	9,892	10,743	2,980	38727
2003	46	465	7,853	8,364	3,943	17,740
2004	64	1,563	8,971	10,598	4,022	27,927
2005	89	5,254	10,248	15,592	9,250	26,281
2006	69	3,871	11,989	15,929	6,600	38,442
2007	53	2,852	14,026	16,931	9,672	29,636
2008	40	1,490	12,839	14,370	5,357	38,546
2009	31	779	11,753	12,563	6,879	22,945
2010	41	700	10,514	11,254	3,801	33,322
2011	54	628	9,405	10,088	4,187	24,303
2012	71	783	11,451	12,305	4,014	37,724
2013	94	975	13,941	15,011	6,917	32,575
2014	81	1,663	16,954	18,698	6,224	56,174
2015	70	2,836	20,618	23,524	9,947	55,629
2016	66	1,258	15,694	17,018	5,586	51,848
2017	63	558	11,945	12,566	5,720	27,605
2018	82	726	10,300	11,108	3,785	32,603
2019	108	944	8,881	9,934	4,979	19,818
2020	75	453	8,477	9,004	3,122	25,973
2021	52	217	8,091	8,360	4,403	15,873
2022	36	442	7,015	7,493	2,495	22,505
2023	25	900	6,083	7,008	2,962	16,583

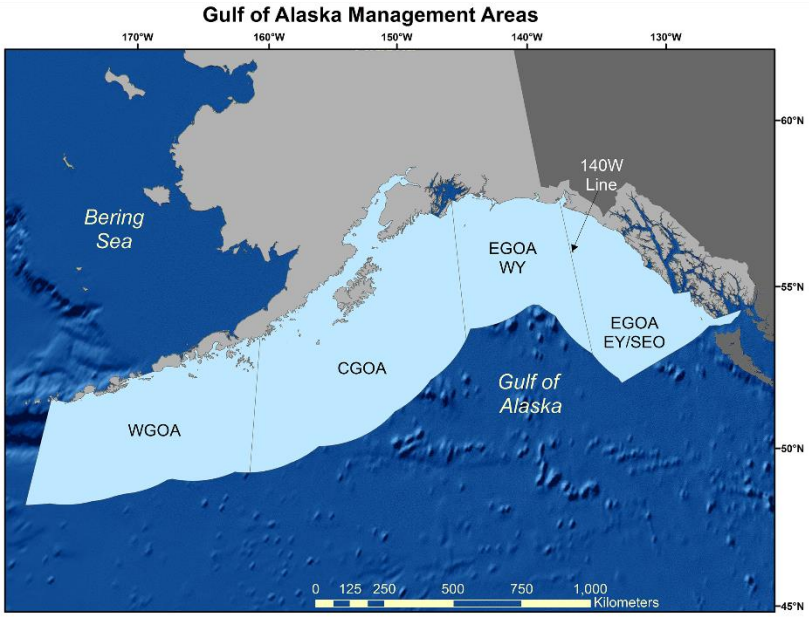
Table 16.10. Estimated random effects biomass (t) by NMFS regulatory area and total Gulf-wide biomass with 95% confidence intervals for four Tier 5 species in the Other Rockfish complex.

Year	Western GOA	Central GOA	Eastern GOA	Gulf-wide Total	95% Confidence Intervals Lower	Upper
1990	123	13,550	48,057	61,731	36,543	104,278
1991	121	12,021	49,302	61,443	15,367	245,673
1992	118	10,665	50,578	61,361	14,948	251,882
1993	115	9,461	51,888	61,464	35,904	105,222
1994	210	7,687	53,745	61,642	14,143	268,663
1995	383	6,245	55,669	62,297	13,991	277,386
1996	698	5,074	57,661	63,433	38,986	103,210
1997	481	7,031	55,335	62,846	14,471	272,943
1998	331	9,742	53,103	63,176	15,442	258,461
1999	228	13,499	50,961	64,688	43,423	96,367
2000	469	9,011	53,554	63,034	13,941	285,014
2001	966	6,014	56,279	63,260	10,254	390,252
2002	258	4,274	59,143	63,675	11,271	359,722
2003	69	3,038	62,153	65,259	25,688	165,787
2004	713	5,704	58,492	64,909	16,535	254,801
2005	7,399	10,711	55,047	73,157	45,293	118,164
2006	2,604	6,753	50,716	60,073	17,577	205,311
2007	917	4,257	46,725	51,899	35,291	76,324
2008	332	3,692	29,701	33,725	9,479	119,994
2009	120	3,201	18,880	22,201	14,636	33,677
2010	312	7,635	40,241	48,188	14,062	165,131
2011	808	18,213	85,771	104,791	61,458	178,678
2012	452	18,155	47,349	65,956	21,249	204,724
2013	253	18,098	26,139	44,490	26,940	73,472
2014	401	17,688	36,125	54,213	18,125	162,160
2015	636	17,287	49,926	67,848	41,291	111,486
2016	1,438	18,219	50,413	70,070	22,723	216,070
2017	3,252	19,202	50,905	73,358	44,746	120,266
2018	745	14,611	47,361	62,717	19,985	196,813
2019	171	11,117	44,063	55,351	39,555	77,457
2020	113	7,603	46,758	54,474	15,787	187,971
2021	75	5,199	49,618	54,892	36,685	82,136
2022	77	7,186	51,417	58,680	16,482	208,907
2023	79	9,931	53,282	63,291	40,069	99,972

Table 16.11. Analysis of ecosystem considerations for the Other Rockfish (OR) complex.

Ecosystem effects on *GOA Other Rockfish*			
Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton	Limited diet analyses	Stable, data limited	No concern
Non-pandalid shrimp and other benthic organism	Trends in indices are variable	Composes the main portion of many OR species diet	Unknown
Herring and other forage fish	Trends in indices are variable	Unknown	Unknown
Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	Reduced predation	No concern
Birds	Stable, some increasing some decreasing	Affects young-of-year mortality	No concern
Fish (walleye pollock, Pacific cod, halibut)	Stable to increasing	Possible increases to OR mortality	No concern
Sharks	Population indices show variable trends	Unknown	No concern
Changes in habitat quality			
Temperature regime	Warm and cold regimes	May shift distribution, and larval survival	Unknown
Prevailing currents	Larvae subject to currents	Potential to alter recruitment events	Unknown
GOA Other Rockfish effects on ecosystem			
Indicator	Observation	Interpretation	Evaluation
Fishery contribution to bycatch			
Not Targeted	None	No concern	No concern
Fishery concentration in space and time	None	No concern	No concern
Fishery effects on amount of large size target fish	If targeted, could reduce avg size of females, reduce recruitment, reduce fecundity, skewed sex ratio	No concern at this time	No concern at this time
Fishery contribution to discards and offal production	None	No concern	No concern
Fishery effects on age-at-maturity and fecundity	Age at maturity and fecundity decrease in areas that have targeted species	No concern at this time	No concern at this time

Figures



WGOA & CGOA	EGOA: W Yakutat	EGOA: Southeast
Aurora Rockfish	Aurora Rockfish	Aurora Rockfish
Blackgill Rockfish	Blackgill Rockfish	Blackgill Rockfish
Bocaccio	Bocaccio	Bocaccio
Canary Rockfish	Canary Rockfish	
Chilipepper Rockfish	Chilipepper Rockfish	Chilipepper Rockfish
China Rockfish	China Rockfish	
Copper Rockfish	Copper Rockfish	
Darkblotched Rockfish	Darkblotched Rockfish	Darkblotched Rockfish
Greenstriped Rockfish	Greenstriped Rockfish	Greenstriped Rockfish
Harlequin Rockfish	Harlequin Rockfish	Harlequin Rockfish
	Northern Rockfish	Northern Rockfish
Pygmy Rockfish	Pygmy Rockfish	Pygmy Rockfish
Quillback Rockfish	Quillback Rockfish	
Redbanded Rockfish	Redbanded Rockfish	Redbanded Rockfish
Redstripe Rockfish	Redstripe Rockfish	Redstripe Rockfish
Rosethorn Rockfish	Rosethorn Rockfish	
Sharpchin Rockfish	Sharpchin Rockfish	Sharpchin Rockfish
Shortbelly Rockfish	Shortbelly Rockfish	Shortbelly Rockfish
Silvergray Rockfish	Silvergray Rockfish	Silvergray Rockfish
Splitnose Rockfish	Splitnose Rockfish	Splitnose Rockfish
Stripetail Rockfish	Stripetail Rockfish	Stripetail Rockfish
Tiger Rockfish	Tiger Rockfish	
Vermillion Rockfish	Vermillion Rockfish	Vermillion Rockfish
Widow Rockfish	Widow Rockfish	Widow Rockfish
Yelloweye Rockfish	Yelloweye Rockfish	
Yellowmouth Rockfish	Yellowmouth Rockfish	Yellowmouth Rockfish
Yellowtail Rockfish	Yellowtail Rockfish	Yellowtail Rockfish

Figure 16.1. Map of the Gulf of Alaska (GOA) management areas: Western (WGOA), Central (CGOA) and Eastern (EGOA). The EGOA is subdivided into the West Yakutat and East Yakutat/Southeast areas. The table below the figure lists the species that are part of the Other Rockfish complex in each of the areas.

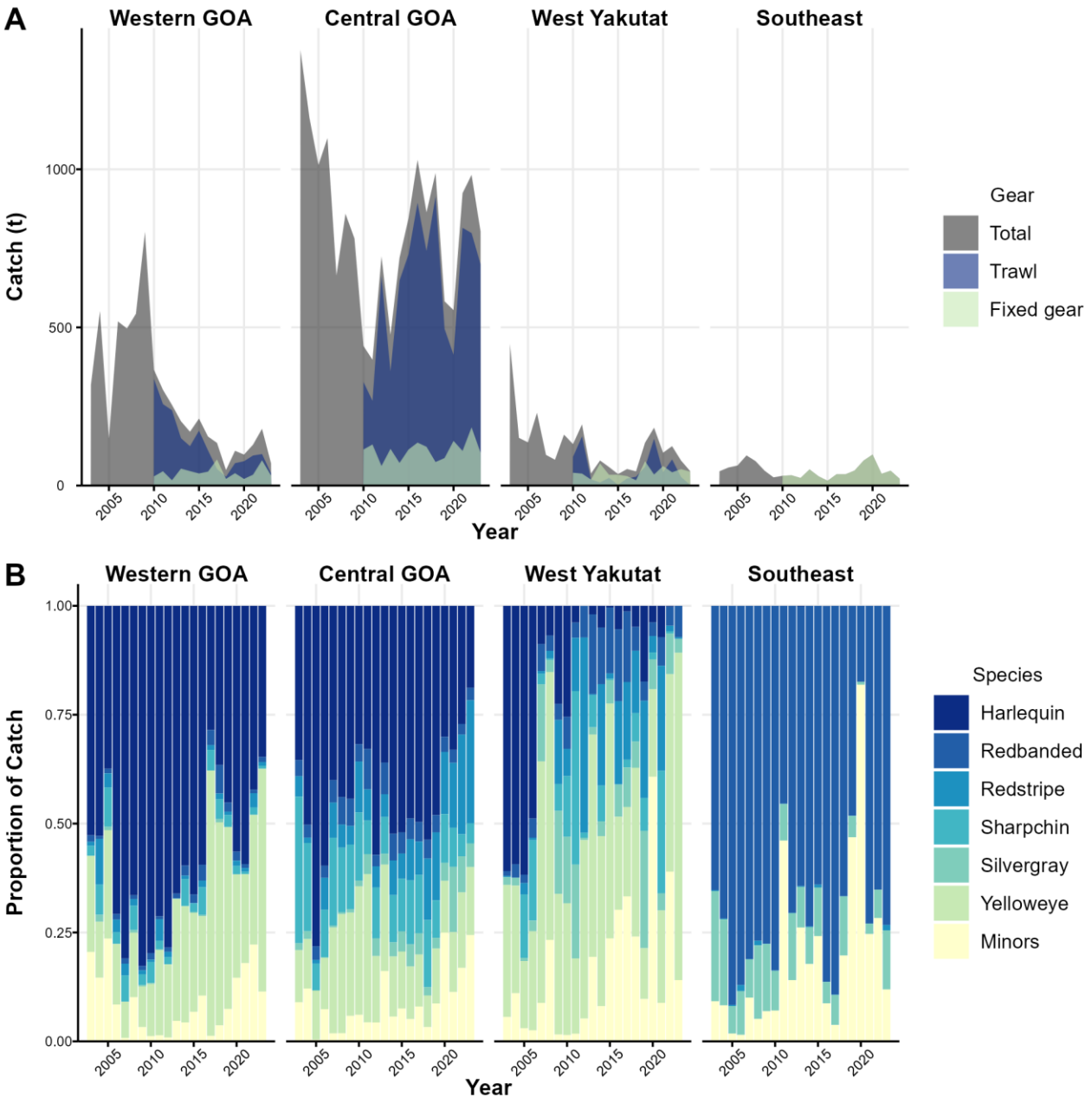


Figure 16.2. Estimated catch (t) of Other Rockfish in Gulf of Alaska (GOA) by area (Western GOA, Central GOA, West Yakutat, and East Yakutat/Southeast (Southeast) by (A) main gear types (trawl and fixed gear, which includes hook-and-line, jig, and pot gear) and (B) proportion of main species caught. Note: yelloweye catch is excluded in the Southeast. National Marine Fisheries Service Alaska Regional Office Catch Accounting System (queried through AKFIN on October 10, 2023).

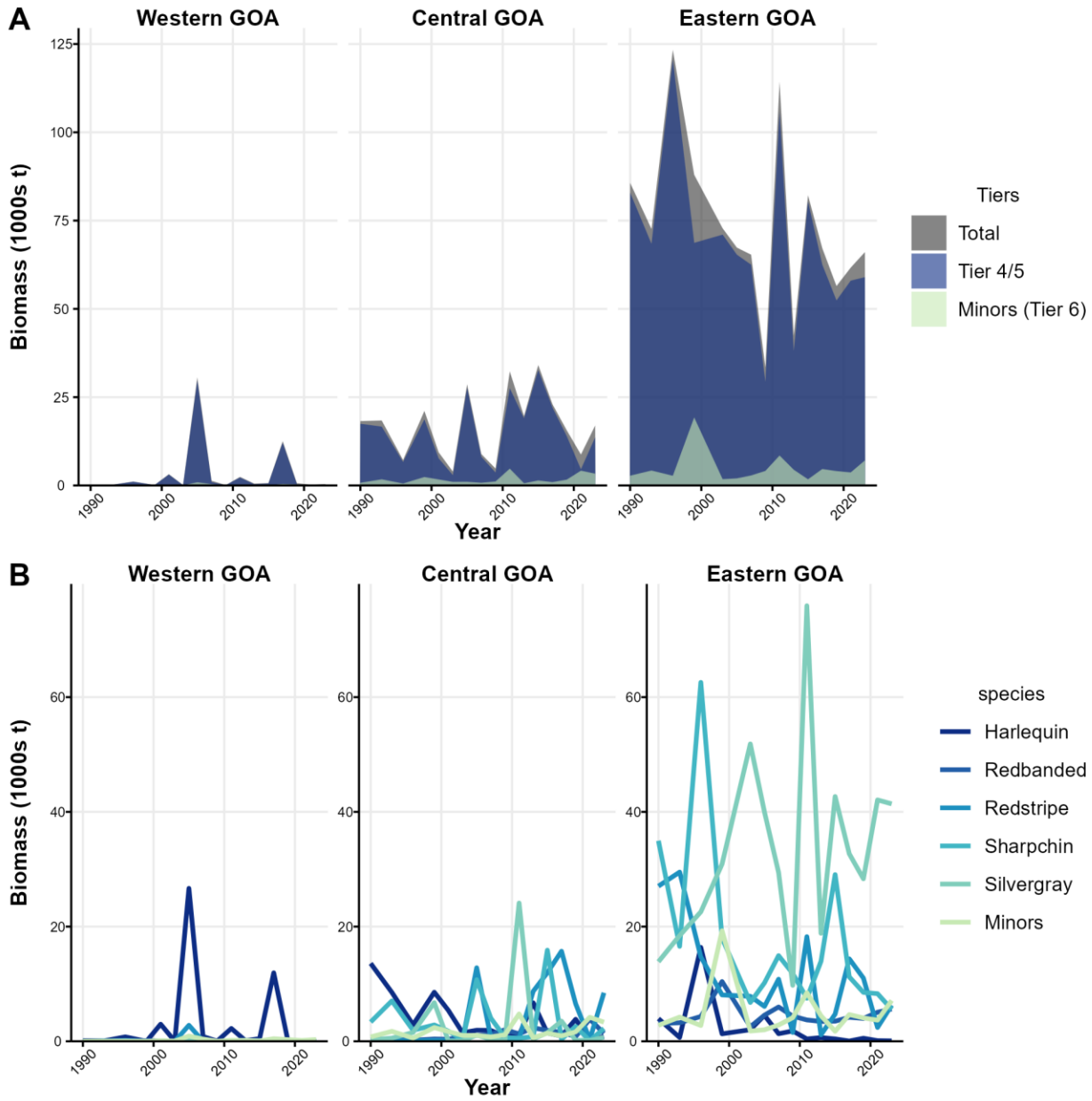


Figure 16.3. Trawl survey biomass estimates for the species in the Other Rockfish complex by assigned Tiers in the Gulf of Alaska (GOA) by (A) regulatory area (Western GOA, Central GOA, Eastern GOA) and (B) main species.

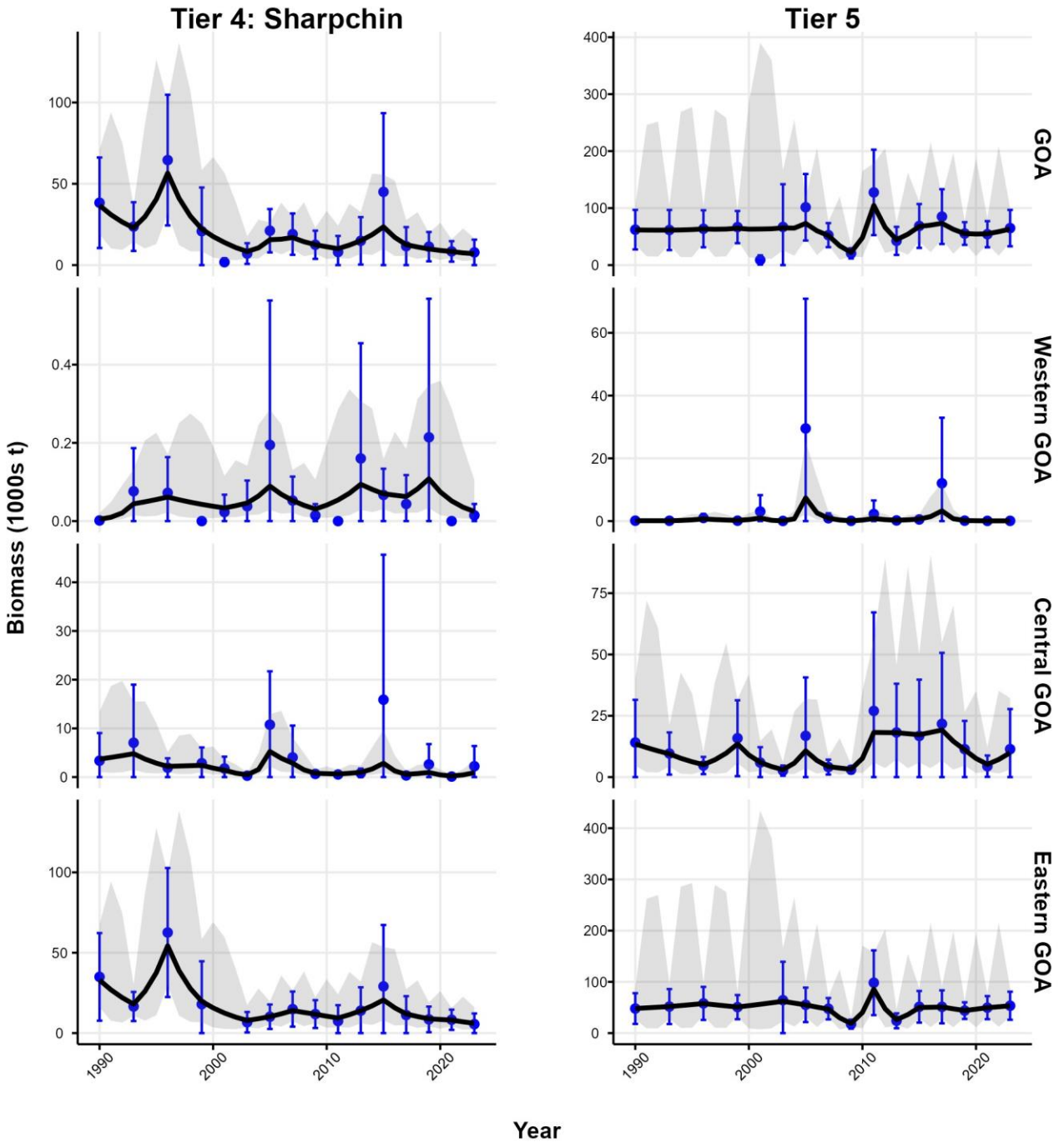


Figure 16.4. Estimated random effects biomass (black line with gray shaded confidence intervals) and NMFS GAP bottom trawl survey biomass estimates (blue dots with confidence intervals) for Tier 4, sharpchin rockfish, (left panel) and the 4 grouped Tier 5 Other Rockfish species (right panel) by Gulf-wide (GOA) and NMFS regulatory areas: Western GOA, Central GOA and Eastern GOA.

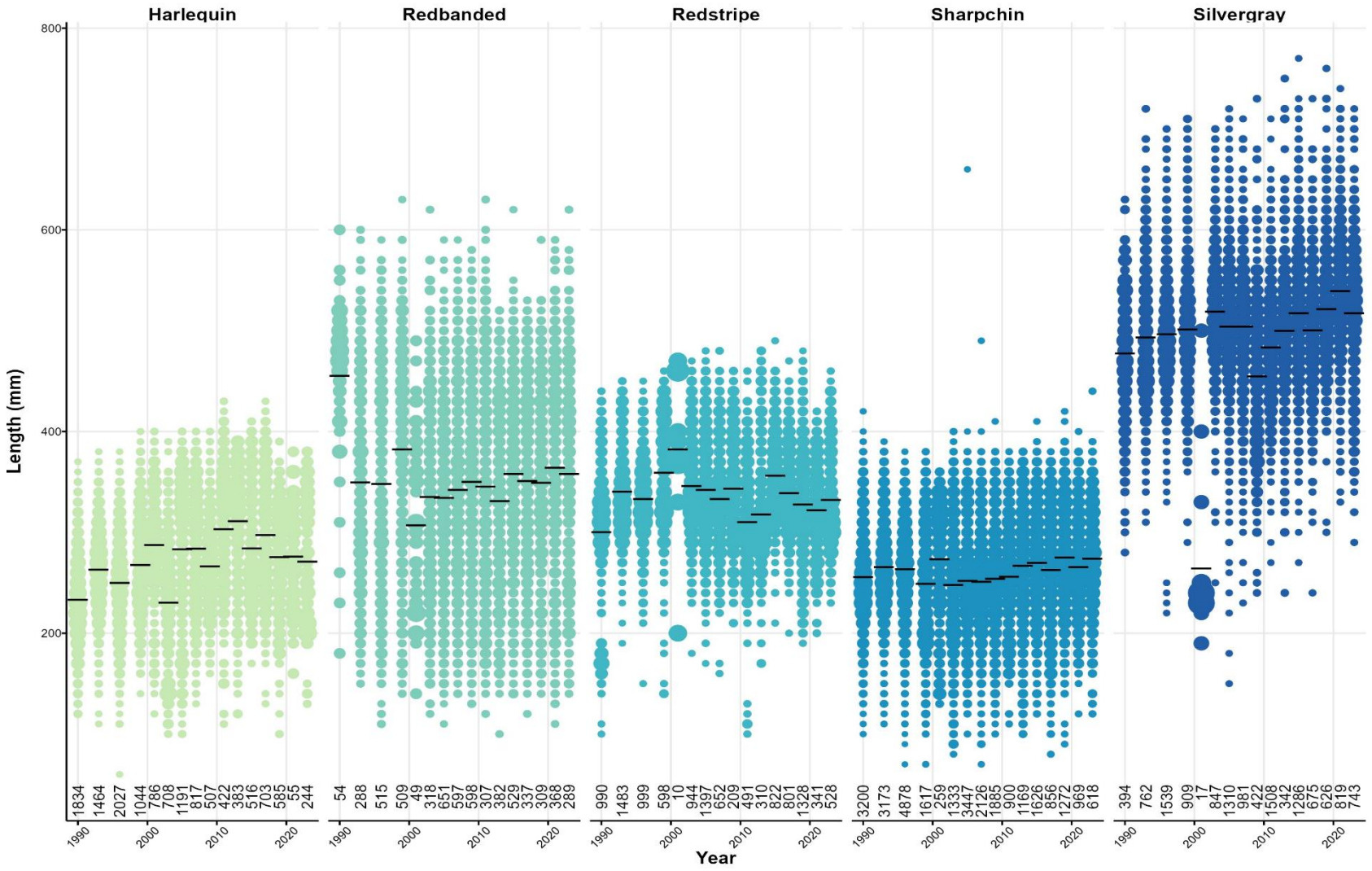


Figure 16.5. Size composition of the primary Other Rockfish species (i.e., Tier 4 and 5 species) from the National Marine Fisheries Service (NMFS) GAP bottom trawl survey. Numbers across the bottom are the sample size and the black horizontal line represents the mean size in a given year. Note that the survey did not sample the Eastern GOA in 2001, contributing to the low sample size.

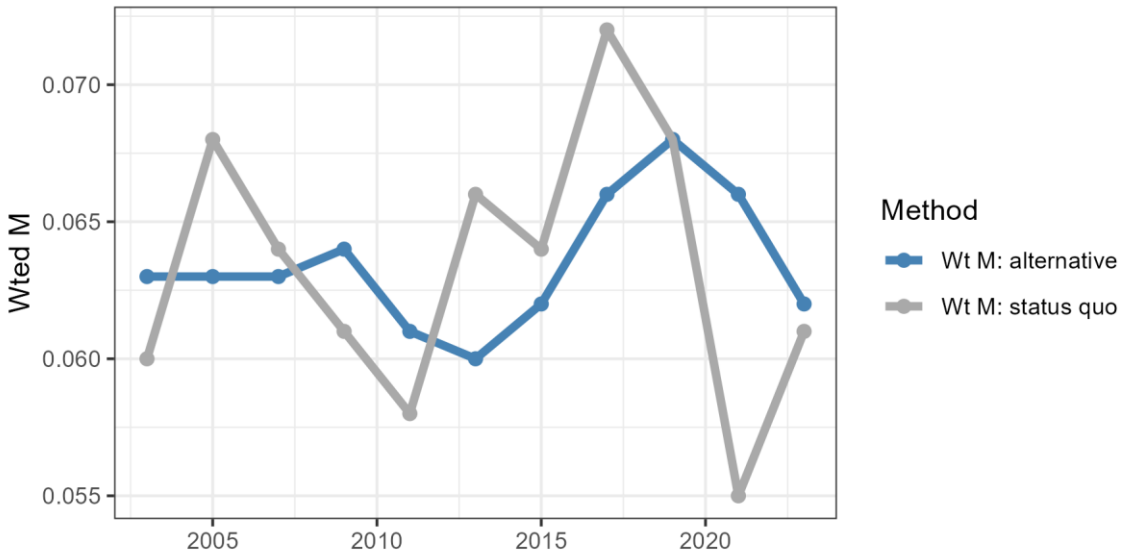


Figure 16.6. Calculated weighted natural mortality (Wt *M*) for Tier 5 species through time for status quo method (weighted *M* using final year estimated biomass proportions from each *M* group) and alternative method (average weighted *M* using an average of 6 years of estimated biomass proportions from each *M* group, where the 6 recent years encompasses the 3 most recent trawl surveys).

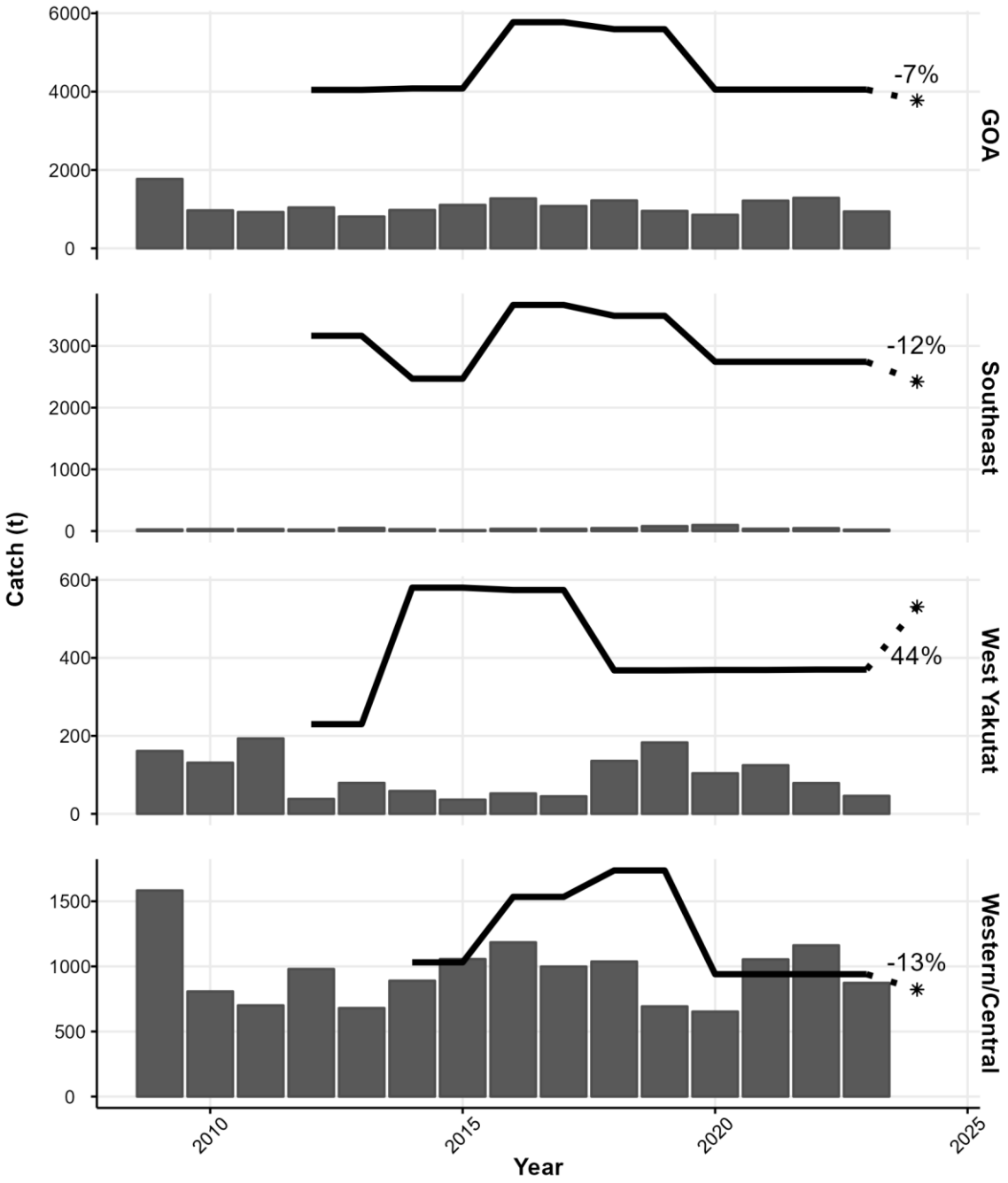


Figure 16.7. Historical Other Rockfish apportioned ABC (lines) compared to the historical Other Rockfish catch (bars). The ABC for the Other Rockfish begins in 2012 when this version of the complex was formed. The 2024 recommended apportioned ABCs are shown as black stars and the proportion change from the previous assessment is noted in each panel.

Appendix 16A. Supplemental Catch Data

Table 16A-1. Research survey and non-commercial catch of Other Rockfish from 2010-present in the Gulf of Alaska (GOA), which are not counted again the total allowable catch. These catch data were provided by the Alaska Regional Office. Research catch from the AFSC Trawl survey from 1977-2009 can be found in Clausen and Echave 2011[A].

Year	Source	AFSC Trawl Surveys (t)	AFSC LL Survey (#s)	AFSC LL Survey (t)	IPHC LL Survey (t)	ADF&G (t) (includes sport and research)
2010			1,453	2.6	8.9	4.7
2011		7.7	1,212	2.2	6.1	3.9
2012			1,320	2.4	6.5	4.9
2013		3.8	1,191	2.2	5.8	50.8
2014			1,636	3.1	9.0	55.7
2015	AKRO	12.0	1,412	2.7	8.0	51.3
2016			1,343	2.5	6.4	58.3
2017		5.2	1,598	2.9	5.2	60.8
2018			1,615	3.0	7.9	56.4
2019		4.3	1,059	2.0	12.3	75.1
2020			1,158	2.2	9.2	44.3
2021		3.7	1,335	2.5	12.5	46.2
2022			1,632	3.1	7.5	51.6

[A] Clausen, D. M. and K.B. Echave. 2011. Assessment of shortraker rockfish. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 971-1008. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501. Available online: http://www.afsc.noaa.gov/refm/docs/2011/GOAshortraker.pdf

Appendix 16B. Gulf of Alaska Other Rockfish stock complex updates

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September, 2023

The harvest specifications for 2022-2023 for the Other Rockfish stock complex (OR) in the Gulf of Alaska (GOA) were rolled over from the 2019 harvest recommendations due to concerns regarding the 2021 GOA OR assessment. To address some of the concerns, we propose the following updates to the 2023 assessment:

1. Updating the Random Effects model using the REMA model
2. Expanding maximum catch time series for Tier 6 GOA OR species
3. Determining reliable survey biomass for Tier 4/5 GOA OR species
4. Updating weighted natural mortality (Wt M) for Tier 5 GOA OR species

Updating the Random Effects model using the REMA model

The Random Effects Multi-area with Additional longline survey (REMA) model (Hulson et al. 2021, Monnahan et al. 2021, Sullivan et al. 2022b) is a multivariate extension of the original Random Effects (RE) model. The REMA model was built to replace the RE model for assessment of AFSC Tier 4/5 stocks and apportion Annual Biological Catch (ABC) to NPFMC management regions. The REMA model went through extensive validation testing to ensure consistency and reproducibility of applications within the assessments. The REMA model was coded using Template Model Builder (TMB; Kristensen et al., 2016) and was developed into a R package (*rema;* Sullivan et al. 2022b), while the predecessor RE model was built in AD Model Builder (ADMB; Fournier et al. 2012). Previous work was completed to demonstrate that the REMA model can produce the same (or very similar) results as the RE model when using the same assumptions and data inputs. The REMA model was supported and approved by the NPFMC PT and SSC in 2022 to use for Tier 4/5 stocks and apportionment.

"*The Teams recommended that stock assessment authors transition from the ADMB random-effects survey smoother to this package [REMA] which implements the same model with several improvements.*"- (NPFMC Joint Groundfish PT, September 2022)

To support the transition to the REMA model for the GOA OR stock complex assessment, we compared REMA model results with previous RE model results. More specifically, we applied the REMA model to the trawl survey catch for GOA OR Tier 4 (sharpchin), Tier 5 (aggregate of all Tier 5 OR species), and Tier 5 natural mortality groupings (5 natural mortality groupings used to calculate a single Tier 5 weighted natural mortality). Then compared REMA model biomass estimates with the previous RE model results from the last full GOA OR assessment in 2021. There was little difference (< 0.25% difference) between the RE and REMA biomass estimates across the time series for Tier 4, Tier 5, and Tier 5 natural mortality grouping models (Table 16B-1; see Figure 16B-1a for Tier 4- sharpchin rockfish example). Likewise, visual comparisons of the two models demonstrated no difference between biomass estimates and confidence intervals (see Figure 16B-1b for Tier 4- sharpchin example). Therefore, we recommend using the REMA model in the GOA OR stock complex assessment beginning in the 2023 assessment cycle.

Expanding the maximum catch time series for Tier 6 GOA OR species

The North Pacific Fishery Management Councils (NPFMC) Tier 6 stocks are managed based on catch history in the fishery. In 2017, the reliable catch history for Tier 6 GOA OR species was defined as the time series from 2013–2016, which corresponded to the years when species-specific discard estimates of non-target rockfish stocks were documented in the Catch Accounting System (CAS). Catch estimates prior to 2013 in CAS were not considered representative of the GOA OR catch due to bias in discard rates estimated using observer data. Since 2017, the 2013–2016 reliable catch time series has continued to be used to calculate the harvest limits for the Tier 6 GOA OR species (i.e., Model 17.1, Overfishing Limit (OFL) = maximum catch, ABC = 0.75*OFL; Tribuzio et al. 2021).

We propose expanding the reliable catch time series to 2013–2022. A ten-year time series better represents the catch history for these long-lived non-target rockfish species compared to a four-year time interval. Likewise, an expanded time series that includes the most current catches would better represent what the fishery is encountering, if any species distribution shifts have occurred, if there were major changes in abundance due to ecosystem changes, or if shifts in fishing patterns have occurred.

Using the catch time series from 2013 to 2022 results in a 90 t increase (35%) in the Tier 6 OFL compared to the 2013- 2016 time series (Table 2). The majority of species had minimal change in maximum catch with the exception of quillback and yelloweye rockfish, which were 13 t and 68 t increase, respectively (Table 16B-2). Note that 7 of these Tier 6 GOA OR species belong to the Demersal Shelf Rockfish sub-group and are managed separately in the East Yakutat/Southeast management area. However, the total Tier 6 GOA OR OFL would account for 8% of the total (i.e., also including the Tier 4/5 species in this complex) 2022 GOA OR stock complex OFL (i.e., as calculated in the 2021 GOA OR assessment, Tribuzio et al., 2021) when using the 2013-2022 time series compared to 6% if using the 2013-2016 time series. Thus, the overall OFL for the GOA OR stock complex would only increase by ~ 2% if using the new catch time series for Tier 6 GOA OR species compared to the 2013-2016. Maximum catch did not substantially change in any one management region using the new time series for any specific Tier 6 GOA OR species. The minor increases in maximum catch spread across the different management areas for each of the Tier 6 GOA OR species suggest that the expanded ten-year time series better captures a stable fishing history in which to base the harvest limits compared to the previous four-year time series.

Determining reliable survey biomass for Tier 4/5 GOA Other Rockfish species

Background

The species in the GOA OR stock complex are divided into three tier levels that align with their original management assemblage designations (i.e., demersal shelf, pelagic shelf, and slope assemblages). This stock complex originated in 1991 as the Other Slope assemblage, but has since had several stock composition changes (i.e., additions and removals of species) throughout its management history. Beginning with the 2012 SAFE cycle, the Other Slope and Pelagic Shelf (excluding dusky rockfish) stock complexes were combined to the current OR stock complex. The Other Slope and Pelagic Shelf rockfish species were all assessed using Tier 5 methodologies. In 2013, the assessment author identified an oversight in the previous OR stock complex assessments. Mainly, the Demersal Shelf Rockfish (DSR) species, which occurred west of the Southeast Outside area (i.e., NMFS Area 650), were not included in the assessment. However, catch from the these DSR species were counted against the TAC for the OR stock complex. The DSR species were integrated into the assessment of the OR complex during the 2013 SAFE. Because the DSR species were poorly sampled by (or completely absent from) the trawl survey gear (i.e., the basis of the Tier 5 assessments), they were assigned a Tier 6 status using fishery catch to determine ABCs and OFLs. Additionally, two slope species, aurora and shortbelly, that have low or no catch, were included in the 2019 GOA OR assessment as Tier 6 species due to an oversight in previous assessments. Tier designations for GOA OR have not been re-evaluated since their

original assignments (i.e., Tier 4/5 assignment for species that belonged to the slope and pelagic shelf assemblages and Tier 6 for species in demersal shelf assemblage).

For the Tier 4/5 GOA OR species, the AFSC GOA bottom trawl survey biomass time series is the primary data input for the random effects assessment model and its successor REMA (Hulson et al. 2021, Sullivan et al. 2022). The resultant REMA generated biomass estimates from the assessment are then used to derive GOA-wide harvest limits. A primary requirement for Tier 4/5 stocks in the NPFMC OFL Control Rule System is that a reliable point estimate of biomass exists (https://www.npfmc.org/fisheries-issues/fisheries/goa-groundfish-fisheries/). For OR Tier 4/5 species, the current assessment paradigm is that trawl survey biomass accurately represents the species biomass across the assessment region (i.e., across the GOA for Tier 4/5 OR species). However, there are a number of factors that could violate the assumption that the trawl survey "reliably" samples a given species and tracks the population trends for many rockfish species, including: 1) the trawl survey does not survey all 'trawlable' habitat types that are fished in the commercial rockfish fisheries, thus, only partially surveying suitable rockfish habitat (e.g., harlequin), 2) patchy distributions contribute to highly variable catches, 3) many of the GOA OR species are rare and difficult to survey, and 4) the survey was not optimized for these non-target rockfish species.

Many of the GOA OR species are either never caught or captured infrequently by the trawl survey. Five of the Tier 4/5 GOA OR species comprise 95% of the total survey biomass catch for these species (Figure 16B-2). Furthermore, many of the GOA OR species are found in higher abundance in the Eastern GOA compared to the low and infrequent survey catches in the Western and Central GOA. While, conversely, the majority of the commercial fisheries catch for GOA OR species are from the rockfish target trawl fishery in the Central GOA (see Table 16.8 and Figure 16.6 in last full assessment, Tribuzio et al. 2021). The inability of the trawl survey to adequately sample GOA OR species (i.e., due to their patchy and spatially unbalanced spatial distribution along with the large number of stocks with low survey catch) warrants further investigation as to whether the AFSC GOA bottom trawl survey can be reliably used to assess Tier 4/5 species that comprise the GOA OR complex.

Metrics for reliable trawl survey biomass

The time series spanning 1984 to 2021 (totaling 17 years) for the AFSC GOA bottom trawl survey is used to examine the reliability of the trawl survey to assess the Tier 4/5 GOA OR species. All Tier 4/5 species from the GOA OR stock complex are included in this analysis as well as additional Tier 3/4/5 GOA rockfish species (i.e., that are assessed and managed on a single-species basis) as a basis for comparison (Table 16B-3). Because the GOA OR stock complex is assessed and managed using a GOA-wide OFL, we use a GOA-wide analysis. However, the average annual proportion of survey catches in the combined Western and Central GOA compared to the total GOA are also examined to determine biomass distribution between Western/Central and Eastern GOA.

We selected three main metrics to assess the ability of the AFSC GOA bottom trawl survey to detect and sufficiently represent biomass trends for GOA rockfish including: REMA model diagnostics (i.e., ability of a single stock model application to converge); proportion of hauls with positive catch; and the coefficient of variation (CV) on survey catch. The three metrics were selected because they provide general insight into data availability (i.e., frequency), consistency, and reliability, and are sensitive to infrequently caught species. The REMA model is run on individual GOA species as a diagnostic test to determine if there were sufficient data to successfully run the REMA model. If there are not enough data available to run the REMA model, the model would fail to estimate a process error and biomass. The indicators that examine catch consistency and frequency are: a) proportion of hauls with positive catch, calculated as the number of hauls with positive catch compared to the total number of hauls each year, b) the proportion of years that a species is caught (across all hauls) on the survey (i.e., proportion of years with positive survey catch; *propyrs*), c) the average annual proportion of hauls that a species is caught in (*avg_pos*), and d) the proportion of years that a species is caught in more than 5% of hauls (*pos_above.05*). Conversely, survey catch stability and variability are indicated by:

the CV time series, the average CV across the time series, and the proportion of years that have a CV below 0.5 (*CV_below.5*). The CV cutoff of 0.5 was selected here, because large CVs indicate high variability and instability in catch (e.g., issues with sampling stocks with patchy distributions) and can be used to identify a time series for which variability might be too great to provide insight into trends.

Results

Based on all GOA rockfish, a tentative baseline (i.e., criteria of a 'reliable survey biomass' for rockfish species) has been established from the metrics to identify those rockfish species that support the use of the trawl survey to their assessment. The criteria include: being caught each year in the survey and in high enough frequency (successful REMA model, *propyrs* ≈ 1, and *avg_prop* > 0.01) and relatively consistently (*avg_CV* < 0.5). In comparison to many of the GOA OR species, the GOA rockfish stocks that are assessed and managed on a single species basis have been caught in each trawl survey year, demonstrate higher survey catch and frequency of presence, have average CVs < 0.5, and are more evenly distributed spatially (Table 16B-3). For GOA OR species, consistency across metrics support the use of the GOA bottom trawl survey in assessments for five of the Tier 4/5 OR species that are most frequently caught in the survey (i.e., sharpchin, harlequin, redbanded, redstripe, and silvergray), while the use of trawl survey should be reconsidered for the remaining GOA OR species (Table 3; Table 4). All species that have positive survey catches appear to have sufficient GOA-wide catch data to run the REMA models, except for vermillion rockfish (Table 16B-3). Vermillion rockfish was only encountered by the survey in one year. Additionally, there were three OR species (i.e., stripetail, blackgill, and chilipepper) that were not caught in the trawl survey during the specified time series (Table 16B-4).

Of the remaining Tier 4/5 species that are caught by the GOA bottom trawl survey, five species (i.e., silvergray, sharpchin, redstripe, harlequin, and redbanded) are present in the survey every year and on average occur in over 1% of hauls (Table 16B-3, Figure 16B-3). The GOA-wide time series of proportion of positive hauls metrics suggest that when species are caught every year in the survey and have above 0.01 average proportion of positive hauls, the survey has the potential to detect biomass trends for the given species. The CV metrics (i.e., average and proportion of years with a CV < 0.5) have more variable results. The general patterns suggest more consistent catches (i.e., lower CVs) equate to more reliable survey biomass when examining across all GOA rockfish species for comparison. Both harlequin and redstripe have an average CV > 0.5, but both are caught in relatively high frequency (i.e., based on *propyrs* and avg proportion of hauls with positive catch) and are caught throughout the GOA. Greenstriped partially met the CV criteria, with an average annual proportion of hauls with positive catch near 0.01 and an average CV around 0.5, but the vast majority of catch is in the Eastern GOA and are infrequently caught in the Western or Central GOA.

Recommendations

We recommend moving 12 OR species (i.e., greenstriped, pygmy, darkblotched, yellowtail, yellowmouth, bocaccio, splitnose, vermillion, widow, stripetail, blackgill, and chilipepper) from Tier 5 to Tier 6 (Table 16B-4). These species did not meet the three criteria examined for having a reliable survey biomass. The recommended 12 OR species have < 1% average annual hauls where the species is observed in the GOA-wide survey, typically result in an average CV around or greater than 0.5, and are infrequently found in the Western/ Central GOA. The total combined biomass of these 12 rockfish species comprise about 5% of the total GOA OR complex bottom trawl survey biomass. For these 12 OR rockfish species, we recommend using existing Tier 6 maximum catch methods to calculate the harvest specification along with the other Tier 6 OR species.

Updating Weighted Natural Mortality as a Proxy for F_{OFL} for Tier 5 GOA OR Species

Background

The GOA OR stock complex was last assessed in 2021. However, the current harvest specifications are based on the 2019 assessment, because the resultant OFL was deemed unsuitable for management advice. This

occurred because of three compounding issues: 1) the AFSC GOA bottom trawl survey had very low catches of many of the GOA OR species; 2) there was a shift in the dominant species from those with high natural mortality values (M) to those with low M values, resulting in a substantial decrease in the weighted M used for estimating the OFL; and 3) the spatial distribution of the biomass shifted such that there was minimal biomass in the Western/Central GOA (Tribuzio et al. 2021). This report is in response to Plan Team and SSC requests to explore alternative methods of estimating a weighted M value for the Tier 5 species within the complex so that it is less sensitive to fluctuations as experienced in 2021.

"the Team recommended rolling over harvest recommendations from 2021 due to the discrepancy between catch and survey biomass and the estimation of weighted M being influenced by a few species that have patchy distributions and survey catchability/availability issues.

The Team recommends the author further explore issues with using the current method of weighted M biomass estimates." – (NPFMC Joint Groundfish PT, November 2021)

The GOA OR harvest specification approach assigns the Tier 5 species into natural mortality (M) sub-groupings based on similar assumed M values. For each M sub-group, the RE or REMA model is applied to the aggregated AFSC GOA bottom trawl survey catch to obtain GOA-wide M sub-group biomass estimates. A single Tier 5 biomass-weighted M is then computed by averaging across M sub-groups. The RE/ REMA model is then applied to the aggregated survey catch of all Tier 5 GOA OR stocks to compute the Tier 5 GOA-wide biomass estimate. Finally, the F_{OFL} is set equal to the weighted M and the OFL is calculated as weighted M multiplied by the Tier 5 total biomass. For each assessment cycle, a new weighted M is calculated based on the terminal year trawl survey catches. Thus, the weighted M, which drives the harvest specifications, has a high dependency on the GOA trawl survey data in the terminal year.

However, the AFSC GOA bottom trawl survey poorly samples the Tier 5 GOA OR species. As previously noted, the GOA trawl survey was not optimized to sample non-target rockfish stocks. Sampling inefficiencies lead to uncertain and variable biomass estimates (Tribuzio et al., 2021), which was one impetus for the proposed ABCs and OFLs from the last full GOA OR assessment in 2021 to not used for final harvest specifications. More specifically, the estimated biomass increased in the lower value M sub-group (i.e., M = 0.05, mainly silvergray), while the estimated biomass decreased in the higher value M sub-groups (i.e., M= 0.092, harlequin, and M= 0.1, redstripe). The switch in species composition dominance in the survey catch from higher to lower value M sub-groups ultimately caused the combined weighted M for the Tier 5 GOA OR species to decline by 21% and the OFL to decline by 962 t from the 2019 to the 2021 assessment (see Fig. 16.3, 16.11 in 2021 assessment; Tribuzio et al., 2021).

We propose an alternative method to calculate weighted M for Tier 5 GOA OR species that uses a three-year average survey catch approach, which is less sensitive to yearly variability in survey catches of OR species. Although the proposed weighted M still changes each assessment cycle, the effects of sudden shifts in survey species composition are dampened by averaging across the three most recent survey years. Moreover, long-term changes in the species composition are still captured.

Weighted M Calculation Methods

Status quo Weighted M:

The status quo method to calculate the weighted M (Wted M) as a proxy for F_{OFL} is described in Tribuzio et al., (2021), where the biomass-weighted M value for terminal year *z* is based on estimated current year biomass from the trawl survey:

$$F_{OFL} = \text{Wted M} = \sum_i p_{i,z} * F_i,$$

where p_i is the proportion of GOA-wide biomass for each *i* sub-group with a shared M (e.g., M sub-groups: 0.05, 0.06, 0.07, 0.92, 0.10) for survey, *z*, and F_i is the sub-group specific fishing mortality with M value as a proxy (i.e., $F_i \approx M_i$) as established for NPFMC Tier 5 stocks.

Alternative Weighted M:

The alternative weighted M ($\overline{\text{Wt\_M}}$) is based on a "moving" average biomass, where the time series shifts to accommodate new survey data. The alternative weighted M is calculated using the average survey biomass from the previous three GOA trawl surveys:

$$F_{OFL} = \overline{\text{Wt\_M}} = \sum_i \overline{p_{i,z-2:z}} * F_i,$$

where the proportion of GOA-wide biomass is now averaged from the 3 most recent surveys (i.e., *z*-2 to *z*, representing the trawl surveys for 2017, 2019, and 2021) for each M sub-group.

Comparing Weighted M methods

The status quo weighted M from 2012 to 2021 ranges from 0.055 (2021) to 0.072 (2017; Figure 16B-4). As previously mentioned, the sudden decease in weighted M in 2021 was due to the change in species composition dominance in the GOA trawl survey from harlequin and redstripe (M sub-groups = 0.092 and 0.1, respectively) to silvergray (M sub-group = 0.05). In comparison, the alternative weighted M ranges from 0.061 (2012) to 0.069 (2018, 2019) when calculated for the time period from 2012 to 2021. Averaging the proportional biomass from the past three surveys for each of the M sub-groups allows subtle changes to occur, but minimizes the impact of a single survey on the weighted M calculation.

Using the total biomass estimated for the Tier 5 GOA OR species from the 2021 assessment, the OFL applying the alternative weighted M method would be ~20% greater than the status quo weighted M method (i.e., OFL with $\overline{\text{Wt\_M}}$ = 3,873 t, OFL with Wted M = 3,228 t; Table 16B-5). Because both approaches utilize the same biomass estimates for this analysis, the increase in the OFL from using the alternative weighted M solely reflects the impact of averaging the survey species composition across three surveys instead of using the just the terminal survey proportion.

We recommend the alternative weighted M approach using the three most recent survey years, because: 1) these GOA OR species are long-lived, later maturing species with high survey variability, thus averaging the last three-survey data points (~ 6 years) would dampen survey uncertainty yet capture population trends; and 2) prior to the implementation of the random effects model for determining biomass, several GOA rockfish assessments including GOA OR used a three survey averaging method to determine exploitable biomass and apportionment, which is similar to this approach and provides consistency with the proposed alternative weighted M approach.

Summary of recommendations

In summary, to improve the GOA OR stock complex assessment and in response to the SSC/PT comments, we propose the following updates:

1. Replace the RE model with the REMA model; no differences were observed when both models were applied to the same inputs, though REMA is preferred due to improved functionality and code base.
2. Expand the time series used to define Tier 6 GOA OR species' maximum catch from the current 2013-2016 time block to a ten-year time period of 2013-2022.
3. Use the methodology (i.e., being caught each year in the survey and in high enough frequency [successful REMA model, *propyrs* ≈ 1, and *avg_prop* > 0.01] and relatively consistently [*avg_CV* <

0.5]) to determine 'reliable' survey biomass for Tier 4/5 GOA OR species, and move the 12 Tier 5 GOA OR species (Table 4) that did not have 'reliable' survey biomass estimates to Tier 6.

4. Update the weighted natural mortality (Wt M) methodology for Tier 5 GOA OR species using the alternative method based on an average weighed M using the 3 most recent surveys, as opposed to basing the weighted M on only the most recent survey values.

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Tables for Appendix 16B

Table 16B-1. Average differences between yearly biomass estimates from the REMA (TMB) model compared to the predecessor RE (ADMB) model along with number of years with > 0.5% difference between the two model results for Tier 4/5 groups, and each Tier 5 natural mortality grouping (Tier 5: M).

Group	Average Difference (t)	No. of years with > 0.5% difference
Tier 4: Sharpchin	-0.0073	0
Tier 5: All species	-0.0084	0
Tier 5: M=0.1	-0.0033	0
Tier 5: M=0.05	-0.0065	0
Tier 5: M=0.06	-0.0029	0
Tier 5: M=0.07	-0.0011	0
Tier 5: M=0.092	-0.0055	0

Table 16B-2. Maximum catch for Tier 6 Gulf of Alaska Other Rockfish (GOA OR) species for each time series (current: 2013-2016; proposed: 2013-2022).

	Maximum Catch (t)							
	2013-2016				2013-2022			
Tier 6	Western GOA	Central GOA	West Yakutat	Total 2013-2016	Western GOA	Central GOA	West Yakutat	Total 2013-2022
aurora	0	<1	0	0	0	<1	<1	0
[1]canary	<1	1	<1	1	<1	1	<1	2
[1]china	<1	1	<1	1	<1	3	<1	3
[1]copper	<1	<1	<1	0	<1	<1	<1	0
[1]quillback	1	25	1	27	1	25	14	40
[1]rosethorn	<1	1	1	2	<1	2	2	5
shortbelly	0	0	0	0	0	0	0	0
[1]tiger	1	4	<1	5	1	6	1	7
[1]yelloweye	57	124	40	221	82	155	53	290
Total OFL				257				347

[1] Stocks that belong to the Demersal Shelf Rockfish (DSR) sub-group that are managed in a separate DSR stock complex in the East Yakutat/Southeast management area, but currently belong to the GOA OR in the other GOA management regions; thus, no max catch or ABCs are calculated for the DSR sub-group stocks in East Yakutat/ Southeast.

Table 16B-3. Reliable survey biomass metrics for Gulf of Alaska (GOA) Other Rockfsh Tier 4/5 stocks and additional GOA rockfish stocks (in italics) for comparison. Metrics include the REMA diagnostic (1= successfully estimates a process error, 0= model fails), proportion of positive years (propyrs), average proportion of hauls with positive catch (avg_pos), proportion of years that have above 0.05 proportion of hauls with positive catch (pos_above.05), average CV (avg_CV), proportion of years with a CV below 0.5 (CV_below.5), and average annual proportion of survey catch in Western/ Central GOA compared to GOA-wide. The rockfish stocks above the red dashed line are caught more frequently and are more represented by the GOA bottom trawl survey compared to stocks below the red dashed line. Note: stripetail, blackgill, and chilipepper rockfish are not included in the table because these stocks were not caught in the GOA bottom trawl survey during the time series.

				Proportion of hauls with positive catch			CV		Avg (WG+CG) GOA
tier	species	avg annual biomass (t)	REMA	propyrs	avg_pos	pos _ above.05	avg_CV	CV_below.5	
3	*POP*	783138	1	1	0.44	1	0.23	0.94	0.75
3	*Northern*	160574	1	1	0.17	1	0.40	0.82	1
3	*Dusky*	71074	1	1	0.17	1	0.35	1	0.84
4	Sharpchin	23258	1	1	0.07	0.82	0.45	0.71	0.21
5	*Thornyheads*	66513	1	1	0.25	1	0.07	1	0.63
5	*Shortraker*	36578	1	1	0.08	1	0.25	1	0.52
5	Silvergray	29898	1	1	0.07	0.94	0.38	0.88	0.11
5	Redstripe	14734	1	1	0.03	0.12	0.55	0.41	0.27
5	Harlequin	12639	1	1	0.07	0.77	0.52	0.59	0.71
5	Redbanded	4988	1	1	0.11	0.94	0.27	1	0.27
5	Yellowtail	2075	1	0.77	<0.01	0	0.66	0.23	0.08
5	Yellowmouth	1067	1	0.82	<0.01	0	0.79	0	0.02
5	Greenstriped	477	1	0.94	0.01	0	0.43	0.81	0
5	Darkblotched	213	1	0.94	<0.01	0	0.57	0.44	0.03
5	Widow	165	1	0.77	<0.01	0	0.71	0	0.16
5	Pygmy	106	1	0.82	<0.01	0	0.79	0	0.35
5	Bocaccio	89	1	0.65	<0.01	0	0.83	0	0.09
5	Splitnose	47	1	0.77	<0.01	0	0.71	0.08	0.05
5	Vermilion	1	0	0.06	0	0	1.00	0	1

Table 16B-4. Current and suggested tier assignments for Gulf of Alaska Other Rockfish Tier 4/5 stocks with current associated natural mortality (M) group and reason for recommended Tier.

Species	Current Tier	Suggested Tier	M group	Reason
sharpchin	4	4 (no change)	sharpchin	Meet criteria
harlequin	5	5 (no change)	0.092	Meet criteria; High biomass in WG/CG
redbanded	5	5 (no change)	0.06	Meet criteria
redstripe	5	5 (no change)	0.1	Meet criteria; Present GOA-wide
silvergray	5	5 (no change)	0.05	Meet criteria
greenstriped	5	6	0.07	Partially met criteria; Driven by EG
pygmy	5	6	0.06	Did not meet criteria
darkblotched	5	6	0.07	Did not meet criteria
yellowtail	5	6	0.07	Did not meet criteria
yellowmouth	5	6	0.06	Did not meet criteria
bocaccio	5	6	0.06	Did not meet criteria
splitnose	5	6	0.06	Did not meet criteria
vermillion	5	6	0.06	Did not meet criteria
widow	5	6	0.05	Did not meet criteria
stripetail	5	6	0.06	Not caught in survey
blackgill	5	6	0.06	Not caught in survey
chilipepper	5	6	0.06	Not caught in survey

Table 16B-5. Resultant OFL for the Tier 5 GOA OR species derived from the status quo weighted M ($Wted\ M$) method and alternative weighted natural mortality using an average of 3 most recent surveys ($\overline{Wt\_M}$) method based on the estimated Tier 5 biomass from the 2021 GOA OR Assessment.

	Year	Estimated Biomass[1]	Weighted M Method	Wted M	OFL
Tier 5	2021	58,687	$Wted\ M$	0.055	3,228
Tier 5	2021	58,687	Alt. $\overline{Wt\_M}$: 3 survey avg	0.066	3,873

[1]Estimated biomass is from the 2021 GOA OR Assessment, Tribuzio et al., 2021

Figures for Appendix 16B

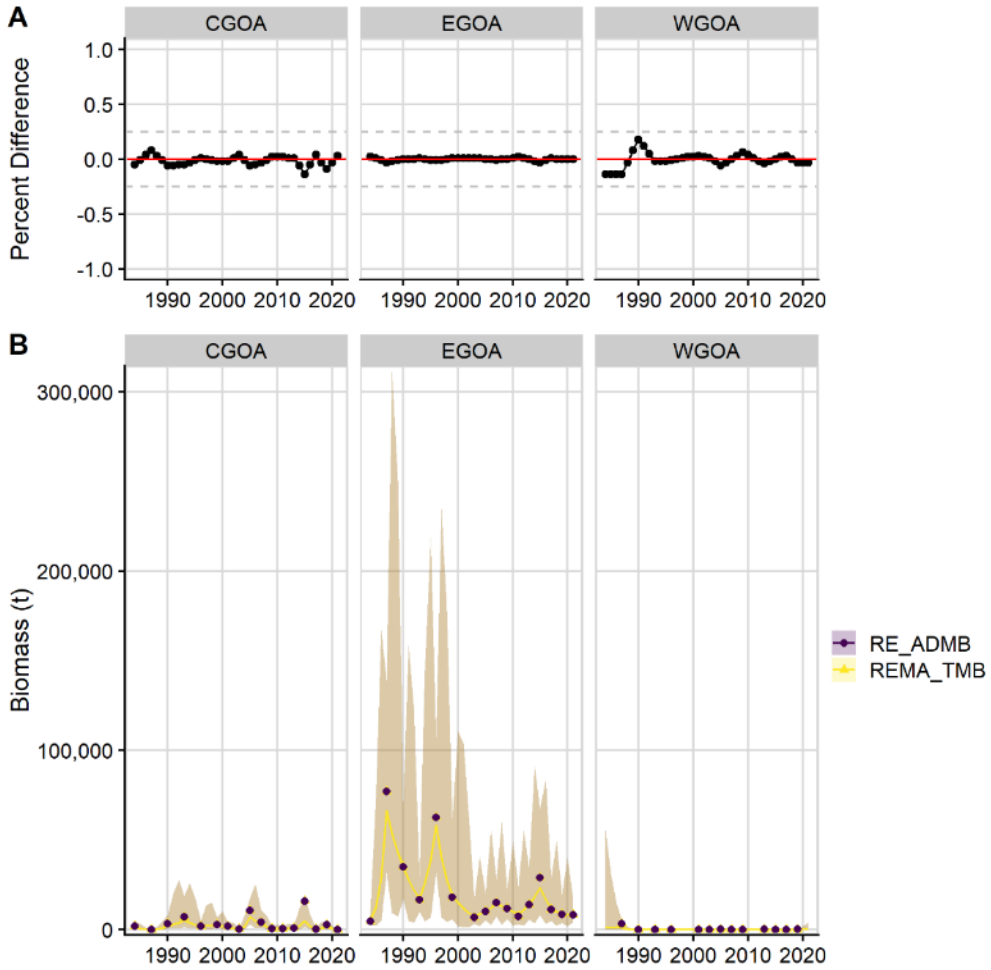

Figure 16B-1. A) Time series of the percent difference between RE (ADMB) and REMA (TMB) biomass estimates and B) time series of biomass estimates from the RE (ADMB; purple points and shading) and REMA (TMB; yellow points and shading) models for Tier 4- sharpchin rockfish as an example from the GOA OR complex. The black points are the biomass estimates. The shading represents the confidence intervals (CI), where the CI overlap significantly represented by the tan shading.

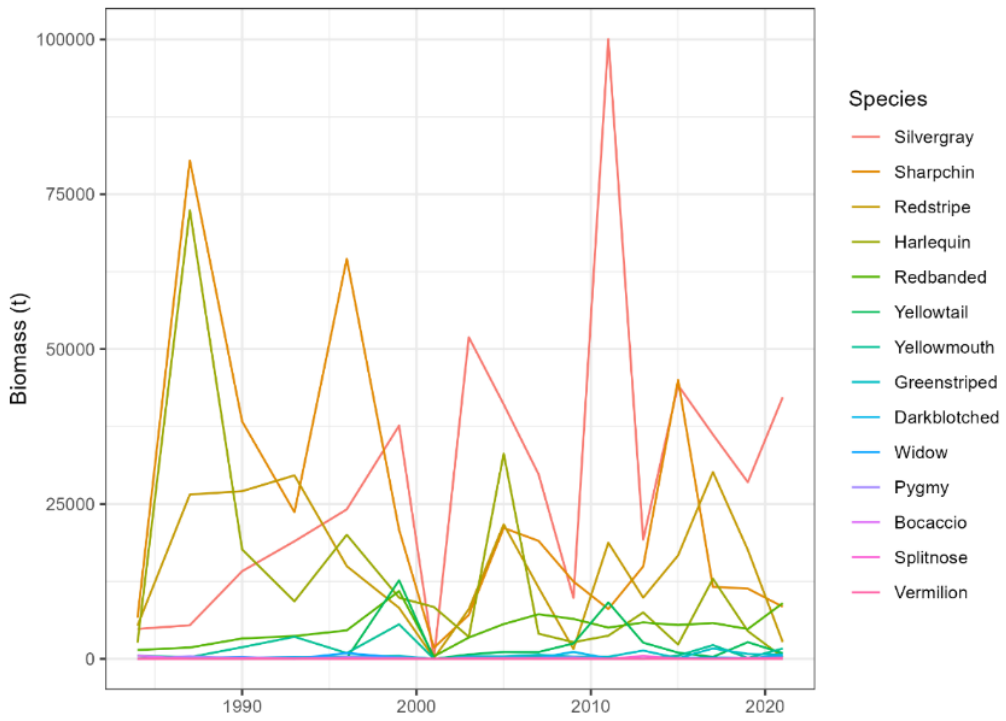

Figure. 16B-2. Time series of the Gulf of Alaska bottom trawl survey biomass for Tier 4/5 rockfish species in the Gulf of Alaska Other Rockfish stock complex.

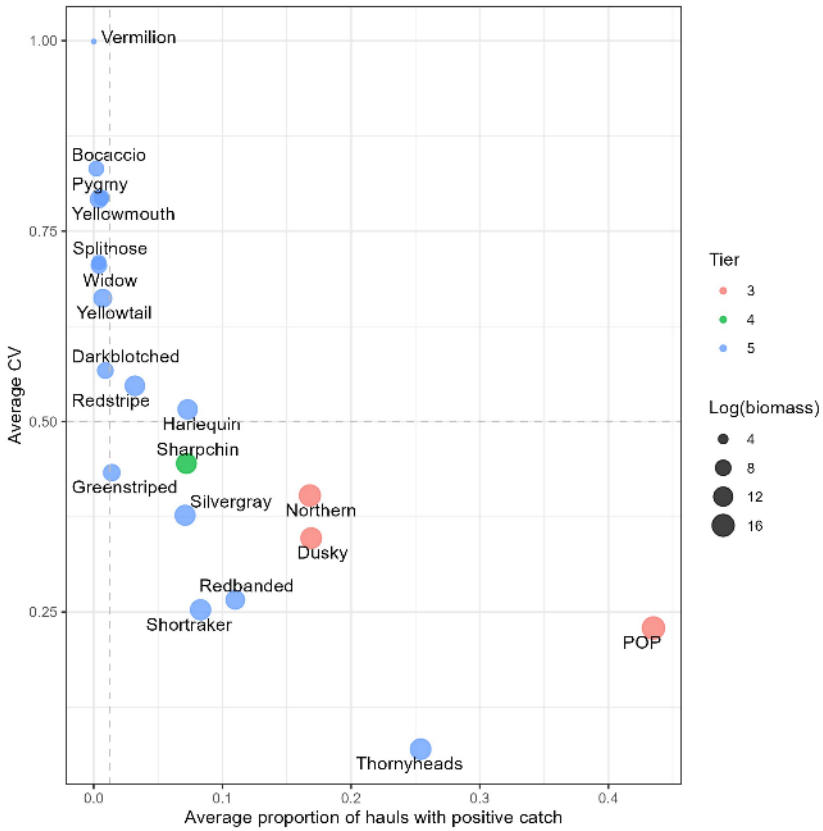

Figure 16B-3. Average annual proportion of hauls with positive catch compared to the average CV from the GOA bottom trawl survey for GOA rockfish species by status quo Tier designation (point color). Size of points indicate relative total biomass caught in the GOA bottom trawl survey. Dashed gray lines represent reference lines for an average proportion of hauls with positive catch = 0.01 and average CV = 0.5.

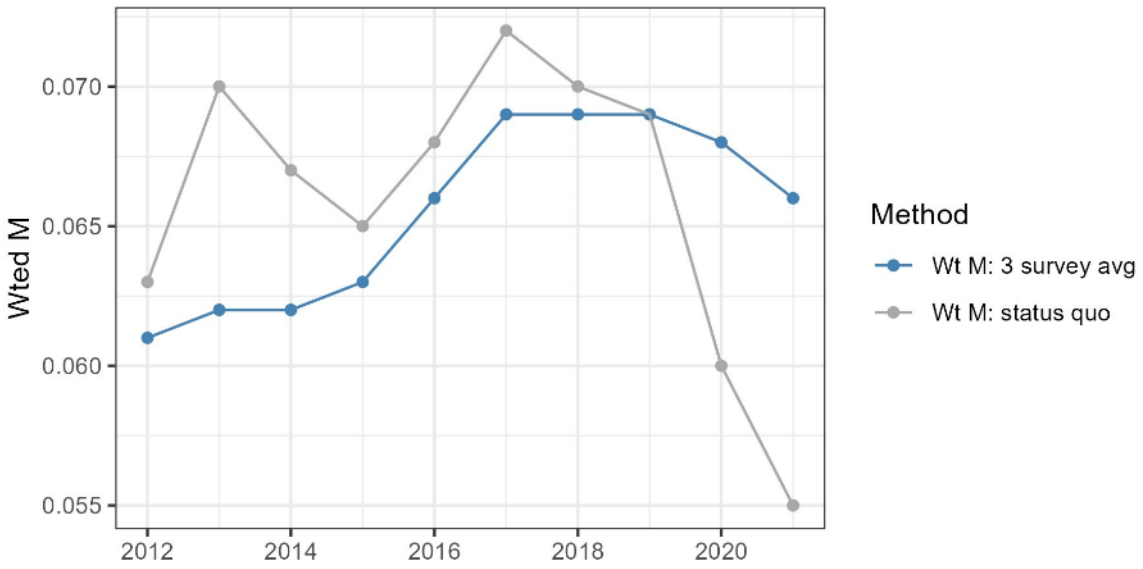

Figure 16B-4. Comparison of Tier 5 Weighted Natural Mortality (Wted M) calculation methods for Tier 5 GOA OR species. The status quo Wted M method is calculated based on the yearly M sub-group proportional biomass (i.e., biomass- weighted M), whereas the proposed alternative method, Wt_M: 3 survey avg, is based on a three recent survey average proportional biomass (i.e., average of about last three surveys biomass-weighted M). Note the GOA trawl survey occurred in years: 2013, 2015, 2017, 2019, and 2021; biomass and weighted M were estimated for each year by the REMA model.

Appendix 16C. Gulf of Alaska Demersal Shelf Rockfish (DSR) Spatial Management: Moving DSR subgroup out of Other Rockfish (OR) assessment

September 2023[1]

Introduction

In October 2022, the Council reviewed a discussion paper (NPFMC 2022) which summarized a proposed change to the Demersal Shelf Rockfish (DSR) and Other Rockfish (OR) stock complexes and highlighted potential fishery and management impacts of the proposed change. At that meeting, the Council made a motion supporting consideration of the proposed change but asked for information on the impacts of the proposed change to both the DSR and OR complexes during the 2023 Plan Team cycle.

At this meeting, the Council can discuss any concerns about spatial management that would interfere with the recommendation to move the DSR subgroup out of the OR assessment**.** As described in the "Next Steps and Timeline" section of this document, **if the Council does not identify any concerns, this change to DSR and OR would move forward during the 2024 Plan Team cycle for implementation in the 2025-2026 harvest specifications for 2025 fisheries, as recommended by the assessment authors.**

Background Information

In the Gulf of Alaska (GOA), the Other Rockfish (OR) and Demersal Shelf Rockfish (DSR) stock complexes share seven species: canary, China, copper, quillback, rosethorn, tiger and yelloweye rockfish. The DSR stock complex consists of only these species, but is limited in spatial extent in the stock assessment to only the East Yakutat/Southeast Outside subdistrict (EY/SEO) (i.e., Area 650) which includes East Yakutat (EY), Northern Southeast Outside (NSEO), Central Southeast Outside (CSEO), and Southern Southeast Outside (SSEO). The OR stock complex is GOA-wide, consists of 27 species, but the seven overlap species (termed DSR subgroup) are only part of the OR stock complex in the Western GOA (WG), Central GOA (CG), and West Yakutat (WY) (all GOA areas except EY/SEO).

Because of the overlap of these species, a joint stock structure document for both complexes was completed and included in the 2015 OR stock complex assessment (Appendix 16A of Tribuzio and Echave 2015). As a result of the stock structure analysis, concerns arose regarding the appropriateness of the species being grouped and the spatial management of the two stock complexes.

Analyses have shown that these seven species are biologically and logistically different from the remaining species within the OR stock complex and that the current stock complex assemblages should be changed. Beginning in 2017, authors from both stock assessments have worked together to propose changing the species assemblage, which would create a GOA-wide DSR assessment by moving the DSR subgroup species from the OR stock complex to the DSR stock complex. This topic has been reviewed by both the GOA Plan Team (PT) and the NPFMC Scientific and Statistical Committee (SSC); both groups have supported moving forward with the proposed change. In 2022, the NPFMC supported consideration of the proposed change for the 2023 Plan Team cycle, but asked for information on the impacts of this proposed change on both stocks.

Authors explored three alternative management groupings to try to address the spatial management needs and the biological appropriateness of the stock complexes (detailed analysis in Tribuzio et al. 2017 with updated values in Tribuzio et al. 2019, Appendix 16A). The GOA Groundfish Plan Team and SSC have repeatedly

[1] Prepared by: Kristen Omori (AFSC), Cindy Tribuzio (AFSC), and Sara Cleaver (NPFMC) with contributions from Mary Furuness (NMFS AKR), Abby Jahn (NMFS AKR), Molly Watson (NOAA GC), Phil Joy (ADFG), Rhea Ehresmann (ADFG), and Laura Coleman (ADFG).

agreed with the authors' recommendation to move forward with Alternative 3: moving the DSR subgroup species that are in the OR complex in the WG, CG, and WY areas, into the DSR complex, which would allow management of DSR as a separate complex or complexes (PT Sept 2017, SSC Oct 2017, PT Nov 2019, SSC Dec 2019, PT Sept 2021, SSC Oct 2021). The authors recommend managing DSR as two complexes, for reasons described under the "Management and Fishery Impacts" section of this document. This proposal was based on four primary findings: 1) the DSR subgroup species are substantially biologically different from the slope subgroup species in the OR stock complex (Omori et al. 2021, Tribuzio et al. 2017, Tribuzio and Echave 2015); 2) the DSR subgroup species are primarily caught in fixed-gear fisheries, while the slope subgroup (the other rockfish species that mainly comprise the OR stock complex) is primarily trawl fisheries (Omori et al. 2021, Tribuzio et al. 2017, Tribuzio and Echave 2015); 3) the DSR subgroup species occupy different habitats than the slope subgroup species (Johnson et al., 2003; Conrath et al., 2019; Omori and Thorson, 2022); and 4) the larger OR stock complex may mask developing issues with DSR subgroup species and/or restrictions on OR stock complex catch (e.g., TAC overages in the trawl fishery) can adversely affect fixed-gear fleets and vice versa.

The OR complex is assessed by the AFSC and managed by NPFMC, whereas the current DSR assessment for EY/SEO is conducted by the ADF&G, and the complex is managed jointly by the State of Alaska and NMFS. The two internal state water Subdistricts, Northern Southeast Inside (NSEI) and Southern Southeast Inside (SSEI), are managed entirely by the State of Alaska and are not included in the stock assessment. The proposed alternative would retain the same assessment structure, but incorporate the DSR species to the west of EY/SEO. The DSR subgroup species are currently assigned as Tier 6 with harvest limits based on historical catch. Therefore, it would be relatively simple to add these species to the existing assessment. The NMFS would participate in the GOA-wide DSR assessment, in that NMFS would provide survey data and estimates of catch from federal fisheries (and the Pacific Halibut IFQ fishery) and AFSC staff to participate in the assessment (i.e., co-authorship).

The proposed change would not change the current jurisdictional structure. The State of Alaska under Council oversight would maintain the management of the DSR fisheries in the EY/SEO and the NMFS would manage the DSR catch in the federal fisheries west of EY/SEO.

The GOA Groundfish FMP provides the Council with authority to recommend to split or combine stocks or stock complexes if sufficient biological information is available.[2] Therefore, implementing the proposed change would not require changes to the FMP. The proposed change would require a regulatory change to Table 10 at CFR Part 679, defining basis species for retention.

The proposed change could be put into effect for the 2024 or 2025 fishery (see "Next Steps and Timeline" section).

SSC/ Council Comments from 2021[3]

"The Team recommends, based on the analyses presented, that the DSR complex be split from the ORx complex GOA-wide. The Team requests guidance from the SSC on any further analyses needed to support this proposal." – GOA PT September 2021

[2] In the GOA Groundfish FMP, Section 3.2.3.1.1: *Identification of Stocks and Stock Complexes for Which Specifications are Made.* Notwithstanding designated stocks or stock complexes listed by category in Table 3-1, the Council may recommend splitting or combining stocks or stock complexes in the "target species" category for purposes of establishing a new harvest specification unit if such action is desirable based on commercial importance of a stock or stock complex or if sufficient biological information is available to manage a stock or stock complex on its own merits.

[3] Full history of PT/SSC comments related to DSR spatial management are available here.

"The SSC concurs with the GOA GPT and recommends that the Council consider taking up this issue of separating DSR from Other Rockfish GOA-wide – thus moving to Step 2 of the Spatial Management Policy." – SSC October 2021

"The Team continues to support an earlier recommendation that the DSR subgroup be moved into the DSR assessment and make the DSR assessment GOA-wide pending a Council analysis on spatial management implications." – GOA PT November 2021

"there are several other outstanding issues and recommendations that will likely affect future assessments of the other rockfish stock complex including a Council-directed analysis on spatial management implications of separating DSR from the other rockfish complex gulf-wide, investigations into elevating some of the species (harlequin and yelloweye rockfish) into different tiers, and if there is evidence of range expansion of species from the south." – SSC December 2021

Harvest Specification Alternative

We provide examples of the status quo (Tables 1, 2; Figure 1) and proposed alternatives (Tables 3, 4; Figure 1, 2) based on the final 2023 harvest specifications as recommended by the SSC/Council and published in the Federal Register by NMFS (88 FR 13238) for both complexes. The harvest recommendations for the OR stock complex are based on the 2019 full assessment (Tribuzio et al. 2019), rather than the 2021 assessment because the harvest recommendations were rolled over from 2019. The harvest recommendations for the DSR stock complex are from the 2022 DSR stock complex assessment (Joy et al. 2022), but using the SSC recommended OFL/ABC and Council recommended TAC. The proposed alternative GOA DSR stock complex adds the harvest specifications (which are based on Tier 6 catch history) from management areas west of EY/SEO (i.e., WG, CG, and WY) provided by NMFS to harvest specifications in EY/SEO from the state DSR assessment run by ADF&G (Table 4; Figure 2).

Management and Fishery Impacts

The main fishery impacts of the proposed alternative relate to in-season management and TAC/ABC/OFL overages. As described in previous sections, the DSR species are currently part of the larger OR complex in all areas west of EY/SEO. This section provides a brief overview of fisheries that could be impacted by this change and a qualitative description of such potential impacts.

NMFS prohibits directed fishing for many rockfish species at the beginning of the year because the TAC (often equal to ABC for some rockfish species) for these species does not support directed fishing. However, both OR and DSR species must be retained and landed as incidental catch in groundfish and IFQ halibut fisheries. The full retention requirement went into effect for rockfish for hook-and-line, pot, and jig-gear catcher vessels (CVs) in 2020 (85 FR 9687). If rockfish is closed to directed fishing, only a proportion of landed rockfish may enter commerce and be sold, bartered, or traded (the maximum commerce amount or MCA, defined in regulation). There are separate MCA proportions for OR GOA-wide and DSR in the SEO. After reaching the MCA, any additional rockfish caught in hook-and-line, pot, and jig gear would still be required to be retained, but would not be able to enter commerce (i.e., the MCA would be set to zero). Similarly, when a rockfish species catch exceeds the TAC, it is prohibited for retention under § 679.20(d)(2), the MCA is set to 0 percent and no amount of that rockfish species may enter commerce through sale, barter, or trade except as fish meal. This is managed by regulatory area, so exceeding TAC in one area would not necessitate prohibiting retention in another area. Hook-and-line, pot, and jig gear CVs would still be required to retain all rockfish, and all trawl vessels and CPs would be required to discard rockfish if on prohibited retention status.

The vast majority of the catch of the OR complex comes from the rockfish trawl fishery (Tribuzio et al. 2021), which typically catch the non-DSR subgroup species. Historically annual catch of OR stocks have been less than either the Gulfwide ABC or Gulfwide TAC (Tribuzio et al. 2021). Catch of the DSR subgroup within the

OR complex (in WG, CG, and WY) represents less than 18% of the OR catch on average since 2015 (Tribuzio et al. 2021).

Considering the seven DSR species in a GOA-wide context, total annual catches do not exceed 500 t (Figure 2). The state-managed directed commercial fishery for DSR in EY/SEO recently has been prosecuted almost exclusively by H&L gear targeting yelloweye and to a lesser extent, quillback. The directed DSR fishery was closed to harvest in all management areas in 2020 and remains closed due to stock health concerns. DSR species are rarely caught incidentally in the rockfish trawl fishery, but rather in the Pacific halibut and cod fisheries on H&L gear (Tribuzio et al. 2019). Of the DSR subgroup, yelloweye dominates catches (NPFMC 2022). Data indicates that while trawl vessels "top-off" for some rockfish species, fixed gear vessels do not typically have this same behavior (NMFS/NPFMC 2019). In the EY/SEO areas, full retention of all seven DSR species has been required since 2005.

Breaking the DSR species out from the OR complex would result in smaller ABCs that are potentially more difficult to manage, for both OR and DSR in WG, CG, and WY (Tables 3 and 4). Therefore, fisheries that incidentally catch OR (slope subgroup) or DSR species would be more likely to be limited by TAC, resulting in going on PSC status earlier. The most consequential impacts of reaching TAC would be for those vessels which incidentally catch whichever rockfish species is on PSC status. For example, DSR being placed on PSC status could lead to negative economic impacts to the H&L fleet, as DSR could no longer be sold except as fish meal. Similarly, once OR is placed on PSC status, vessels fishing with trawl gear would be required to discard any OR, which would result in foregone revenue. These impacts are possible under the status quo, but the likelihood of reaching a TAC is higher under a scenario with smaller TACs. In the last ten years, OR have been put on PSC status in four years due to reaching TAC in at least one regulatory area, while DSR have not been placed on PSC status (NPFMC 2022).

One option that could reduce the potential for TAC overages due to small DSR TACs is to combine the WY ABC (and therefore TAC) with that of the WG and CG areas, so ABC (and therefore TAC) would be apportioned into two sub-areas: (1) WG/CG+WY and (2) EY/SEO. This has been recommended by authors, PT, and SSC in the past (Tribuzio et al. 2017, Tribuzio et al. 2019, NPFMC 2022), because the fishery characteristics differ between EY/SEO and the rest of the GOA. In EY/SEO there are state-managed directed fisheries, and non-directed fisheries included in the assessment. The catch in the EY/SEO has been much less than the ABC for the last 5 years. In all other areas catch of the DSR species is incidental.

The proposed change would result in ABCs and OFLs being spatially apportioned in the following ways:

> OR: One Gulf-wide OFL with three separate ABCs for WG/CG, WY ABC, EY/SEO (Table 3). These are the same as the current status quo, but would no longer include species in the DSR-subgroup.
>
> DSR: Two stock complexes with separate OFLs and ABCs for WG/CG/WY and EY/SEO (Table 4). Until more is known about the DSR stock structure in the Gulf, the EY/SEO DSR stock complex would be managed separately from the WG/CG/WY stock complex, with different OFLs and ABCs. This will enable monitoring of catch of each complex to ensure that underharvested catch for one complex is not utilized in another area, which is a particular concern for DSR in EY/SEO.

If a fishery were to exceed the TAC or approach the OFL, other fisheries could be limited. For example, if a TAC were exceeded due to overages in the trawl fishery, fixed-gear fleets could be adversely affected, or vice versa, because retention is prohibited once TAC is reached (except for vessels subject to full retention requirements, in which case additional rockfish must be retained but cannot enter commerce). NMFS may also limit fisheries to prevent overfishing of any stock or stock complex (50 CFR 679.25). In recent years, these fisheries have not closely approached their OFLs, and Figures 1 and 2 indicate that the proposed change does not have a large impact on these fisheries reaching their respective OFLs.

Next Steps and Timeline

While this action could be implemented in the 2024-2025 harvest specifications for the 2024 fishery, doing so would result in the SAFE reports authored in 2023 with different stock assemblages than what would be included in final harvest specifications for 2024. The OR complex is scheduled for an operational full assessment (previously known as a "full" assessment) in the 2023 assessment cycle, but the DSR assessment is not scheduled for an operational full/update assessment until 2024. The SAFE reports could be updated during the 2024 assessment cycle to reflect the changes to the assemblages. The action would then be implemented in the 2025-2026 harvest specifications so that the harvest specifications are consistent with the SAFE reports authored in 2024.

Unless the SSC/Council recommend otherwise, the 2023 full assessment for the OR stock complex and the harvest projections/partial assessment for the DSR stock complex will contain harvest recommendations under the status quo. This document will be an appendix to the 2023 SAFE for informational purposes. Regardless of the year for which this change would be implemented, NMFS would publish harvest specifications on the standard annual timeline and separately modify regulations to capture the change to the DSR subgroup and OR complex. This approach avoids any delay in publishing the annual harvest specifications for the GOA.

If the Council does not identify any concerns, this change to the DSR subgroup would move forward during the 2024 Plan Team cycle for implementation in the 2025-2026 harvest specifications for 2025 fisheries, as recommended by the assessment authors. If the Council does identify specific obstacles or constraints, staff requests additional direction as to how to move forward, including an appropriate timeline.

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Tables

Table 1. Gulf of Alaska Other Rockfish Stock Complex final harvest specifications for 2021 - 2023 (Federal register).

All OR combined	OFL (t)	ABC (t)	TAC (t)
WG/CG	n/a	940	940
WY	n/a	370	370
EY/SEO	n/a	2,744	300
Total	5,320	4,054	1,610

Table 2. Gulf of Alaska DSR final harvest specifications for 2023 (Federal register). Note that the 2022 DSR assessment (for 2023 specifications) had an ABC of 244t.

DSR	OFL (t)	ABC (t)	TAC (t)
EY/SEO	376	283	283

Table 3. Proposed alternative Gulf of Alaska Other Rockfish Stock Complex harvest specifications for 2021-2023, which excludes Demersal Shelf Rockfish subgroup GOA-wide.

All OR Combined	OFL (t)	ABC (t)
WG/CG	n/a	768
WY	n/a	336
EY/SEO	n/a	2744
Total	5045	3848

Table 4. Proposed alternative Gulf of Alaska Demersal Shelf Rockfish Stock Complex harvest specifications for 2021-2023.

DSR	OFL (t)	ABC (t)
WG/CG+WY	275	206
EY/SEO	376	283

Figures

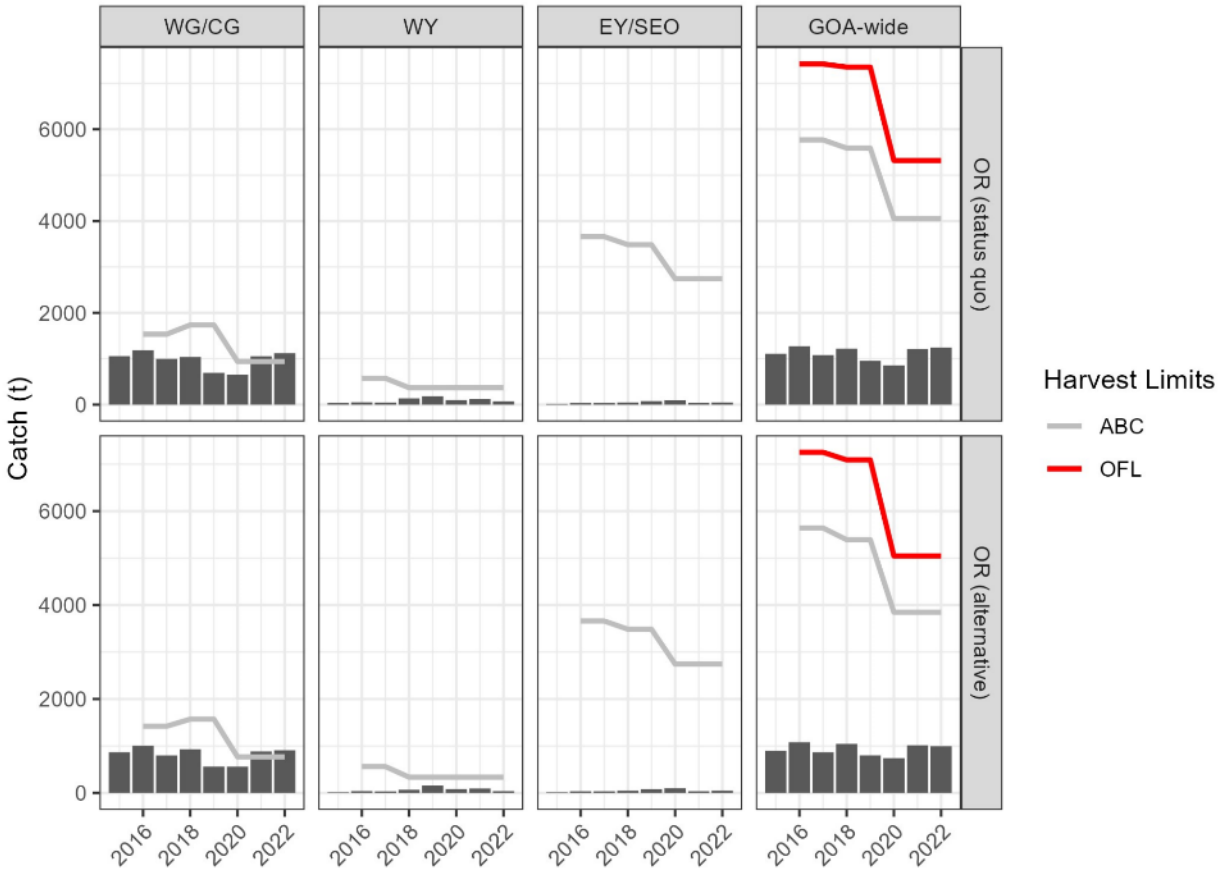

Figure 1. Historical catch from 2015 – 2022 for status quo Other Rockfish complex (OR (status quo, top)) and proposed alternative complex (OR (alternative), bottom) in each management area (Western and Central Gulf (WG/CG), West Yakutat (WY), and EY/SEO- East Yakutat/ Southeast Outside) and Gulf of Alaska-wide (GOA-wide) with harvest limits. Solid gray line indicates the ABC, solid red line designates the OFL. Catch in the OR (alternative) row represents catch of OR without DSR subgroup species.

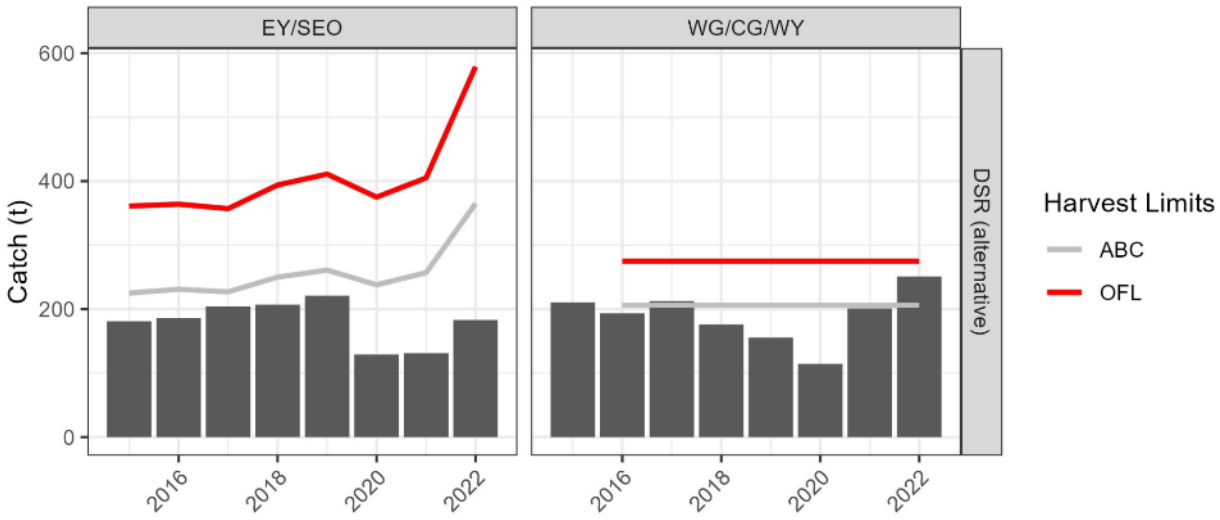

Figure 2. Historical catch from 2015 – 2022 for the proposed alternative Demersal Shelf Rockfish complex (DSR (alternative)) in the two management area groupings (Western Gulf, Central Gulf, and West Yakutat (WG/CG/WY), and EY/SEO- East Yakutat/ Southeast Outside) with harvest limits. Status quo for DSR would be the same as EY/SEO figure, with no figure for WG/CG/WY because DSR subgroup is included in OR in WG/CG and WY areas in status quo (Figure 1 top row). Solid gray line indicates the ABC, solid red line designates the OFL. Note, the historical catch for DSR (alternative) are from Catch Accounting System (CAS) for WG/CG/WY and the 2022 DSR stock complex assessment for EY/SEO.