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

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EXECUTIVE SUMMARY

The Other Rockfish (OR) 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 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 OR from 2003 – 2021 has been updated (as of October 1, 2021).
2. NMFS GOA bottom trawl survey data have been updated to include 2021 survey data.
3. The random effects models for the GOA OR Tiers 4 and 5 species were updated to include the 2021 GOA bottom trawl survey data.
4. Catch estimates in federal fisheries occurring within NMFS areas 649 (Prince William Sound) and 659 (Southeast Alaska inside waters) are reported in Table 16.11.
5. The trawl survey fractional biomass for separating Eastern GOA biomass between the West Yakutat and East Yakutat/Southeast subareas were updated to reflect the assessment methods, as opposed to one value for the full complex.
6. Catch data from "unidentified rockfish" have been added to this assessment. Catch of that species group counts against the GOA OR ABC and OFLs, but are not part of the specification calculations.

Changes in assessment methodology

There are no changes to the methods used in this assessment.

Summary of Results

The recommended ABC for the 2022 fishery is 3,162 t and the OFL is 4,146 t for the OR complex. This is a 22% decrease from 2020. There is no evidence to suggest that overfishing is occurring for the OR complex in the GOA because the OFL has not been exceeded. Total OR catch in 2020 was 630 t and catch in 2021 was 1,152 t as of October 1, 2021, lower than the ABC of 4,053 t for both years.

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 exceeded the combined ABC of these areas in 2021. The proposed 2022 ABC for the combined area (396 t) is a 58% reduction from 2020, and is likely to be exceeded. This reduction is due to a combination of the following:

1) The proportion of biomass in the Western/Central GOA decreased which shifted apportionment (Figure 16.2).
2) Trawl survey biomass declined for some of the primary Tier 5 species, in particular harlequin and redstripe (Figure 16.3).
3) The weighted natural mortality (Wted M) for the combined Tier 5 species declined by 25% due to the change in the M group biomass (Figure 16.11).

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We recommend continuing with combining the Western and Central GOA ABCs, as data do not suggest any developing conservation concerns that would be alleviated by splitting the ABCs.

We do not recommend reductions below the max ABC. A full risk table was completed in the 2019 assessment and there are insufficient new data to necessitate an updated version. A more detailed explanation is included in the Harvest Recommendations section.

Tier 4 recommendation of ABC and OFL for sharpchin rockfish for 2022–2023.

Quantity	As estimated or specified last year for: 2021	2022	As estimated or recommended this year for: 2022	2023
M (natural mortality rate)	0.06	0.06	0.06	0.06
Tier	4	4	4	4
Biomass (t)	10,826	10,826	8,638	8,638
$F_{OFL} = F_{35\%}$	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	0.065	0.065
OFL (t)	855	855	682	682
maxABC (t)	704	704	561	561
ABC (t)	704	704	561	561
Status	As determined *last* year for: 2019	2020	As determined *this* year for: 2020	2021
Overfishing		n/a		n/a

Tier 5 recommendation of ABC and OFL for 17 OR species for 2022-2023.

Quantity	As estimated or specified last year for: 2021	2022	As estimated or recommended this year for: 2022	2023
M (natural mortality rate)	0.070	0.070	0.055	0.055
Tier	5	5	5	5
Biomass (t)	59,861	59,861	58,687	58,687
F_{OFL}	0.070	0.070	0.055	0.055
$maxF_{ABC}$	0.053	0.053	0.041	0.041
F_{ABC}	0.053	0.053	0.041	0.041
OFL (t)	4,190	4,190	3,228	3,228
maxABC (t)	3,143	3,143	2,421	2,421
ABC (t)	3,143	3,143	2,421	2,421
Status	As determined *last* year for: 2019	2020	As determined *this* year for: 2020	2021
Overfishing		n/a		n/a

Tier 6 recommendation of ABC and OFL for nine OR species for 2022-2023.

Quantity	As estimated or specified last year for: 2021	2022	As estimated or recommended this year for: 2022	2023
Tier	6	6	6	6
OFL (t)	275	275	236[1]	236
maxABC (t)	206	206	180	180
ABC (t)	206	206	180	180
Status	As determined *last* year for: 2019	2020	As determined *this* year for: 2020	2021
Overfishing		n/a		n/a

[1]For the Tier 6 calculations, the OFL is the sum of the maximum catch from 2013 – 2016 for each species. Chages in the ABC and OFL values are due to updates to the catch estimates provided by the NMFS Alaska Regional Office Catch Accounting System (AKRO CAS), and not due to methodological changes in this assessment or changes to the years used.

ABC and OFL recommendations for the full OR complex for 2022-2023.

All OR Combined	As estimated or specified last year for: 2021	2022	As estimated or recommended this year for: 2022	2023
Tier	4/5/6	4/5/6	4/5/6	4/5/6
OFL (t)	5,320	5,320	**4,146**	4,146
maxABC (t)	4,053	4,053	3,162	3,162
ABC (t)	4,053	4,053	**3,162**	3,162
Status	As determined *last* year for: 2019	2020	As determined *this* year for: 2020	2021
Overfishing		n/a		n/a

Updated catch data (t) for the OR stock complex in the GOA are summarized in the following table with ABCs and TACs. Gulfwide ABC values do not include any additions for northern rockfish, as none were transferred from the northern rockfish ABC during the last assessment. Source: NMFS AKRO CAS accessed through the Alaska Fisheries Information Network (AKFIN) database, http://www.akfin.org as of October 1, 2021.

Year	Western GOA	Central GOA	Eastern GOA West Yakutat	Eastern GOA E. Yak/ Southeast	Gulfwide Total	Gulfwide ABC	Gulfwide TAC
2020	99	564	109	111	882	4,053	4,053
2021	134	914	118	36	1,201	4,053	4,053

Area Apportionment

Area apportionment was estimated using a random effects model for Tier 4 and 5. Beginning in the 2014 fishery, the ABCs for the Western and Central GOA were combined, which is continued here for the 2022 fishery. 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 West Yakutat	Eastern GOA E Yakutat/ Southeast	Total
Area Apportionment	3.54%	19.05%	77.41%	100%
Area ABC (t)	20	107	434	561
OFL (t)				682

Tier 5 – 17 species	Western/Central GOA	Eastern GOA West Yakutat	Eastern GOA E Yakutat/ Southeast	Total
Area Apportionment	9.26%	7.32%	83.42%	100%
Area ABC (t)	224	177	2,020	2,421
OFL (t)				3,228

Tier 6 – 9 species	Western/Central GOA	Eastern GOA West Yakutat	Eastern GOA E Yakutat/ Southeast	Total
Area ABC (t)	152	28	0	180
OFL (t)				236

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA West Yakutat	Eastern GOA E Yakutat/ Southeast	Total
Area ABC (t)	396	312	2,454	3,162
OFL (t)				4,146

Summaries for Plan Team

Species	Year	Biomass[1]	OFL	ABC	TAC	Catch[2]
Other Rockfish	2020	70,687	5,320	4,053[3]	4,053	882
	2021	70,687	5,320	4,053	1,609	1,201
	2022	67,325	4,146	3,162		
	2023	67,325	4,146	3,162		

Stock/ Assemblage	Area	2021 OFL	2021 ABC	2021 TAC	2021 Catch[2]	2022 OFL	2022 ABC	2023 OFL	2023 ABC
Other Rockfish	WGOA/ CGOA		940	940	1,048		396		396
	EGOA								
	WY		369	369	118		312		312
	EY/SE		2,744[3]	300	36		2,454[4]		2,454[4]
	Total	5,320	4,053[3]	1,609	1,201	4,146	3,162[4]	4,146	3,162[4]

[1]Total biomass estimates from the random effects model for the Tier 4/5 species only.
[2]Current as of October 1, 2021. Source: NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database (http://www.akfin.org).
[3]These ABCs do not include any ABC transferred from the northern rockfish ABC to the OR ABC. Historically, the total northern rockfish ABC is estimated in the northern rockfish assessment for the GOA. The ABC for the WY and EY/SE areas are deducted from the ABC in the northern rockfish

assessment and added to the GOA OR total ABC. This quantity has ranged from 2 - 4 t. This is typically done during Plan Team deliberations, when the northern rockfish ABC becomes available.
[4]The recommended ABC for EY/SE in 2022 - 2023 does not include the ABC for northern rockfish, because the value has not been set.

Responses to SSC and Plan Team Comments on Assessments in General

The SSC provided a number of comments regarding the risk tables in stock assessments. We have grouped the comments by topic and provide responses to the topics.

Risk Tables: timing and need
"*The SSC revised and clarified the recommendation to maintain the status quo and only produce risk tables for full assessments (rather than all assessments, as indicated in the subgroup recommendation).*" (SSC, June 2021)

"*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. We chose to not update the previous risk table (presented in the 2019 full assessment), and provide justification in the Harvest Recommendations section.

Risk Tables: inclusions
"*For cases where a process external to the assessment is relevant to two or more risk categories, the SSC recommends that the narrative reflect the interconnected relationships that exist between rankings among risk categories (Appendix A, Preliminary Guidance and SSC recommendations, bullet 7). Additionally, the SSC supports the recommendation that the fishery/community performance column should focus only on factors that provide insight as to the condition of the stock and that economic and community impact information be excluded (Appendix A, Preliminary Guidance and SSC recommendations, bullet 6).*" (SSC, June 2021)

"*The SSC recognizes the current use of LK/TK/S in the population dynamics, ecosystem considerations and fishery/community performance columns, and highlights the desire to encourage usage of this information (Appendix A, Preliminary Guidance and SSC recommendations, bullet 6).*" (SSC, June 2021)

"*The SSC agreed that positive trends in the Assessment, Ecosystem or Fishery performance should not be included, as the default is that conditions are positive or neutral, and the default option is for no reduction from maxABC. Therefore, the SSC recommended no changes to the language in the Risk Table template*." (SSC, October 2021)
This comment is not applicable to the current assessment, however, a future update to the risk table will follow these guidelines.

Risk Tables: reductions to maxABC
"*The SSC continues to support that reductions from the maximum permissible ABC should be infrequent and only for exceptional circumstances (Appendix A, Preliminary Guidance and SSC recommendations, bullet 9).*" (SSC, June 2021)

"*The SSC recommended maintaining the status quo, where authors are encouraged (but not required) to provide a recommendation on a reduction from maxABC, if warranted, and the Plan Teams and SSC would then evaluate and modify the reductions based on the information available for the stock.*" (SSC, October 2021)

At this time, there are no exceptional circumstances in this assessment to warrant reductions from maxABC.

Risk Tables: review and process
"*The SSC also recommends that stock assessment authors and the Plan Teams review all recommendations and provide feedback.*" (SSC, June 2021)

"*There was also agreement that reducing the number of scoring levels from 4 to 3 would be helpful, but the JGPT asked to postpone this until next year's assessments as many authors had already begun working on risk tables for the upcoming season; the SSC agreed with this request.*" (SSC, October 2021)
The above comments do not apply to this assessment this year.

SSC and Plan Team Comments Specific to this Assessment

"*The Team continues to recommend the Council move forward with Step 2 of the Spatial Management Policy for this complex and cautions potential changes in catch estimates may occur in 2020 due to full retention regulations and the incorporation of EM data.*" (GOA GPT, November 2019)

"*The SSC supports the GPT's recommendation for the Council to move forward with Step 2 of the Spatial Management Policy for this complex.*" (SSC, December 2019)

"*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 GPT, September 2021)

"*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. As part of the next steps, the SSC suggests that a white paper be written, potentially an update of the 2017 discussion paper, to identify economic and management implications and tools to achieve management and conservation goals. Issues that the white paper might address include:*

- *How would separating DSR from Other Rockfish impact setting harvest specifications?*
    - *Would an FMP amendment or other regulatory change be needed?*
    - *How would separate DSR assessments (as outlined in the GOA GPT September 2021 minutes) produce harvest specifications? GOA-wide, or regionally?*
    - *Should a combined assessment with two tiers (e.g., skates assessment) be considered?*
- *How would these specifications align with state management of the DSR complex?*
- *Are there conservation concerns with the proposed assessment structure? Do other tools need to be considered for appropriate management and conservation?*
- *Are there any economic or other management impacts (e.g., catch accounting) to be considered?*" (SSC, October 2021)

"*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)

We have deferred responding to the above comments and updating the 2017 discussion paper (Tribuzio et al. 2017) pending guidance on the above Council motion.

"*The Team recommended, as new data is collected based on the 2020 full retention mandate and new EM data, the author may provide an update to the Team in September, especially if there are concerns bycatch amounts approaching ABC levels.*" (GOA GPT, November 2019)

We have expanded the discussion in the Discards section of this assessment. Despite the full retention requirement on hook-and-line catcher vessels, observers are still reporting high discard rates. Some of this would be expected due to drop-offs at the rail. Staff at the AKRO are investigating operational reasons behind the discarding, as this is a concern for many rockfish species (J. Keaton, pers. Comm.)

"*The SSC offers the following comments to the assessment authors:*

1. *The SSC supports the authors' plan to explore elevating species up a tier for the estimation of biological reference points (Tier 4 methods for harlequin rockfish and Tier 5 methods for yelloweye rockfish)*
2. *The SSC supports the GPT's recommendation to monitor new data collected under the 2020 full-retention mandate and new EM data, and their request that the authors provide an update to the GPT in September, especially if there are concerns that bycatch amounts are approaching ABC levels.*
3. *Efforts to examine range expansions of species from Canada and the US west coast should be considered. Concurrently, the SSC recommends that the stock structure template is updated given the recent additions of Aurora and shortbelly rockfish (species that have historically been found in the south) to this complex.*" (SSC, December 2019)

In response to item #1, the manuscripts detailing updated maturity information for harlequin rockfish are in publication, but not yet available for this assessment. The Tier 4 analysis will be conducted once the manuscripts are in print. We opted to delay the Tier 5 (and possibly Tier 4) analysis for yelloweye rockfish until a method for incorporating the IPHC survey into the random effects model is available because the AFSC bottom trawl survey likely does not sample the species well. For item #2 see the above response.

In response to item #3, aurora and shortbelly rockfish were not recent additions to the assessment as defined in the FMP. They were not included in the stock assessment due to an oversight by authors. While both species are more prominent in southern waters, occurrences in catch in Alaskan fisheries are limited to < 5 total observations over the entire 1991 – 2021 time series, with no apparent trend. Given warming ocean temperatures, considerations of range expansions will be necessary, but at this time, none of the species within the Other Rockfish stock complex that are more dominant in southern waters have detectable trends in fishery or survey data.

Introduction

The Other Rockfish stock complex (termed OR in this document) is a group of up to 27 rockfish species (*Sebastes spp.*), depending on the Gulf of Alaska (GOA) management area (Table 16.1, Figure 16.1). This complex is further complicated by eight species that occur in other assessments in some management areas.

The Demersal Shelf Rockfish (DSR) complex includes seven species (canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfish) in the East Yakutat/Southeast Outside (EY/SE) region (east of the 140° W longitude, NMFS Area 650). These seven species are managed as part of the OR complex west of the 140° W longitude (i.e., NMFS Areas 610 – 640, the Western and Central GOA, and the West Yakutat portion of the Eastern GOA). For the purposes of this document, these seven species in all areas west of East Yakutat/Southeast will be termed the demersal (DSR) sub-group and the remaining 20 species in the OR complex will be termed the slope sub-group. While the demersal sub-group was not accounted for in the full OR assessments (called the Other Slope Rockfish stock complex in prior assessments) prior to 2013, catch estimates provided by the Alaska Region Office Catch Accounting System (AKRO CAS) include both the species in the slope and demersal sub-groups in all areas west of NMFS Area 650 and only the slope sub-group in NMFS Area 650. The authors of the OR and DSR complex have proposed moving demersal sub-group out of the OR complex and into a Gulf wide DSR complex and the NPFMC has submitted a motion to conduct further analyses.

Northern rockfish are included in the OR complex only in the Eastern GOA (NMFS Areas 640 and 650) and are a separate assessment in the Western and Central GOA. This is because of the extremely low abundance of northern rockfish in the Eastern GOA and the consequent difficulty of managing northern rockfish as a separate species in this area. In 1999, northern rockfish in the Eastern GOA was reassigned to the Other Slope Rockfish category for this area only. Therefore, northern rockfish is listed as an OR species in Table 16.1, but only for the Eastern GOA. The overfishing limit (OFL) and acceptable biological catch (ABCs) for northern rockfish in the Eastern GOA are estimated as part of the full northern rockfish assessment, thus the species is not included in the random effects model runs reported here. Instead, a portion of the ABC is taken from the northern rockfish assessment and added to the OR assessment during the November Plan Team deliberations. This was not done for the 2020 – 2021 specifications, possibly because the northern rockfish and OR assessments are now on different cycles.

There are six species that generally comprise > 95 % of the OR catch and/or biomass: harlequin, redbanded redstripe, sharpchin, silvergray, and yelloweye rockfish. This document focuses primarily on those species, with all other species being grouped into a category termed “minors”.

General Distribution of Other Rockfish

Nearly all of the OR species in the GOA 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. One exception is harlequin rockfish, which occurs predominantly in Alaska throughout the GOA (Figure 16.2). The center of abundance for silvergray rockfish, the most abundant of the OR species, based on recent trawl survey biomass estimates, appears to be in Southeast Alaska (Figure 16.2 and Figure 16.3) and British Columbia (Mecklenberg et al. 2002, Love et al. 2002). Much of the information describing the spatial distribution for the majority of the OR species comes from Mecklenberg et al. (2002) and Love et al. (2002), as reports of catch for many of these species are rare and distribution information is largely based on surveys. Summarized information on the distribution of each of the OR complex species can be found in the stock structure document (Tribuzio and Echave 2015, Appendix Table 16B.2).

Research focusing on untrawlable habitats found that some OR species associate with biogenic structure and tend to have patchy distributions (Du Preez et al. 2011; Laman et al. 2015), 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, because currently, survey catch estimates are extrapolated to untrawlable habitat. It is unknown if there are species-specific differences in density among the two habitats (Jones et al. 2012; Rooper et al. 2012).

Evidence of Stock Structure

The stock structure of the GOA OR 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 27 species in question. However, there are concerns over which species are currently being grouped into both the OR complex and the DSR complex. As described above, the 27 species within DSR and OR complexes can be categorized into two groups: 1) a demersal sub-group consisting of seven species managed as the DSR complex in the EY/SE area and in the OR complex in all other GOA management areas; and 2) a slope sub-group consisting of 20 species (which also includes two former pelagic shelf rockfish species: widow and yellowtail rockfish), which are in the OR complex in all GOA management areas. Biologically, there are differences between the demersal and slope sub-groups life history characteristics (e.g., growth, habitat, feeding zone), as shown in Figure 16B.2 of Tribuzio and Echave (2015). However, recent research showed the wide range in life history characteristics within both sub-groups with some species having conflicting levels of productivity based on different life history characteristics (e.g., long lived with early age at maturity; Omori et al. 2021). From a fishery perspective, the catch characteristics of

these two sub-groups (demersal and slope) are different. The demersal sub-group are primarily caught in hook and line fisheries in the Western, Central, and West Yakutat regulatory areas and are often retained, whereas the slope sub-group are generally caught as bycatch in the rockfish trawl fishery and generally have lower retention rates (i.e., higher discard rates). Rockfish are generally considered vulnerable species because they are slow-growing and late to mature. In a productivity-susceptibility analysis of 39 species in the GOA, yelloweye rockfish (the major species of the demersal sub-group) were the most vulnerable species in the GOA (Ormseth and Spencer 2011). Thus, lumping this species, and the other demersal sub-group species which are similar to it, into a complex with substantially different characteristics is inappropriate.

Lastly, data suggest that there is no apparent spatial structure within each sub-group within the GOA and should be considered a single population throughout the GOA. Recent research using multivariate techniques, including ordination and clustering analyses, and spatio-temporal species distribution modeling, support the distinction between the two sub-groups (demersal and slope) gulf-wide (Omori et al. 2021; Omori and Thorson, in review). Ward's hierarchical clustering, k-mediods non-hierarchical clustering, and canonical correspondence analysis (CCA) were applied to a combined dataset that comprised a temporal (i.e., month and year), spatial (i.e., broad-scale NMFS management areas), and gear components using the fishery independent surveys (i.e., NMFS AFSC bottom trawl survey and NMFS AFSC longline survey) and fishery dependent catch. Results indicated that the two main fishing gear types (trawl and longline) primarily defined the differences in the species composition, which aligned with the two rockfish sub-groups, throughout the GOA (Omori et al. 2021). Another research study applied a joint, dynamic species distribution model using a vector autoregressive spatio-temporal (VAST) model on the NMFS bottom trawl survey to identify possible fine-scale spatial or temporal groupings with the GOA OR species (Omori and Thorson, in review). Although only two species belonging to the demersal sub-group were included with seven slope sub-group species, the results reached similar conclusions as the previous multivariate analysis study; one of the demersal sub-group species (i.e., canary) consistently grouped away from the slope sub-group, whereas the other demersal rockfish (i.e., yelloweye) was found throughout the GOA, but comprise the majority of the catch for the DSR complex. Both studies concluded that the catch of the two sub-groups species was different by fishing gear and fine spatial scale throughout the GOA. Because the demersal sub-group species are different from the slope sub-group species in terms of life history, vulnerability, and the fisheries in which they are caught, it is logical that they should be managed separately.

The authors of both the DSR and OR stock assessments have proposed moving the demersal sub-group species that are in the OR complex in the WGOA, CGOA, and WY areas, into the DSR complex, which would effectively create a GOA-wide DSR complex (a detailed document is available here: http://npfmc.legistar.com/gateway.aspx?M=F&ID=9277d62c-0622-4779-8d36-ae564f04b821.pdf). The GOA Plan Team (September and November 2017 minutes) and the SSC (October and December 2017 minutes) agreed that the author recommendations were an "improved description of structure and a reasonable approach to spatial management" (SSC, October 2017), and that the demersal sub-group of the OR assessment should be categorized as "moderate concern" and moved to Step 2 of the Council's Stock Structure and Spatial Management Policy (PT November and SSC December 2017 minutes), which applies "to both spatial structure (area management) and stock structure (e.g., splitting out a stock from a complex)" (Council minutes, December 2015).

The authors, Plan Team, and SSC all agreed that the proposed changes to the composition of the complexes are an improvement over current groupings. The change we propose would reorganize both the OR and DSR complex structures, which will require regulatory changes. These regulatory changes consist of changing the footnotes on Table 10 to 50 CFR Part 679, defining basis species for retention. The SSC and Council have asked for a discussion paper to further explore the proposed change (October 2021). The timeline for this discussion paper has not yet been established.

Life History Information

Life history data are limited for most OR 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 harlequin, redstripe, sharpchin, silvergray, China, and yelloweye rockfish. All species of rockfish are ovoviviparous, with fertilization, embryonic development, and larval hatching occurring inside the female. Summarized information on the life history of the OR complex species can be found in Table 16.2.

Of the primary species, sharpchin rockfish are the only species in the OR complex with sufficient maturity and growth data available for the GOA stock, and are considered a Tier 4 species. Maximum observed age in the GOA is 58 years, with age at 50% maturity at 10 years (Malecha et al. 2007). Maximum age and age at maturity data are available for silvergray (82 and 9 years, respectively, Malecha et al. 2007) and redbanded (106 and 19 years, Munk 2001, Mangel et al. 2006) rockfish from outside of the GOA, but there is believed to be considerable geographic variation in age at maturity for redbanded rockfish (O'Connell 1987). Harlequin and redstripe rockfish have maximum observed ages of 72 and 55 years, respectively, (Tenbrink and Helser 2021, St. Savior et al. in prep) from within Alaskan waters. Harlequin rockfish have age and length at 50% maturity of 4.5 years and 19 cm, respectively (Tenbrink and Helser 2021). Harlequin rockfish might be considered for Tier 4 pending the results of ongoing ageing studies. Yelloweye rockfish could be considered a Tier 4 species, with maximum observed age (117 years) and age at maturity data (22 years, O'Connell and Funk 1987, Andrews et al. 2002); however, the survey biomass estimate is considered unreliable because this species tends to be closely associated with nearshore rocky habitats and is not commonly encountered by the trawl survey.

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., Then et al. 2015, Hamel 2015) and the some of the species in this assessment should have their *M* values re-evaluated.

Life history information is limited to parturition timing. In Southeast Alaska and British Columbia, redbanded rockfish are thought to release larvae from March to September (O'Connell 1987), while female redstripe rockfish off Southeast Alaska appear to release larvae from April to July (Archibald et al. 1981, Chilton and Beamish 1982). In contrast, sharpchin rockfish in British Columbia primarily extrude larvae in July only (Archibald et al. 1981). Yelloweye rockfish in Southeast Alaska have been reported to extrude larvae from February through September, but peak between April and July (O'Connell and Funk 1987).

Fishery

Management History and Management Units

The history of management changes for the OR 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. In 2011, the GOA Groundfish Plan Team and the NPFMC SSC both recommended that yellowtail rockfish and widow rockfish be moved from the Pelagic Shelf Rockfish complex into the Other Slope Rockfish complex (for the 2012 fishery). It was also recommended that the official name of Other Slope Rockfish be changed to Other Rockfish because yellowtail and widow rockfish mainly inhabit the continental shelf rather than the

slope. Table 16.4 shows the catch estimates, total allowable catch (TAC), acceptable biological catch (ABC) and overfishing level (OFL) for the various iterations of the Other Slope Rockfish and subsequent OR complexes. Note that the TAC for OR in East Yakutat/Southeast was set well below the ABC 2001 - 2018, as per a Council request to set the TAC "at levels sufficient to allow bycatch to be retained throughout the year but that would be insufficient to allow directed fishing" (66 FR 7275, https://www.federalregister.gov/d/01-1744). For 2020, the TAC was set equal to the ABC and for 2021 it was again reduced as has been done historically. No rationale for either change was provided in the minutes of the Advisory Panel or the Council.

From 2005 to 2010, the assessments for Other Slope Rockfish and shortraker rockfish in the GOA were presented in one SAFE chapter because each was assessed using a similar Tier 5 methodology, even though both were distinct management entities. However, in 2010 the GOA Groundfish Plan Team and the SSC recommended that future assessments for shortraker rockfish and Other Slope Rockfish be presented in separate SAFE chapters.

Northern rockfish are managed as a separate species in the Central GOA and Western GOA; however, because of their extremely low abundance and the consequent difficulty of managing them as a separate species in the Eastern GOA they were reassigned to the OR complex in 1999 for this area only. 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.

The species in the demersal sub-group have been accounted for in the AKRO Catch Accounting System (CAS) in the OR complex, but were not included in the OR stock assessment prior to 2013. Thus, early OR and Other Slope Rockfish assessments do not recognize the demersal sub-group species within the catch estimates. Again, these are the canary, china, copper, quillback, rosethorn, tiger, and yelloweye rockfish, but only when occurring outside of the East Yakutat/Southeast management area (i.e., NMFS areas 610-640, the Western and Central GOA and the West Yakutat portion of the Eastern GOA).

The current OR complex comprises 27 species, depending on area (Table 16.1 and Figure 16.1). Beginning in this assessment, we are including catch from "unidentified rockfish". This species group counts against the OR TAC/ABC/OFL, but has not historically been documented in this assessment. Unidentified rockfish generally occur in hook-and-line fisheries, where an observer or EM video reviewer is unable to confidently identify a species that falls off the line before being brought onboard. Catches of unidentified rockfish are generally low (< 30 t, on average), and are combined with the "minor" species for catch summary figures and tables.

Beginning in the 2014 fishery, the ABC and TAC for the Western and Central GOA were combined. The ABC for the OR had been exceeded in the Western GOA consistently from 2009 to 2013 and would have been exceeded each year since if the ABCs were not combined. During this period harlequin rockfish was, on average, 77% of the OR catch in the Western GOA. In 2012 the ABC was similarly exceeded (although by a substantially smaller margin) in the Central GOA as well, and harlequin was 52% of the OR catch. 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, the Plan Team and SSC agreed that the overages were likely not a conservation concern and that combining the Western and Central GOA ABC/TAC was an acceptable alternative. We continue with this recommendation as no conservation concerns warrant separating the Western and Central GOA ABC/TACs, despite the ABC overage in 2021 and the reduced ABC recommendations for 2022.

Directed Fishery, Effort and CPUE

Since the mid-1990s, directed fishing has not been permitted for OR in the GOA, but they are retained as "incidental-catch". Therefore, the fishery is bycatch only and does not reflect targeted fishing behavior. There are, however, two exceptions: 1) in 1993, when directed fishing was permitted for OR, it appears

some targeting by trawlers occurred in the eastern GOA for silvergray and yellowmouth rockfish, two larger sized species that can be caught in bottom trawls; 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

Gulfwide 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 average 50% over the entire time series. However, since 2016 discard rates have ranged 26-44%. This decrease in discards consists primarily of harlequin, sharpchin, and silvergrey rockfish in the rockfish target fishery in the Central GOA, totaling 479 – 595 t. The discard rate is highly variable by regulatory area and gear type (Figure 16.4). A full retention requirement went into effect for hook-and-line catcher vessels in 2020. With the full retention requirements, it is expected that some discarding would still occur due to drop-offs, or fish falling off the line before being brought onboard. Discard rates for hook-and-line catcher vessels, while variable, did not notably drop with the onset of the full retention requirements and remain >50% (Figure 16.4). 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 OR species were obtained from the following sources:

Source	Data	Years
AKRO Catch Accounting System	Catch estimates	1991 – 2021
NMFS Bottom Trawl Surveys –GOA (biennial)	Biomass Index, Age/length – compositions	1984 – 2021

Fishery

Fishery catch statistics for the OR complex are available from AKRO blend estimates and CAS beginning in 1991. Catch by species were estimated back to 1991 in Tribuzio and Echave (2013). Table 16.6 presents the time series of estimated catch of the current OR complex by species and Table 16.7 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 within this assessment based on observed species ratios; 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.

Since the mid-1990s, directed fishing has not been allowed for OR (and previously when it was the Other Slope Rockfish) in the GOA, and the fish can only be retained as “incidentally-caught” species. Annual catch since 1993 has always been much less than either the Gulfwide ABC or TAC (Table 16.3). Catches of OR in the Eastern GOA (where these species are most abundant) have been especially small in the years since 1999, when trawling was prohibited east of 140° W. long.

OR are predominately caught in trawl fisheries (Table 16.8), with much of the bycatch occurring in the rockfish trawl fishery in the Central GOA (Figure 16.6). The predominance of trawl catches is not surprising, as many of the abundant species such as sharpchin and harlequin rockfish are thought to feed on plankton and thus are likely not attracted to longline gear. Harlequin rockfish is generally the most common species caught, with the exception of EY/SE, where redbanded rockfish is most common (Figure 16.7).

Unidentified rockfish are generally a small portion of the total OR catch, however 2020 was an exception. The estimated catch of unidentified rockfish is usually ~ 30 t annually on average, and generally occurring in the hook-and-line catcher vessel fleet (> 90% on average). However, in 2020, catch was 253 t, with > 99% from the hook-and-line fleet catcher vessel fleet. More than likely, this is due to an observer effect, likely complicated by the COVID-19 pandemic. Occurrences of unidentified rockfish will continue to be tracked in this assessment.

Catch distribution

The rockfish trawl fishery is the predominant source of OR catch and the overall distribution of the catch shows little change from year to year (Figure 16.6). However, there is some variability amongst the species of OR (Figure 16.7). For example, in 2019, silvergray rockfish catch has been mostly in the West Yakutat area, compared to catch being mostly in the Central GOA since 2012 (Figure 16.7). There are distribution differences between the slope and DSR sub-groups of the OR species, the DSR sub-group species tend to be caught more near-shore and in shallower waters, while the slope sub-group tend to be further off shore, and often deeper.

Catch at age and length

The number of lengths sampled by observers for OR 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.

Survey

NMFS AFSC bottom trawl survey biomass estimates are available for the OR species in the GOA (1984 – 2021, Table 16.9). Bottom trawl surveys were conducted on a triennial basis in the GOA from 1984 – 1996 and a biennial survey schedule has been used since 1999. The below table summarizes how many stations have been fished each survey, within each regulatory area, or within each depth stratum. Due to funding constrains, the survey has either eliminated stations within a regulatory area (e.g., 2001), not sampled deeper depths, and/or reduced the total number of survey stations. Species within the OR complex are found in depths < 500 m. Therefore, it is unlikely that not sampling deeper strata would impact the accuracy of OR biomass estimates. However, given the patchy nature of the 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.

		Regulatory Area			Depth Stratum (m)					
Year	Total Stations	WGOA	CGOA	EGOA	0-100	101-200	201-300	301-500	501-700	701-1000
1984	929	242	485	202	228	391	179	70	43	18
1987	783	177	446	160	232	406	81	39	18	7
1990	708	135	371	202	168	364	116	60		
1993	774	170	412	192	241	353	126	54		
1996	807	200	393	214	272	337	140	58		
1999	764	147	414	203	283	265	109	60	23	24
2001	489	139	350		241	178	52	18		
2003	809	230	420	159	371	281	103	39	15	
2005	837	180	470	187	321	316	117	48	23	12
2007	816	205	470	141	331	290	107	49	23	16
2009	823	196	470	157	335	299	109	52	16	12
2011	670	163	383	124	282	255	83	33	17	
2013	548	136	313	99	232	208	67	29	12	
2015	771	189	434	148	279	321	106	37	16	12
2017	536	125	296	115	200	223	76	26	11	
2019	541	123	297	121	205	221	77	28	10	
2021	531	114	292	125	196	221	74	28	10	

Most of the OR biomass is in the Eastern GOA (Table 16.9 and Figure 16.3). Harlequin rockfish is the one exception, as it has had sporadic biomass estimates in all areas, primarily in the Western and Central GOA (Table 16.9). Many of these species tend to inhabit areas that are considered untrawlable by the survey, and thus catches can be highly variable. The CVs for the estimates are generally higher than for 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 17% to 34% for shortraker rockfish and 11% to 23% for rougheye/blackspotted rockfish (see Shotwell et al. 2019 and Echave et al. 2019).

The total biomass from the 2021 trawl survey for all the OR species was 70,644 t (Table 16.9). This is a 3% decrease from the 2019 survey (Figure 16.3). The 2021 survey biomass of yelloweye (120%), silvergray (48%), and redbanded (87%) all increased from the previous survey (Figure 16.5). Harlequin (-94%), redstripe (-85%), and sharpchin (-26%) rockfish were all down from the previous survey. These dramatic changes in biomass estimates are likely due in part to the patchiness of the species, as suggested by the high CVs (e.g., 68% CV for 2019 harlequin rockfish biomass). Such wide fluctuations in biomass do not seem reasonable given the slow growth and low natural mortality rates of all *Sebastes* species. Large catches of aggregating species, such as most OR appear to be, in just a few individual hauls can greatly influence biomass estimates and may be a source of much variability. For example, the increase in the 2017 biomass of harlequin rockfish was a result of a single large haul of in the Western GOA which resulted in an increased biomass estimate and a high coefficient of variation (Figure 16.2).

In the past, the authors of the Other Slope Rockfish SAFE reports (e.g., Clausen and Echave 2011) have speculated that a change in the availability of rockfish to the survey, caused by unknown behavioral or environmental factors, may explain some of the observed variation in biomass. It seems prudent to repeat this speculation in the present report, while acknowledging that until more is known about rockfish behavior, the actual cause of changes in biomass estimates will remain the subject of conjecture.

Catch at age and length

What little is known of the size structure for OR species comes from trawl survey data, and is limited to harlequin, redbanded, redstripe, sharpchin, silvergray, and yelloweye rockfish. Survey size compositions for the primary OR species are shown in Figure 16.8. It is not possible to determine significant recruitment events from the size composition data, nor if there are any shifts in mean length over time. Rockfish grow slowly, and thus the impact of a large recruitment event on the size composition could be dampened. The size composition data are limited in 2001 because the survey did not sample the Eastern GOA, as demonstrated by the small sample size for some of the species that are caught primarily in that area. Survey size composition data from the AFSC longline survey may also be useful for redbanded and yelloweye rockfish and will be investigated in the future.

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 OR complex.

Distribution of catch: fishery and survey

The majority of the survey biomass for OR 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 (Figure 16.9). While the estimated biomass based on the trawl survey for harlequin rockfish is substantially lower than for other species in the OR 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.

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 OR. Thus, the fishery data may provide some distribution information for the species farther west, in which untrawlable habitat may impact the survey catch.

Other Sources of Removals

In general, research catch is small relative to biomass (research catches are in Table 16.10 and biomass in Table 16.9). Sport catch of canary, China, copper, quillback, rosethorn, tiger, and yelloweye rockfish was not included until 2013, and only includes catch of those species west of the 140° W longitude (i.e., NMFS areas 610 – 640). Thus, the estimated catch from ADF&G sources increases dramatically in 2013. 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). These catches count against the OR ABC/TAC. Catch occurring in these areas should be monitored and are included in Table 16.11. The estimated catches from NMFS area 659 do not include the species within the DSR 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.

Analytic Approach

The OR stock complex is assessed using three separate models: Tier 4 sharpchin random effects model (Model 15.1), Tier 5 species random effects model (Model 15.1), and Tier 6 max catch 2013-2016 (Model 17.1).

Model Structure

The majority of species in the OR are managed as Tier 4 or Tier 5 with the bottom trawl survey biomass as the primary data input. Exploitable biomass is estimated using the random effects (RE) model. The RE model was first used in this assessment for setting specifications for the 2016 fishery (Tribuzio and Echave 2015).

In short, the RE model uses the process errors (step changes) from one year to the next as the random effects to be integrated over, and the process error variance is the free parameter. The observations can be irregularly spaced; therefore, this model can be applied to datasets with missing data. Large observation errors increase errors predicted by the model, which can provide a way to weight predicted estimates of biomass. Please see the Survey Averaging Working Group document for more information on the random effects methodology and results across species (https://www.afsc.noaa.gov/REFM/stocks/Plan_Team/2012/Sept/survey_average_wg.pdf).

Exploitable biomass estimates and estimates of uncertainty for the Tier 4 and 5 species are available from the 1984-2021 GOA trawl surveys. In both the Tier 4 and Tier 5 Model 15.1, the RE model was fit separately by area (Western GOA, Central GOA, and Eastern GOA) and then summed to obtain Gulfwide biomass estimates. Because the trawl survey did not sample the EGOA in 2001, in our application of the RE model the 2001 EGOA biomass estimate is treated as missing data.

Model 15.1 for Tier 4 consists of one species: sharpchin rockfish. The output of the RE model provides a Gulfwide biomass estimate, as well as biomass by area. The Tier 4 $F_{OFL} = F_{35\%}$ and the OFL = F_{OFL}*Biomass from the random effects model. The $F_{ABC} = F_{40\%}$ and the ABC = F_{ABC}*Biomass from the random effect model.

The Tier 5 Model 15.1 was fit separately to biomass estimates by area for all Tier 5 species (17 total) combined, which is then summed to obtain Gulfwide biomass estimates. To estimate F_{ABC} and F_{OFL} the model was fit to trawl survey biomass and variance estimates for sub-groups with the same M rates (resulting in five sub-groups for M = 0.05, 0.06, 0.07, 0.092, and 0.1). A biomass-weighted M value is calculated using the sub-group proportion of Gulfwide biomass, p_i (where the subscript i denotes the sub-group with a shared M), such that the Wted M = $F_{OFL} = \Sigma p_i * F_i$, where F_i is the sub-group specific fishing mortality rate (using M as the proxy). The F_{ABC} is 0.75* F_{OFL}.

The demersal sub-group primarily occurs in longline fisheries, are generally not sampled or at best poorly sampled by the trawl survey, and are considered Tier 6. The NPFMC defines the time series of catch for Tier 6 calculations as “reliable catch history from 1978-1995”. Species specific catch estimates are not available for these species prior to 1991, and should not be considered reliable prior to 2003. In the previous assessment the time series of catch since observer restructuring began (i.e., 2013 – 2016) was used because those are the most unbiased catch estimates, and therefore “reliable”. Changes in the estimated discard rates of these species after 2013 suggest that a substantial portion of the discards may not have been captured in CAS with the earlier observer program, thus the most representative time series of catch is that beginning in 2013. For Tier 6 species within the OR stock complex, we continue using Model 17.1, which uses the summed maximum catch of each of the Tier 6 species over the time series (beginning in 2013) to estimate the OFL. The ABC = 75% * OFL (Tribuzio and Echave 2019). The aurora and shortbelly rockfish are also included in the Tier 6 group because neither species has ever been caught in the trawl survey.

Parameter Estimates

Age and maturity curves are used in a spawning biomass per recruit analysis to estimate $F_{40\%}$ and $F_{35\%}$ for sharpchin rockfish.

Estimates of mortality for most of the OR species, but in particular the Tier 5 species, are shown in Table 16.2. 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*).

Results

Model Evaluation

Estimated biomass is presented in Table 16.12 and Figure 16.10 for sharpchin rockfish and Table 16.13 and Figure 16.10 for the 17 grouped, Tier 5 species.

Summary of computations of the ABC and OFL for the Tier 4 and Tier 5 components of the OR complex in the GOA, using the random effects estimated exploitable biomass are in the following table. The Wted M value used for the Tier 5 ABC and OFL calculations declined by 21% this assessment, due to the changes in biomass of the M groups (Figure 16.11).

Model	Group	Tier	2021 RE Biomass	F_{OFL}	OFL	F_{ABC}	ABC
Model 15.1	Sharpchin	4	8,638	$F_{35\%}$ = 0.079	682	$F_{40\%}$ = 0.065	561
Model 15.1	M=0.05 Group	5	41,719				
	M=0.06 Group	5	7,292				
	M=0.07 Group	5	1,941				
	M=0.092 Group	5	303				
	M=0.1 Group	5	2,996				
	Tier 5 Biomass	5	58,687[1]	F_{OFL} = Wted M = 0.055	3,228	F_{ABC} = 0.75*F_{OFL}	2,421
Total Tier 4/5 Gulf Wide					3,910		2,982

[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 (2013 – 2016) of each of the Tier 6 species by region are in the following table. The ABC and OFL are calculated for each species then summed for the Tier 6 totals. Catches are rounded to the nearest whole number for the ABC/OFL calculations. The ABC is combined for the Western and Central GOA. Changes in value from the previous assessment are due to CAS updates. There are no records of shortbelly rockfish catch during the 2013 – 2016 timeframe.

	Maximum Catch (t)			
Tier 6 Model 17.1	Western GOA	Central GOA	West Yakutat	East Yak/SE
aurora rockfish	0	0.05	0	
canary rockfish	<0.01	1.15	0.04	0
China rockfish	0.02	0.83	0.05	0
copper rockfish	<0.01	0.19	0.01	0
quillback rockfish	0.63	24.53	1.17	0
rosethorn rockfish	0.02	0.68	0.62	0
shortbelly rockfish	0	0	0	0
tiger rockfish	0.70	3.60	0.13	0
yelloweye rockfish	48.75	117.17	33.70	0
Total Tier 6 ABC	152		28	0
Total Tier 6 OFL	236			

Harvest Recommendations

The methods for ABC and OFL estimation for the OR complex are the same as those used in the previous assessment (status quo) and we do not recommend any changes to the methodology. Resulting ABCs and OFLs are below:

Tier - Model	2021 Random Effects Biomass	F_{OFL}	OFL	F_{ABC}	ABC
4-Model 15.1	8,638	$F_{35\%} = 0.079$	682	$F_{40\%} = 0.065$	561
5-Model 15.1	58,687	F_{OFL} = Wted M = 0.055	3,228	$F_{ABC} = 0.75*F_{OFL}$	2,421
6-Model 17.1			236		180
All Tiers Combined			4,146		3,162

Risk Table

A Risk Table was completed in the 2019 assessment. The risk table was not updated for this assessment, as per the SSC guidelines (October 2021). In general, a risk table for this complex would not provide useful information for management. We feel this is justified for the following reasons:

1) We do not recommend a reduction from the maxABC.
2) The OR complex consists of up to 27 data-limited species. With a complex of this size, a risk table is not informative if it encompasses all of the species.
3) It is difficult to identify a single primary/dominant species, as it changes between assessments. It would be untenable to complete a risk table for each of the 6 primary species.
4) The six primary species are varied in their life histories, fishery characteristics, survey data availability and would be difficult to combine into a single meaningful risk table.
5) If a single species were selected, data are sparse at the individual species level to inform species specific risk tables.
6) Much of the environmental data is borrowed from proxy species or generalizations that may not be informative for all of the species in the complex.

Area Allocation of Harvests

Based on the geographic distribution of the species' exploitable biomass in the trawl surveys, the NPFMC has allocated the Gulfwide ABC and thus the TAC for OR into three geographic management areas: the 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.

Since 1999, trawling has been prohibited in the Eastern GOA east of 140° W. longitude. Because most species of the OR 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.) (Figure 16.1). 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 OR 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 complex level, thus the same split fraction was used for Tier 4 species as for the Tier 5 OR species.

Tier 4 – Sharpchin	Western/Central GOA	Eastern GOA (80.97%)		Total
		West Yakutat[1]	E Yakutat/ Southeast	
Area Apportionment	3.54%	19.05%	77.41%	100%
Area ABC (t)	20	107	434	561
OFL (t)				682

Tier 5 – 17 species	Western/Central GOA	Eastern GOA (79.82%)		Total
		West Yakutat[1]	E Yakutat/ Southeast	
Area Apportionment	9.26%	7.32%	83.42%	100%
Area ABC (t)	224	177	2,020	2,421
OFL (t)				3,228

Tier 6 – seven species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	152	28	0	180
OFL (t)				236

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	396	312	2,454	3,162
OFL (t)				4,146

The OR ABC is a 22% reduction from the previous assessment, but due to apportionment of the ABC, the reductions by area are disproportionate. The combined Western/Central GOA ABC is a 58% reduction from 2020 and well below historical catch for this area (Figure 16.12). This reduction is due to a combination of the following:

1) The proportion of biomass in the Western/Central GOA decreased which shifted apportionment (Figure 16.2).
2) Trawl survey biomass declined for some of the primary Tier 5 species, in particular harlequin and redstripe (Figure 16.3).
3) The weighted natural mortality (Wted M) for the combined Tier 5 species declined by 21% due to the change in the M group biomass (Figure 16.11).

The ABC reductions in the West Yakutat and E Yakutat/Southeast areas are less dramatic (-15% and -11%, respectively), and the ABC in these areas are still well above historical catch.

Ecosystem Considerations

The ecosystem considerations for the GOA OR stock complex are summarized in Table 16.14.

Ecosystem Effects on Stock

Prey availability/abundance trends: Similar to other rockfish species, stock condition of OR is probably influenced by periodic abundant year classes. Availability of suitable zooplankton prey items in sufficient quantity for larval or post-larval rockfish may be an important determining factor of year-class strength. Unfortunately, there is no information on the food habits of larval or post-larval rockfish to help determine possible relationships between prey availability and year-class strength; moreover, identification to the species level for field collected larval rockfish is difficult. Visual identification is generally not possible, although genetic techniques allow identification to species level for larvae of many OR species (Gharrett et al. 2001). 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 on OR 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). Little if anything is known about abundance trends of these rockfish prey items.

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

Changes in physical environment: Strong year classes corresponding to the period around 1976 – 1977 have been reported for many species of groundfish in the GOA, including 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 OR. The environmental mechanism for this increased survival remains unknown. Changes in water temperature and currents could have an effect on prey item abundance and success of transition of rockfish from the pelagic to demersal stage. Rockfish in early juvenile stage have been found in floating kelp patches, which would be subject to ocean currents.

Changes in bottom habitat due to natural or anthropogenic causes could affect survival rates by altering available shelter, prey, or other functions. Associations of juvenile rockfish with biotic and abiotic structure have been noted by Carlson and Straty (1981), 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 OR 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. Thus, the reader is referred to the discussions on "Fishery Effects" in the chapters for these species in this SAFE report.

Data Gaps and Research Priorities

Data limitations are severe for OR in the GOA, and it is extremely 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 OR complex management category, improving biological sampling of OR 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.

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Tables

Table 16.1. Species comprising the Other Rockfish (OR) 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.

Common name	Scientific name	Former (pre-2012) Management Category	Current Tier within OR Complex
	Slope Sub-Group		
aurora rockfish	*Sebastes aurora*	Other Slope Rockfish	6
blackgill rockfish	*S. melanostomus*	Other Slope Rockfish	5
bocaccio	*S. paucispinis*	Other Slope Rockfish	5
Chilipepper	*S. goodie*	Other Slope Rockfish	5
darkblotched rockfish	*S. crameri*	Other Slope Rockfish	5
greenstriped rockfish	*S. elongates*	Other Slope Rockfish	5
harlequin rockfish	*S. variegatus*	Other Slope Rockfish	5
northern rockfish[a]	*S. polyspinis*	Other Slope Rockfish	
pygmy rockfish	*S. wilsoni*	Other Slope Rockfish	5
redbanded rockfish	*S. babcocki*	Other Slope Rockfish	5
redstripe rockfish	*S. proriger*	Other Slope Rockfish	5
sharpchin rockfish	*S. zacentrus*	Other Slope Rockfish	4
shortbelly rockfish	*S. jordani*	Other Slope Rockfish	6
silvergray rockfish	*S. brevispinis*	Other Slope Rockfish	5
splitnose rockfish	*S. diploproa*	Other Slope Rockfish	5
stripetail rockfish	*S. saxicola*	Other Slope Rockfish	5
vermilion rockfish	*S. miniatus*	Other Slope Rockfish	5
widow rockfish	*S. entomelas*	Other Slope Rockfish	5
yellowmouth rockfish	*S. reedi*	Other Slope Rockfish	5
yellowtail rockfish	*S. flavidus*	Other Slope Rockfish	5
	Demersal Sub-Group		
canary rockfish [a]	*S. pinniger*	Other Rockfish	6
China rockfish [a]	*S. nebulosus*	Other Rockfish	6
copper rockfish [a]	*S. caurinus*	Other Rockfish	6
quillback rockfish[a]	*S. maliger*	Other Rockfish	6
rosethorn rockfish [a]	*S. helvomaculatus*	Other Rockfish	6
tiger rockfish[a]	*S. nigrocinctus*	Other Rockfish	6
yelloweye rockfish[a]	*S. ruberrimus*	Other Rockfish	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 (OR) and 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 (O), British Columbia (BC), Gulf of Alaska (GOA), Eastern Gulf of Alaska (EGOA), and Washington (W). Mortality rates with no superscript have unknown methodology for their calculations.

Species	Mortality Rate	Max Age	Age at Maturity	Size at Maturity	Area	References
blackgill rockfish		90	21	35	O, CA	1, 16
bocaccio rockfish	0.06	45	4	45	W, O, CA	2, 3, 17, 18
canary rockfish	0.03-0.17	84	9	51	CA, BC	2, 3, 18
chilipepper rockfish		35	2.5	26	O, CA	2, 19
China rockfish		79	4	27	GOA, EGOA, CA	2, 4, 18
copper rockfish		50	6	34	GOA?, CA	2, 3, 15, 18
darkblotched rockfish	0.05[b]	48, 105	8.4	36.5	O, BC	2, 5, 20
greenstriped rockfish	0.07	54	8.5	23	GOA, WA, O, CA	2, 3, 18, 21
harlequin rockfish	0.092[b]	72	5	23	EGOA	8, 29
pygmy rockfish	0.06	26			BC	2, 3
quillback rockfish	0.06	90	5	26	GOA, CA	2, 3, 10, 18, 22, 23
redbanded rockfish	0.06	106	19	42	GOA, BC, CA	2, 3, 4. 18
redstripe rockfish	0.1[a]	55	8	29	BC	2, 3, 5, 6, 7, 15
rosethorn rockfish	0.06	87	8	21.5	GOA, CA	2, 3, 18
sharpchin rockfish	0.056-0.059[a]	58	10	26.5	GOA	8, 23
silvergray rockfish	0.05[b]	75	10	34-45	GOA, BC	8, 11, 23
splitnose rockfish	0.05	103	7	22	BC, WA, O	2, 18, 24, 25
stripetail rockfish		38	4	20	BC, CA	2, 26
tiger rockfish		116			EGOA	2, 3, 5
vermilion rockfish	0.1[b]	60	6	33	GOA, CA	2, 3, 26
widow rockfish	0.05[a]	60	5	37	BC, CA	2, 3, 7, 18
yelloweye rockfish	0.02	118	22	47.5	EGOA	2, 13, 23
yellowmouth rockfish	0.06[a]	99	11	380	BC	3, 5, 7, 27
yellowtail rockfish	0.07	64	9	41	BC, WA, O, CA	2, 7, 14, 28

(1)Helser 2005; (2) Love et al. 2002; (3) Munk 2001; (4) O'Connell 1987; (5) Archibald et al. 1981; (6) Clausen and Echave 2011; (7) Chilton and Beamish 1982; (8) Malecha et al. 2007; (9) Heifetz et al. 1998; (10) Kerr et al. 2003; (11) Stanley and Kronlund 2005; (12) Stanley and Kronlund 2000; 13) O'Connell and Funk 1987; 14) Leaman and Nagtegaal 1987; 15) Meyer and Failor in prep; 16) Stevens et al. 2004; 17) Piner et al. 2006; 18) Echeverria 1987; 19) Field 2007; 20) Nichol and Pikitch 1994; 21) Hicks et al. 2009; 22) Kerr et al. 2005; 23) Bechtol 1998; 24) Gertseva et al. 2010; 25) Gertseva and Cope 2011; 26) Phillips 1964; 27) Edwards et al. 2012; 28) Tagart et al. 2000; 29) TenBrink and Helser 2021; 30) Gunderson et al. 2003

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

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.
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".
2014	Merge Western and Central GOA ABCs and TACs

Table 16.4. Time series of catch estimates for the Other Rockfish (OR) complex with total allowable catch (TAC), acceptable biological catch (ABC), overfishing level (OFL) and the management category. Catch values presented here show estimated catches for the complex **at that time**, meaning that in 1991 the catches in this table represent all of the species in the Other Slope Rockfish (OSR) group at that time, which includes northern rockfish GOA wide. Data queried through AKFIN on October 1, 2021.

	Gulf of Alaska Region Catch			Total				
Year	Western	Central	Eastern	Catch	TAC	ABC	OFL	Management Group
1991	20	175	83	4,806[a]	10,100	10,100		OSR
1992	76	854	745	9,445[a]	14,060	14,060	28,200	OSR
1993	342	2,423	2,658	5,423	5,383	8,300	9,850	OSR - northerns removed
1994	101	715	797	1,613	2,235	8,300	9,850	OSR
1995	31	883	483	1,397	2,235	7,110	8,395	OSR
1996	19	618	244	881	2,020	7,110	8,395	OSR
1997	68	941	208	1,217	2,170	5,260	7,560	OSR
1998	46	701	114	861	2,170	5,260	7,560	OSR
1999	39	614	135	788	5,270	5,270	7,560	OSR - EGOA northern included
2000	49	363	165	577	4,900	4,900	6,390	OSR
2001	25	318	216	559	1,010	4,900	6,390	OSR
2002	223	481	70	774	990	5,040	6,610	OSR
2003	133	677	249	1,059	990	5,050	6,610	OSR
2004	240	534	106	880	670	3,900	5,150	OSR
2005	64	516	118	698	670	3,900	5,150	OSR
2006	279	603	216	1,098	1,480	4,152	5,394	OSR
2007	249	339	106	695	1,482	4,154	5,394	OSR
2008	250	439	78	768	1,730	4,297	5,624	OSR
2009	403	399	96	899	1,730	4,297	5,624	OSR
2010	366	431	161	958	1,192	3,749	4,881	OSR
2011	303	391	226	920	1,192	3,749	4,881	OSR
2012	255	723	63	1,041	1,080	4,045	5,305	OR - includes widow and yellowtail
2013	192	465	118	775	1,080	4,045	5,305	OR
2014	166	714	90	971	1,811	4,081	5,374	OR[b]
2015	206	839	47	1,092	1,811	4,081	5,374	OR
2016	155	1,018	82	1,255	2,308	5,773	7,424	OR
2017	141	856	81	1,078	2,308	5,773	7,424	OR
2018	49	990	156	1,194	2,305	5,594	7,356	OR
2019	106	577	259	942	2,305	5,594	7,356	OR
2020	99	564	219	882	4,053	4,053	5,320	OR
2021	134	914	153	1,201	4,053	4,053	5,320	OR

[a]The total OR catch includes Gulfwide catch of northern rockfish, catch by region are not currently available.
[b]Beginning in 2014, the Apportioned ABCs for the Western and Central GOA were combined, and thus the catch for those regions was also combined. They are left separate here for the sake of demonstration.

Table 16.5. Estimated discard rates for the Other Rockfish stock complex. Discard rates 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 NMFS Alaska Regional Office Catch Accounting System. Data queried through AKFIN on October 1, 2021.

Year	Discards	Catch	Discard Rate
1991	255.2	364.4	70%
1992	1,077.4	1,733.4	62%
1993	2,682.7	5,462.5	49%
1994	1,081.5	1,638.6	66%
1995	1,035.6	1,421.0	73%
1996	678.0	893.5	76%
1997	634.2	1,218.4	52%
1998	572.7	862.9	66%
1999	562.7	810.1	69%
2000	315.1	587.4	54%
2001	268.5	559.8	48%
2002	451.3	776.9	58%
2003	732.3	1069.4	68%
2004	577.1	967.3	60%
2005	301.1	699.7	43%
2006	797.3	1,099.9	72%
2007	269.2	696.6	39%
2008	442.8	769.6	58%
2009	494.3	903.9	55%
2010	571.1	969.9	59%
2011	503.0	928.1	54%
2012	520.1	1,041.4	50%
2013	513.4	774.5	66%
2014	386.7	970.9	40%
2015	574.5	1,091.6	53%
2016	297.1	1,255.1	24%
2017	354.0	1,078.5	33%
2018	361.5	1,194.3	30%
2019	441.6	941.6	47%
2020	422.0	881.9	48%
2021	479.5	1,201.3	40%

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 by species from 1991 – 2002 from previous assessments, from 2003 – present from the Alaska Regional Office Catch Accounting System. Data queried through AKFIN on October 1, 2021.

Year	Harlequin	Redbanded	Redstripe	Sharpchin	Silvergray	Yelloweye	Minors	OR Total
1991	78.5	7.6	63.3	6.1	4.7	81.5	122.7	364.4
1992	653.9	15.3	131.5	393.3	216.7	106.1	216.7	1,733.4
1993	1,997.0	43.4	1,393.6	1,328.2	319.7	131.2	249.4	5,462.5
1994	721.8	22.7	191.2	273.8	205.0	46.7	177.5	1,638.6
1995	633.7	23.1	175.9	323.4	104.7	38.9	121.4	1,421.0
1996	339.5	26.7	138.5	299.6	10.8	30.0	48.4	893.5
1997	460.6	15.6	279.1	307.8	34.3	43.1	77.9	1,218.4
1998	418.4	23.3	52.8	295.2	7.5	29.2	36.5	862.9
1999	362.1	20.1	78.0	150.2	15.3	130.0	54.4	810.1
2000	157.8	40.9	59.7	221.7	24.9	35.4	47.0	587.4
2001	254.6	76.9	41.6	122.2	15.7	28.8	20.0	559.8
2002	346.4	59.8	15.3	242.6	57.0	20.7	35.0	776.9
2003	509.8	50.0	41.3	250.5	25.7	149.5	42.6	1,069.4
2004	470.1	46.0	40.0	154.8	21.3	128.1	107.0	967.3
2005	475.2	62.7	9.9	51.4	4.3	88.9	7.3	699.7
2006	616.8	98.4	64.9	98.0	12.8	146.7	62.5	1,099.9
2007	329.3	72.2	39.5	96.8	12.4	131.5	15.0	696.6
2008	366.7	52.3	30.8	78.0	9.6	200.6	31.6	769.6
2009	517.7	46.3	34.2	84.2	22.9	166.9	31.7	903.9
2010	465.5	58.6	61.8	104.9	29.5	213.4	36.1	969.9
2011	353.8	60.5	67.2	113.5	63.3	227.9	41.7	928.1
2012	614.4	41.9	55.4	89.2	33.6	168.9	38.1	1,041.4
2013	307.3	78.1	24.9	46.2	17.9	191.4	108.7	774.5
2014	481.0	79.7	72.4	93.2	27.9	154.1	62.7	970.9
2015	579.5	57.5	49.6	106.4	42.9	172.5	83.1	1,091.6
2016	597.6	87.9	109.8	160.9	58.0	154.8	86.1	1,255.1
2017	467.8	80.6	75.7	123.0	48.4	195.0	88.0	1,078.5
2018	555.1	79.9	159.7	163.2	33.2	133.8	69.5	1,194.3
2019	361.4	68.8	132.7	66.8	67.5	134.3	110.0	941.6
2020	226.0	47.1	84.2	65.7	30.6	108.6	319.7	881.9
2021	393.0	64.6	167.5	118.6	144.2	171.7	141.6	1,201.3

Table 16.7. Estimated catch of the combined species of the current Other Rockfish (OR) by Gulf of Alaska (GOA) NMFS regulatory area. The acceptable biological catches (ABCs) are only presented for the years of the current OR complex. The ABCs for Western and Central GOA were combined starting in 2014. Catch by species from 1991 – 2002 from previous assessments, from 2003 – present from the Alaska Regional Office Catch Accounting System. Data queried through AKFIN on October 1, 2021.

	Gulf of Alaska Catch				Acceptable Biological Catch			
Year	Western GOA	Central GOA	West Yakutat	Southeast	Western GOA	Central GOA	West Yakutat	Southeast
1991	89.6	175.7	96.7	2.4				
1992	77.4	855.3	734.3	66.4				
1993	342.3	2,462.1	735.4	1,922.6				
1994	101.0	722.8	569.0	245.9				
1995	41.1	886.4	469.5	24.1				
1996	27.6	620.3	234.9	10.7				
1997	68.0	942.4	122.6	85.4				
1998	46.1	702.7	107.8	6.3				
1999	39.2	614.8	125.2	30.9				
2000	49.1	370.2	133.7	34.4				
2001	25.0	318.1	169.9	46.8				
2002	223.0	483.9	45.0	25.0				
2003	133.2	683.4	226.6	26.2				
2004	275.0	584.0	77.7	30.6				
2005	64.6	516.3	70.9	48.0				
2006	279.2	604.1	137.7	78.9				
2007	249.3	340.5	53.6	53.3				
2008	250.5	439.5	50.4	29.2				
2009	403.3	402.9	83.1	14.6				
2010	366.1	441.4	131.4	30.9				
2011	302.7	398.0	194.6	32.7				
2012	255.0	723.5	38.2	24.7	44	606	230	3,165
2013	191.6	464.9	68.4	49.6	44	606	230	3,165
2014	166.4	714.2	54.9	35.5	1,031		580	2,469
2015	205.6	839.3	31.9	14.8	1,031		580	2,469
2016	154.9	1018.1	50.8	31.2	1,534		574	3,665
2017	141.2	856.5	44.7	36.1	1,534		574	3,665
2018	48.5	990.2	111.8	43.8	1,103		442	3,360
2019	106.2	576.8	180.8	77.8	1,103		442	3,360
2020	98.9	564.0	109.0	110.0	940		369	2,744
2021	133.9	914.2	117.8	35.5	940		369	2,744

Table 16.8. Proportion of Other Rockfish (Other Slope Rockfish prior to 2011) catch by gear type. Proportions are displayed by sub-groups within the Other Rockfish complex. HAL = hook and line, which includes jig; TWL = trawl gear types, POT = pot gear. "tr" represents trace amounts, those <0.5%. Data from the Alaska Regional Office Catch Accounting System, queried through AKFIN on October 1, 2021.

	Slope sub-group			Demersal sub-group		
Year	HAL	TWL	POT	HAL	TWL	POT
2003	23%	77%	0%	87%	13%	0%
2004	11%	89%	tr	62%	38%	tr
2005	12%	88%	tr	67%	33%	0%
2006	12%	88%	tr	71%	29%	tr
2007	19%	81%	tr	73%	27%	tr
2008	20%	80%	tr	67%	33%	tr
2009	14%	86%	tr	69%	31%	tr
2010	34%	66%	tr	73%	26%	tr
2011	34%	65%	tr	74%	23%	tr
2012	25%	75%	tr	45%	55%	tr
2013	50%	50%	tr	74%	25%	tr
2014	27%	73%	tr	65%	34%	tr
2015	26%	74%	tr	59%	40%	tr
2016	26%	74%	tr	73%	26%	tr
2017	30%	68%	tr	77%	20%	tr
2018	26%	74%	tr	79%	21%	tr
2019	30%	69%	tr	74%	25%	tr
2020	6%	94%	tr		56%	42%
2021	5%	95%	tr		57%	40%

Table 16.9. Biomass estimates (t) by NMFS regulatory area for the six primary species of Other Rockfish (OR) in the Gulf of Alaska (GOA), based on bottom trawl surveys conducted between 1984 and 2019. Note that biomass estimates for yelloweye rockfish do not include the Eastern GOA. This species is included in the OR complex in the West Yakutat portion of the Eastern GOA. The Eastern GOA biomass for this species is not included in this table because biomass estimates are calculated based on INPFC areas, which do not line up with NMFS Regulatory areas, and split fractions used to deal with this difference for the species in the Other Rockfish Complex have not been created for yelloweye rockfish. CV is the coefficient of variation.

		Regulatory Area				
		Western GOA	Central GOA	Eastern GOA	Gulfwide Total	CV%
Harlequin	1984	65.1	1,313.6	1,246.2	2,624.9	31%
	1987	7,491.2	20,248.7	44,665.2	72,405.1	29%
	1990	124.6	13,584.0	3,955.6	17,664.2	51%
	1993	84.2	8,528.9	667.5	9,280.6	47%
	1996	772.7	2,882.5	16,371.0	20,026.2	64%
	1999	7.4	8,562.6	1,306.5	9,876.5	42%
	2001	2,987.2	5,377.7	0.0	8,364.9	50%
	2003	25.1	1,498.3	2,021.2	3,544.6	45%
	2005	26,667.6	1,930.3	4,525.9	33,123.8	64%
	2007	834.1	1,902.3	1,320.5	4,056.9	45%
	2009	44.2	839.8	1,802.2	2,686.2	43%
	2011	2,237.6	1,081.9	415.0	3,734.5	61%
	2013	122.8	6,720.4	642.1	7,485.3	71%
	2015	468.3	1,430.5	417.6	2,316.4	48%
	2017	11,939.2	927.8	53.0	12,920.0	83%
	2019	104.4	3,842.4	533.6	4,480.4	68%
	2021	24.2	127.7	117.6	269.5	34%
Redbanded	1984	0.0	168.8	1,261.5	1,430.3	31%
	1987	21.1	604.0	1,197.1	1,822.2	33%
	1990	0.0	219.5	3,065.9	3,285.4	35%
	1993	10.5	434.2	3,230.4	3,675.1	29%
	1996	61.2	199.8	4,332.7	4,593.7	34%
	1999	118.4	402.7	10,420.0	10,941.1	41%
	2001	60.8	353.8	0.0	414.6	24%
	2003	18.9	889.3	2,532.4	3,440.6	22%
	2005	41.3	1,009.7	4,559.3	5,610.3	22%
	2007	51.8	1,164.2	5,982.2	7,198.2	25%
	2009	34.0	2,020.4	4,387.9	6,442.3	17%
	2011	12.2	1,304.0	3,725.6	5,041.8	23%
	2013	66.2	2,346.0	3,455.7	5,867.9	19%
	2015	52.1	1,901.0	3,503.9	5,457.0	18%
	2017	43.4	1,557.0	4,187.7	5788.1	22%
	2019	0.0	822.4	3,982.3	4,804.7	24%
	2021	43.4	3,863.8	5,070.3	8,977.5	35%
Redstripe	1984	0.0	138.8	5,225.2	5,364.0	41%
	1987	1,263.0	1,819.7	23,435.9	26,518.6	47%
	1990	0.0	14.7	27,049.2	27,063.9	52%
	1993	5.3	111.5	29,502.5	29,619.3	55%
	1996	152.1	90.8	14,721.0	14,963.9	54%
	1999	0.0	138.8	8,087.1	8,225.9	49%
	2001	2.5	124.2	0.0	126.7	60%
	2003	4.9	175.0	7,845.4	8,025.3	36%
	2005	2,796.2	12,826.8	6,079.5	21,702.5	58%
	2007	15.2	655.6	10,829.9	11,500.7	61%
	2009	1.2	48.3	1,542.0	1,591.5	46%
	2011	0.0	499.1	18,245.7	18,744.8	87%
	2013	17.8	8,721.5	1,131.8	9,871.1	87%
	2015	0.0	11,951.7	4,747.6	16,699.3	71%
	2017	72.8	15,710.1	14,378.5	30,161.4	54%

Table 16.9. Continued

		Regulatory Area				
		Western GOA	Central GOA	Eastern GOA	Gulfwide Total	CV%
Redstripe	2019	9.1	6,551.6	11,019.7	17,580.4	36%
	2021	0.0	315.6	2,404.6	2,720.2	36%
Sharpchin	1984	0.0	1,945.4	4,666.5	6,611.9	36%
	1987	3,366.3	43.0	77,029.2	80,438.5	39%
	1990	1.6	3,363.3	34,968.6	38,333.5	37%
	1993	73.6	7,047.4	16,554.9	23,675.9	32%
	1996	72.2	1,921.4	62,576.4	64,570.0	32%
	1999	0.0	2,856.2	17,984.4	20,840.6	66%
	2001	23.2	1,774.0	0.0	1,797.2	69%
	2003	38.0	289.5	6,766.1	7,093.6	46%
	2005	194.7	10,757.3	10,183.2	21,135.2	32%
	2007	52.5	4,047.8	14,936.7	19,037.0	34%
	2009	14.7	654.6	11,823.4	12,492.7	35%
	2011	0.0	538.0	7,503.0	8,041.0	63%
	2013	160.1	810.6	13,949.0	14,919.7	50%
	2015	66.9	15,888.7	29,060.7	45,016.3	55%
	2017	43.7	343.6	11,234.4	11,621.7	51%
	2019	214.2	2,598.1	8,523.7	11,336.0	41%
	2021	0	110.0	8,307.1	8,417.1	38%
Silvergray	1984	0.0	52.2	4,764.5	4,816.7	28%
	1987	37.4	149.1	5,239.4	5,425.9	40%
	1990	0.0	280.4	13,868.5	14,148.9	42%
	1993	0.0	543.8	18,435.1	18,978.9	31%
	1996	0.0	1,552.7	22,574.6	24,127.3	27%
	1999	0.0	6,745.1	30,896.0	37,641.1	33%
	2001	0.0	63.0	0.0	63.0	58%
	2003	0.0	64.8	51,850.6	51,915.4	73%
	2005	18.1	1,073.2	39,989.4	41,080.7	40%
	2007	0.0	358.9	29,438.6	29,797.5	26%
	2009	0.0	94.3	9,757.1	9,851.4	43%
	2011	0.0	24,109.7	75,939.4	100,049.1	35%
	2013	0.0	406.3	18,832.2	19,238.5	38%
	2015	0.0	1,497.6	42,676.8	44,174.4	35%
	2017	0.0	3,517.2	32,689.2	36,206.4	41%
	2019	18.2	181.6	28,326.5	28,526.3	25%
	2021	0	145.1	42,085.9	42,231.0	27%
Yelloweye	1984	21.9	97.1		119.0	52%
	1987	73.2	349.4		422.6	35%
	1990	0.0	308.9		308.9	39%
	1993	13.7	579.6		593.3	33%
	1996	43.5	479.4		522.9	48%
	1999	0.0	2,280.8		2,280.8	46%
	2001	41.5	1,508.3		1,549.8	50%
	2003	45.9	858.1		904.0	49%
	2005	904.9	986.5		1,891.4	39%
	2007	325.9	654.5		980.4	33%
	2009	0.0	777.0		777.0	34%
	2011	173.5	2,344.5		2,518.0	44%
	2013	154.8	592.3		747.1	57%
	2015	49.0	823.1		872.1	36%
	2017	442.4	912.8		1,355.2	33%
	2019	250.9	1,441.7		1,816.2	35%
	2021	112.0	3,425.3		3,537.3	77

Table 16.9. Continued

		Regulatory Area				
		Western GOA	Central GOA	Eastern GOA	Gulfwide Total	CV%
Minor	1984	0.0	120.1	1,500.0	1,620.1	
	1987	71.4	373.3	669.5	1,114.2	
	1990	5.5	453.1	2,776.0	3,234.6	
	1993	3.1	1,160.8	4,227.2	5,391.1	
	1996	0	72.8	2,755.6	2,828.5	
	1999	0	117.7	19,281.5	19,399.2	
	2001	80.9	197.4	0	278.2	
	2003	0	162.3	1,802.9	1,965.1	
	2005	6.7	52.4	2,009.9	2,069.0	
	2007	61.6	113.8	2,838.5	3,014.0	
	2009	10.6	372.5	4,117.5	4,500.6	
	2011	0	2,421.5	8,482.1	10,903.6	
	2013	0	31.8	4,451.2	4,483.0	
	2015	21.2	594.0	1,748.3	2,363.5	
	2017	1.8	33.3	4,694.6	4,729.7	
	2019	42.6	219.3	4,074.7	4,336.6	
	2021	34.9	764.4	3,692.3	4,491.7	
Complex	1984	86.9	3,836.1	18,664.2	22,587.3	
	1987	12,323.6	23,587.0	152,236.1	188,146.7	
	1990	131.7	18,223.8	85,683.8	104,039.4	
	1993	196.0	18,405.9	72,617.9	91,219.8	
	1996	1,101.7	7,199.3	123,331.3	131,632.4	
	1999	125.8	21,104.0	87,975.6	109,205.4	
	2001	3,196.2	9,398.0	0	12,594.2	
	2003	132.7	3,937.0	72,818.6	76,888.4	
	2005	30,629.5	28,636.1	67,347.4	126,613.0	
	2007	1,341.1	8,897.0	65,346.5	75,548.6	
	2009	104.7	4,807.0	33,429.9	38,341.6	
	2011	2,423.3	32,298.8	114,310.6	149,032.6	
	2013	521.6	19,628.9	42,462.3	62,612.8	
	2015	657.5	34,086.6	82,154.5	116,898.6	
	2017	12,543.3	23,002.1	67,237.4	102,782.9	
	2019	639.5	15.657.2	56.460.5	72,757.2	
	2021	214.6	8,752.1	61,677.8	70,644.4	

Table 16.10. Research survey catch of Other Rockfish 1977 - 2020 in the Gulf of Alaska (GOA). Beginning in 2010 all research and other non-commercial catch was provided by the Alaska Regional Office. These removals do not count against the total allowable catch.

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)
1977	Assessment of the Other Rockfish in the Gulf of Alaska (Clausen and Echave 2011)	0.8				
1978		9.5				
1979		0.4				
1980		0.4				
1981		16.3				
1982		2.9				
1983		0.1				
1984		3.4				
1985		1.7				
1986		0.0				
1987		19.8				
1988		0.7				
1989		0.1				
1990		11.8				
1991		tr				
1992		0.0				
1993		11.3				
1994		0.0				
1995		0.0				
1996		16.9				
1997		0.0				
1998		2.4				
1999		51.6				
2000		0.0				
2001		0.7				
2002		tr				
2003		8.7				
2004		tr				
2005		11				
2006		tr				
2007		8.1				
2008		tr				
2009		4.2				
2010	AKRO	tr	1,453	2.6	7.3	4.7
2011		7.7	1,212	2.2	4.8	3.9
2012			1,320	2.4	5.1	4.9
2013		3.8	1,191	2.2	4.7	50.8
2014			1,636	3.1	6.9	55.7
2015		12.0	1412	2.7	6.7	51.3
2016			1343	2.5	5.5	58.3
2017		5.2	1,598	2.9	4.2	60.8
2018			1,615	3.0	5.9	56.4
2019		4.3	1,059	2.0	8.4	75.1
2020			1,158	2.2	7.4	44.3

Table 16.11. Estimated catch (t) of Other Rockfish (OR) from federally managed fisheries occurring in Prince William Sound (PWS, NMFS Area 649) and Southeast Alaska Inside Waters (SE, NMFS Area 659). Catches in SE do not include the DSR sub-group.

Year	PWS	SE
2013	19.4	14.0
2014	11.2	12.6
2015	22.3	10.7
2016	39.0	11.1
2017	9.6	14.7
2018	9.0	11.4
2019	10.7	13.0
2020	9.4	54.8
2021	14.6	7.6

Table 16.12. Estimated random effects biomass (t) by NMFS regulatory area and total Gulfwide biomass with 95% confidence intervals (CI) for sharpchin rockfish (the only Tier 4 species).

	Western GOA	Central GOA	Eastern GOA	Gulfwide Total	95% Confidence Intervals Lower	Upper
1984	1,154.4	1,394.9	5,333.5	7,882.8	324.4	191,540.0
1985	1,154.4	521.1	12,360.8	14,036.2	2,296.0	85,807.4
1986	1,154.4	194.6	28,647.0	29,996.0	5,533.8	162,594.0
1987	1,154.4	72.7	66,391.4	67,618.5	32,752.4	139,601.0
1988	214.6	226.0	53,570.7	54,011.3	9,397.0	310,444.0
1989	39.9	702.8	43,225.7	43,968.4	7,756.3	249,245.0
1990	7.4	2,185.1	34,878.5	37,071.0	18,772.1	73,207.3
1991	14.8	2,917.6	27,609.5	30,541.9	6,007.8	155,267.0
1992	29.5	3,895.8	21,855.4	25,780.7	5,517.0	120,472.0
1993	59.0	5,201.9	17,300.5	22,561.3	13,190.5	38,589.5
1994	61.7	3,835.6	25,922.2	29,819.5	6,268.3	141,857.0
1995	64.5	2,828.2	38,840.7	41,733.4	8,080.8	215,532.0
1996	67.5	2,085.4	58,197.0	60,349.9	33,522.3	108,648.0
1997	57.1	2,246.9	40,082.6	42,386.6	7,734.5	232,286.0
1998	48.2	2,420.9	27,606.5	30,075.7	5,152.1	175,569.0
1999	40.8	2,608.4	19,013.7	21,662.9	7,409.0	63,339.2
2000	34.5	1,992.0	14,971.4	16,997.9	2,623.2	110,143.0
2001	29.2	1,521.3	11,788.5	13,338.9	1,669.9	106,553.0
2002	35.8	759.3	9,282.3	10,077.4	1,629.7	62,315.1
2003	43.9	379.0	7,308.9	7,731.8	3,479.2	17,182.1
2004	71.0	1,648.3	8,631.6	10,350.8	2,641.6	40,559.0
2005	114.8	7,168.4	10,193.6	17,476.8	10,031.3	30,448.4
2006	77.6	4,910.2	12,136.4	17,124.2	4,930.2	59,478.2
2007	52.5	3,363.4	14,449.5	17,865.4	9,867.3	32,346.5
2008	35.6	1,558.8	13,029.5	14,623.9	3,602.4	59,366.1
2009	24.1	722.5	11,749.1	12,495.6	6,622.2	23,578.5
2010	35.3	648.3	10,051.6	10,735.2	2,375.8	48,508.1
2011	51.8	581.7	8,599.4	9,232.9	3,463.4	24,613.9
2012	76.0	743.0	10,974.1	11,793.2	2,543.7	54,676.8
2013	111.6	949.2	14,004.4	15,065.2	6,524.0	34,788.6
2014	87.9	2,155.4	18,183.3	20,426.5	4,610.0	90,507.7
2015	69.2	4,894.4	23,609.1	28,572.7	11,531.8	70,795.1
2016	64.0	1,538.4	16,662.1	18,264.5	4,020.2	82,979.2
2017	59.2	483.5	11,759.2	12,302.0	5,223.8	28,970.9
2018	99.2	774.9	10,130.8	11,004.9	2,496.6	48,509.1
2019	166.1	1,241.9	8,727.8	10,135.8	4,920.9	20,877.1
2020	166.1	416.6	8,527.5	9,110.3	2,105.2	39,424.7
2021	166.1	139.8	8,331.8	8,637.7	3,962.5	18,829.1

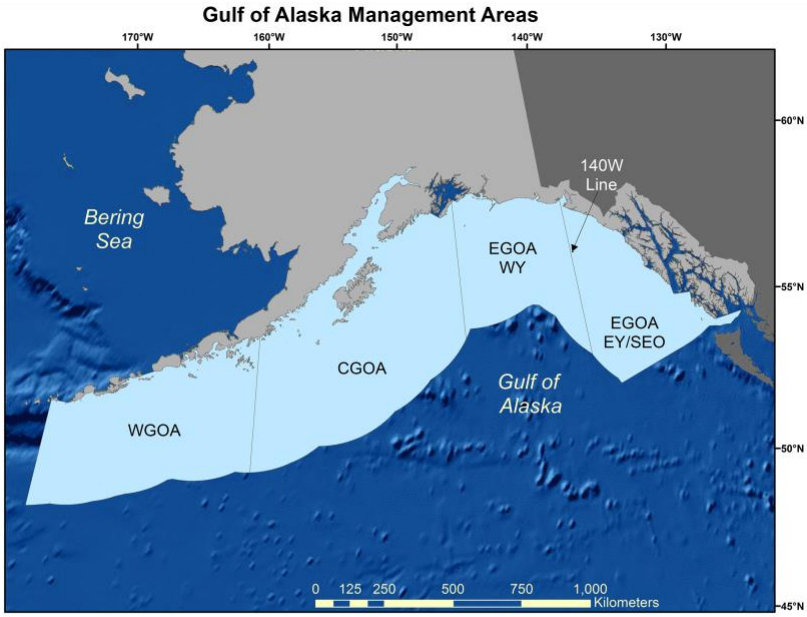
Table 16.13. Estimated random effects biomass by NMFS regulatory area and total Gulfwide biomass with 95% confidence intervals for the 17 Tier 5 species of Other Rockfish.

	Western GOA	Central GOA	Eastern GOA	Gulfwide Total	95% Confidence Intervals Lower	Upper
1984	119.0	1,839.1	14,263.2	16,221.2	11,226.2	23,438.8
1985	389.3	4,088.7	24,290.4	28,768.4	5,657.2	146,295.0
1986	1,274.0	9,090.2	41,366.7	51,731.0	10,438.6	256,365.0
1987	4,169.4	20,209.8	70,447.9	94,827.2	55,413.5	162,274.0
1988	1,467.9	17,910.7	63,429.7	82,808.3	17,080.7	401,460.0
1989	516.8	15,873.2	57,110.6	73,500.6	14,920.9	362,066.0
1990	181.9	14,067.4	51,421.1	65,670.4	36,635.2	117,717.0
1991	157.3	12,355.1	52,921.4	65,433.8	12,818.2	334,024.0
1992	135.9	10,851.2	54,465.6	65,452.7	12,422.3	344,869.0
1993	117.5	9,530.4	56,054.7	65,702.6	34,783.1	124,107.0
1994	210.8	7,795.4	57,617.9	65,624.1	11,807.3	364,734.0
1995	378.3	6,376.3	59,224.8	65,979.3	11,634.0	374,187.0
1996	678.8	5,215.5	60,876.4	66,770.7	34,739.7	128,335.0
1997	468.4	7,172.1	63,681.2	71,321.7	12,743.9	399,155.0
1998	323.2	9,862.8	66,615.3	76,801.2	14,370.4	410,457.0
1999	223.0	13,562.8	69,684.5	83,470.4	50,398.3	138,245.0
2000	498.9	9,041.2	68,555.7	78,095.9	12,694.3	480,450.0
2001	1,116.1	6,027.1	67,445.2	74,588.3	8,428.7	660,057.0
2002	276.9	4,367.1	66,352.7	70,996.6	9,967.7	505,687.0
2003	68.7	3,164.3	65,277.9	68,510.8	26,778.0	175,283.0
2004	770.0	6,031.6	61,078.4	67,880.1	14,720.0	313,023.0
2005	8,632.8	11,497.4	57,149.1	77,279.2	47,862.0	124,777.0
2006	2,838.0	7,037.8	53,276.9	63,152.7	15,602.2	255,622.0
2007	933.0	4,308.0	49,667.1	54,908.1	36,172.7	83,347.2
2008	327.4	3,875.7	33,512.1	37,715.2	8,877.6	160,227.0
2009	114.9	3,486.9	22,611.7	26,213.4	17,913.4	38,359.2
2010	322.6	8,317.5	46,550.8	55,190.9	13,471.0	226,119.0
2011	906.0	19,840.7	95,834.3	116,581.0	67,597.6	201,059.0
2012	476.7	19,048.9	53,764.0	73,289.7	19,498.1	275,482.0
2013	250.8	18,288.7	30,162.2	48,701.7	29,434.1	80,582.2
2014	399.6	17,859.3	39,654.1	57,913.1	15,922.7	210,638.0
2015	636.7	17,440.0	52,133.1	70,209.8	41,531.0	118,692.0
2016	1,573.9	18,344.8	53,773.8	73,692.6	19,689.9	275,807.0
2017	3,890.9	19,296.5	55,466.2	78,653.6	45,277.2	136,634.0
2018	846.8	14,704.5	51,657.7	67,209.0	17,639.8	256,071.0
2019	184.3	11,205.2	48,110.7	59,500.2	41,953.9	84,384.8
2020	116.2	7,748.8	50,617.5	58,482.5	14,179.7	241,203.0
2021	73.2	5,358.6	53,254.8	58,686.7	38,864.0	88,620.0

Table 16.14. Analysis of ecosystem considerations for the Other Rockfish 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.

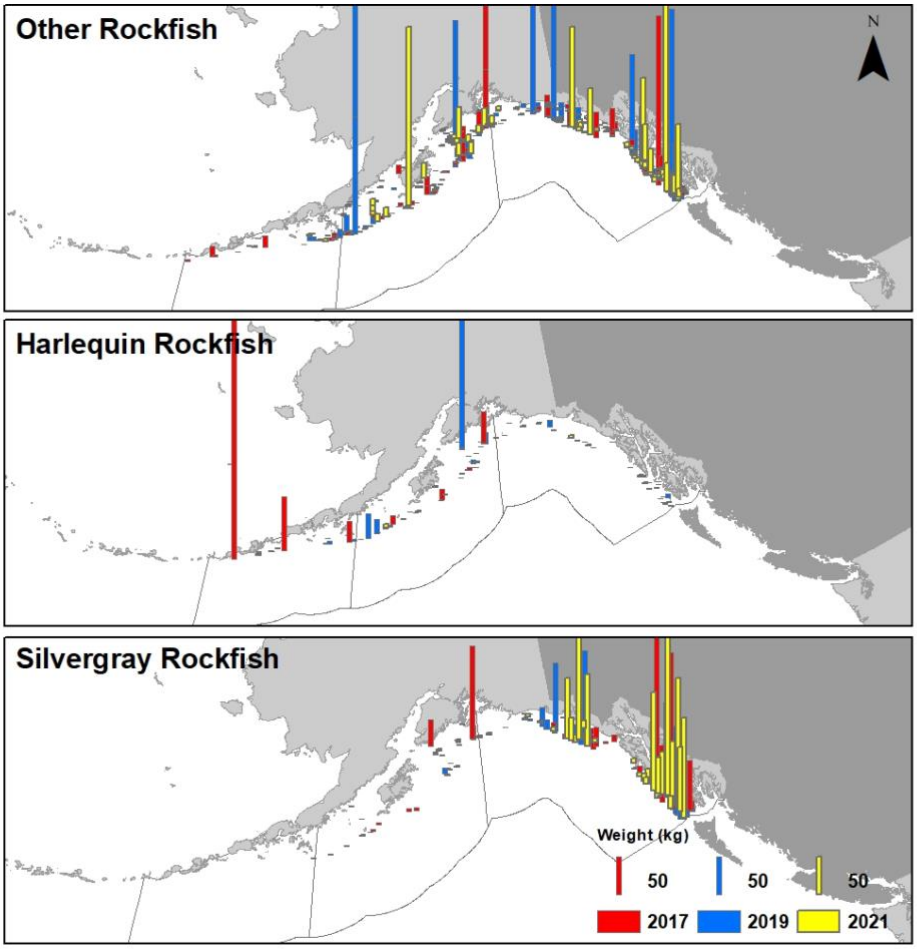


Figure 16.2. Spatial distribution of trawl survey catch in the Gulf of Alaska (GOA) from the three most recent National Marine Fisheries Service (NMFS) trawl surveys (2017, 2019, and 2021) for: (top panel) the Other Rockfish (OR) complex (with the exception of harlequin and silvergray rockfish); (middle panel) harlequin rockfish; and (bottom panel) silvergray rockfish.

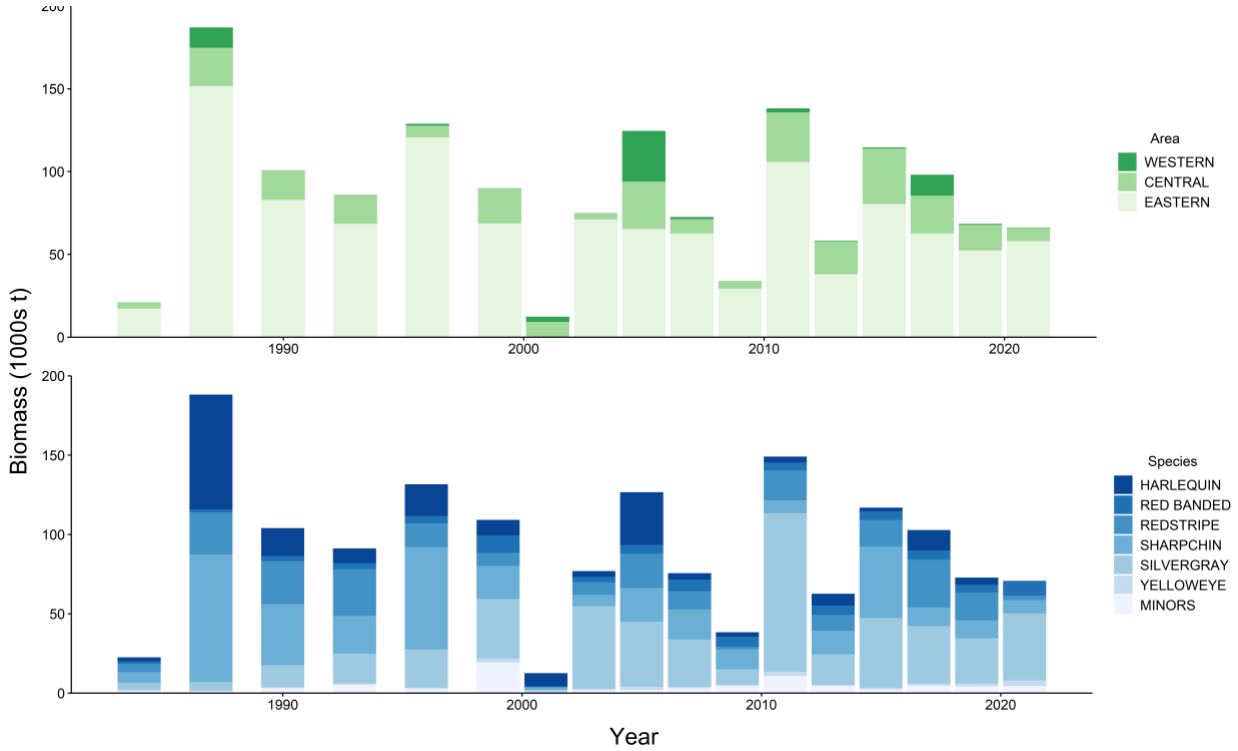


Figure 16.3. Trawl survey biomass estimates for the species in the Other Rockfish complex, by Gulf of Alaska (GOA) regulatory area (top, Western GOA, Central GOA, Eastern GOA) and by species (bottom).

Figure 16.4. Discard rates for all Other Rockfish species by regulatory area, gear (HAL = hook-and-line, TWL = trawl) and harvest sector (CP = catcher processor, or CV = catcher vessel)

Figure 16.5. Trawl survey biomass for the six primary species in the Other Rockfish complex by regulatory area. The percent change from the previous survey are presented for the full GOA biomass.

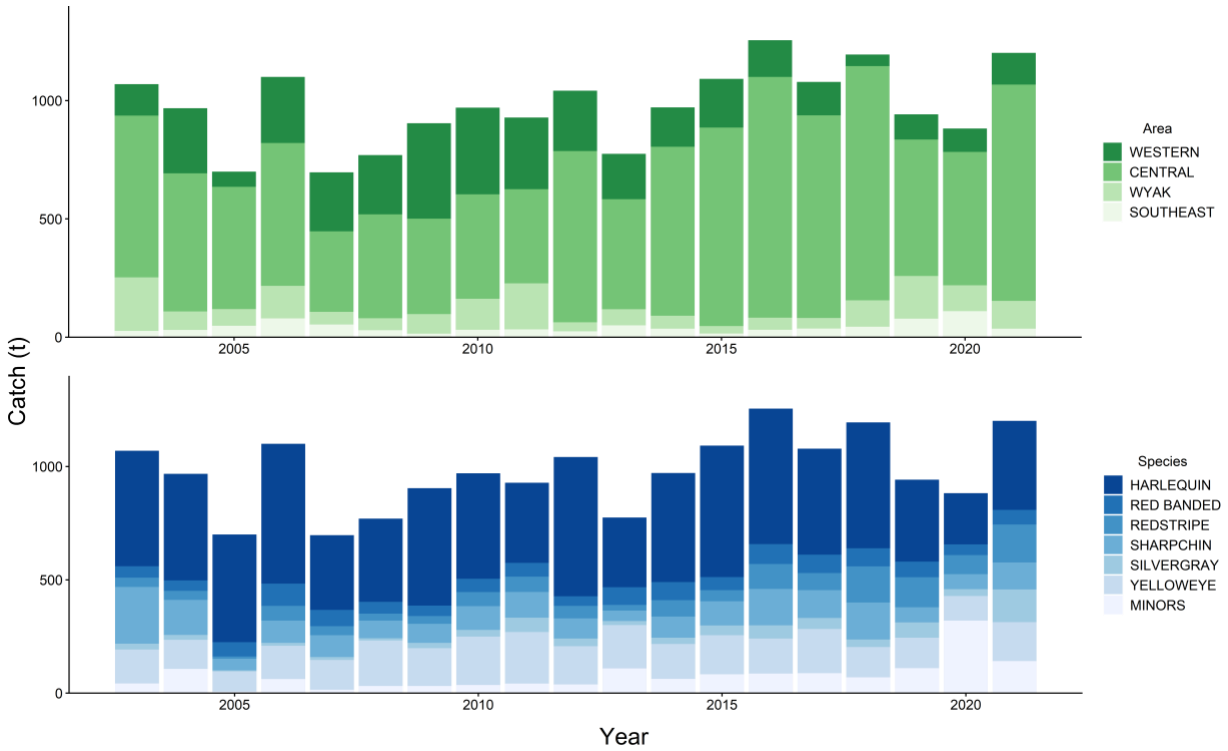


Figure 16.6. Estimated incidental catch (t) of Other Rockfish in Gulf of Alaska (GOA) by area (Western GOA, Central GOA, West Yakutat (West Yak), and East Yakutat/Southeast (Southeast) and species. National Marine Fisheries Service Alaska Regional Office Catch Accounting System (queried through AKFIN on October 1, 2021).

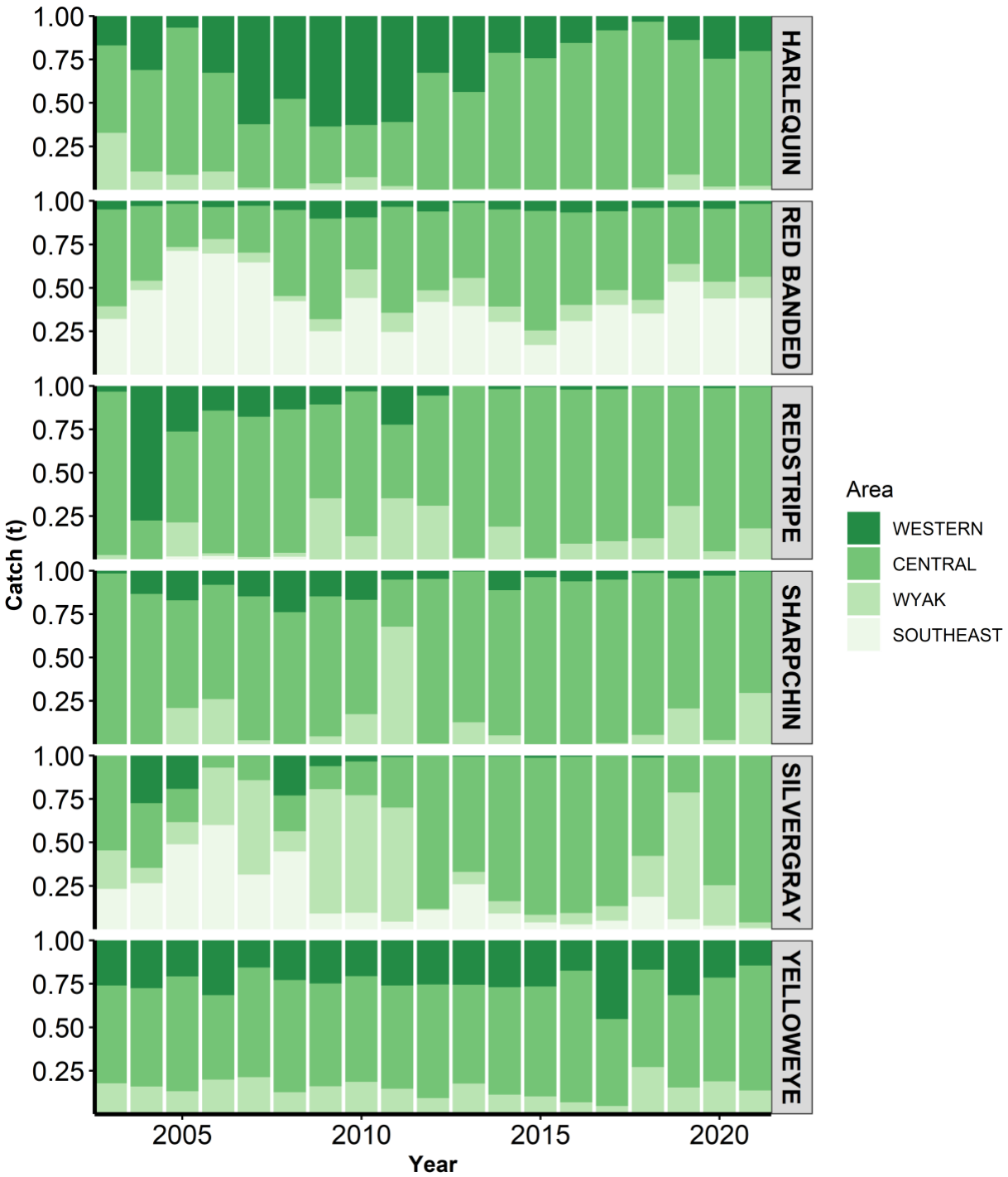


Figure 16.7. Proportion of catch by regulatory area (Western Gulf of Alaska (GOA), Central GOA, West Yakutat and East Yakutat/Southeast) for the six primary species of Other Rockfish. Note that the yelloweye rockfish panel does not include catch in the East Yakutat/Southeast regulatory area because that catch is included in the Demersal Shelf Rockfish complex. NMFS AKRO Catch Accounting System (queried through AKFIN on October 1, 2021).

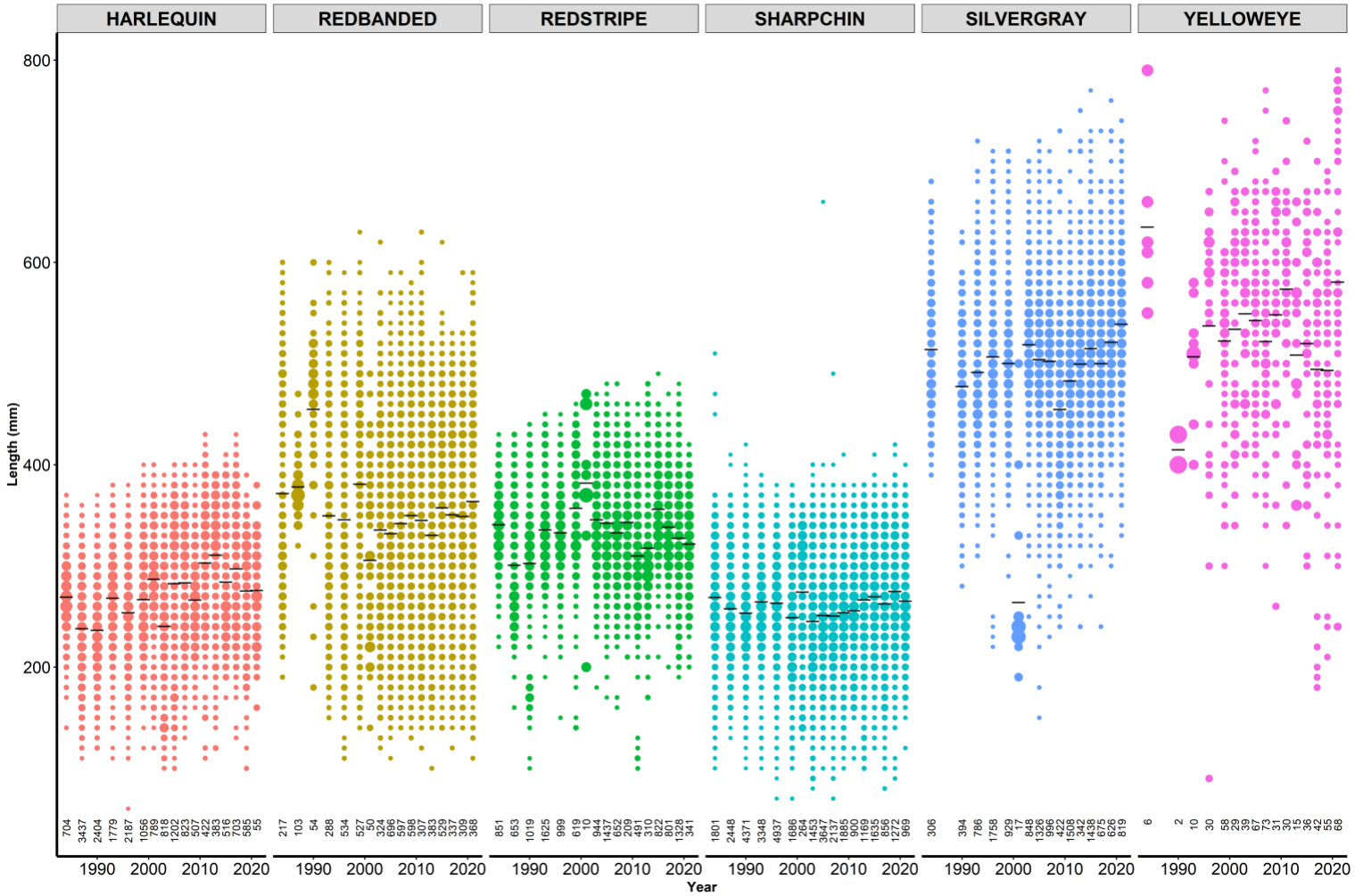


Figure 16.8. Size composition of the primary Other Rockfish (OR) species from the National Marine Fisheries Service (NMFS) bottom trawl survey. Numbers across the bottom are the sample size and the black horizontal line represents the mean size in a given year. Note that he survey did not sample the Eastern GOA in 2001, contributing to the low sample size.

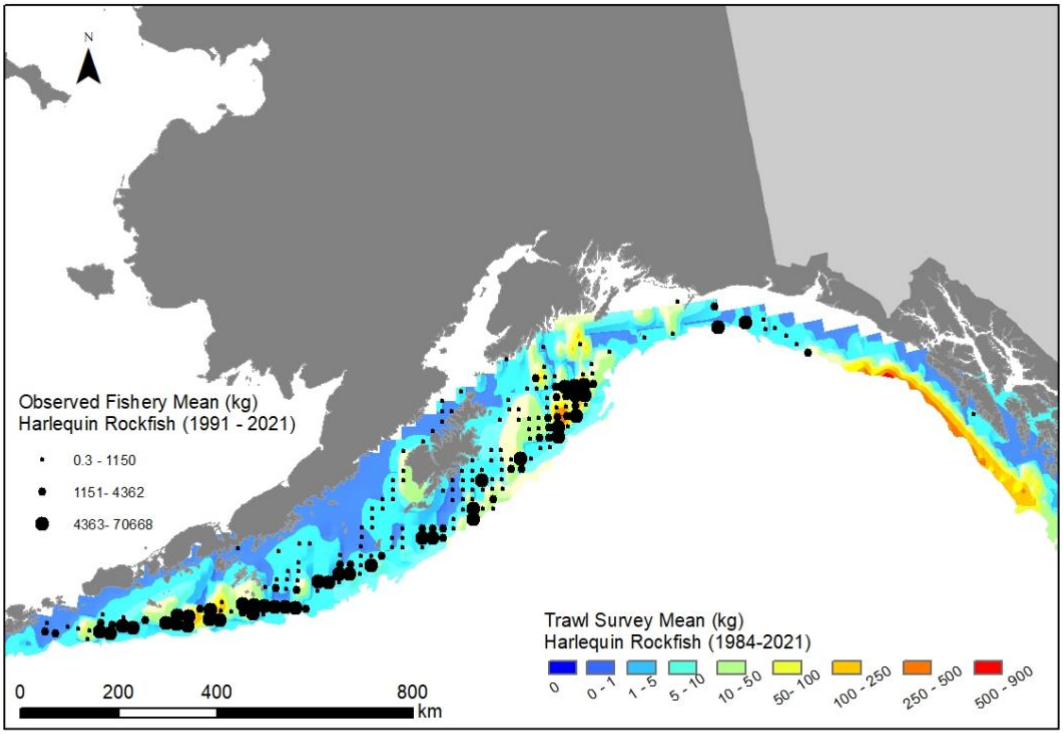


Figure 16.9. Distribution map of harlequin rockfish trawl survey mean kg per haul from 1984 – 2019 and observed fishery catch mean kg per haul (1993 – 2018). Data is through 2018 to match available non-confidential data from the fishery.

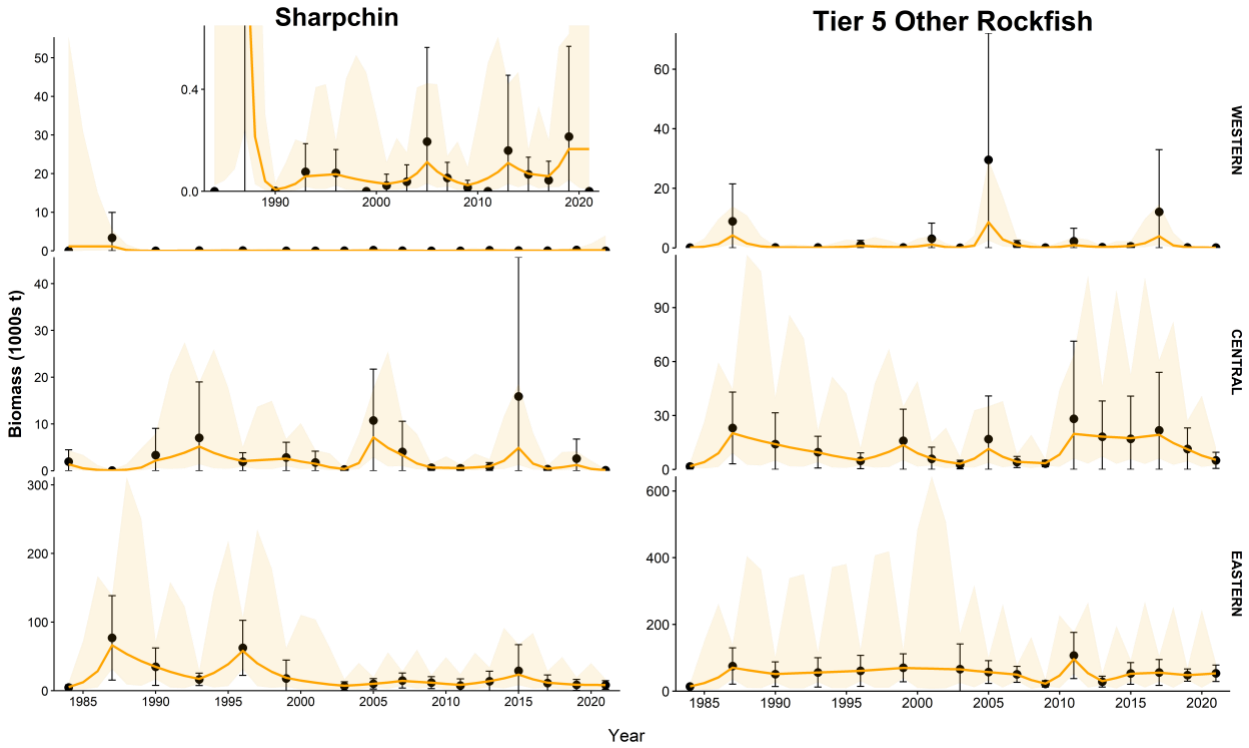


Figure 16.10. Estimated random effects biomass (orange line with orange shaded confidence intervals) and NMFS bottom trawl survey biomass estimates (black dots with confidence intervals) for sharpchin rockfish (left panel) and the 17 grouped Other Rockfish (OR) species (right panel) by NMFS regulatory areas: Western Gulf of Alaska (WGOA), Central GOA (CGOA) and Eastern GOA (EGOA). The regional model accounts for the missing survey in the EGOA in 2001. The inset in the WGOA sharpchin panel shows the same data as the panel, but zoomed in to show detail.

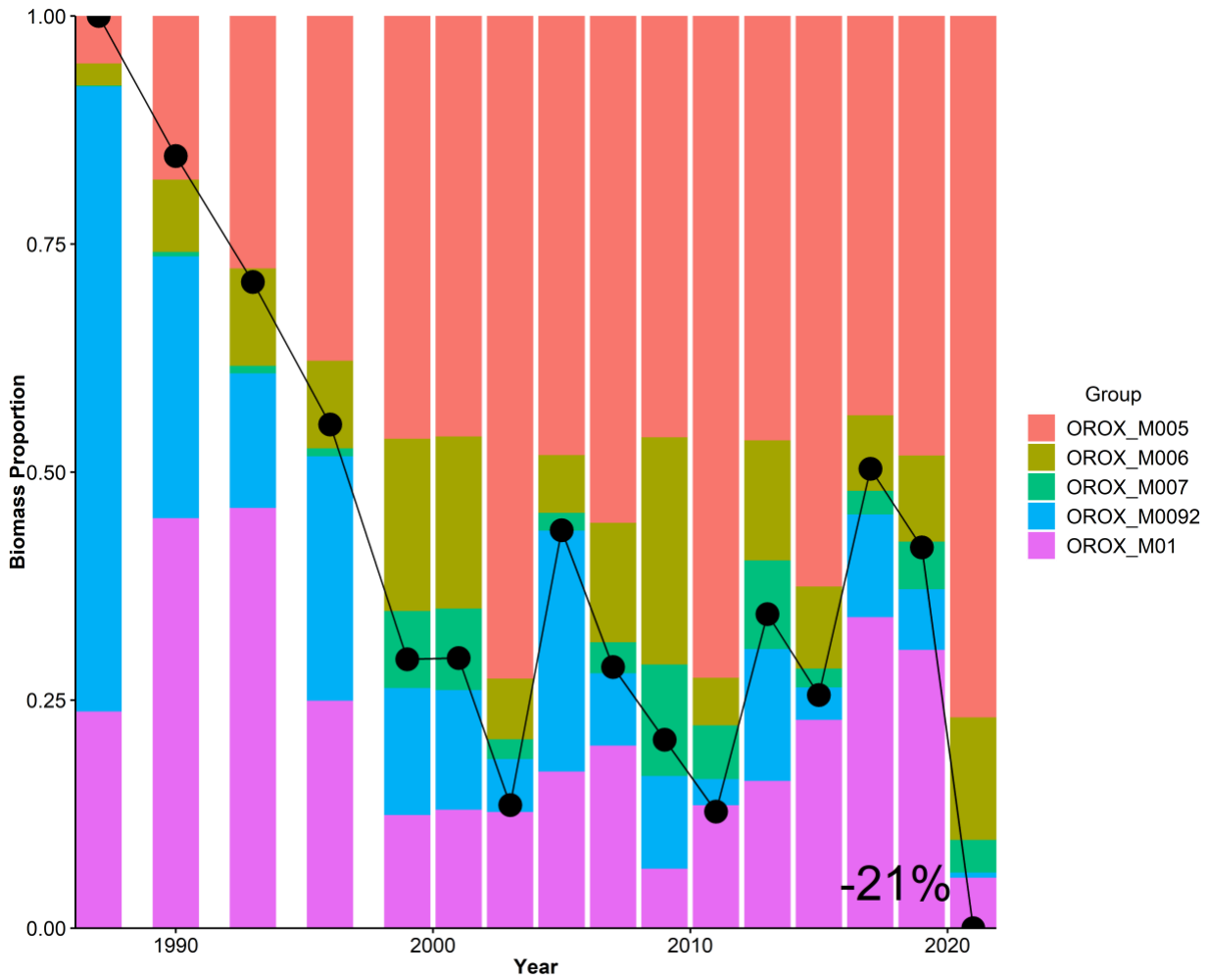


Figure 16.11. Composition of the Tier 5 biomass by natural mortality grouping (M group) and relative weighted natural mortality (Wted M) through time. The proportion of change from the previous year is noted in the bottom right corner.

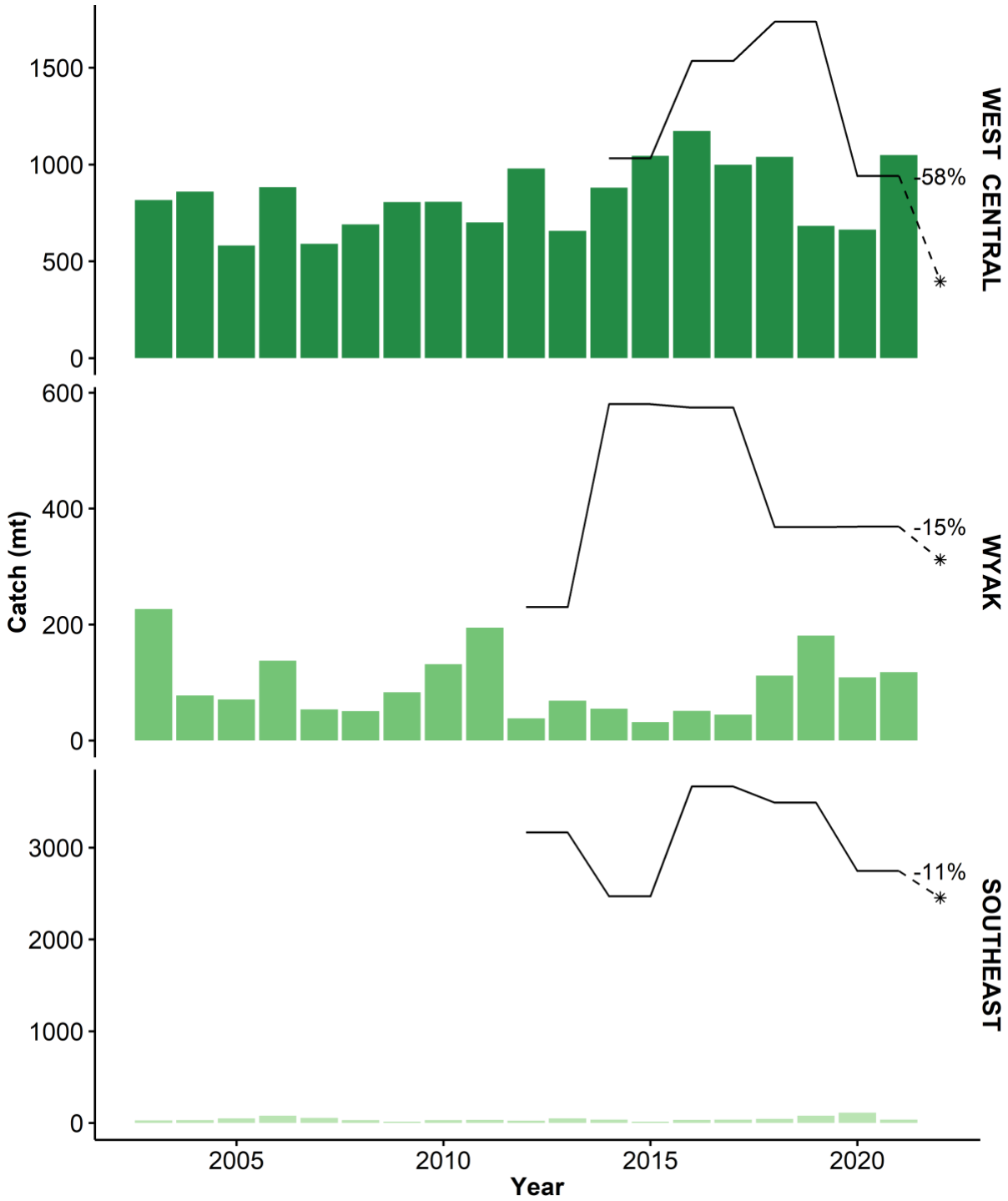


Figure 16.12. Historical Other Rockfish (OR) apportioned ABC (black lines) compared to the historical OR catch (green bars). The ABC for the OR begins in 2012 when this version of the complex was formed. The 2022 recommended apportioned ABCs are shown as black stars and the proportion change from the previous assessment is noted in each panel.