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 – 2019 has been updated (as of October 1, 2019).
2. NMFS GOA bottom trawl survey data have been updated to include 2019 survey data.
3. The random effects models for the GOA OR Tiers 4 and 5 species were updated to include the 2019 GOA bottom trawl survey data.
4. Aurora and shortbelly rockfish are now included in the document. While not previously reported in the document, these two species have historically been counted within the OR complex for catch estimates.
5. The Alaska Regional Office Catch Accounting System (CAS) has created species specific catch estimates back to 2010. Catch estimates reported in this document have been updated.
6. Catch estimates in federal fisheries occurring within NMFS areas 649 (Prince William Sound) and 659 (Southeast Alaska inside waters) are reported in Table 0.10.

Changes in assessment methodology

GOA OR ABC/OFL calculations are based on Tier 4 (Model 15.1), 5 (Model 15.1), and 6 (Model 17.1) methods (depending on species). There are no changes to the methods used in this assessment. However, the two new species that were not previously included in the assessment (aurora and shortbelly rockfish) are now included in the Tier 6 calculations.

Summary of Results

The recommended ABC for the 2020 fishery is 4,053 t and OFL is 5,320 t for the OR complex. This is a 28 % decrease from 2019. 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 2018 was 1,205 t and catch in 2019 was 835 t as of October 1, 2019, lower than the ABC of 5,594 t for both years (the total OR ABC was 5,590 t + 4 t from the norther rockfish assessment). The authors, Plan Team, and SSC recommended that the ABCs for the Western GOA and Central GOA be combined for the 2014 fishery. We recommend continuing with this method, 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 as per the following risk table. The expanded risk table description is included in the harvest recommendations section.

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

Tier 4 recommendation of ABC and OFL for sharpchin rockfish for 2020–2021.

	As estimated or specified last year for:		As estimated or recommended this year for:	
Quantity	2019	2020	2020	2021
M (natural mortality rate)	0.06	0.06	0.06	0.06
Tier	4	4	4	4
Biomass (t)	12,583	12,583	10,826	10,826
$F_{OFL} = F_{35\%}$	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)	994	994	855	855
maxABC (t)	818	818	704	704
ABC (t)	818	818	704	704
	As determined *last* year for:		As determined *this* year for:	
Status	2017	2018	2018	2019
Overfishing		n/a		n/a

Tier 5 recommendation of ABC and OFL for 17 OR species for 2020-2021.

	As estimated or specified last year for:		As estimated or recommended this year for:	
Quantity	2019	2020	2020	2021
M (natural mortality rate)	0.073	0.073	0.073	0.073
Tier	5	5	5	5
Biomass (t)	83,524	83,524	59,861	59,861
F_{OFL}	0.073	0.073	0.070	0.070
$maxF_{ABC}$	0.055	0.055	0.053	0.053
F_{ABC}	0.055	0.055	0.053	0.053
OFL (t)	6,097	6,097	4,190	4,190
maxABC (t)	4,573	4,573	3,143	3,143
ABC (t)	4,573	4,573	3,143	3,143
	As determined *last* year for:		As determined *this* year for:	
Status	2017	2018	2018	2019
Overfishing		n/a		n/a

Tier 6 recommendation of ABC and OFL for nine OR species for 2020-2021.

Quantity	As estimated or specified last year for: 2019	2020	As estimated or recommended this year for: 2020	2021
Tier	6	6	6	6
OFL (t)	265	265	275[1]	275[1]
maxABC (t)	199	199	206	206
ABC (t)	199	199	206	206
Status	As determined *last* year for: 2017	2018	As determined *this* year for: 2018	2019
Overfishing		n/a		n/a

[1]Chages in the ABC and OFL values are due to changes in the catch by species estimates created by CAS, and not due to methodological changes in this assessment.

ABC and OFL recommendations for the full OR complex for 2020-2021.

All OR Combined	As estimated or specified last year for: 2019	2020	As estimated or recommended this year for: 2020	2021
Tier	4/5/6	4/5/6	4/5/6	4/5/6
OFL (t)	7,356	7,356	**5,320**	**5,320**
maxABC (t)	5,590	5,590	4,053	4,053
ABC (t)	5,590	5,590	**4,053**	**4,053**
Status	As determined *last* year for: 2017	2018	As determined *this* year for: 2018	2019
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 include the 4 t added for northern rockfish. Source: NMFS Alaska Regional Office Catch Accounting System accessed through the Alaska Fisheries Information Network (AKFIN) database, http://www.akfin.org as of October 1, 2019.

Year	Western GOA	Central GOA	Eastern GOA		Gulfwide Total	Gulfwide ABC	Gulfwide TAC
			West Yakutat	E. Yak/ Southeast			
2018	48	984	132	41	1,205	5,594	2,305
2019	104	517	172	42	835	5,594	2,305

Area Apportionment

Area apportionment was estimated using a random effects model. Beginning in the 2014 fishery, the ABCs for the Western and Central GOA were combined, which is continued here for the 2020 fishery, such that the combined Western and Central GOA ABC = 940 t (WGOA (67 t) + CGOA (873 t), for all three tiers combined). The tables below show the apportionment for the Tier 4 (sharpchin rockfish), Tier 5 species, and Tier 6 species separately.

Tier 4 - Sharpchin	Western/Central GOA	Eastern GOA (80.97%)		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	19.03%	8.81%	72.16%	100%
Area ABC (t)	134	62	508	704
OFL (t)				855

Tier 5 – 17 species	Western/Central GOA	Eastern GOA (79.82%)		Total
		West Yakutat	E Yakutat/ Southeast	
Area Apportionment	20.18%	8.69%	71.14%	100%
Area ABC (t)	634	273	2,236	3,143
OFL (t)				4,190

Tier 6 – 7 species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	172	34	0	206
OFL (t)				275

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	940	369	2,744	4,053
OFL (t)				5,320

Summaries for Plan Team

Species	Year	Biomass[1]	OFL	ABC	TAC	Catch[2]
Other Rockfish	2018	96,107	7,356	5,594[3]	2,305	1,205
	2019	96,107	7,356	5,594[3]	2,305	835
	2020	70,687	5,320	4,053		
	2021	70,687	5,320	4,053		

Stock/ Assemblage	Area	2019				2020		2021	
		OFL	ABC	TAC	Catch[2]	OFL	ABC	OFL	ABC
Other Rockfish	WGOA/ CGOA		1,737	1,737	621		940		940
	EGOA								
	WY		368	368	172		369		369
	EY/SE		3,489[3]	200	42		2,744[4]		2,744[4]
	Total	7,356	5,594[3]	2,305	835	5,320	4,053[4]	5,320	4,053[4]

[1]Total biomass estimates from the random effects model for the Tier 4/5 species only.
[2]Current as of October 1, 2019. Source: NMFS Alaska Regional Office Catch Accounting System via the Alaska Fisheries Information Network (AKFIN) database (http://www.akfin.org).
[3]These ABCs do include the 4 t that was 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 2020 does not include the ABC for northern rockfish, because the value has not been set for 2020.

Responses to SSC and Plan Team Comments on Assessments in General

"Secondly, a few assessments incorporate multiple indices that could also be used for apportionment. The Team recommends an evaluation on how best to tailor the RE model to accommodate multiple indices." (Plan Team, November 2015)

The approach was developed to integrate the AFSC longline survey into the random effects model and has only been reviewed within the GOA thornyhead (2015) and shortraker (2019) assessments to date. Methods have not been developed for using the IPHC longline survey data, which is more informative for the OR species than the AFSC longline survey. The authors plan to work with the authors of the thornyhead and shortraker assessments to investigate methods to use this method with the IPHC survey data.

"The SSC requests that all authors fill out the risk table in 2019…" (SSC December 2018)

"…risk tables only need to be produced for groundfish assessments that are in 'full' year in the cycle." (SSC, June 2019)

"The SSC recommends the authors complete the risk table and note important concerns or issues associated with completing the table." (SSC, October 2019)

In response to these three comments, we provide a risk table as recommended by the SSC. After completing this exercise, there is no recommendation that the ABC be reduced below maximum permissible ABC.

"Stock assessment authors are encouraged to work with ESR analysts to identify a small subset of indicators prior to analysis, and preferably based on mechanistic hypotheses." (SSC October 2018)

The Gulf of Alaska has experienced a marine heatwave since September 2018, and the 2019 RPA spring larval survey indicated below average abundance of rockfish. How these warm temperatures affect the species in the OR stock complex in their various life history stages is unknown. Authors will continue to examine this.

SSC and Plan Team Comments Specific to this Assessment

"The Team again supports the conclusions of the author and reiterates our earlier recommendation that the demersal sub-group be moved into the DSR assessment and make the DSR assessment GOA-wide pending Council evaluation of management and economic implications."

"The Team concluded that the demersal sub-group of the OR assessment should be categorized as "moderate concern" in the Council's Stock Structure and Spatial Management Policy scale of concern." The Team recommends that this issue move to Step 2 of the Council's Stock Structure and Spatial Management Policy." (PT, November 2017)

"The SSC agrees with this assessment of stock structure and urges the Council to consider step 2 of the Stock Structure and Spatial Management Policy." (SSC December 2017)

See Appendix 16A at the end of this document for further discussion

Introduction

The Other Rockfish stock complex (termed OR in this document) is a group of up to 25 rockfish species (*Sebastes spp.*), depending on the Gulf of Alaska (GOA) management area (Table 0.1, Figure 0.1). This assessment presents catch and survey information for these species and provides recommended management reference points. 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 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 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 included 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 (AKRO) include both the species in the slope and demersal sub-groups in all areas east 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, see the discussion in the Evidence of Stock Structure section and Appendix 16A.

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 OFL and 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.

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 0.2). 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 0.2 and Figure 0.3) and British Columbia (Mecklenberg et al. 2002 and 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). 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 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 is available to address stock structure concerns across management regions for any of the 27 species in question. However, there are concerns over which species we are currently grouping into the OR complex and which are also in the DSR complex. As described above, the 27 species within DSR and OR complexes can be categorized into two groups: a demersal sub-group consisting of seven species, which are managed as the DSR complex in the EY/SE area only and in the OR complex in all other GOA management areas, and a slope sub-group consisting of 20 species, which are in the OR complex in all GOA management areas. Biologically, there are substantial 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). 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 and are often retained, whereas the slope sub-goup are generally caught as bycatch in the rockfish trawl fishery and generally have lower retention 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 of these species within the GOA and should be considered a single population 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. See Appendix 16A for further information.

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, 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 Tribuzio and Echave 2015, Appendix 16B.

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) 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. in prep, 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 in prep). 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 (118 years) and age at maturity data (22 years, O'Connell and Funk 1987); 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* were computed using life history invariant methods, such as Hoenig (1983) and Alverson and Carney (1983). 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.

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 0.2. The North Pacific Fishery Management Council (NPFMC) established a separate management category for Other Slope Rockfish in the Gulf of Alaska (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 0.3 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 has been set well below the ABC since 2001, 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).

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 0.1 and Figure 0.1). Beginning in the 2014 fishery, the ABC and TAC for the Western and Central GOA were combined. The ABC for the OR (formerly Other Slope Rockfish) 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.

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 0.4). Discard rates have been on average 56% over the entire time series. However, since 2016 discard rates have ranged 22-43%. This increase in retention consists primarily of harlequin, sharpchin and silvergrey rockfish in the rockfish target fishery in the Central GOA, totaling 479 – 595 t, with some also occurring in the Western GOA to a lesser extent.

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 – 2019
NMFS Bottom Trawl Surveys –GOA (biennial)	Biomass Index, Age/length – compositions	1984 – 2019

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 0.5 presents the time series of estimated catch of the current OR complex by species and Table 0.6 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. With the exception of 1993, Gulfwide catches of OR have always been <1,800 t. 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. Estimated catch in the Western and Central GOA has not exceeded the ABC since it was combined in 2014.

OR are predominately caught in trawl fisheries (Table 0.7), with much of the bycatch occurring in the rockfish trawl fishery in the Central GOA (Figure 0.4). 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 longlines. Harlequin rockfish is generally the most common species caught, with the exception of EY/SE, where redbanded rockfish is most common (Figure 0.5).

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 0.4). However, there is some variability amongst the species of OR (Figure 0.5). 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 0.5).

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 – 2019, Table 0.8). 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 surveys cover all areas of the GOA out to a depth of 1,000 m, with the following exceptions (see below table): 1990, 1993, 1996, 2001, and 2017 surveys did not sample deeper than 500 m and the 2003, 2011, and 2013 surveys did not sample deeper than 700 m. Species within the OR complex are found in depths < 500 m. Therefore, it is unlikely that this would impact the estimation of OR biomass. Other important caveats are that the 2001 survey did not sample the Eastern GOA and so there were no estimates of biomass and the 2013, 2017 and 2019 surveys had a reduced number of stations. It is important to note the potential for measurement error and that the reduction in stations is expected to increase CVs.

		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	

Most of the OR biomass is in the Eastern GOA (Table 0.8 and Figure 0.3). Harlequin rockfish is the one exception, as it has had sporadic, high biomass estimates in all areas, but only in the Western and Central GOA in recent years (Table 0.8). 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. 2015 and Echave et al. 2015).

The total biomass from the 2019 trawl survey for all the OR species was 72,597 t (Table 0.8). This is a 29% decrease from the 2017 survey and 21% below the historical survey average. The 2019 survey biomass of yelloweye rockfish increased by 12% from the previous survey. Harlequin (65%), redbanded (17%), redstripe (42%), sharpchin (2%) and silvergray (21%) 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. In the example of harlequin rockfish, the increase in the 2017 biomass 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.

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.

Other Sources of Removals

In general, research catch is small relative to biomass (research catches are in Table 0.9 and biomass in Table 0.8). 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 have not previously been reported in this assessment nor do they count against the OR ABC/TAC. Catch occurring in these areas should be monitored and are now included in this SAFE report, Table 0.10. 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.

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. Age composition data is limited to harlequin, redstripe, sharpchin, and silvergray rockfish. The ages are all based on the break-and-burn technique of ageing otoliths (Chilton and Beamish, 1982). No age validation has been done for any of these species, so the results should be considered preliminary.

Survey ages are available from between one and four survey years for each of the species aged (Figure 0.6). A large sampling effort was conducted during the 1996 survey, resulting in the greatest number of age samples. Other survey years generally had low sample sizes, with the exception of silvergray rockfish, which had meaningful sample sizes from 1993 – 1999 and harlequin rockfish, which was sampled in 2005. It is difficult to detect the presence of strong cohorts based on the age structure of available data. However, based on the 1996 survey samples, the 1981 – 1983 year classes appeared predominant in the age structures of redstripe, sharpchin, and silvergray rockfish, and the 1986 year class was predominant for harlequin rockfish.

Survey size compositions for the primary OR species are shown in Figure 0.7. 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, when 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.

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 0.8). 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 7% of survey hauls, on average, in the Central GOA and 4% 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 where certain species are distributed 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.

Analytic Approach

Model numbers were not previously used in this assessment. For the 2019 assessment we are implementing the model numbering format consistent with other assessments. Model numbers are based on the year that that method was first used. For the Tier 4 and Tier 5 species, the most recent model was from the 2015 assessment, when the random effects model was first used. All of the Tier 5 species are considered one model because biomass is estimated as a group for all of the Tier 5 species, as well as by M group. The Tier 6 species had some changes to the time series and the most recent method began in 2017. Thus, the OR assessment consists of 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, in which the overfishing limit (OFL) = biomass * F_{OFL}. F_{OFL} is either a proxy rate, assuming F_{OFL} = natural mortality (M) (Tier 5 Model 15.1), or it is estimated as F_{OFL} = $F_{40\%}$ based on age at maturity information (Tier 4 Model 15.1). 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 1984-2019 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 provided a Gulfwide biomass estimate, as well as biomass by area. The OFL was calculated as the product of the

Gulfwide biomass and F_{OFL}, which for this species is $F_{35\%}$ = 0.079, and the Gulfwide ABC = Gulfwide biomass * $F_{40\%}$ = 0.065.

The Tier 5 Model 15.1 was fit separately to biomass estimates by area for all Tier 5 species (17 total) combined, and 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 5 sub-groups for M = 0.05, 0.06, 0.07, 0.092, and 0.1). Using the sub-group proportion of Gulfwide biomass, p_i (where the subscript i denotes the sub-group with a shared M), we then calculated $F_{OFL} = \Sigma p_i * F_i$, 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. Beginning in the 2017 assessment, the maximum catch over the years 2003 – 2016 was used for the Tier 6 calculations. 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. While the period prior to 2013 likely does not account for all sources of removals, it is still likely an underestimate of true catch. These species are not targeted, occur sporadically and are generally discarded. The maximum catch of each of the Tier 6 species over the time series is summed for the Tier 6 OFL, and ABC is 75% of the OFL (Model 17.1).

Parameter Estimates

Estimates of mortality, maximum age, and female age- and size-at-50% maturity are shown in Table 0.10. The mortality rates 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 0.12 and Figure 0.9 for sharpchin rockfish and Table 0.13 and Figure 0.9 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 Other Rockfish (OR) complex in the Gulf of Alaska, using the random effects estimated exploitable biomass are in the following table.

Model	Group	Tier	2019 RE Biomass	F_{OFL}	OFL	F_{ABC}	ABC
Model 15.1	Sharpchin	4	10,826	$F_{35\%}$ = 0.079	855	$F_{40\%}$ = 0.065	704
Model 15.1	M=0.05 Group	5	28,850				
	M=0.06 Group	5	5,653				
	M=0.07 Group	5	3,123				
	M=0.092 Group	5	3,982				
	M=0.1 Group	5	18,255				
	Tier 5 Biomass	5	59,861[1]	F = Wted M = 0.070	4,190	F_{ABC} = 0.75*F_{OFL}	3,143
Total Tier 4/5 Gulf Wide					5,045		3,847

[1]The total tier 5 biomass is not the sum of the M groups, but the weighted biomass based on the random effects model output.

Summary of the maximum catch (t) of each of the Tier 6 species by region are in the following table. The ABC is combined for the Western and Central GOA to match that of the rest of the OR complex. Each of these species is in the DSR sub-group and thus there are no catch estimates in the East Yakutat/Southeast area. Changes in value from the previous assessment are due to CAS updates and the AKRO now providing species specific catch estimates.

	Maximum Catch (t)			
Tier 6 Model 17.1	Western GOA	Central GOA	West Yakutat	E Yak/ Southeast
aurora rockfish	0	0.67	0.15	0
canary rockfish	0.57	1.15	0.14	NA
China rockfish	0.03	1.08	0.23	NA
copper rockfish	<0.01	0.19	0.02	NA
quillback rockfish	0.73	24.65	1.32	NA
rosethorn rockfish	0.26	0.69	1.73	NA
Shortbelly rockfish	<0.01	0	0	0
tiger rockfish	0.70	4.15	1.00	NA
yelloweye rockfish	59.16	135.63	40.55	NA
Total Tier 6 ABC	172		34	
Total Tier 6 OFL	275			

Harvest Recommendations

The methods for ABC and OFL estimation for the within 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	2019 Random Effects Biomass	F_{OFL}	OFL	F_{ABC}	ABC
4-Model 15.1	10,825	$F_{35\%} = 0.079$	855	$F_{40\%} = 0.065$	704
5-Model 15.1	59,861	F_{OFL} = Wted M = 0.070	4,190	$F_{ABC} = 0.75*F_{OFL}$	3,143
6-Model 17.1			275		206
All Tiers Combined			5,320		4,053

Risk Matrix

For the 2019 assessment we completed the Risk Matrix, as shown in the following section. The overall score was a Level 1: Normal, and we do not recommend any changes from the maxABC.

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

in assessment.	range.	concerns

Assessment Considerations

The OR complex is a bycatch only stock complex, with catches occurring across many fisheries and gears. The complex consists of 27 species with diverse life histories and that range across diverse habitats. There are six primary species in both catch and biomass: harlequin, redbanded, redstripe, sharpchin, silvergray and yelloweye rockfish. In general, very little is known regarding the life history of the species within the OR stock complex and ages are generally not available for the assessment. Recent research on harlequin rockfish may enable the species to move from Tier 5 to Tier 4, but none of the species have data to support a Tier 3 assessment. **Within the Other Rockfish complex, harlequin rockfish has one of the lowest biomass values but is one of the primary bycatch species. In general, this complex is highly associated with untrawlable habitat, is poorly sampled by the survey, and it is unclear if the exploitation rates by area should be a concern. These concerns are typical, and do not at this time warrant increased level of concern, thus assessment considerations are classified as Level 1.**

Population Dynamics Considerations

We are unable to estimate recruitment for any of the species. The historical biomass trends are characterized by large inter-survey swings. The large changes seen in biomass estimates are not likely for long-lived fish that comprise the OR complex, so detecting significant trends in population status may be challenging. Therefore, the population dynamics are considered typical for this assessment and thus classified as Level 1.

Environmental/Ecosystem Considerations

The OR complex consists of two main groups 1) slope sub-group throughout the GOA and 2) demersal sub-group in the East Yakutat/Southeast management region. Limited information on temperature, zooplankton, and condition of other marine species indicate less favorable foraging and growing conditions for the zooplanktivorous species or life history stages during 2019. Sea temperatures were at a record high for the entire GOA during the 2019 summer (Thoman and Walsh 2019). In waters above the continental shelf around Kodiak Island, temperatures were warmer through the water column during spring (6.8°C surface, 6.1°C bottom) and summer (13.3°C surface, 7.3°C bottom to 200m) (Rogers et al. 2019a) and across the shelf during May (Danielson and Hopcroft 2019). The AFSC bottom trawl survey temperature profiles were similar to 2015 profiles with warmer anomalies (7.0°C) consistently observed across the entire survey area and penetrating to 200 m depths (Laman 2019a). Nearshore mean summer surface temperatures was second highest on record in northern southeast Alaska, 1997-2019 (Fergusson 2019). Summer and fall temperatures during 2019 indicate heat wave conditions similar to 2015-2016 in the GOA (Barbeaux 2019). It is reasonable to expect that the current heat wave may impact age-0 rockfish in pelagic waters during a time when they are growing to a size that promotes over winter survival, however it is unknown what this impact will be.

The primary prey of the adults in either the slope or demersal sub-groups feed on both benthic and pelagic prey, including: zooplankton, shrimp, copepods, small crabs and fish in the GOA (Byerly 2001, Love et al. 2002, Yang et al. 2006). Warm conditions tend to be associated with zooplankton communities that are dominated by smaller and less lipid rich species in the GOA (Kimmel et al. 2019). The biomass of copepods and euphausiids were slightly below the long-term mean around Kodiak Island, with Barnabus trough as a hotspot (Kimmel et al. 2019, Ressler 2019). In Icy Strait, northern southeast Alaska, the lipid content of all zooplankton taxa examined decreased, from 2018 to 2019 and were below average, except for euphausiids, indicating a decrease in the nutritional quality of the prey field utilized by larval and juvenile fish (Fergusson and Rogers 2019). However, bottom trawl CPUE of shrimp increased in the Kodiak, Chirikof, and Yakutat areas over the last few surveys, while they have remained fairly constant

and low relative abundance in the eastern GOA (Palsson 2019). Body condition and reproductive success of other zooplanktivores were below average during the summer of 2019 and in marine heat wave years. For example, YOY pollock in the western GOA had lower than average body condition during the 2005 and 2015-16 marine heat wave years (Rogers et al. 2019). The body condition of 8 of adult groundfish species captured near the sea floor in the AFSC bottom trawl surveys were below average except for adult Pacific cod (Laman 2019b). Little is known about the impacts of predators, such as fish and marine mammals, on the Other Rockfish species. The 2019 foraging conditions were below average for the zooplanktivorous OR species in the GOA. However, given that the indicators were warm and larval fish abundance and condition below average, but euphausiid abundance spotty and at or slightly above average in the GOA and with limited information on rockfish, we scored this category as level 1, as normal concern. No apparent environmental/ecosystem concern.

Fishery Performance

There is no directed fishing of the species within the OR, and they can only be retained as "incidentally-caught." Catch of the OR species is primarily in the Central and Western GOA, which is different from the distribution of the biomass, with most species being most abundant in the Eastern GOA. While catch of OR species varies greatly by species, area, gear type, and year, the majority of catch comes from the rockfish fishery in the Central and Western GOA, and is primarily harlequin rockfish. The OR species are generally discarded, however, beginning in 2016 harlequin rockfish (and to a lesser extent sharpchin and silvergray rockfish) have been retained at a higher rate than previous years in the Central and Western GOA rockfish fisheries. The increased retention does not warrant increased concern at this time and we classify Fishery Performance as Level 1. As a whole, catch is on average ~50% of TAC, but in the combined Western/Central GOA it has ranged between 63 – 99% of the apportioned TAC.

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 0.1). Separate ABCs and TACs were assigned to each of these smaller areas for the OR complex. A proportional fraction of the biomass in the WY vs. EY/SE areas is computed for each trawl survey (termed "split fraction"). The ABCs in West Yakutat and East Yakutat/Southeast are computed 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	19.03%	8.81%	72.16%	100%
Area ABC (t)	134	62	508	704
OFL (t)				855

Tier 5 – 17 species	Western/Central GOA	Eastern GOA (79.82%)		Total
		West Yakutat[1]	E Yakutat/ Southeast	
Area Apportionment	20.18%	8.69%	71.14%	100%
Area ABC (t)	634	273	2,236	3,143
OFL (t)				

Tier 6 – seven species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	172	34	0	206
OFL (t)				275

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	940	369	2,744	4,053
OFL (t)				5,320

Ecosystem Considerations

The ecosystem considerations for the GOA OR stock complex are summarized in Table 0.14.

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 is 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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Literature Cited

Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B.C. coastal waters, 1977-1979. Can. Tech. Rep. Fish. Aquat. Sci. 1048. 57 p.

Barbeaux S. 2019. Fall 2019 marine heatwave. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Byerly, M. 2001. The ecology of age-1 copper rockfish (*Sebastes caurinus*) in vegetated habitats of Sitka Sound, Alaska. MS. Thesis. University of Alaska Fairbanks. 127p.

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

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

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

Clausen, D., T. Pearson, and C. Lunsford. 2011. Management reorganization of species in the Gulf of Alaska pelagic shelf rockfish and "other slope rockfish" assemblages. Unpubl. discussion paper submitted to the NPFMC Gulf of Alaska Groundfish Plan Team, Sept. 2011. 12 p. Available from North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501.

Danielson, S., and R. Hopcroft. 2019. Seward line May temperatures. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

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

Drinkwater, K. 2004. Review of the Draft of Appendix B: Evaluation of fishing activities that may adversely affect essential fish habitat. 23 p. Available from National Marine Fisheries Service, Alaska Region.

Fergusson, E. 2019. Long-term Zooplankton and Temperature Trends in Icy Strait, Southeast Alaska. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Fergusson, E., and M. Rogers. 2019. Zooplankton nutritional quality trends in Icy Strait, Southeast Alaska. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

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

Gharrett, A.J., A.K. Gray, and J. Heifetz. 2001. Identification of rockfish (*Sebastes* spp.) by restriction site analysis of the mitochondrial ND-3/ND-4 and 12S/16S gene regions. Fish. Bull. 99:49-62.

Heifetz, J., J. N. Ianelli, and D. M. Clausen. 1998. Assessment of Slope rockfish. In Stock assessments and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 281-321. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501.

Helser, T. E. 2005. Status of the blackgill rockfish resource in 2005. In Appendix to Status of the Pacific Coast groundfish fishery through 2005 and recommended acceptable biological catches for 2006 stock assessment and fishery evaluation. Portland, Ore.: Pacific Fishery Management Council.

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82: 898-903.

Jones, D.T., C.D. Wilson, A. De Roberts, C.N. Rooper, T.C. Weber and J.L. Butler. 2012. Evaluation of rockfish abundance in untrawlable habitat: combining acoustic and complimentary sampling tools. Fishery Bulletin. 110:332-343.

Kerr, L.A., A.H. Andrews, K. Munk, G.M. Calliet, K.H. Coale, T.A. Brown, B.R. Frantz. 2003. Age validation of quillback rockfish (*Sebastes maliger*) using bomb radiocarbon. Fishery Bulletin. 103:97-107.

Kimmel, D., C. Harpold, J. Lamb, M. Paquin, L. Rogers. 2019. Rapid zooplankton assessment in the western Gulf of Alaska. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Laman, E.A., S. Kotwicki, and C.N. Rooper. 2015. Correlating environmental and biogenic factors with abundance and distribution of Pacific ocean perch (Sebastes alutus) in the Aleutian Islands, Alaska. Fishery Bulletin 113(3).

Laman, N. 2019a. Gulf of Alaska survey bottom trawl temperature analysis. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Laman, N. 2019b. Gulf of Alaska groundfish condition. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Leaman, B. M., and D. A. Nagtegaal. 1987. Age Validation and revised natural mortality rate for yellowtail rockfish. Trans. Amer. Fish. Soc. 116:171-175.

Love, M. S., P. Morris, M. McCrae, and R. Collins. 1990. Life history aspects of 19 rockfish species (*Scorpaenidae*: Sebastes) from the Southern California Bight. NOAA Tech Rep. NMFS 87. Seattle.

Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. Univ. Calif. Press, Berkeley. 405 p.

Malecha, P.W., D. H. Hanselman, and J. Heifetz. 2007. Growth and mortality of rockfish (Scorpaenidae) from Alaska waters. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/AFSC-172. 61 p.

Mecklenberg, C.W., T.A. Mecklenberg and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, MD. 1037pp.

Moles. A., J. Heifetz, and D.C. Love. 1998. Metazoan parasites as potential markers for selected Gulf of Alaska rockfishes. Fish. Bull 96: 912-916.

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

NMFS, National Marine Fisheries Service-Alaska Region. 2005. Final Environmental Impact Statement for Essential Fish Habitat identification and conservation in Alaska. 1124 p.

O'Connell, V. M. 1987. Reproductive seasons for some *Sebastes* species in southeastern Alaska. Alaska Dept. Fish Game, Informational Leaflet No. 263.

O'Connell, V. M., and F. C. Funk. 1987. Age and growth of yelloweye rockfish (*Sebastes ruberrius*) landed in southeastern Alaska. In *Proceedings of the International Rockfish Symposium*, 171-185. Alaska Sea Grant Rep. 87-2. Fairbanks.

Palsson, W. 2019. Miscellaneous Species - Gulf of Alaska Bottom Trawl Survey. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

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

Ressler, P. 2019. Gulf of Alaska euphausiids "krill". In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

Rogers, L., M. Wilson, and D. Cooper. 2019b. Body condition of age-0 pollock. In Zador, S., and Yasumiishi, E., 2019. Ecosystem Status Report 2019: Gulf of Alaska, Stock Assessment and Fishery Evaluation Report, North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage, AK 99501.

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

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

Shotwell, S. K., D. H. Hanselman, P-J. F. Hulson, and J. Heifetz. 2014. Assessment of the rougheye and blackspotted rockfish stock complex in the Gulf of Alaska. In Stock assessment and fishery evaluation report for the groundfish resources of the Gulf of Alaska, p. 655-750. North Pacific Fishery Management Council, 605 W 4th Ave, Suite 306, Anchorage AK 99501. Available online: http://www.afsc.noaa.gov/REFM/Docs/2014/GOArougheye.pdf

St. Savior et al. In prep. Characteristics of the recreational rockfish (Sebastes) harvest in Southcentral Alaska, 1996 – 2013. Alaska Department of Fish and Game, Fishery Data Series No. YY – XX, Anchorage.

Stanley, R. D., and A. R. Kronlund. 2000. Silvergray rockfish (*Sebastes brevispinis*) assessment for 2000 and recommended yield options for 2001/2002. Can. Stock Assess. Secretariat Res. Doc. 2000/173, 116 p.

Stanley, R. D., and A. R. Kronlund. 2005. Life history characteristics for silvergray rockfish (*Sebastes brevispinis*) in British Columbia waters and the implications for stock assessment and management. Fish. Bull. 103: 670-684.

TenBrink, T. and T. Helser. In prep.

Thoman, R. and J. E. Walsh. 2019. Alaska's changing environment: documenting Alaska's physical and biological changes through observations. H. R. McFarland, Ed. International Arctic Research Center, University of Alaska Fairbanks.

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

Tables

Table 0.1. 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 0.2. 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 0.3. 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, 2019.

	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	362	429	160	951	1,192	3,749	4,881	OSR
2011	299	388	210	896	1,192	3,749	4,881	OSR
2012	254	720	60	1,034	1,080	4,045	5,305	OR - includes widow and yellowtail
2013	194	450	107	751	1,080	4,045	5,305	OR
2014	163	713	88	964	1,811	4,081	5,374	OR[b]
2015	201	823	43	1,068	1,811	4,081	5,374	OR
2016	140	1,019	80	1,239	2,308	5,773	7,424	OR
2017	134	838	73	1,045	2,308	5,773	7,424	OR
2018	48	984	173	1,205	2,305	5,594	7,356	OR
2019	104	517	214	835	2,305	5,594	7,356	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 0.4. Estimated discard rates for the Other Rockfish stock complex. Data queried through AKFIN on October 1, 2019.

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	1,069.4	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	564.5	963.3	59%
2011	482.1	904.9	53%
2012	516.1	1,034.4	50%
2013	492.3	751.4	66%
2014	380.7	964.1	39%
2015	553.1	1,067.8	52%
2016	278.8	1,239.1	22%
2017	318.2	1,044.5	30%
2018	369.5	1,204.9	31%
2019	356.0	834.7	43%

Table 0.5. 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, 2019.

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	30.7	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	58.7	61.8	104.9	29.5	213.3	29.5	963.3
2011	353.8	61.5	67.2	113.5	63.3	228.2	17.4	904.9
2012	614.4	41.9	55.4	89.2	33.6	168.9	31.1	1,034.4
2013	307.4	83.2	24.9	46.2	18.1	213.9	57.5	751.4
2014	481.0	80.3	72.4	93.2	28.0	167.2	42.0	964.1
2015	579.5	60.3	49.6	106.4	43.6	178.4	50.0	1,067.8
2016	596.6	95.0	110.9	165.2	60.2	163.5	47.6	1,239.1
2017	465.9	76.6	76.0	123.2	50.0	195.5	57.5	1,044.5
2018	556.8	85.9	159.8	163.7	35.6	146.2	56.8	1,204.9
2019	348.5	48.9	128.7	68.4	64.1	115.8	60.4	834.7

Table 0.6. 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, 2019.

	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	362.1	439.8	131.3	30.1				
2011	299.1	394.7	192.5	18.6				
2012	254.3	720.4	37.1	22.7	44	606	230	3,165
2013	194.0	450.2	66.9	40.2	44	606	230	3,165
2014	163.4	713.0	59.3	28.4	1,031		580	2,469
2015	201.2	823.3	29.6	13.7	1,031		580	2,469
2016	139.8	1019.4	43.5	36.4	1,534		574	3,665
2017	133.5	838.4	42.3	30.3	1,534		574	3,665
2018	47.5	983.9	132.2	41.3	1,103		442	3,360
2019	104.3	517.2	171.8	41.4	1,103		442	3,360

Table 0.7. 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, 2019.

	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

Table 0.8. 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%
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	822.4	3,982.3	4,804.7	24%
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%
	2019	9.1	6,551.6	11,019.7	17,580.4	36%

Table 0.8. Continued

		Regulatory Area				
		Western GOA	Central GOA	Eastern GOA	Gulfwide Total	CV%
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	2598.1	8523.7	11336	41%
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%
Yelloweye	1984	21.9	97.1		119.0	10%
	1987	73.2	349.4		422.6	5%
	1990	0.0	308.9		308.9	12%
	1993	13.7	579.6		593.3	17%
	1996	43.5	479.4		522.9	18%
	1999	0.0	2,280.8		2,280.8	32%
	2001	41.5	1,508.3		1,549.8	50%
	2003	45.9	858.1		904.0	30%
	2005	904.9	986.5		1,891.4	25%
	2007	325.9	654.5		980.4	8%
	2009	0.0	777.0		777.0	16%
	2011	173.5	2,344.5		2,518.0	40%
	2013	154.8	592.3		747.1	50%
	2015	49.0	823.1		872.1	19%
	2017	442.4	912.8		1,355.2	28%
	2019	250.9	1,441.7		1816.2	33%

Table 0.8. Continued

		Regulatory Area				
		Western GOA	Central GOA	Eastern GOA	Gulfwide Total	CV%
Minor	1984	0.0	120.1	995.2	1,115.3	
	1987	71.4	337.4	669.6	1,078.4	
	1990	5.5	453.1	2,603.7	3,062.3	
	1993	3.1	1,160.8	4121	5,284.9	
	1996	0	72.8	2,618.7	2,691.5	
	1999	0	117.7	19,281.7	19,399.4	
	2001	80.9	197.4	0	278.3	
	2003	0	162.3	1,655.6	1,817.9	
	2005	6.7	52.4	2,010.1	2,069.2	
	2007	61.6	113.8	2,734.6	2,910.0	
	2009	10.6	361.6	4,115.3	4,487.5	
	2011	0	2,421.6	8,466.3	10,887.9	
	2013	0	31.8	4,451.4	4,483.2	
	2015	21.2	593.9	1,651.1	2,266.2	
	2017	1.8	33.3	4,643.6	4,678.7	
	2019	42.6	205.8	3,815.2	4,063.6	
Complex	1984	87	3,836	18,159.1	22,082.1	
	1987	12,323.6	23,551.3	152,236.4	188,111.3	
	1990	131.7	18,223.9	85,511.5	103,867.1	
	1993	196	18,406.2	72,511.4	91,113.6	
	1996	1,101.7	7,199.4	123,194.4	13,1495.5	
	1999	125.8	21,103.9	87,975.7	109,205.4	
	2001	3,196.1	9,398.4	0	12,594.5	
	2003	132.8	3,937.3	72,671.3	76,741.4	
	2005	30,629.5	28,636.2	67,347.4	126,613.1	
	2007	1,341.1	8,897.1	65,242.5	75,480.7	
	2009	104.7	4,796.0	33,427.9	38,328.6	
	2011	2,423.3	32,298.8	114,311.3	149,033.4	
	2013	521.7	19,628.9	42,462.2	62,612.8	
	2015	657.5	34,086.5	82,060.6	116,804.6	
	2017	12,543.3	23,001.8	67,186.4	102,731.5	
	2019	15,643.6	56,314.7	639.4	72,597.7	

Table 0.9. Research survey catch of Other Rockfish 1977 - 2018 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 (#s)	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	NA	7.3	4.7
2011		7.7	1,212	2.2	NA	4.8	3.9
2012			1,320	2.4	NA	5.1	4.9
2013		3.8	1,191	2.2	NA	4.7	50.8
2014			1,636	3.1	NA	6.9	55.7
2015		12.0	1412	2.7	NA	6.7	51.3
2016			1343	2.5	NA	5.5	58.3
2017		5.2	1,598	2.9	NA	4.2	60.8
2018			1,615	3.0	NA	5.9	56.4

Table 0.10. 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	20.0	16.1
2014	11.2	10.4
2015	22.5	11.1
2016	39.2	12.0
2017	9.6	16.1
2018	11.2	12.0
2019	9.2	11.6

Table 0.11. 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), Central Gulf of Alaska (CGOA), 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
aurora rockfish		> 75	5	26 (m), 31 (f)	O, CA	2
blackgill rockfish		87			CA	1
bocaccio rockfish	0.06	> 40		54	O, CA	2, 3
canary rockfish	0.05	84		51	BC	2, 3
chilipepper rockfish		35			CA	2
China rockfish		79			GOA, EGOA	2, 4
copper rockfish		61				2, 15
darkblotched rockfish	0.07[a]	48, 105		39	BC	2, 5
greenstriped rockfish	0.07	54		22		2
harlequin rockfish	0.092[b]	72, 47	4.5	19, 23	CGOA, EGOA	8, 16
pygmy rockfish	0.06	26				2
quillback rockfish	0.06	95	11	29	BC	2, 3, 10
redbanded rockfish	0.06	106	19	42	BC	2, 3, 4
redstripe rockfish	0.1[a]	41			BC	2, 3, 5, 6, 7, 15
rosethorn rockfish	0.06	87		21.5		2, 3
sharpchin rockfish	0.056-0.059[a]	58	10	26.5	GOA	8
Shortbelly rockfish		> 32	2	14		2
silvergray rockfish	0.05[b]	75		34-45	GOA	8
splitnose rockfish	0.06	86		27	BC	2
stripetail rockfish		38			CA	2
tiger rockfish		116			EGOA	2, 3, 5
vermilion rockfish		60			CA	2
widow rockfish	0.05[a]	59			BC	2, 7
yelloweye rockfish	0.02	118	22	45	EGOA	2, 13
yellowmouth rockfish	0.06[a]	71			BC	3, 5, 7
yellowtail rockfish	0.07	64			BC	2, 14

(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) St. Savior et al. in prep; (16) Tenbrink and Helser in prep.

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 0.12. 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	1,147.3	1,391.8	5,339.1	7,878.1	332.6	186,593.0
1985	1,147.3	520.9	12,364.7	14,032.9	2,323.5	84,753.3
1986	1,147.3	195.0	28,635.3	29,977.5	5,565.7	161,463.0
1987	1,147.3	73.0	66,316.4	67,536.6	32,711.4	139,437.0
1988	214.3	226.4	53,529.4	53,970.1	9,453.7	308,109.0
1989	40.0	702.4	43,207.9	43,950.4	7,806.1	247,453.0
1990	7.5	2,179.4	34,876.6	37,063.5	18,771.1	73,181.6
1991	14.9	2,910.4	27,611.7	30,537.0	6,045.6	154,244.0
1992	29.6	3,886.6	21,860.1	25,776.3	5,550.8	119,697.0
1993	58.9	5,190.3	17,306.6	22,555.7	13,193.9	38,560.4
1994	61.6	3,830.5	25,923.4	29,815.5	6,308.4	140,917.0
1995	64.5	2,826.9	38,830.5	41,721.9	8,133.7	214,014.0
1996	67.5	2,086.3	58,163.9	60,317.7	33,506.9	108,581.0
1997	57.1	2,247.0	40,072.4	42,376.5	7,785.1	230,668.0
1998	48.3	2,420.1	27,608.1	30,076.5	5,186.0	174,431.0
1999	40.8	2,606.6	19,020.8	21,668.2	7,416.4	63,306.7
2000	34.5	1,990.5	14,977.9	17,002.9	2,642.2	109,414.0
2001	29.2	1,520.0	11,794.2	13,343.5	1,684.9	105,674.0
2002	35.8	759.7	9,287.3	10,082.9	1,642.3	61,905.0
2003	44.0	379.7	7,313.3	7,736.9	3,482.8	17,187.1
2004	70.9	1,647.5	8,634.3	10,352.7	2,656.2	40,349.9
2005	114.5	7,148.1	10,193.9	17,456.4	10,019.8	30,412.5
2006	77.5	4,899.7	12,135.0	17,112.3	4,951.1	59,144.4
2007	52.5	3,358.6	14,445.8	17,856.9	9,865.7	32,320.9
2008	35.6	1,558.2	13,027.8	14,621.6	3,622.2	59,023.2
2009	24.1	723.0	11,748.9	12,496.0	6,624.2	23,572.8
2010	35.4	648.7	10,056.0	10,740.1	2,390.4	48,254.4
2011	51.8	582.1	8,607.0	9,240.9	3,469.3	24,614.6
2012	76.0	743.8	10,978.8	11,798.6	2,559.1	54,397.2
2013	111.4	950.4	14,004.3	15,066.1	6,528.2	34,770.4
2014	87.8	2,158.1	18,171.7	20,417.7	4,634.1	89,959.1
2015	69.3	4,900.6	23,579.3	28,549.2	11,532.9	70,672.4
2016	64.1	1,570.0	16,656.6	18,290.7	4,055.2	82,498.0
2017	59.3	503.0	11,766.3	12,328.6	5,242.9	28,990.6
2018	99.2	976.2	10,155.4	11,230.8	2,597.5	48,559.7
2019	165.9	1,894.7	8,765.1	10,825.7	5,206.0	22,511.7

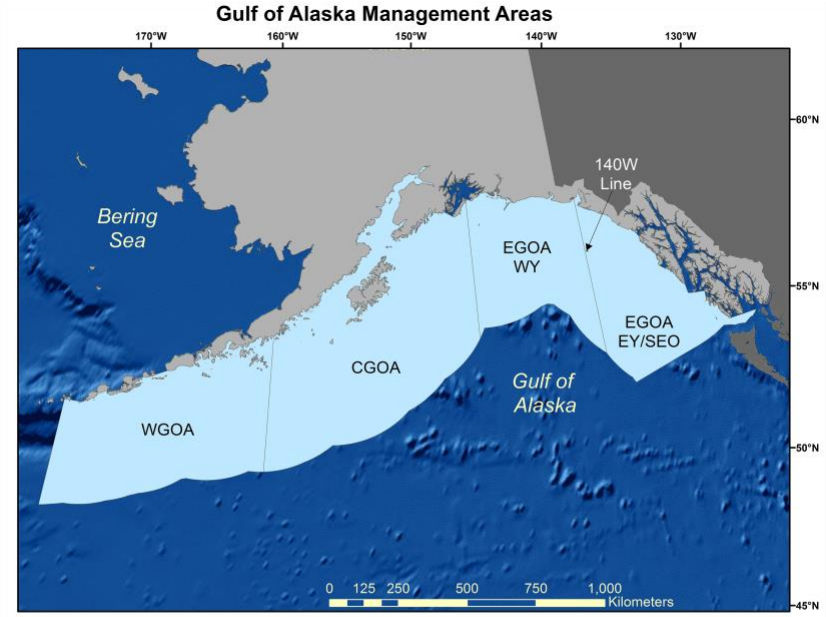
Table 0.13. Estimated random effects biomass by NMFS regulatory area and total Gulfwide biomass with 95% confidence intervals for the 17 Tier 5 species of Other Rockfish.

	Western GOA	Central GOA	Eastern GOA	Gulfwide Total	95% Confidence Intervals Lower	95% Confidence Intervals Upper
1984	117.3	1,827.3	14,244.1	16,188.6	11,200.3	23,398.5
1985	391.4	4,085.7	24,305.4	28,782.4	5,292.1	156,539.0
1986	1,305.9	9,135.4	41,473.6	51,914.9	9,819.7	274,464.0
1987	4,357.8	20,426.3	70,768.7	95,552.7	55,832.3	163,531.0
1988	1,503.2	18,044.1	63,604.3	83,151.6	16,094.1	429,609.0
1989	518.5	15,939.8	57,165.2	73,623.5	14,013.3	386,806.0
1990	178.9	14,080.9	51,378.0	65,637.7	36,555.4	117,857.0
1991	155.1	12,365.3	52,891.5	65,411.9	12,004.0	356,442.0
1992	134.5	10,858.8	54,449.5	65,442.8	11,630.1	368,249.0
1993	116.6	9,535.9	56,053.4	65,705.9	34,727.2	124,319.0
1994	211.2	7,784.9	57,614.6	65,610.6	11,043.3	389,807.0
1995	382.4	6,355.4	59,219.2	65,956.9	10,875.4	400,016.0
1996	692.4	5,188.4	60,868.5	66,749.2	34,668.8	128,515.0
1997	471.3	7,170.8	63,682.6	71,324.7	11,919.4	426,801.0
1998	320.8	9,910.7	66,626.9	76,858.4	13,458.6	438,917.0
1999	218.3	13,697.5	69,707.3	83,623.1	50,455.9	138,593.0
2000	505.3	9,081.5	68,585.9	78,172.7	11,816.2	517,169.0
2001	1,169.7	6,021.0	67,482.6	74,673.3	7,731.5	721,222.0
2002	280.7	4,346.9	66,397.0	71,024.6	9,278.4	543,681.0
2003	67.4	3,138.2	65,328.9	68,534.5	26,640.7	176,309.0
2004	789.0	6,069.3	61,104.5	67,962.9	13,942.4	331,287.0
2005	9,240.4	11,738.0	57,153.3	78,131.7	48,293.6	126,405.0
2006	2,944.4	7,103.6	53,305.7	63,353.6	14,836.8	270,522.0
2007	938.2	4,299.0	49,717.1	54,954.2	36,177.7	83,475.9
2008	324.9	3,864.7	33,476.3	37,666.0	8,365.6	169,590.0
2009	112.5	3,474.4	22,540.8	26,127.7	17,845.2	38,254.3
2010	325.8	8,382.1	46,647.6	55,355.5	12,780.4	239,760.0
2011	943.3	20,222.2	96,536.0	117,701.0	68,106.5	203,411.0
2012	484.0	19,244.6	53,860.1	73,588.7	18,578.5	291,482.0
2013	248.4	18,314.3	30,050.0	48,612.7	29,301.7	80,650.5
2014	397.5	17,876.0	39,603.6	57,877.1	15,099.1	221,852.0
2015	636.1	17,448.2	52,194.6	70,278.9	41,464.3	119,118.0
2016	1,633.3	18,484.1	53,822.9	73,940.3	18,765.4	291,343.0
2017	4,193.6	19,581.5	55,502.0	79,277.1	45,524.7	138,054.0
2018	926.6	15,288.4	51,632.2	67,847.1	16,972.8	271,212.0
2019	204.7	11,936.5	48,032.1	60,173.3	42,028.4	86,151.8

Table 0.14. 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 0.1. 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.

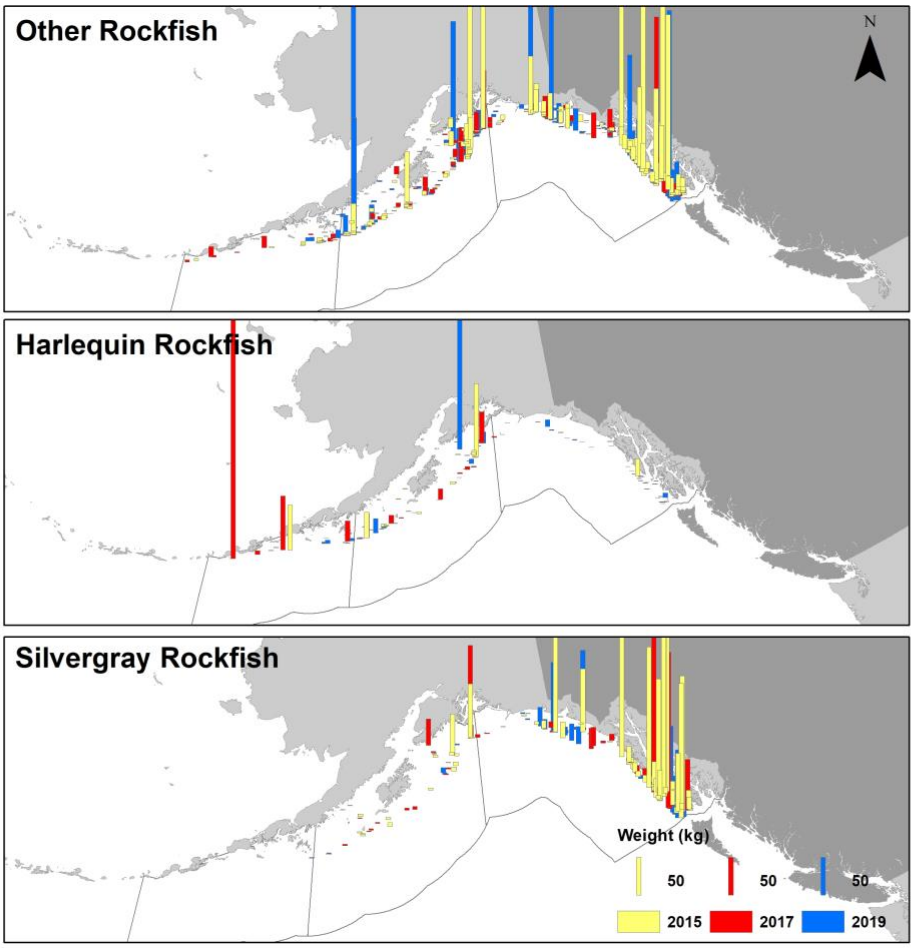


Figure 0.2. Spatial distribution of trawl survey catch in the Gulf of Alaska (GOA) from the three most recent National Marine Fisheries Service (NMFS) trawl surveys (2015, 2017, and 2019) for: (top panel) the Other Rockfish (OR) complex (with the exception of harlequin and silvergray rockfish); (middle panel) harlequin rockfish; and (bottom panel) silvergray rockfish.

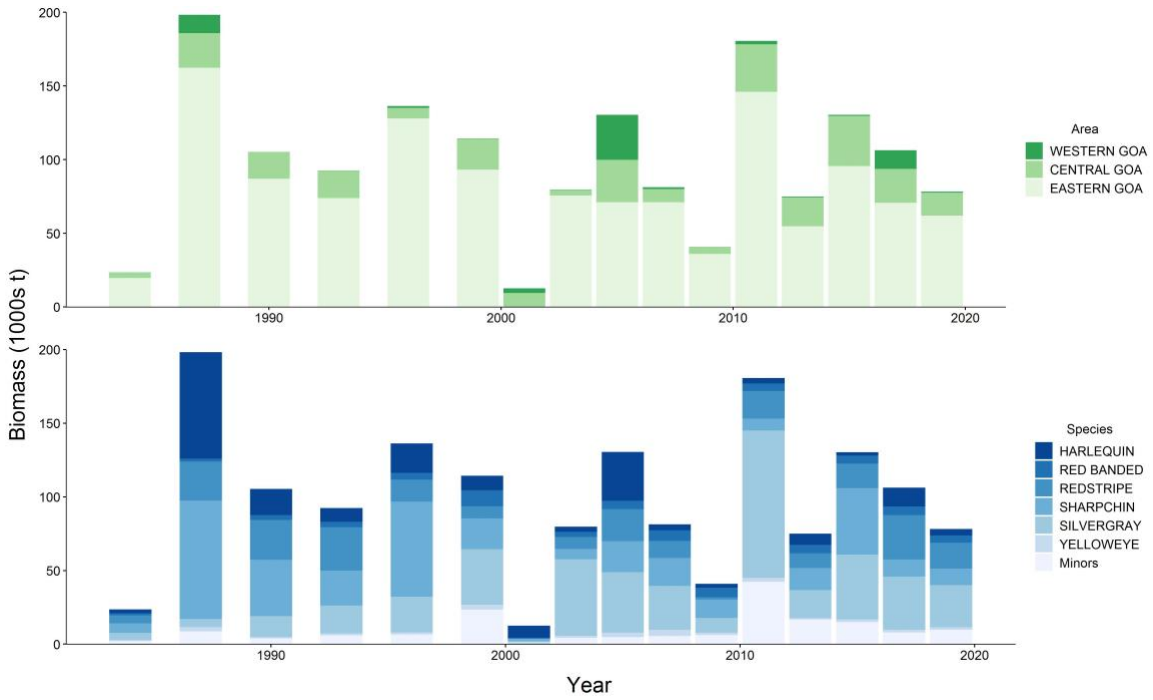


Figure 0.3. Trawl survey biomass estimates for the species in the Other Rockfish complex, by Gulf of Alaska (GOA) regulatory area (Western GOA, Central GOA, Eastern GOA) and by species (bottom).

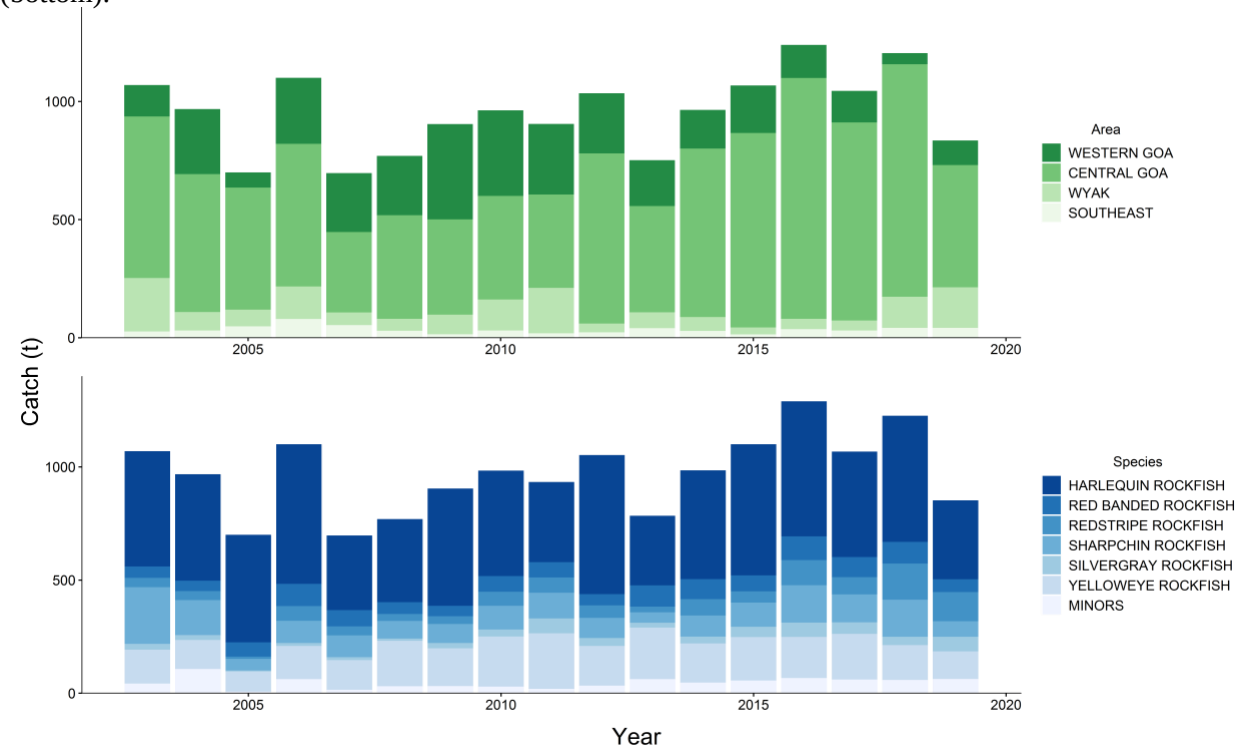


Figure 0.4. Estimated incidental catch (t) of Other Rockfish in Gulf of Alaska (GOA) by area (Western GOA, Central GOA, West Yakutat (West Yak), and East Yakutat/Southeast (Southeast) and species. National Marine Fisheries Service Alaska Regional Office Catch Accounting System (queried through AKFIN on October 13, 2017).

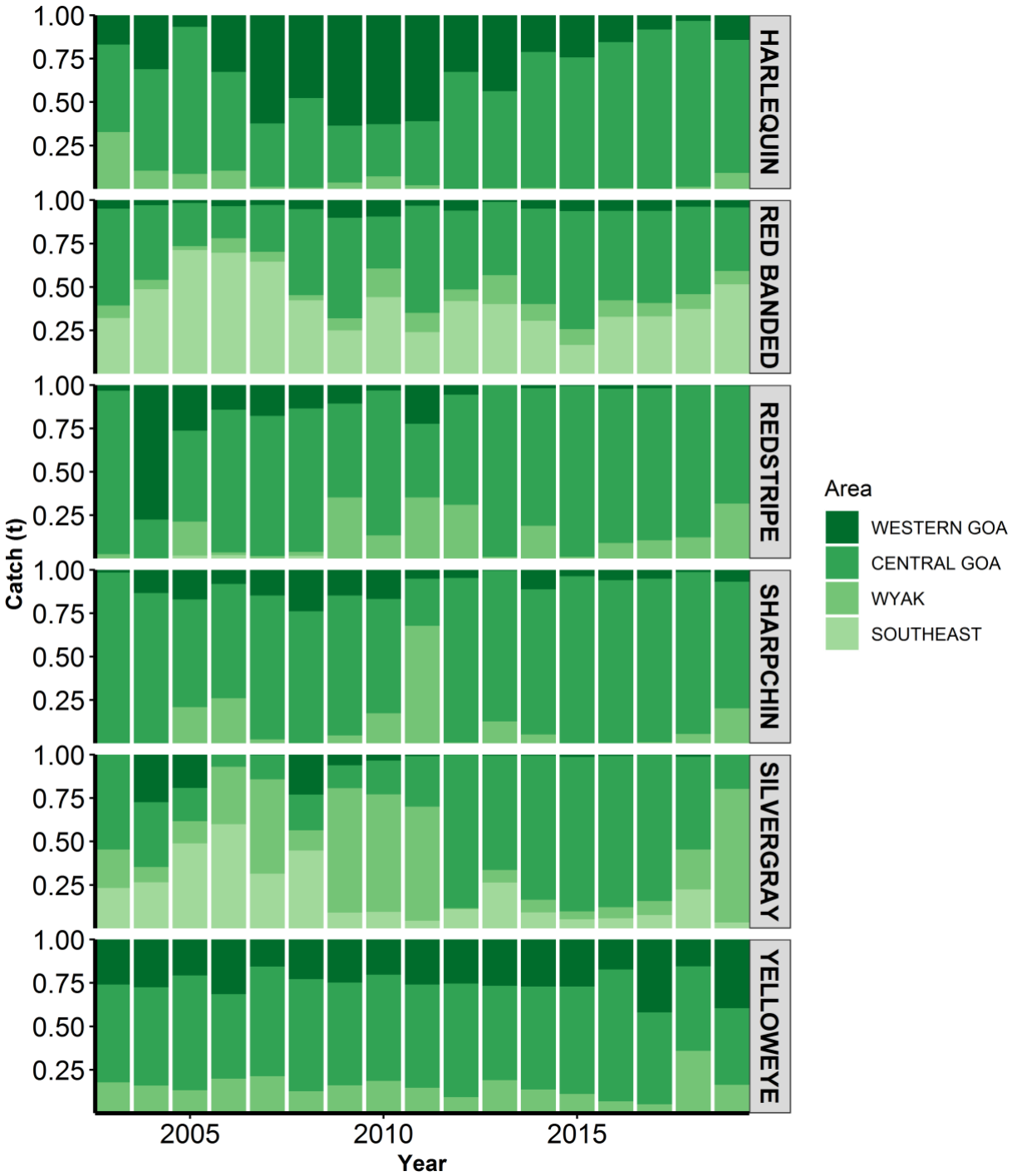


Figure 0.5. Proportion of catch by regulatory area (Western Gulf of Alaska (GOA), Central GOA, West Yakutat and East Yakutat/Southeast) for the six primary species of Other Rockfish. Note that the yelloweye rockfish panel does not include catch in the East Yakutat/Southeast regulatory area because that catch is included in the Demersal Shelf Rockfish complex. NMFS AKRO Catch Accounting System (queried through AKFIN on October 13, 2017).

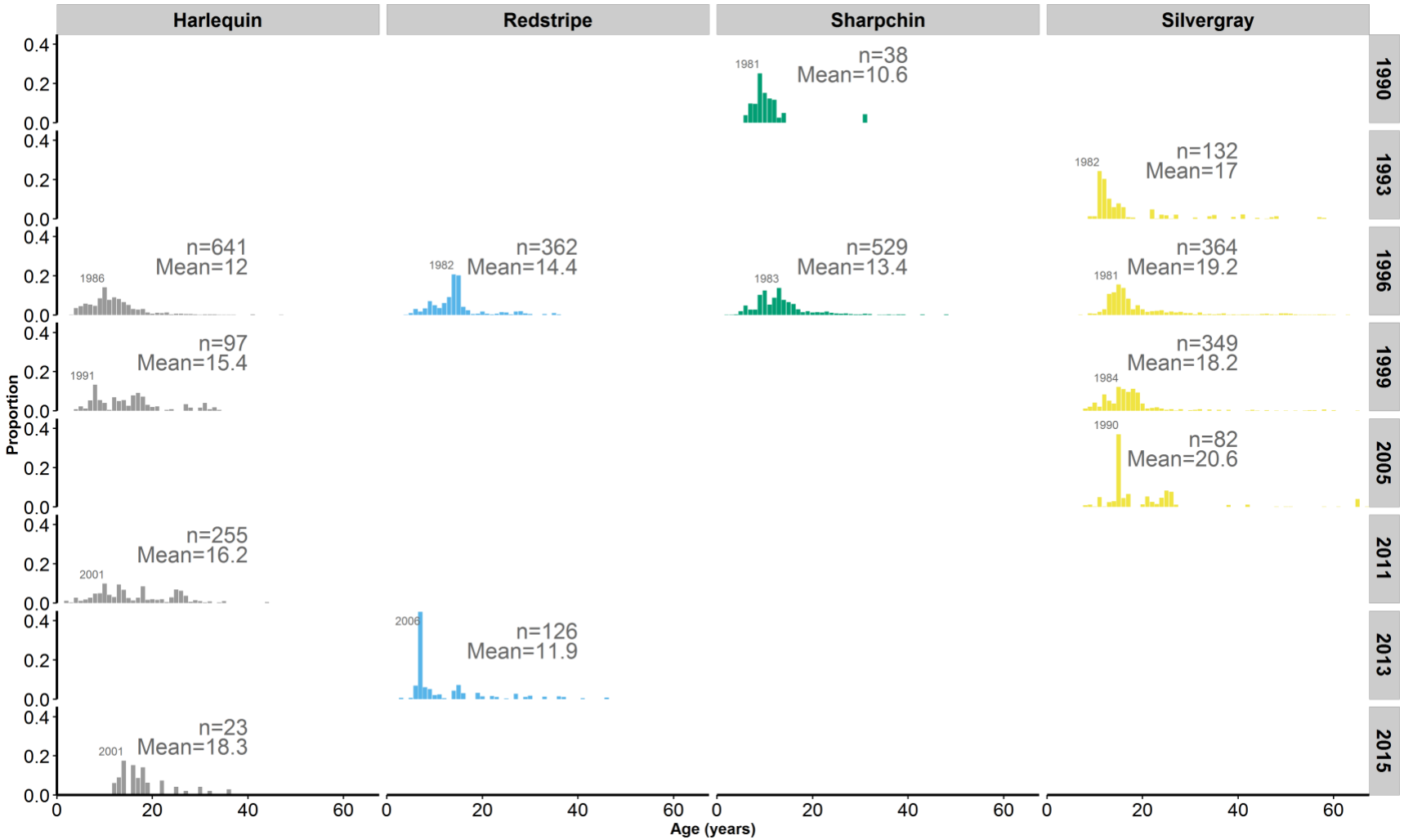


Figure 0.6. Age compositions of harlequin, redstripe, sharpchin and silvergray rockfish from the Gulf of Alaska (GOA) National Marine Fisheries (NMFS) bottom trawl survey. Sample size and mean age are presented for each species and survey year with age compositions available. The birth year of the largest cohort is labeled as well.

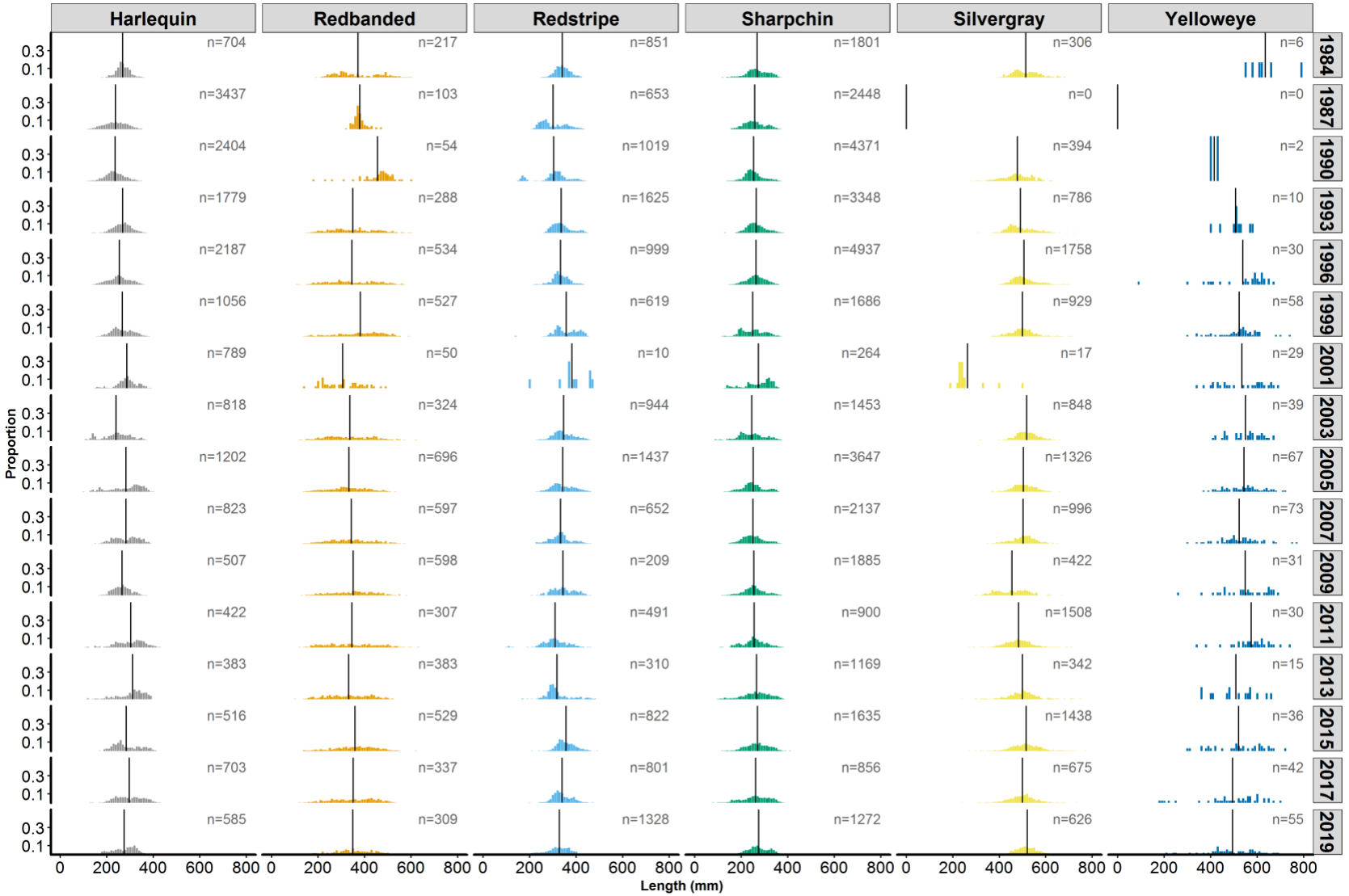


Figure 0.7. Size composition of the primary Other Rockfish (OR) species from the National Marine Fisheries Service (NMFS) bottom trawl survey. Note that he survey did not sample the Eastern GOA in 2001, contributing to the low sample size. The black vertical line represents the mean size.

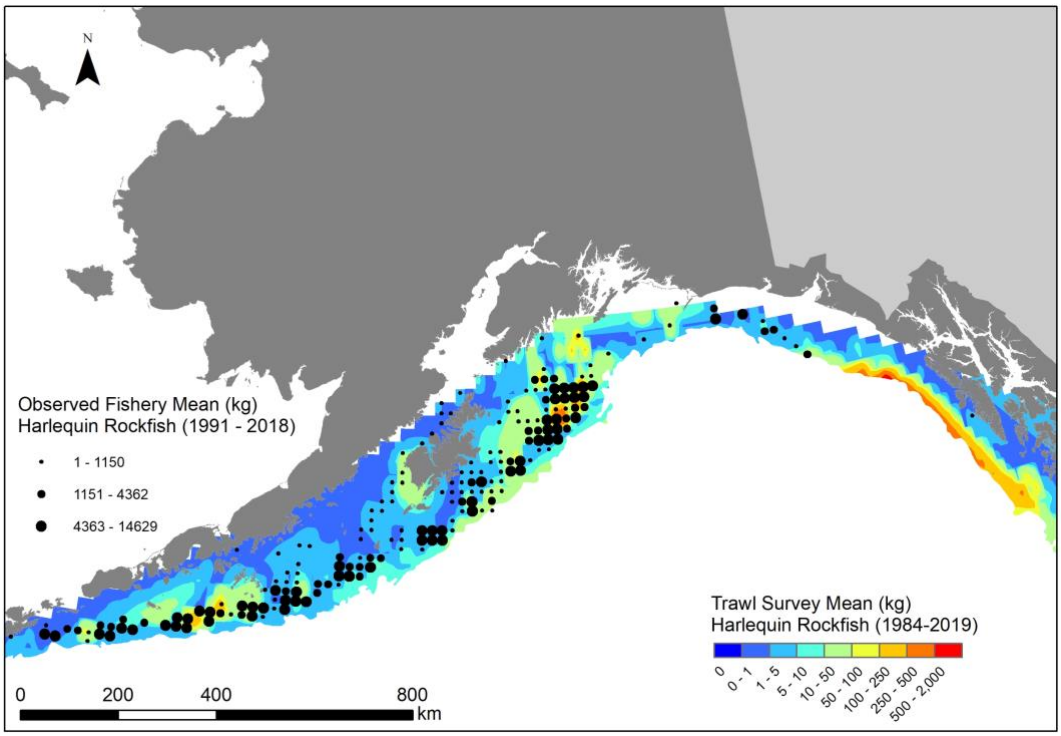


Figure 0.8. Distribution map of harlequin rockfish trawl survey mean kg per haul from 1984 – 2019 and observed fishery catch mean kg per haul (1993 – 2018). Data is through 2018 to match available non-confidential data from the fishery.

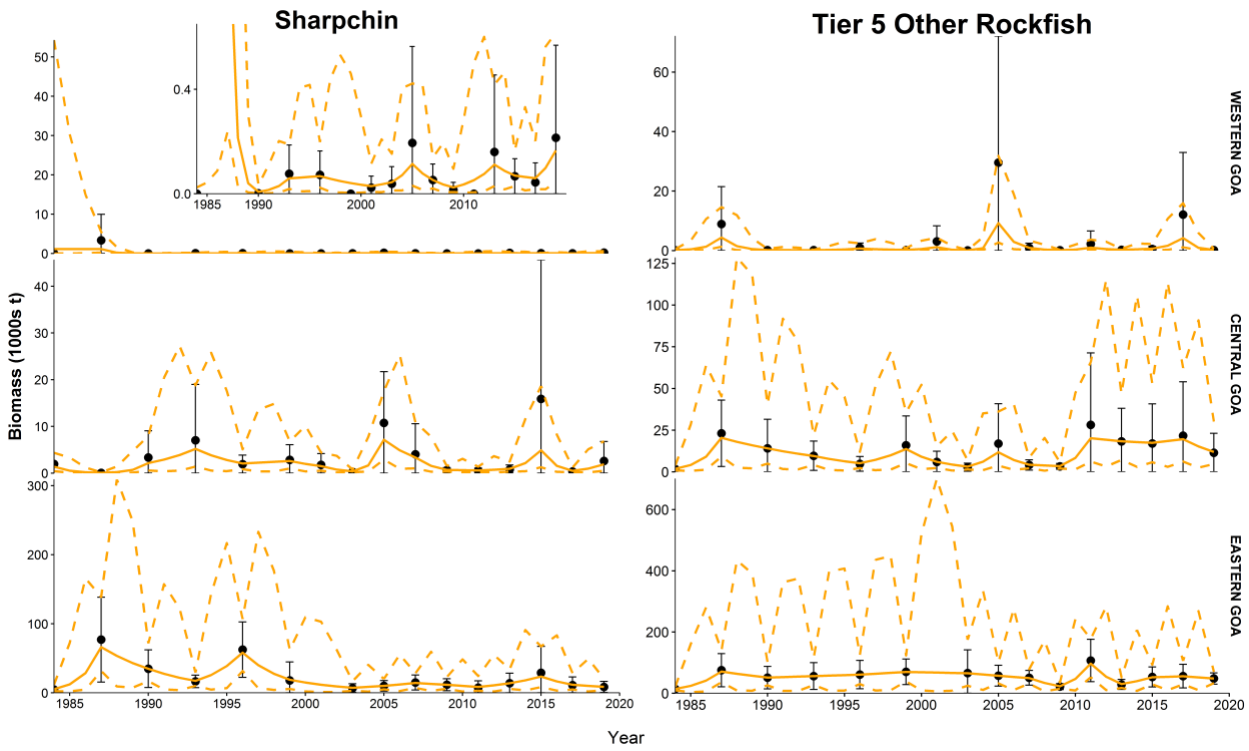


Figure 0.9. Estimated random effects biomass for sharpchin rockfish (left panel) and the 17 grouped Other Rockfish (OR) species (right panel) by NMFS regulatory areas: Western Gulf of Alaska (WGOA), Central GOA (CGOA) and Eastern GOA (EGOA). The regional model takes into account the missing survey in the EGOA in 2001. The inset in the WGOA sharpchin panel shows the same data as the panel, but zoomed in to show detail.

Appendix 16A. Moving DSR sub-group to GOA-wide DSR assessment

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Ben Williams (ADF&G)
November 2019

Executive Summary

The Other Rockfish (OR) and Demersal Shelf Rockfish (DSR) stock complexes share seven species (canary, China, copper, quillback, rosethorn, tiger and yelloweye rockfish) that are managed in different assessments depending on area. Within the OR assessment, these species are considered the demersal sub-group. Because of this overlap, a joint stock structure document for both complexes was completed and included in the 2015 OR assessment (Appendix 16A of Tribuzio and Echave 2015).

As a result of that stock structure analysis, 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 recent specific comments are below:

"The Team again supports the conclusions of the author and reiterates our earlier recommendation that the demersal sub-group be moved into the DSR assessment and make the DSR assessment GOA-wide pending Council evaluation of management and economic implications."

"The Team concluded that the demersal sub-group of the OR assessment should be categorized as "moderate concern" in the Council's Stock Structure and Spatial Management Policy scale of concern."

"The Team recommends that this issue move to Step 2 of the Council's Stock Structure and Spatial Management Policy." (PT, November 2017)

"The SSC agrees with this assessment of stock structure and urges the Council to consider step 2 of the Stock Structure and Spatial Management Policy." (SSC December 2017)

The authors, Plan Team, and SSC all agree that the proposed changes to the composition of the complexes are an improvement over current groupings. The proposed changes would reorganize both the OR and DSR complex structures, requiring regulatory changes. These regulatory changes consist of changing the footnotes on Table 10 06 50 CFR Part 679, defining basis species for retention.

GOA-wide DSR Example Specifications

After discussion with Council staff it is unclear how to proceed to Step 2 of the *Stock Structure and Spatial Management Policy*. The PT posed the question of management and economic implications and staff are asking for feedback on those topics. To facilitate addressing these questions, the authors have provided examples of what the GOA-wide harvest recommendations would be based on the most recent assessment results.

Total GOA-wide DSR ABC by area

	Western GOA	Central GOA	Eastern GOA		Total
			West Yakutat	E Yakutat/Southeast	
Area ABC (t)	46	126	34	238	444
OFL (t)					648

Due to the state-managed rockfish fisheries which occur in the East Yakutat/Southeast area, we recommend the OFL and ABCs be apportioned as below. Outside of East Yakutat/Southeast these species are not targeted and catch is spatially and temporally patchy, which can result in highly variable catch estimates between regions. For these reasons and because of the difficulty in managing small ABCs, the authors recommend aggregating the Western, Central GOA and West Yakutat harvest recommendations.

	Western/Central GOA/West Yakutat	Eastern GOA EastYakutat/Southeast	Total
Area ABC (t)	206	238	444
OFL (t)	275	375	650

Yelloweye rockfish is currently considered a Tier 6 species outside of East Yakutat/Southeast. This species may be a candidate to move to Tier 5 in areas outside of East Yakutat/Southeast and authors will investigate the data and alternative modelling approaches (e.g., data-limited models) in future assessments.

Next Steps

Given the recommended approach of aggregating the demersal sub-group species into a GOA-wide DSR complex, the Council is requested to initiate a regulatory amendment to modify 50 CFR Part 679 to accommodate changes to both the OR and DSR complexes. There may be additional economic and management considerations that need to be identified as a result of this change that should be addressed by staff. This would be consistent with Step 2 of the Council's spatial management policy.