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

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EXECUTIVE SUMMARY

The Other Rockfish (OR) complex (Table 16.1 and Figure 16.1) 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 over fishing 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 – 2017 has been updated (as of October 13, 2017).
2. NMFS GOA bottom trawl survey data have been updated.
3. The random effects time series of biomasses have been updated.

Changes in assessment methodology

GOA OR ABC/OFL calculations are based on Tier 4, 5, and 6 methods (depending on species). There are no changes to the Tier 4 or 5 methods used in this assessment.

Based on SSC comments, the historical catch time series used to calculate the Tier 6 OFL was expanded to include 2003 – 2016, from the 2013 – 2014 time series used in the last full assessment. The years prior to 2013 may not include all sources of catch and those catch estimates should be considered a minimum estimate of catch for each of those years. Tier 6 ABC/OFL estimates were calculated individually by species for the Tier 6 species and summed for the Tier 6 OFL. We continue to use the maximum value of catch during the time series. We have included a table of the maximum, mean, median and percentiles of the historical catch based OFLs and ABCs for comparison.

Summary of Results

There is no evidence to suggest that over fishing is occurring for the OR complex in the GOA because the OFL has not been exceeded. Total OR catch in 2016 was 1,281 t and catch in 2017 was 970 t as of October 13, 2017, lower than the ABC of 5,773 t for both years. **The recommended ABC for the 2018 fishery is 5,590 t and OFL is 7,356 t for the OR complex.** This is a 3.2 % decrease from 2017. 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 combination, as data do not suggest any developing conservation concerns that would be alleviated by splitting the ABCs.

Tier 4 recommendation of ABC and OFL for sharpchin rockfish for 2018 – 2019.

Quantity	As estimated or *specified last* year for: 2017	2018	As estimated or *recommended this* year for: 2018	2019
M (natural mortality rate)	0.06	0.06	0.06	0.06
Tier	4	4	4	4
Biomass (t)	35,083	35,083	12,583	12,583
$F_{OFL} = F_{35\%}$	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)	2,772	2,772	994	994
maxABC (t)	2,280	2,280	818	818
ABC (t)	2,280	2,280	818	818
Status	As determined *last* year for: 2015	2016	As determined *this* year for: 2016	2017
Overfishing		n/a		n/a

Tier 5 recommendation of ABC and OFL for 17 OR species for 2018-2019.

Quantity	As estimated or *specified last* year for: 2017	2018	As estimated or *recommended this* year for: 2018	2019
M (natural mortality rate)	0.02-0.10	0.02-0.10	0.073	0.073
Tier	5	5	5	5
Biomass (t)	69,743	69,743	83,524	83,524
F_{OFL}	0.02-0.10	0.02-0.10	0.073	0.073
$maxF_{ABC}$	0.0015-0.0750	0.0015-0.0750	0.055	0.055
F_{ABC}	0.0015-0.0750	0.0015-0.0750	0.055	0.055
OFL (t)	4,482	4,482	6,097	6,097
maxABC (t)	3,362	3,362	4,573	4,573
ABC (t)	3,362	3,362	4,573	4,573
Status	As determined *last* year for: 2015	2016	As determined *this* year for: 2016	2017
Overfishing		n/a		n/a

Tier 6 recommendation of ABC and OFL for seven OR species for 2018-2019.

Quantity	As estimated or *specified last* year for: 2017	2018	As estimated or *recommended this* year for: 2018	2019
Tier	6	6	6	6
OFL (t)	170	170	265	265
maxABC (t)	127	127	199	199
ABC (t)	127	127	199	199
Status	As determined *last* year for: 2015	2016	As determined *this* year for: 2016	2017
Overfishing		n/a		n/a

ABC and OFL recommendations for the full OR complex for 2018-2019.

All OR Combined	As estimated or *specified last* year for: 2017	2018	As estimated or *recommended this* year for: 2018	2019
Tier	4/5/6	4/5/6	4/5/6	4/5/6
OFL (t)	7,424	7,424	**7,356**	7,356
maxABC (t)	5,769	5,769	5,590	5,590
ABC (t)	5,769	5,769	**5,590**	5,590
Status	As determined *last* year for: 2015	2016	As determined *this* year for: 2016	2017
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 13, 2017.

Year	Western GOA	Central GOA	Eastern GOA West Yakutat	Eastern GOA E. Yak/ Southeast	Gulfwide Total	Gulfwide ABC	Gulfwide TAC
2016	156	1,033	53	40	1,281	5,773	2,308
2017	114	785	41	29	970	5,773	2,308

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 2018 fishery (1,737 t total ABC, if separated: WGOA = 440 t and CGOA = 1,297 t). 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 (96.14%) West Yakutat[1]	Eastern GOA (96.14%) E Yakutat/ Southeast[1]	Total
Area Apportionment	3.86%	8.43%	87.71%	100%
Area ABC (t)	32	69	717	818
OFL (t)				994

Tier 5 – 17 species	Western/Central GOA	Eastern GOA (66.35%) West Yakutat[1]	Eastern GOA (66.35%) E Yakutat/ Southeast[1]	Total
Area Apportionment	33.65%	5.82%	60.53%	33.65%
Area ABC (t)	1,539	266	2,768	4,573
OFL (t)				6,097

Tier 6 – 7 species	Western/Central GOA	Eastern GOA West Yakutat	Eastern GOA E Yakutat/ Southeast	Total
Area ABC (t)	166	33	0	199
OFL (t)				265

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	1,737	368	3,485	5,590
OFL (t)				7,356

Summaries for Plan Team

Species	Year	Biomass[1]	OFL	ABC	TAC	Catch[2]
Other Rockfish	2016	104,826	7,424	5,769[3]	2,308	1,281
	2017	104,826	7,424	5,769[3]	2,308	970
	2018	96,107	7,356	5,590		
	2019	96,107	7,356	5,590		

Stock/ Assemblage	Area	2017				2018		2019	
		OFL	ABC	TAC	Catch[2]	OFL	ABC	OFL	ABC
Other Rockfish	WGOA/ CGOA		1,534	1,534	899		1,737		1,737
	EGOA								
	WY		574	574	41		368		368
	EY/SE		3,665[3]	200	29		3,485[4]		3,485
	Total	7,424	5,773[3]	2,308	970	7,356	5,590[4]	7,356	5,590

[1]Total biomass estimates from the random effects model for the Tier 4/5 species only.

[2]Current as of October 13, 2017. 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 2018 does not include the ABC for northern rockfish, because the value has not been set for 2018.

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)
Methods to incorporate the IPHC survey relative population numbers into the random effects model are underway for other assessments and will be investigated for Other Rockfish in the future.

"Finally, an area apportionment approach using the RE model which specifies a common "process error" has been developed and should be considered. This may help in some situations where observation errors are particularly high and/or vary between regions." (Plan Team, November 2015)
Already accounted for in this assessment.

"The SSC requests that stock assessment authors bookmark their assessment documents and commends those that have already adopted this practice." (SSC, October 2016)
This document has been bookmarked.

"*…The SSC also recommends explicit consideration and documentation of ecosystem and stock assessment status for each stock, perhaps following the framework suggested below, during the December Council meeting to aid in identifying areas of concern.*" (SSC October 2017)
A newly proposed framework for considering ecosystem and socioeconomic factors has been submitted as an appendix in some assessments this year, but not in this assessment. This is an attempt to document these factors with respect to stock status and also provide indicators for continued monitoring to identify areas of concern. In future years it is anticipated that they would be available for all stocks, as the framework is adaptable for data-limited to data-rich stocks. We plan to evaluate and potentially incorporate this new ecosystem/socioeconomic report as an appendix when it becomes available for the Other Rockfish stock complex.

SSC and Plan Team Comments Specific to this Assessment

"Potential areas of future research include: verifying that these species are more similar to each other in their complex than to species in other complexes with statistical models such as ANOVA or investigating the relationship between individual species in a multivariate approach (i.e., k-nearest neighbors)." (Plan Team, November 2015)
A PhD student, Kristen Omori, at Virginia Institute of Marine Science is examining this for a chapter of her dissertation. The lead author is on her committee.

"The SSC joins the PT in suggesting caution regarding use of maximum catch for OFL for the Tier 6 species in this complex going forward, as OFL could only remain static or increase." (SSC, December 2015)
See response to OCT 2017 SSC comments below.

"The SSC recommends work continue on the following as indicated by the PT and authors: 1) verifying that species in this complex are more similar to each other than to other complexes using ANOVA or similar techniques, 2) investigating whether there should be a correction factor for NMFS trawl data for those species not well sampled by trawl, and 3) investigating how to incorporate IPHC index into assessment for the 5 species that the IPHC surveys well." (SSC, December 2015)

1) See comment above.
2) New trawable/untrawlable habitat study planned (see Rooper and Williams Sept. 2017 presentation).
3) Four of the species the IPHC survey samples well are Tier 5 and the random effects model is run on the complex trawl survey biomass with species grouped by common natural mortality rates. Thus, the IPHC survey would not be able to be applied universally across the natural mortality groupings because not all of the species within a grouping are sampled by that survey. Methods to incorporate the IPHC survey relative population numbers into the random effects model are underway for other assessments and will be investigated for Other Rockfish in the future. With regards to yelloweye rockfish, the IPHC survey may be informative. However, at this time, the species is considered Tier 6 because data are insufficient to develop an age-structured or survey biomass model. If a model were to be developed in the future for yelloweye rockfish, the IPHC survey data could be a useful input.

SSC and Plan Team Comments Specific to the reorganization of species between OR and DSR

"The Team recommends moving ahead with the author preferred Alternative 3a to split DSR species out of the ORX complex. The Team also requests that the author develop clear justification for how the Tier 6 method was selected before the November meeting." (PT, September 2017)

We present more information in support of Alternative 3a and in response to the SSC comments below in the Evidence of Stock Structure section. We have included justification for the Tier 6 methods in the Results section.

"The SSC concurs with the authors and Plan Team that the groupings and spatial specifications described under Alternative 3a are an improved description of structure and a reasonable approach to spatial management." (SSC, October 2017)
No action necessary

"…Given the scope of this action [i.e., GOA-wide DSR] and potential impacts to the fishery, the SSC recommends that the Council's Stock Structure and Spatial Management Policy is followed." (SSC, October 2017)
The policy is a four step process:

1. *As soon as preliminary scientific information indicates that further stock structure separation or other spatial management measures may be considered, the stock assessment authors, Plan Teams (groundfish, crab, scallop), and SSC should advise the Council of their findings and any associated conservation concerns and reasonable timeframes to address the concern.*
2. *With input from the agency, the public, and its advisory bodies, the Council (and NMFS) should identify the economic and management implications and potential options for management response to these findings and identify the suite of tools that could be used to achieve conservation and management goals. This suite of tools includes separate harvest specifications at the TAC, ABC, and/or OFL level. In the case of crab and scallop management, ADF&G needs to be part of this process.*
3. *To the extent practicable, further refinement of stock structure or other spatial conservation concerns and potential management responses should be discussed through the process described in recommendations 1 and 2 above.*
4. *Based on the best information available provided through this process, the SSC should continue to recommend OFLs and ABCs that prevent overfishing of stocks.*

Step 1 has occurred. The assessment authors presented stock structure concerns as part of the stock assessment process in 2015 and all findings are documented in Tribuzio and Echave (2015). We provide a summary of the stock structure findings in the Evidence of Stock Structure section of this document. In short, the findings show that there are two groups of species within the OR complex: seven species that tend to be demersal, termed the demersal sub-group; and the remaining 18 species, termed the slope sub-group. The demersal sub-group species are the canary, china, copper, quillback, rosethorn, tiger and yelloweye rockfishes, the same species which compose the Demersal Shelf Rockfish complex in the East Yakutat/Southeast portion of the Eastern GOA. However, the GOA Plan Team has not yet specified a scale of concern (i.e., little or no, moderate, strong, or emergency).

As we understand it, implementing further steps is the responsibility of the Council. However, we have provided information for Step 2. The OR and DSR authors have proposed alternative ABC/OFLs for a GOA-wide DSR complex (Alternative 3a in the document presented to the September 2017 GOA Plan Team, which incorporates the demersal sub-group of the OR complex into the existing DSR complex, making the DSR complex GOA-wide). The SSC suggested using the 2003 – 2016 time series for Tier 6 methods and the authors will further evaluate potential ABC/OFLs before this potential change goes into effect (see Results section of this document). Economic implications have not been identified.

"The SSC recommends that the Plan Team, during its November 2017 meeting: 1) provide guidance on the level of conservation concern for this stock; 2) evaluate whether the proposed breakout is appropriate given the level of concern; and, as appropriate 3) determine whether other measures would adequately

address conservation needs. The stock structure template would be an appropriate tool for determining the level of conservation concern." (SSC, October 2017)
The authors conclude that the grouping of the demersal sub-group into the OR complex in management areas outside of East Yakutat/Southeast is incorrect based on basic biological life history characteristics, spatial distribution, and fishery catch characteristics and that these species should be considered of "moderate concern" due to the life history (e.g., slow growth, long generation times, potential for low reproductive rates), fishery catch characteristics, and vulnerability. A classification of "moderate concern" requires special monitoring and may activate steps 2 and 3 above. Given the level of concern, the proposed break-out is appropriate to adequately monitor the status of these species. Further, catch is currently estimated at the species group level, future work will explore breaking the complex catch into species-specific estimates, which will also result in better alignment between the assessment estimation method and those used for management. With species occurring in multiple assessments, there is a greater chance for critical information to be missed. Lastly, the seven species do not exhibit spatial stock structure within the GOA. Therefore, these species should be considered within one assessment.

The SSC requested discussion regarding the appropriateness of the proposed species break-out (or reorganization) with regards to the level of concern. Given the classification of "moderate concern" it would be prudent to examine the NS1 guidelines regarding complexes along with the stock structure template. Text in the 2016 revised NS1 guideline states "Where practicable, the group of stocks should have a similar geographic distribution, life history characteristics, and vulnerabilities to fishing pressure such that the impact of management actions on the stocks is similar. The vulnerability of individual stocks should be considered when determining if a particular stock complex should be established or reorganized, or if a particular stock should be included in a complex" (http://www.nmfs.noaa.gov/sfa/laws_policies/national_standards/ns1_revisions.html).

"Under the assumption of a breakout moving forward, and Alternative 3a still being the preferred management option, the SSC has the following comments regarding tier-specific calculations:

1) *The Tier 6 method used in the analysis is based on maximum catch for the post-observer restructure period, which is a short period: 2013-16. This period corresponds to the post-observer restructure period and thus includes rockfish discard from the halibut IFQ fishery that is not available prior to 2013. However, the time series of harvest shows higher harvest levels than those realized in 2013-16. In addition, with the exception of EY/SEO yelloweye, the IPHC longline survey RPNs for several of the DSR species have also been stable over this time period (figure 4). Given the longevity of this species and relatively stable catch series, the SSC recommends Tier 6 methods be evaluated using a longer historical time series (2003-16), and whether there are important biological reasons for selecting the recent period (2013-16).*

2) *Rockfish species in the DSR complex are not estimated individually in catch accounting system (CAS). The CAS produces an aggregate estimate for the entire Other Rockfish complex. The SSC recommends the author work with AKRO to make adjustments to CAS to better reflect estimation methods used for management under the proposed breakout.*

3) *The revised NS1 guidelines allow carry-over ABC control rules. Future analysis should consider whether this provision is appropriate for GOA Other Rockfish management (including DSR)."* (SSC, October 2017)

    1) We have changed the Tier 6 methods used in this assessment to include the years 2003 – 2016, and have provided a table of Tier 6 calculations for comparison in the Results section.
    2) The authors will work with AKRO staff to examine the demersal sub-group catch estimates when estimated apart from the rest of the Other Rockfish species.
    3) The appropriateness of utilizing carry-over ABC is an issue that is likely relevant to many assessments and should be discussed by a larger group, including staff involved in developing the NS1 guidelines.

"The Team recommends that redbanded rockfish remain in the ORX complex." (PT, September 2017)
Redbanded rockfish remain in the Other Rockfish complex.

"The SSC recommends investigating Tier 5 methods for redbanded rockfish given it appears to be well represented in the trawl survey." (SSC, October 2017)
Redbanded rockfish are a Tier 5 species.

Introduction

The Other Rockfish stock complex (termed OR in this document) is a group of up to 25 rockfish species (*Sebastes spp.*), depending on Gulf of Alaska (GOA) management area (Tables

Table 16.1, Figure 16.1). 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 east of East Yakutat/Southeast will be termed the demersal sub-group and the remaining 18 species in the OR complex will be termed the slope sub-group. While the demersal sub-group was not previously included in the full OR assessments (called the Other Slope Rockfish stock complex in prior assessments), 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.

Northern rockfish are included in the OR complex only in the Eastern GOA (NMFS Areas 640 and 650) and are a separate assessment in other management areas of the 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 16.2). The center of abundance for silvergray rockfish, the most abundant of the OR species, based on recent trawl survey

biomass estimates, appears to be in Southeast Alaska (Figure 16.2) and 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 further research is needed to address if there are differences in rockfish density between trawlable and untrawlable habitats, because currently survey catch estimates are extrapolated to untrawlable habitat, and if there are species-specific differences (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 within a species across management regions for any of the 25 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 25 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 18 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 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 ad Spencer 2011). Thus, having this species, and the other demersal sub-group species which are similar to it, lumped 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 consistent 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 they are caught in, it is logical that they should not be combined into the same complex for management.

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 2017 minutes) and the SSC (October 2017 minutes) agreed that the author recommendations were an “improved description of structure and a reasonable approach to spatial management” (SSC, October 2017), but requested the issue be evaluated following the Council’s Stock Structure and Spatial Management Policy, 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.

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 47 and 55 years, respectively, (Malecha et al. 2007, Myer and Failor in prep), but no estimates of age at maturity. 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 16.2. 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 16.3 shows the catch estimates, the 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.

From 2005 to 2010, the assessments for Other Slope Rockfish and shortraker rockfish in the GOA were presented in one SAFE chapter, even though Other Slope Rockfish and shortraker rockfish were distinct management entities, because each was assessed using a similar Tier 5 methodology. 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 25 species, depending on area (Tables

Table 16.1 and Figure 16.1). 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) has 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.

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). The CAS estimates of catch do not include catch from unobserved fisheries, such as the Pacific halibut IFQ fleet prior to the 2013 observer restructuring, or state managed fisheries.

Discards

Gulfwide discard rates (% of the total catch discarded within management categories) are provided in two time series: 1) pre – 2003, where the catch and discards were estimated by species in Tribuzio and Echave (2013) by extrapolating observed species compositions to the total catch; and 2) 2003 – present from the CAS (Table 16.4). Discard rates have been on average 56% over the entire time series. The high discard

of OR is not surprising, as most of the abundant species in this category, such as harlequin and sharpchin rockfish, are small in size and of low economic value. There are some species with higher value, which are likely discarded at a lower rate.

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 – 2017
NMFS Bottom Trawl Surveys –GOA (biennial)	Biomass Index, Age/length – compositions	1984 – 2017

Fishery

Fishery catch statistics for the OR complex are available from AKRO blend estimates and CAS beginning in 1991. Catch by species were estimated back to 1991 in Tribuzio and Echave (2013). Table 16.5 presents the time series of estimated catch of the current OR complex by species and Table 16.6 presents catch of the full complex by area. 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 16.7**Error! Reference source not found.**), with much of the bycatch occurring in the rockfish trawl fishery in the Central GOA (Figure 16.3). 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 16.4).

Catch distribution

The rockfish trawl fishery is the predominant source of OR catch and the overall distribution of the catch shows little change from year to year (Figure 16.3). However, there is some variability amongst the species of OR (Figure 16.4). Historically, redbanded and silvergray were often caught in the Eastern GOA, but in recent years, the majority of slivergray catch has occurred in the Central GOA (Figure 16.4).

Catch at age and length

The numbers 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 – 2017, Table 16.8). 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 covered all areas of the GOA out to a depth of 1,000 m, with the following exceptions: the 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 and 2017 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.

Most of the OR biomass is in the Eastern GOA (Table 16.8 and Figure 16.5). 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 16.8). 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 2017 trawl survey for all the OR species was 102,731 t (Table 16.8). This is a 12% decrease from the 2015 survey and 25% above the historical survey average. The survey biomass of harlequin (458%), redbanded (6%), and redstripe (81%) increased over the 2015 survey. Sharpchin and silvergray rockfish were both down from the previous survey, 74% and 18%, respectively. These dramatic changes in biomass estimates are likely due in a large part to the patchiness of the species, as suggested by the high CVs (e.g., 83% CV for 2017 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 large increase in the Western GOA where a single large haul of harlequin rockfish drove the biomass estimate and resulted in the high coefficient of variation.

In past Other Slope Rockfish SAFE reports (e.g., Clausen and Echave 2012), the authors have speculated that a change in 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.

In general, research catch is small relative to biomass (research catches are in Table 16.9 and biomass in Table 16.8). 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.

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. 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 16.6). 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 16.7. 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 vast majority of the survey biomass for OR occurs in the Eastern GOA, whereas much of the commercial catch occurs in the Western GOA and Central GOA. One example of the discontinuity between catch and abundance is harlequin rockfish (Figure 16.8). 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. The survey is more restricted by untrawlable habitat than fishery gear.

Analytic Approach

Model Structure

The majority of species in the OR are managed as Tier 4 or Tier 5, in which the over fishing limit (OFL) = biomass * F_{OFL}. F_{OFL} is either a proxy rate, assuming F_{OFL} = natural mortality (M) (Tier 5), or it is estimated as $F_{OFL} = F_{40\%}$ based on age at maturity information (Tier 4). 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 1984-2017 GOA trawl surveys. 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.

The RE model was fit to biomass data of the only Tier 4 species: sharpchin rockfish. The output of the RE model provided a Gulfwide biomass estimate, as well as biomass by area and proportions for Eastern GOA allocation of the ABC to WY and EY/SE. 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 RE model 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 $F_{ABC/OFL}$ 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. In the previous assessment the time series of catch since observer restructuring began (i.e., 2013 – 2014) was used because those are the most unbiased catch estimates, and therefore "reliable". Changes in the estimated discard rates of these species after 2013, suggest that a substantial portion of the discards may not have been captured in CAS with the earlier observer program, thus the most representative time series of catch is that beginning in 2013. However, that is a short time series and in October 2017 the SSC suggested including historical catches since 2003, with the understanding that those catches are likely underestimated due to unobserved catch. This year we have included the 2003 – 2016 time series. Within the Tier 6 definition, there is flexibility to determine the most appropriate metric, thus in the Results section we present a range of options that have been examined in other Tier 6 assessments, which include: average, median, and maximum catch, and 95th and 99th percentile of catch.

Parameter Estimates

Estimates of mortality, maximum age, and female age- and size-at-50% maturity are shown in Table 16.10. 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

The random effect model was fit separately for the Tier 4 (sharpchin) and Tier 5 (17 other OR species with reliable trawl survey biomass) species. Estimated biomass is presented in Table 16.11 and Figure 16.9 for sharpchin rockfish and Table 16.12 and Figure 16.9 for the 17 grouped, Tier 5 species.

Summary of computations of acceptable biological catches (ABC) and overfishing levels (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.

Group	Tier	2017 RE Biomass	F_{OFL}	OFL	F_{ABC}	ABC
Sharpchin	4	12,582.6	$F_{35\%} = 0.079$	994.0	$F_{40\%} = 0.065$	817.9
M=0.05 Group	5	36,606.7				
M=0.06 Group	5	8,319.4				
M=0.07 Group	5	689.4				

M=0.092 Group	5	9,410.3				
M=0.1 Group	5	28,497.7				
Tier 5 Biomass	5	83,523.5	F = Wted M = 0.073	6,097.2	$F_{ABC} = 0.75*F_{OFL}$	4,572.9
Total Tier 4/5 Gulf Wide				7,091.2		5,390.8

The ABC/OFLs were calculated for the Tier 6 species for two catch time series: 1) 2013 – 2016, the time series since observer restructuring took effect and, 2) 2003 – 2016, the time series of modern catch accounting. We include the average and maximum catches for both time series, and median catches, 75th, 95th and 99th percentile of the data for the 2003 – 2016 time series. Calculations are made for each species, then summed for the total Tier 6 options. It is important to note that these Tier 6 calculations are to be combined with that of the random effects ABC/OFLs and are not intended to be separately managed ABC/OFLs. The ABCs are calculated by species and area, thus the total Tier 6 ABC may not exactly equal 0.75*OFL. For the 2018 fishery we are recommending the Tier 6 method using the maximum historical catch of the 2003 – 2016 time series.

Tier 6 options		Western GOA	Central GOA	West Yakutat	Total Tier 6 ABC	Total Tier 6 OFL
2003-2016	Avg	28	79	17	124	165
	Median	29	76	18	122	163
	Max	43	123	33	199	265
	75th Percentile	35	89	21	144	192
	95th Percentile	41	116	27	184	245
	99th Percentile	43	121	31	196	261
2013-2016	Avg	21	92	13	126	169
	Max	29	117	22	168	223

Harvest Recommendations

The methods for ABC and OFL estimation for the Tier 4 and Tier 5 species 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. We do recommend a change to the method used for the Tier 6 species. Based on SSC comments, we recommend using the time series of historical catch from 2003 – 2016 for ABC and OFL estimation and continuing with using the maximum catch during that time series as the OFL. While the earlier years in the time series may underestimate catch, the longer time series will be more representative of potential catches than the shorter time series used previously. Resulting ABCs and OFLs are below:

Tier	2017 Random Effects Biomass	F_{OFL}	OFL	F_{ABC}	ABC
4	12,583	$F_{35\%} = 0.079$	994	$F_{40\%} = 0.065$	818
5	83,524	F_{OFL} = Wted M = 0.073	6,097	$F_{ABC} = 0.75*F_{OFL}$	4,573
6			265		199
All Tiers Combined			7,356		5,590

Area Allocation of Harvests

Based on the geographic distribution of the species' exploitable biomass in the trawl surveys, the NPFMC has apportioned the ABC and thus the TAC for OR in the GOA into three geographic management areas: the Western GOA, Central GOA, and Eastern GOA. After the apportionment calculations are conducted, the ABCs and TAC for the Western and Central GOA are combined. As recommended by the Plan

Team's Survey Averaging Work Group, methodology for calculating the distribution changed in 2015 to the use of the random effects model to estimate the exploitable biomass by region, and continues to be used in 2017. For apportionment of ABC/OFL, the random effects model was fit to area-specific biomass and subsequent proportions of biomass by area were calculated.

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 in 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 (area between 147° and 140° W long.) and EY/SE (area east of 140° W. long.) (Figure 16.1). 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 (96.14%)		Total
		West Yakutat[1]	E Yakutat/ Southeast	
Area Apportionment	3.86%	8.43%	87.71%	100%
Area ABC (t)	32	69	717	818
OFL (t)				994

Tier 5 – 17 species	Western/Central GOA	Eastern GOA (66.35%)		Total
		West Yakutat[1]	E Yakutat/ Southeast	
Area Apportionment	33.65%	5.82%	60.53%	33.65%
Area ABC (t)	1,539	266	2,768	4,573
OFL (t)				6,097

Tier 6 – seven species	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	166	33	0	199
OFL (t)				265

Total OR ABC apportioned by area

	Western/Central GOA	Eastern GOA		Total
		West Yakutat	E Yakutat/ Southeast	
Area ABC (t)	1,736	368	3,485	5,590
OFL (t)				7,356

Ecosystem Considerations

The ecosystem considerations for the GOA OR stock complex are summarized in Table 16.13.

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. (1991), 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.

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Tables

Table 16.1. Species comprising the Other Rockfish (OR) management category in the Gulf of Alaska. The demersal sub-group species are included in this assessment in all areas west of East Yakutat/Southeast, but in the Demersal Shelf Rockfish assessment otherwise.

Common name	Scientific name	Former (pre-2012) Management Category	Current Tier within OR Complex
	Slope Sub-Group		
blackgill rockfish	*Sebastes 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
silvergray rockfish	*S. brevispinis*	Other Slope Rockfish	5
splitnose rockfish	*S. diploproa*	Other Slope Rockfish	5
stripetail rockfish	*S. saxicola*	Other Slope Rockfish	5
vermilion rockfish	*S. miniatus*	Other Slope Rockfish	5
widow rockfish	*S. entomelas*	Other Slope Rockfish	5
yellowmouth rockfish	*S. reedi*	Other Slope Rockfish	5
yellowtail rockfish	*S. flavidus*	Other Slope Rockfish	5
	Demersal Sub-Group		
canary rockfish [a]	*S. pinniger*	Other Rockfish	6
China rockfish [a]	*S. nebulosus*	Other Rockfish	6
copper rockfish [a]	*S. caurinus*	Other Rockfish	6
quillback rockfish[a]	*S. maliger*	Other Rockfish	6
rosethorn rockfish [a]	*S. helvomaculatus*	Other Rockfish	6
tiger rockfish[a]	*S. nigrocinctus*	Other Rockfish	6
yelloweye rockfish[a]	*S. ruberrimus*	Other Rockfish	6

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

Table 16.2. 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 ABC and TAC

Table 16.3. Time series of catch estimates for the Other Rockfish (OR) complex with total allowable catch (TAC), acceptable biological catch (ABC), over fishing 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.

	Gulf of Alaska Region Catch							
Year	Western	Central	Eastern	Total 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	438	78	767	1,730	4,297	5,624	OSR
2009	403	399	96	899	1,730	4,297	5,624	OSR
2010	365	429	170	964	1,192	3,749	4,881	OSR
2011	301	359	226	886	1,192	3,749	4,881	OSR
2012	254	723	60	1,038	1,080	4,045	5,305	OR - includes widow and yellowtail
2013	202	475	140	817	1,080	4,045	5,305	OR
2014	170	717	98	985	1,811	4,081	5,374	OR[b]
2015	210	842	56	1,107	1,811	4,081	5,374	OR
2016	156	1,033	92	1,281	2,308	5,773	7,424	OR
2017	114	785	71	970	2,308	5,773	7,424	OR

[a]The total OR catch includes Gulfwide catch of northern rockfish, catch by region are not currently available.

[b]Beginning in 2014, the Apportioned ABCs for the Western and Central GOA were combined, and thus the catch for those regions was also combined. They are left separate here for the sake of demonstration.

Table 16.4. Estimated discard rates for the Other Rockfish stock complex.

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	732.0	1,069.1	68%
2004	569.6	959.8	59%
2005	300.9	699.5	43%
2006	797.2	1,099.9	72%
2007	269.1	696.6	39%
2008	442.5	768.9	58%
2009	494.2	903.8	55%
2010	579.3	975.2	59%
2011	472.3	894.3	53%
2012	520.9	1,037.9	50%
2013	558.4	816.7	68%
2014	403.4	985.5	41%
2015	593.5	1,107.1	54%
2016	326.0	1,281.3	25%
2017	326.2	970.1	34%

Table 16.5. Time series of estimated catches 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 to the "Minor" 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 13, 2017.

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	366.1	52.4	31.0	78.3	9.6	200.4	31.3	769.2
2009	517.7	46.3	34.2	84.2	22.9	166.9	31.7	903.9
2010	446.1	65.4	77.3	122.2	35.6	200.0	28.9	975.6
2011	368.2	71.8	79.2	91.4	92.5	176.4	17.1	896.6
2012	566.6	38.2	60.7	98.9	40.5	200.3	32.7	1,037.9
2013	369.1	89.5	43.6	75.7	24.6	160.3	53.9	816.6
2014	509.2	75.3	94.2	94.8	35.2	135.7	40.9	985.3
2015	609.4	57.7	44.3	92.4	60.9	188.9	53.9	1,107.5
2016	648.9	81.3	136.2	182.7	66.2	120.6	45.5	1,281.4
2017	509.7	55.0	69.1	145.9	52.4	90.9	47.1	970.1

Table 16.6. 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.

	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	683.2	226.6	26.2				
2004	269.2	582.3	77.7	30.5				
2005	64.6	516.1	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	439.0	50.4	29.0				
2009	403.3	402.8	83.1	14.6				
2010	365.3	438.6	131.3	40.1				
2011	300.9	365.7	189.7	38.0				
2012	254.5	722.9	37.5	23.0	44	606	230	3,165
2013	202.1	474.5	77.0	63.1	44	606	230	3,165
2014	169.8	717.6	60.0	38.0	1,031		580	2,469
2015	209.7	842.0	36.3	19.1	1,031		580	2,469
2016	155.6	1,033.3	52.7	39.7	1,534		574	3,665
2017	114.3	785.1	41.3	29.4	1,534		574	3,665

Table 16.7. 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, Other = primarily pot gear. “tr” represents trace amounts, those <0.5%.

	Slope sub-group			Demersal sub-group		
Year	HAL	TWL	Other	HAL	TWL	Other
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	16%	84%	tr	66%	34%	tr
2011	16%	84%	tr	66%	34%	tr
2012	10%	90%	0%	46%	54%	0%
2013	16%	84%	0%	58%	42%	0%
2014	10%	90%	tr	56%	44%	tr
2015	11%	89%	0%	52%	48%	0%
2016	10%	90%	tr	63%	37%	tr
2017	9%	91%	tr	58%	42%	tr

Table 16.8. 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 2017. 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.

		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%
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%
Redstripe	1984	0.0	138.8	5,225.2	5,364.0	41%
	1987	1,263.0	1,819.7	23,435.9	26,518.6	47%
	1990	0.0	14.7	27,049.2	27,063.9	52%
	1993	5.3	111.5	29,502.5	29,619.3	55%
	1996	152.1	90.8	14,721.0	14,963.9	54%
	1999	0.0	138.8	8,087.1	8,225.9	49%
	2001	2.5	124.2	0.0	126.7	60%
	2003	4.9	175.0	7,845.4	8,025.3	36%
	2005	2,796.2	12,826.8	6,079.5	21,702.5	58%
	2007	15.2	655.6	10,829.9	11,500.7	61%
	2009	1.2	48.3	1,542.0	1,591.5	46%
	2011	0.0	499.1	18,245.7	18,744.8	87%
	2013	17.8	8,721.5	1,131.8	9,871.1	87%
	2015	0.0	11,951.7	4,747.6	16,699.3	71%
	2017	72.8	15,710.1	14,378.5	30,161.4	54%

Table 16.8. Continued

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%
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%
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%
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	8,482.6	10,904.2	
	2013	0	31.8	4,451.4	4,483.2	
	2015	21.2	593.9	1,654.0	2,269.1	
	2017	1.8	33.3	4,643.6	4,678.7	

Table 16.8. Continued

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

Table 16.9. Research survey catch of Other Rockfish 1977 - 2016 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 2010)	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

Table 16.10. A description of the life history of each of the species within the Other Rockfish (OR) and complex along with mortality rates, maximum age, and female age and size at 50% maturity, where available. Size is fork length in cm. Area indicates location of study: California (CA), Oregon (O), British Columbia (BC), Gulf of Alaska (GOA), Eastern Gulf of Alaska (EGOA), and Washington (W). Mortality rates with no superscript have unknown methodology for their calculations.

Species	Mortality Rate	Max Age	Age at Maturity	Size at Maturity	Area	References
blackgill rockfish		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]	47		23	EGOA	8
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
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) Meyer and Failor 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 16.11. 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).

					95% Confidence Intervals	
	Western GOA	Central GOA	Eastern GOA	Gulfwide Total	Lower	Upper
1984	1,197.0	1,413.0	5,301.6	7,911.6	276.7	226,176.0
1985	1,197.0	521.9	12,338.3	14,057.3	2,115.0	93,432.3
1986	1,197.0	192.8	28,714.6	30,104.4	5,346.5	169,509.0
1987	1,197.0	71.2	66,826.7	68,094.9	32,949.8	140,727.0
1988	216.4	224.1	53,809.9	54,250.4	9,059.2	324,873.0
1989	39.1	705.1	43,328.5	44,072.7	7,462.9	260,275.0
1990	7.1	2,218.6	34,888.8	37,114.4	18,778.0	73,356.3
1991	14.4	2,960.1	27,596.3	30,570.8	5,785.3	161,544.0
1992	29.2	3,949.5	21,828.1	25,806.8	5,317.8	125,238.0
1993	59.3	5,269.5	17,265.6	22,594.4	13,157.9	38,798.7
1994	62.0	3,865.5	25,915.7	29,843.2	6,032.3	147,642.0
1995	64.8	2,835.6	38,899.5	41,799.9	7,769.8	224,875.0
1996	67.7	2,080.1	58,388.3	60,536.0	33,597.1	109,075.0
1997	57.1	2,246.1	40,141.3	42,444.5	7,436.9	242,242.0
1998	48.2	2,425.4	27,596.7	30,070.3	4,952.9	182,563.0
1999	40.6	2,619.0	18,972.5	21,632.1	7,365.5	63,532.2
2000	34.3	2,000.9	14,934.1	16,969.2	2,511.7	114,644.0
2001	28.9	1,528.6	11,755.3	13,312.8	1,582.2	112,019.0
2002	35.6	757.0	9,253.1	10,045.7	1,556.0	64,854.8
2003	43.8	374.9	7,283.6	7,702.2	3,457.4	17,158.7
2004	71.4	1,652.9	8,616.0	10,340.3	2,555.1	41,845.6
2005	116.6	7,287.2	10,192.1	17,595.9	10,074.9	30,731.2
2006	78.3	4,971.2	12,144.4	17,193.9	4,804.0	61,538.0
2007	52.5	3,391.3	14,470.8	17,914.6	9,874.2	32,502.2
2008	35.3	1,562.1	13,039.8	14,637.2	3,485.4	61,469.1
2009	23.7	719.6	11,750.3	12,493.5	6,610.5	23,612.1
2010	35.0	645.7	10,026.8	10,707.4	2,289.8	50,070.5
2011	51.6	579.4	8,556.1	9,187.1	3,427.5	24,624.9
2012	76.2	739.8	10,948.6	11,764.6	2,453.6	56,408.6
2013	112.4	944.7	14,010.0	15,067.1	6,503.3	34,908.3
2014	87.4	2,170.3	18,289.9	20,547.6	4,487.1	94,093.8
2015	67.9	4,985.9	23,877.3	28,931.1	11,616.9	72,050.8
2016	56.9	1,477.6	16,995.5	18,529.9	3,896.8	88,114.0
2017	47.7	437.9	12,097.1	12,582.6	5,096.0	31,068.1

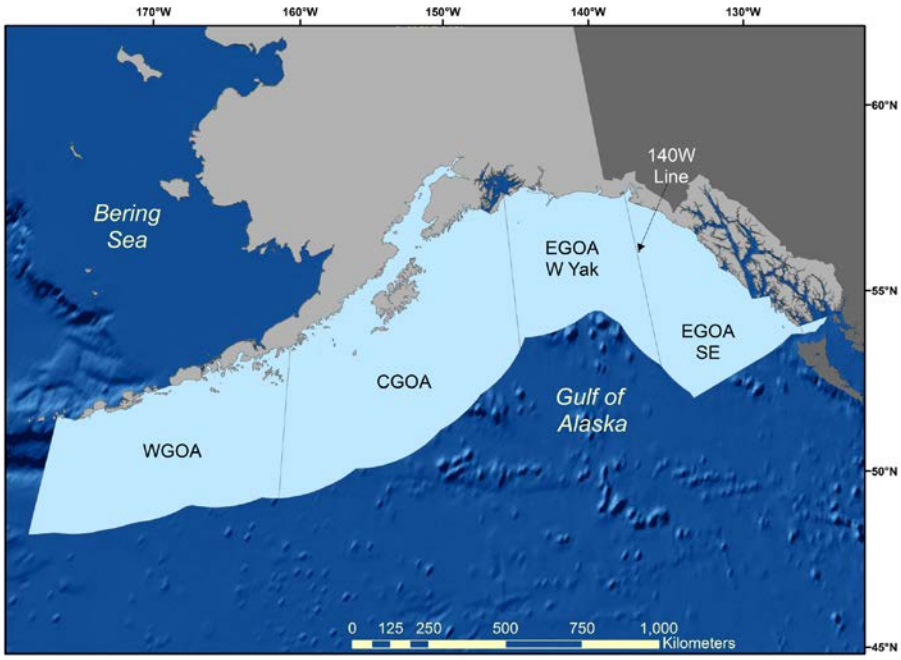
Table 16.12. Estimated random effects biomass by NMFS regulatory area and total Gulfwide biomass with 95% confidence intervals (CI) for the 17 Tier 5 species of Other Rockfish.

					95% Confidence Intervals	
	Western GOA	Central GOA	Eastern GOA	Gulfwide Total	Lower	Upper
1984	117.6	1,828.3	14,245.7	16,191.6	11,202.6	23,402.2
1985	391.6	4,086.2	24,304.1	28,781.9	5,324.2	155,590.0
1986	1,304.0	9,132.5	41,464.5	51,900.9	9,874.7	272,790.0
1987	4,341.8	20,410.9	70,741.2	95,494.0	55,797.8	163,431.0
1988	1,500.3	18,034.7	63,589.4	83,124.3	16,181.6	427,008.0
1989	518.4	15,935.1	57,160.6	73,614.1	14,093.1	384,517.0
1990	179.1	14,079.9	51,381.7	65,640.8	36,562.3	117,846.0
1991	155.3	12,364.6	52,894.0	65,413.9	12,075.0	354,366.0
1992	134.6	10,858.2	54,450.9	65,443.7	11,699.2	366,084.0
1993	116.7	9,535.4	56,053.5	65,705.6	34,732.0	124,301.0
1994	211.1	7,785.8	57,614.9	65,611.7	11,109.8	387,486.0
1995	382.0	6,357.2	59,219.6	65,958.8	10,941.4	397,626.0
1996	691.2	5,190.7	60,869.1	66,751.1	34,674.8	128,500.0
1997	471.0	7,170.9	63,682.4	71,324.4	11,991.2	424,242.0
1998	321.0	9,906.6	66,625.7	76,853.3	13,538.1	436,282.0
1999	218.7	13,685.9	69,705.1	83,609.7	50,450.6	138,563.0
2000	504.8	9,078.0	68,579.6	78,162.4	11,892.0	513,736.0
2001	1,164.9	6,021.6	67,472.3	74,658.8	7,790.8	715,453.0
2002	280.4	4,348.6	66,382.9	71,011.9	9,336.5	540,103.0
2003	67.5	3,140.4	65,311.1	68,519.0	26,642.9	176,214.0
2004	787.4	6,066.0	61,095.8	67,949.2	14,009.1	329,579.0
2005	9,186.3	11,716.8	57,152.6	78,055.6	48,244.6	126,287.0
2006	2,935.1	7,097.3	53,303.0	63,335.5	14,904.1	269,146.0
2007	937.8	4,299.2	49,712.8	54,949.7	36,176.7	83,464.5
2008	325.2	3,859.9	33,479.4	37,664.5	8,407.8	168,726.0
2009	112.8	3,465.6	22,546.9	26,125.2	17,841.6	38,254.8
2010	325.7	8,363.4	46,639.3	55,328.4	12,835.6	238,496.0
2011	940.9	20,183.3	96,475.8	117,600.0	68,055.0	203,214.0
2012	485.1	19,231.9	53,852.0	73,568.9	18,662.2	290,019.0
2013	250.1	18,325.4	30,059.7	48,635.2	29,320.3	80,673.8
2014	415.9	17,959.9	39,611.6	57,987.5	15,212.1	221,044.0
2015	691.7	17,601.8	52,198.8	70,492.3	41,587.9	119,486.0
2016	2,238.8	19,252.9	53,971.9	75,463.6	19,457.0	292,684.0
2017	7,245.8	21,058.9	55,805.2	84,109.9	47,403.2	149,240.0

Table 16.13. 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
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 Rockfrish	Quillback Rockfrish	
Redbanded Rockfish	Redbanded Rockfish	Redbanded Rockfish
Redstripe Rockfish	Redstripe Rockfish	Redstripe Rockfish
Rosethorn Rockfish	Rosethorn Rockfish	
Sharpchin Rockfish	Sharpchin Rockfish	Sharpchin Rockfish
Silvergray Rockfish	Silvergray Rockfish	Silvergray Rockfish
Splitnose Rockfish	Splitnose Rockfish	Splitnose Rockfish
Stripetail Rockfish	Stripetail Rockfish	Stripetail Rockfish
Tiger Rockfish	Tiger Rockfish	
Vermilion Rockfish	Vermilion Rockfish	Vermilion Rockfish
Widow Rockfish	Widow Rockfish	Widow Rockfish
Yelloweye Rockfish	Yelloweye Rockfish	
Yellowmouth Rockfish	Yellowmouth Rockfish	Yellowmouth Rockfish
Yellowtail Rockfish	Yellowtail Rockfish	Yellowtail Rockfish

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

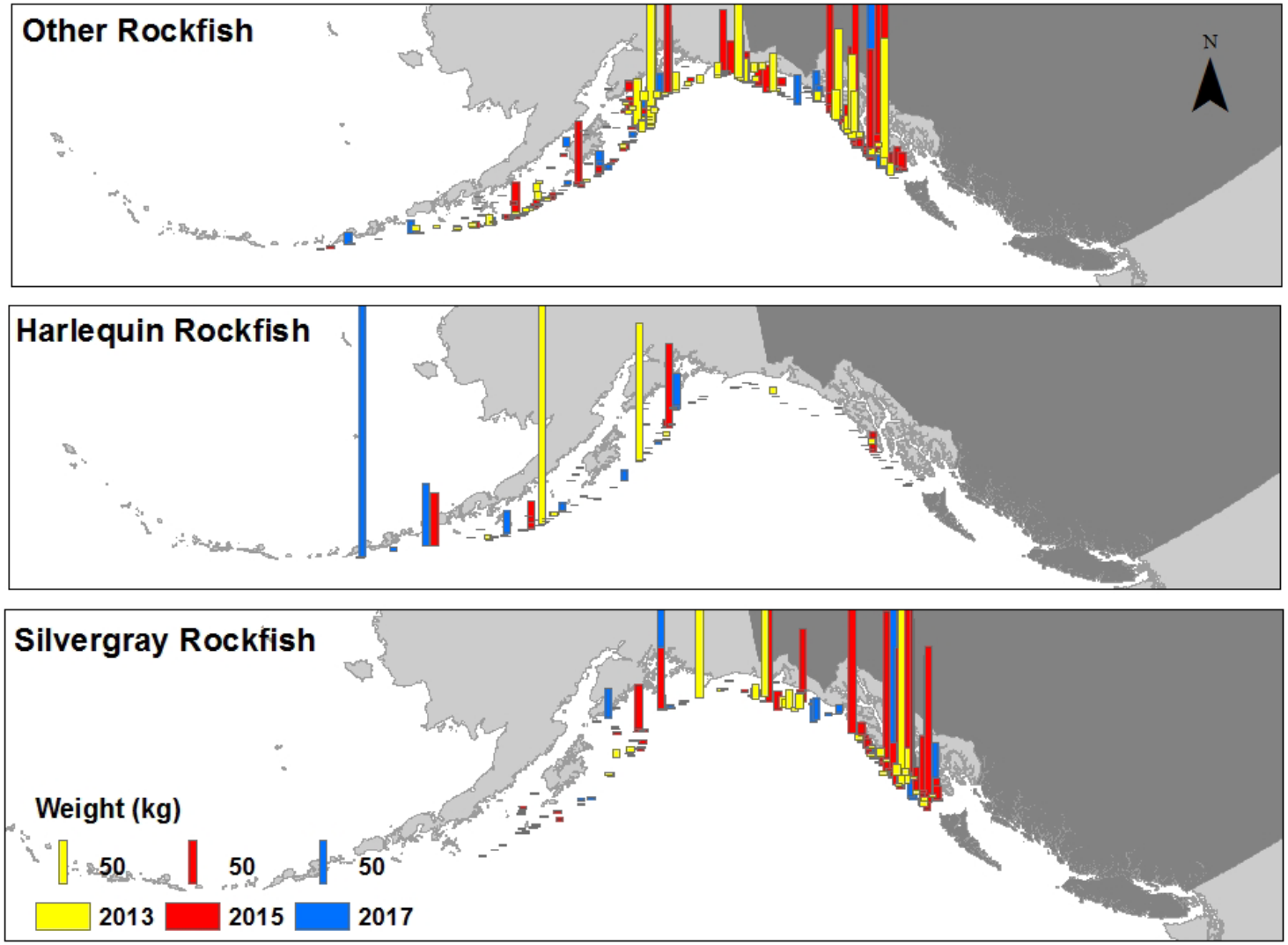


Figure 16.2. Spatial distribution of trawl survey catch in the Gulf of Alaska (GOA) from the three most recent National Marine Fisheries Service (NMFS) trawl surveys (2013, 2015, and 2017) for: (top panel) the Other Rockfish (OR) complex (with the exception of harlequin and silvergray rockfish); (middle panel) harlequin rockfish; and (bottom panel) silvergray rockfish.

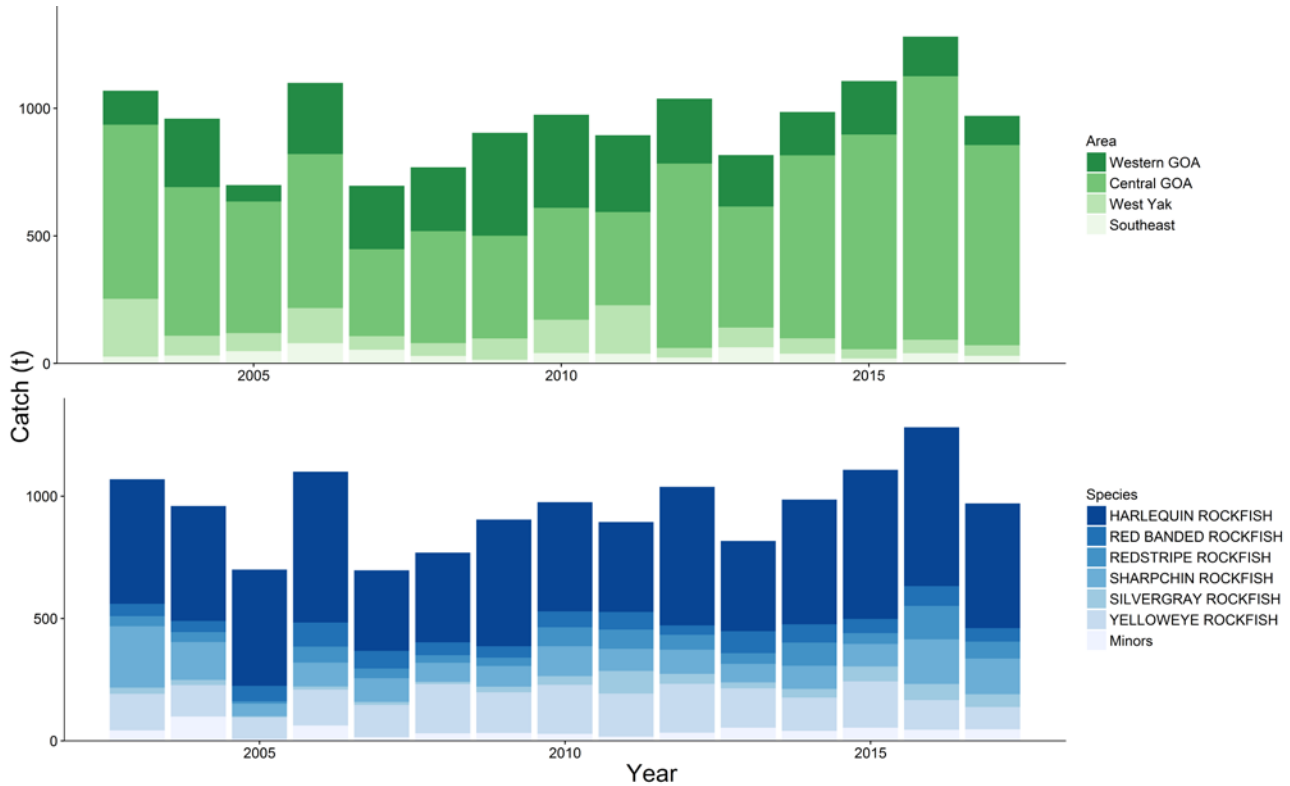


Figure 16.3. Estimated incidental catch (t) of Other Rockfish in Gulf of Alaska (GOA) by area (Western GOA, Central GOA, West Yakutat (West Yak), and East Yakutat/Southeast (Southeast)) and species. National Marine Fisheries Service Alaska Regional Office Catch Accounting System (queried through AKFIN on October 13, 2017).

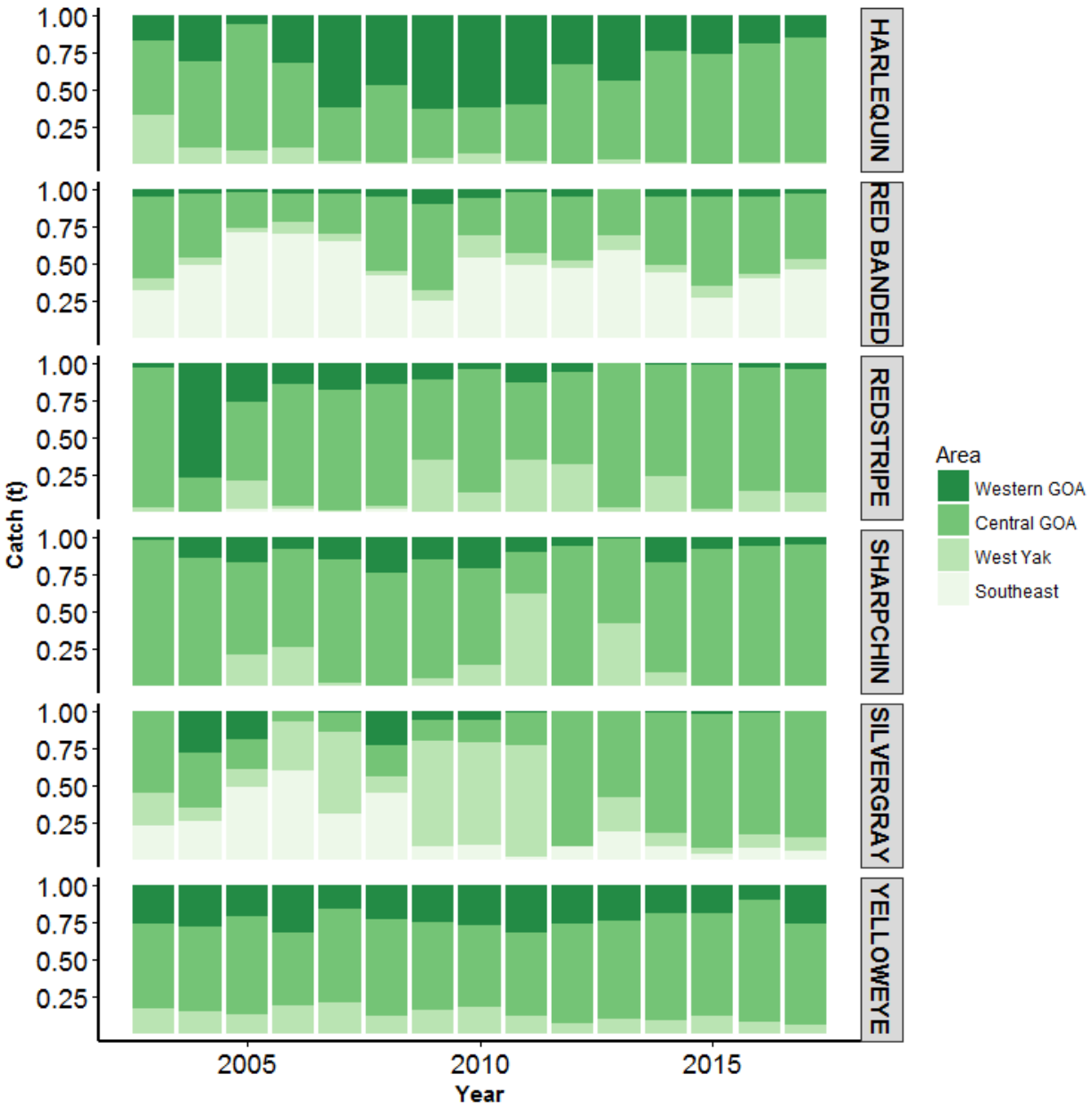


Figure 16.4. Proportion of catch by regulatory area (Western Gulf of Alaska (GOA), Central GOA, West Yakutat and East Yakutat/Southeast) for the six primary species of Other Rockfish. Note that the yelloweye rockfish panel does not include catch in the East Yakutat/Southeast regulatory area because that catch is included in the Demersal Shelf Rockfish complex. NMFS AKRO Catch Accounting System (queried through AKFIN on October 13, 2017).

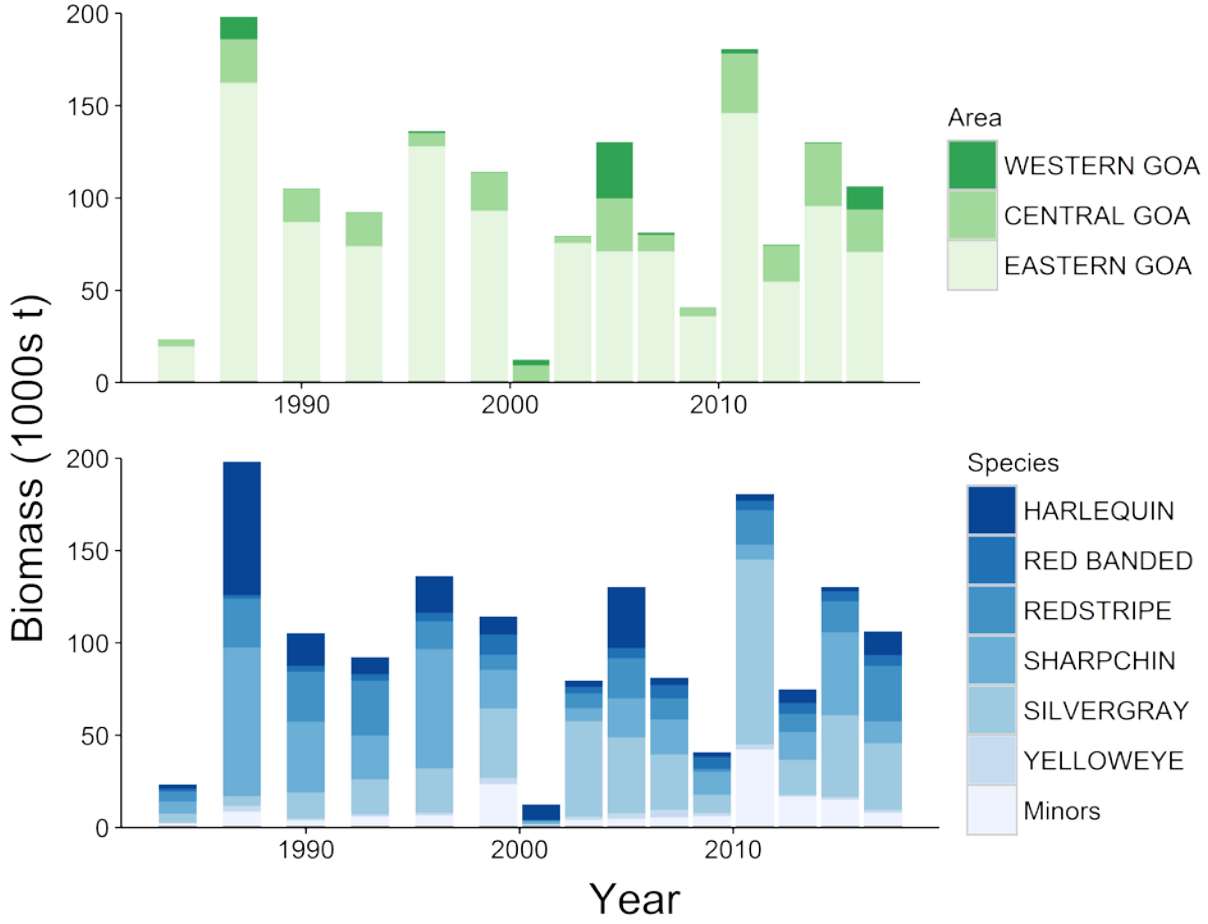


Figure 16.5. Trawl survey biomass estimates for the species in the Other Rockfish complex, by Gulf of Alaska (GOA) regulatory area (Western GOA, Central GOA, Eastern GOA) and by species (bottom).

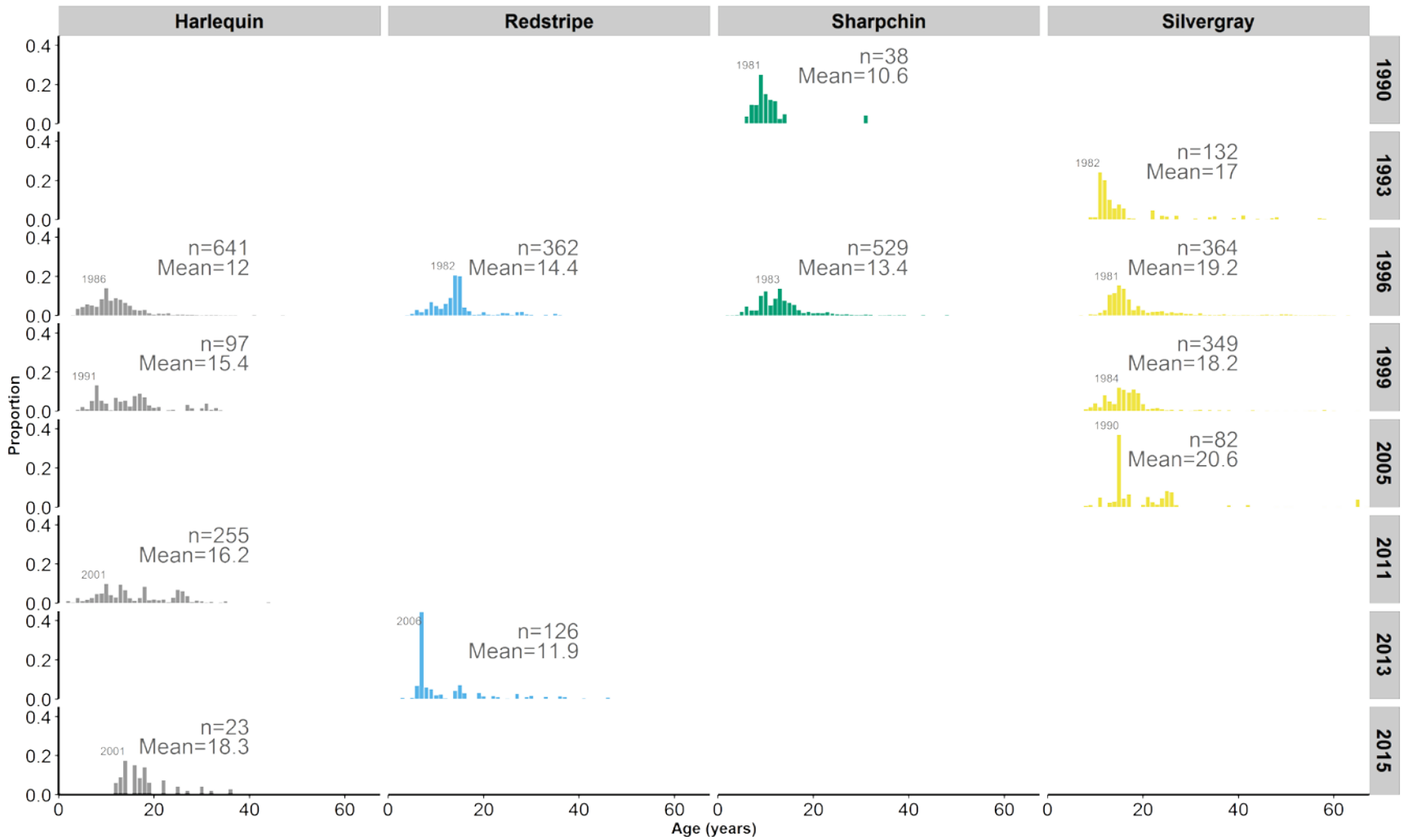


Figure 16.6. Age compositions of harlequin, redstripe, sharpchin and silvergray rockfish from the Gulf of Alaska (GOA) National Marine Fisheries (NMFS) bottom trawl survey. Sample size and mean age are presented for each species and survey year with age compositions available. The birth year of the largest cohort is labeled as well.

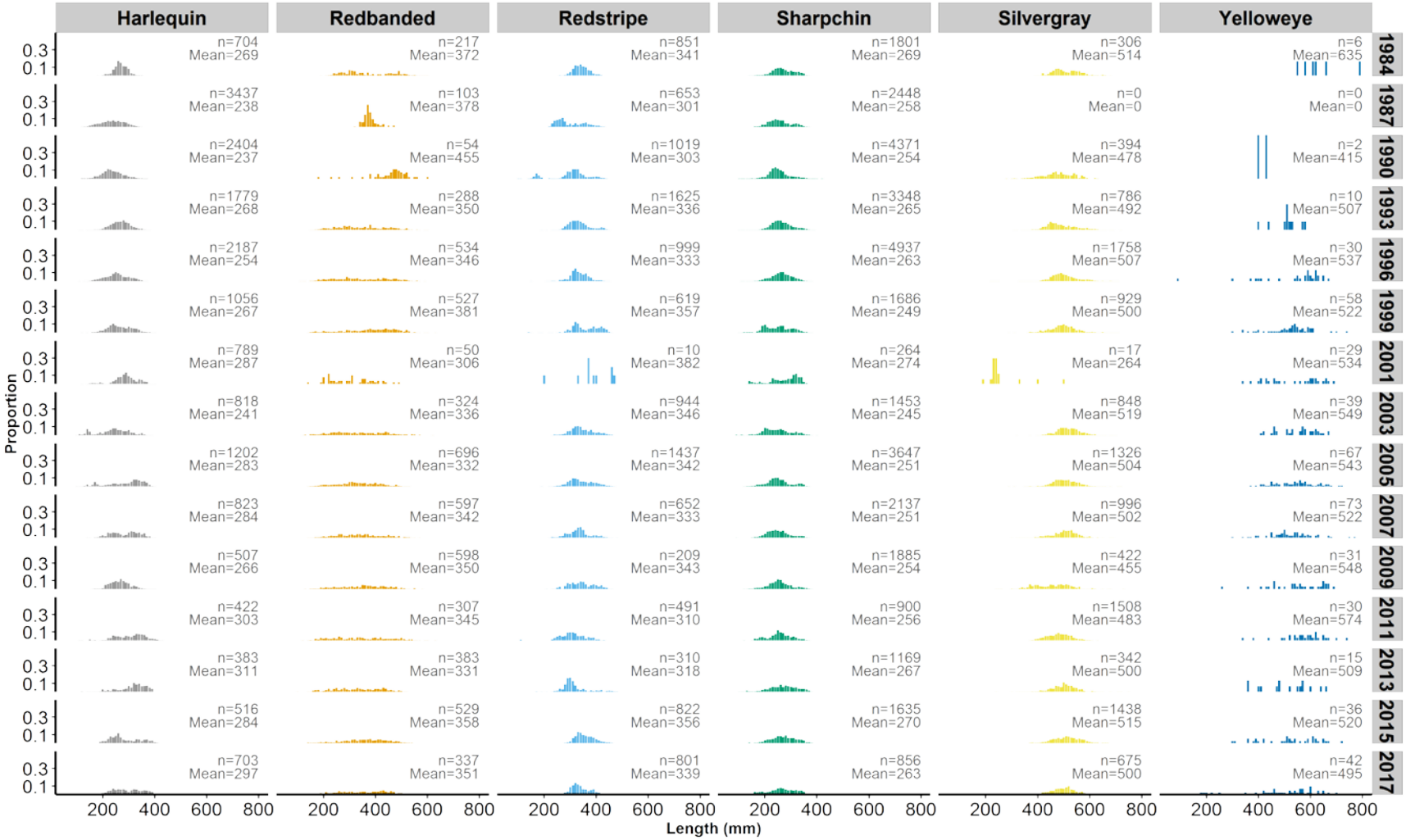


Figure 16.7. Size composition of the primary Other Rockfish (OR) species from the National Marine Fisheries Service (NMFS) bottom trawl survey. Sample size and mean length (mm) are presented for each of the primary species and survey year. Note that he survey did not sample the Eastern GOA in 2001, contributing to the low sample size.

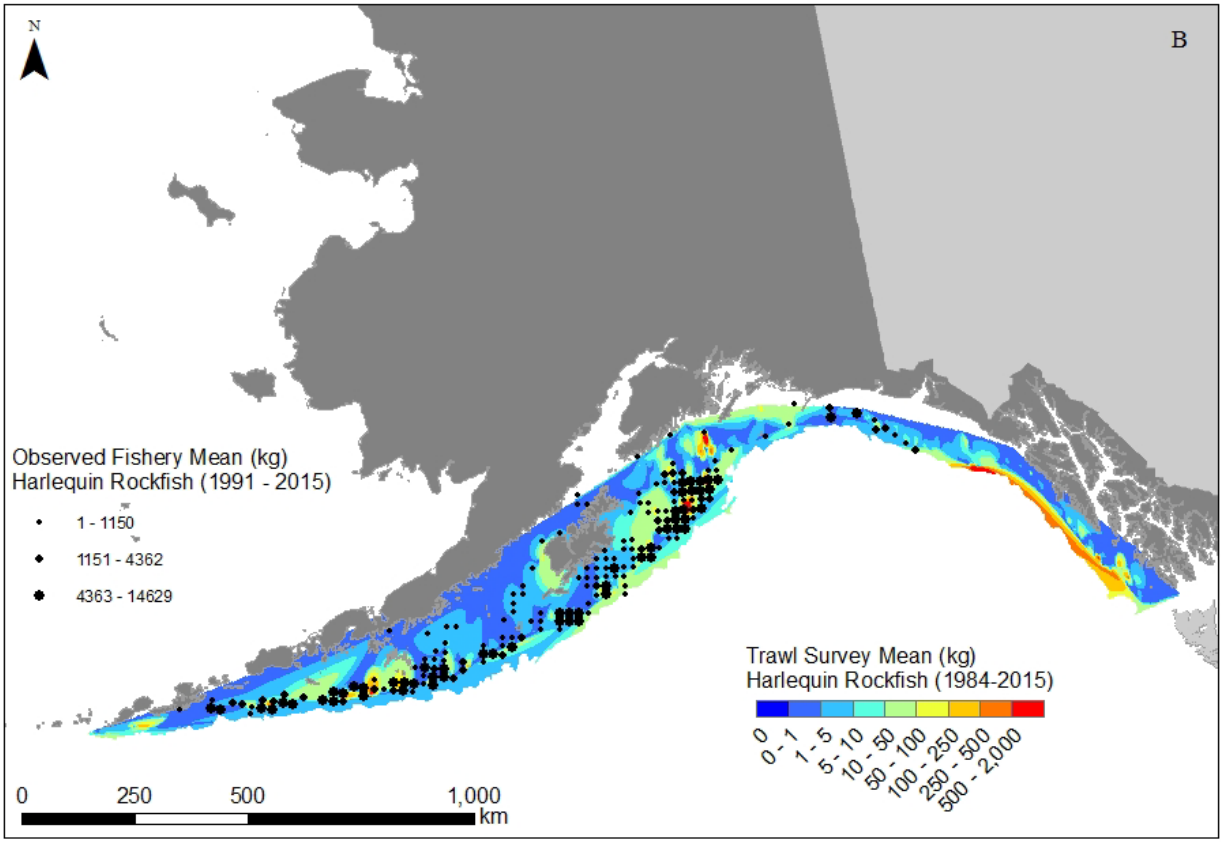


Figure 16.8. Distribution map of harlequin rockfish trawl survey mean kg per haul from 1984 – 2015 and observed fishery catch mean kg per haul (1993 – 2015). Data is through 2015 to match available non-confidential data from the fishery.

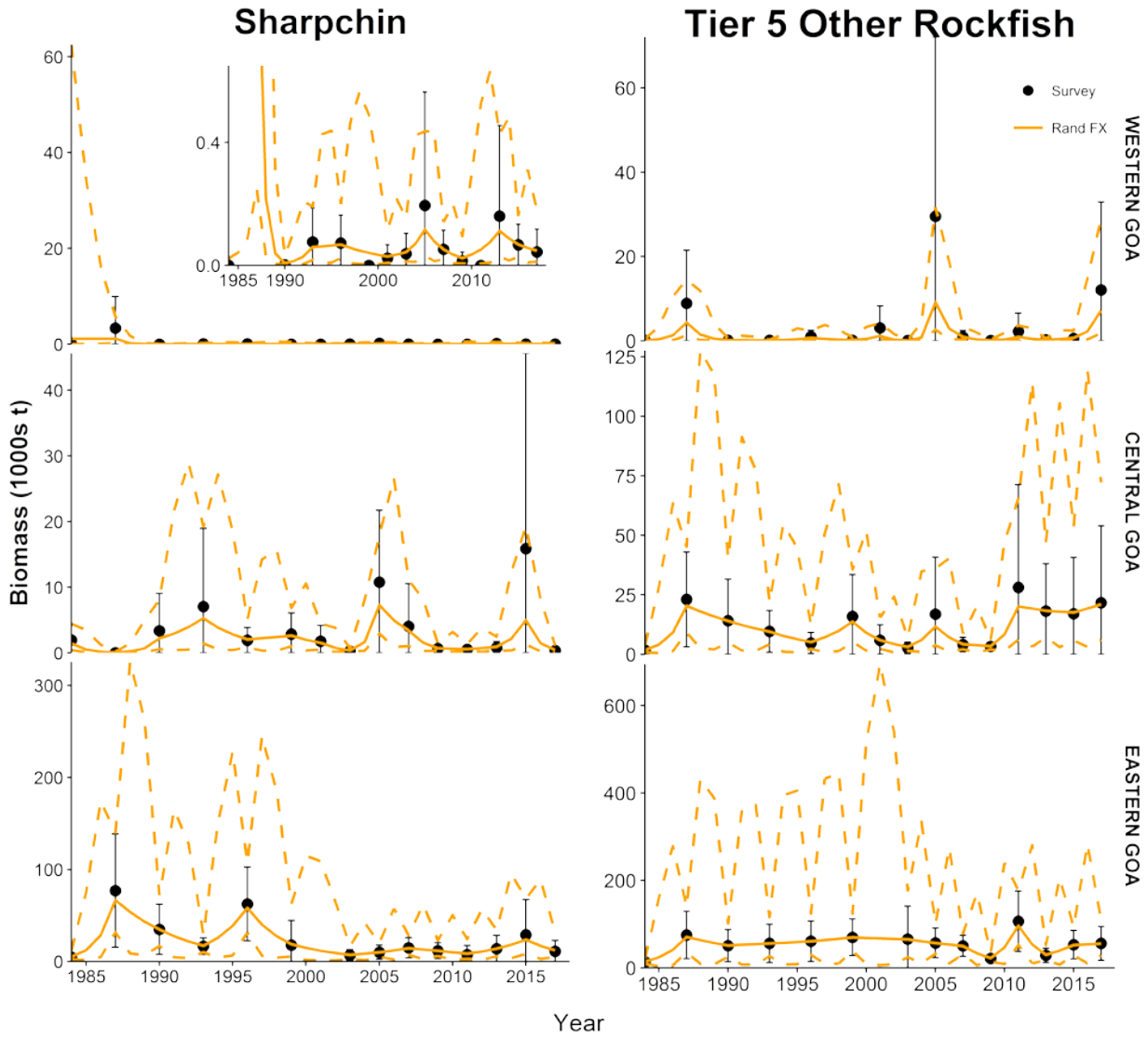


Figure 16.9. Estimated random effects biomass for sharpchin rockfish (left panel) and the 17 grouped Other Rockfish (OR) species (right panel) by NMFS regulatory areas: Western Gulf of Alaska (WGOA), Central GOA (CGOA) and Eastern GOA (EGOA). The regional model takes into account the missing survey in the EGOA in 2001. The inset in the WGOA sharpchin panel shows the same data as the panel, but zoomed in to show detail.