Gulf of Alaska Rockfish Stock Structure and Spatial Management Discussion Paper

September 13, 2024[1]

1 Introduction

In December 2023, the Council requested a discussion paper on spatial management of several rockfish stocks / stock complexes in the Gulf of Alaska (GOA).

Discussions at recent Groundfish Plan Team, Scientific and Statistical Committee (SSC), and Council meetings have questioned the appropriate spatial scale at which to manage these rockfish stocks in the GOA. At present, while the Overfishing Limits (OFL), Acceptable Biological Catch (ABC), and Total Allowable Catch (TAC) are specified at the GOA-wide level for these stocks / stock complexes, the ABC and TAC are further apportioned to GOA subareas. Highly variable survey biomass estimates that fluctuate across management areas can result in lower subarea catch limits that have restricted some fisheries in recent years.

The spatial management of rockfish, in general, is complicated both by biological factors (e.g., multiple species, biological diversity, overlapping distributions) as well as management factors (quotas managed variously across numerous spatial areas, management structures such as quota programs versus incidental catch in non-quota programs, and the overlay of historical subarea apportionments interacting with regulations and fisheries). As a result, during the December 2023 harvest specifications process, the SSC recommended that addressing the question of spatial management for several rockfish species simultaneously may allow comparison of biological processes and management goals across species, which may better inform and potentially create alignment of subareas across stocks and could facilitate public input on multiple stock issues.[2]

[1] For questions, contact Sara Cleaver (NPFMC) or Abby Jahn (NMFS AKRO).

[2] December 2023 SSC Final Report

For definition of acronyms and abbreviations, see online list: https://www.npfmc.org/library/acronyms

The Council asked that the discussion paper include:

1) the stock structure status for GOA shortraker rockfish, rougheye and blackspotted rockfish, and thornyhead rockfish[3] and the current ABC spatial management level; and

2) management or fishery implications resulting from alternative spatial apportionments of ABC (i.e, if there are no conservation concerns, what combinations of subareas are necessary to reduce or avoid fishery management implications).

The first part of the Council motion is addressed in this paper with a focus on the current spatial management and management triggers for these stocks (Section 2), and current information on their stock structure (Section 3). **The best scientific information available indicates no stock structure exists for shortraker rockfish, shortspine thornyhead (thornyhead) rockfish, or the Other Rockfish (OROX) complex in the GOA, whereas available data on the rougheye/blackspotted (RE/BS) rockfish complex suggests spatial structuring of the population.** However, as described in Section 3, life history, behavior, and movement information are lacking for each of these species, which adds to the uncertainty surrounding the appropriate spatial scale for managing these species.

Sections 4 and 5 highlight potential implications from alternative spatial apportionments, as well as options for next steps. Section 4 summarizes whether alternative spatial apportionments may be warranted or appropriate, and describes, at a high level, associated fishery and management implications. Section 5 considers issues pertinent to rockfish spatial management that could provide increased clarity and/or efficiency in the Council's harvest specifications process. These issues stem from concurrent discussions regarding spatial apportionment of rockfish ABCs during the last few harvest specifications cycles and which may continue to pose challenges if not addressed more holistically.

2 Background on Rockfish Management

2.1 Spatial Apportionment of Rockfish ABCs

Spatial apportionment of GOA rockfish ABCs, as well as the species categories for rockfish, have been changed numerous times since implementation of the GOA Fishery Management Plan (FMP).[4] While apportionment of catch limits may be influenced by biological factors (e.g., genetic diversity, concerns of localized depletion), subarea apportionments can have significant allocative implications. In some instances, additional biological information has provided for improved monitoring and assessment of certain stocks, allowing those stocks to be split from the species group and managed as a separate, single stock. One result of these changes is narrower "boxes" within which each stock is managed (i.e., smaller subarea ABCs). In recent years, lower catch limits, when apportioned across subareas or further allocated to specific programs, have led to catch overages or near overages in some fisheries that catch certain rockfishes. Below, we describe the management and catch history for these stocks. Summaries of key management measures, such as changes in species assemblages, and catch history for these stocks or complexes are detailed in the respective SAFE documents for each stock or complex (Echave et al., 2023; Sullivan et al., 2023; Echave et al., 2022; Omori et al., 2023).

GOA Groundfish management areas are shown in Figure 1, and current spatial apportionments for the applicable rockfish stocks are shown in Table 1. Currently, shortraker rockfish, RE/BS rockfish, and thornyhead rockfish ABCs are apportioned between the Western (WGOA), Central (CGOA), and Eastern GOA (EGOA). In recent years, OROX has been apportioned between WGOA/CGOA, Western Yakuat

[3] The Council also noted that the Other Rockfish stock complex could be included in the paper if staff indicate it would be appropriate.

[4] See for GOA Groundfish Harvest Specifications (including apportionments thereof) 1986-present https://www.fisheries.noaa.gov/s3/2024-03/GOA-harvest-specs-1986-2024-508.pdf

(WY), and Southeast Outside (SEO).[5] Beginning in 2024, the OROX ABC is apportioned between SEO and the rest of the GOA (WGOA/CGOA/WY).[6] Subarea TACs for these species in the GOA are typically set equal to the corresponding subarea ABC apportionments, except for OROX in the SEO subarea and GOA wide area.

Figure 1 Management Area for the FMP for Groundfish of the GOA. The WGOA includes the Shumagin district (610), CGOA Regulatory Area (CGOA) is divided into the Chirikof (620) and Kodiak (630) districts, and the EGOA is divided into the Western Yakutat (WY, 640) and Southeast Outside (SEO, 650) districts.

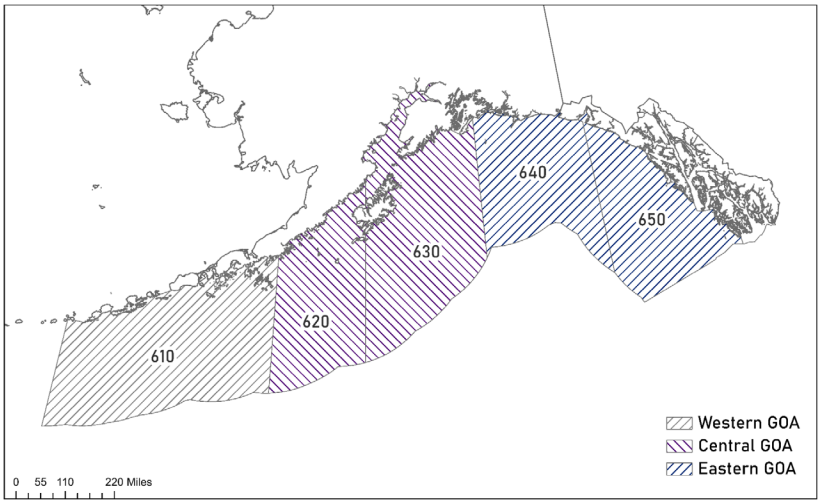

Table 1 Final 2024 Harvest Specifications for GOA shortraker rockfish, RE/BS rockfish, thornyhead rockfish, and Other rockfish

Species/Stock	Subarea/Reporting Area	2024 OFL	2024 ABC	2024 TAC
Shortraker Rockfish	W	n/a	34	34
	C	n/a	189	189
	E	n/a	424	424
	Total	863	647	647
Rougheye and Blackspotted Rockfish	W	n/a	197	197
	C	n/a	315	315
	E	n/a	525	525
	Total	1,555	1,037	1,037
Thornyhead Rockfish	W	n/a	314	314
	C	n/a	693	693
	E	n/a	621	621
	Total	2,170	1,628	1,628
Other Rockfish	W/C/WYAK	n/a	1,353	1,353
	SEO	n/a	2,421	300
	Total	4,977	3,774	1,653

Recommended on an annual basis by the SSC, these ABC apportionments, often referred to as "subarea ABCs" do not represent the specification of the "true" ABC, despite their misleading naming convention. National Standard 1 Guidelines require that the ABC, like OFL, must be specified at the stock or stock complex level. Additionally, the Council has set ACL to equal ABC, which is hardwired into the groundfish FMPs and is not an annual decision (GOA FMP Section 3.2.3.3.2). While exceedances of subarea ABCs do not necessitate management "triggers" associated with accountability measures (AM),[7] the Council's current harvest specifications process relies on these apportionments to develop subarea TACs. These subarea TACs are used by NMFS to manage at the level of each regulatory area, and do

[5] " / " indicates combined subareas.

[6] See Council motions Oct 2023 (Proposed Harvest Specifications), Dec 2023 (Final 2024 Harvest Specifications). In December 2023, the Council deferred to the SSC recommendation for spatial apportionment that the Western Yakutat subarea ABC be combined with the Western/Central GOA subarea ABC for 2024.

[7] 50 C.F.R. § 600.310(f)(4)(i) and 50 C.F.R. § 600.310(g).

have associated management triggers, described in the following sections. Inseason management actions and triggers associated with overages or potential overages for these rockfish stocks can vary by fishery or program. Below, we describe the current management structure and recent catch and inseason actions applicable to shortraker rockfish, RE/BS rockfish, thornyhead rockfish, and OROX. See Appendix 1 for figures comparing recent catch with subarea TACs for these stocks.

2.2 Inseason Fisheries Management and Rockfish Catch History

NMFS Inseason Management may determine that a TAC for a target species in any regulatory area is not large enough to support directed fishing and the TACs are needed as incidental catch allowance (ICA) to support incidental catch of these species in other directed fisheries. In such cases, NMFS Inseason Management will prohibit directed fishing in the area (50 CFR 679.20(d)(1)(iii)(A)). This means that the fishery is placed on **'bycatch status'** for that season or for the remainder of the year.

In all sub-areas of the GOA, fisheries for shortraker rockfish, thornyhead rockfish, RE/BS rockfish, and OROX typically start the season/year on bycatch status. However, these directed fishery closures do not apply to cooperative participants in the CGOA Rockfish Program (RP). For non-RP participants in all sub-areas of the GOAs, these stocks are managed inseason through Maximum Retainable Amounts (MRAs) and Maximum Commerce Amounts (MCAs). With few exceptions, these rockfish are retained as incidental catch and are mostly taken in fisheries targeting other species, such as Pacific ocean perch (POP) or sablefish. Shortraker rockfish, thornyhead rockfish, and RE/BS rockfish can be important "top off" species in non-directed fisheries.

In the CGOA, a portion of these rockfish TACs are allocated to the RP. However, these species are not exclusively caught by vessels participating in the Rockfish Program. These species may also be caught by trawl, hook-and-line, pot, and jig gear in the CGOA, and continue to be managed through MRAs and MCAs for those vessels not in the RP. The RP assigns quota share and cooperative quota (CQ) to participants for these species and allows a participant holding a License Limitation Program (LLP) license with rockfish CQ to form a rockfish cooperative with other persons, and allows holders of CP LLP license to opt out of the Program. Most vessels in the RP use trawl gear, though there is a small entry-level longline fishery. Under the RP:

- Portions of the shortraker rockfish and RE/BS rockfish TACs are allocated to the CP cooperatives and the remainder is available to non-RP fisheries.
- A portion of the thornyhead rockfish TAC is allocated to the catcher vessel (CV) and CP cooperatives and the remainder is allocated to non-RP fisheries (see Table 2 as an example for 2024).
- Cooperatives are prohibited from exceeding their allocations (§ 679.7(n)(6)(viii)) and overages are handled by NOAA Office of Law Enforcement (OLE) rather than Inseason Management.

These allocations are set in regulation at Table 28c to 50 CFR part 679—Allocation of Rockfish Secondary Species, which implemented the RP (GOA Groundfish FMP Amendment 88). These 'secondary species' may be taken as a directed fishery in the RP if sufficient CQ is available, or they may also be taken as incidental species (i.e., caught in non RP fisheries). In recent years, lower TACs have accordingly resulted in reduced quantities of CQ in the RP. OROX are not a RP species and are not allocated to RP cooperatives, therefore OROX are managed through MRAs and MCAs in the CGOA as well as other regulatory areas. Directed fishing for this species is closed to RP participants, but incidental catch may occur by RP participants and in non RP fisheries.

Table 2 2024 Apportionments of shortraker rockfish, rougheye/blackspotted rockfish, and thornyhead rockfish to Rockfish Program CV and C/P cooperatives (rounded mt) in the CGOA.

Rockfish secondary species	Central GOA annual TAC	CV Cooperatives	CP Cooperatives
Shortraker rockfish	189	0	76
Rougheye/blackspotted rockfish	315	0	185
Thornyhead rockfish	693	54	184

Inseason Management monitors the catch of species that are closed to directed fishing for non RP fisheries but open to the RP, as is the case for thornyhead rockfish, RE/BS rockfish, and shortraker rockfish. If Inseason Management determines that an annual (subarea) TAC will be reached in any regulatory area, they will place a species or species group on **'PSC status'** for that regulatory area. Because rockfish TACs are managed by GOA regulatory areas, a species could be on PSC status in one regulatory area but remain open or in bycatch status in another regulatory area.

Typically, PSC status indicates that a species is prohibited for retention § 679.20(d)(2) and that species must be discarded at sea. However, there are exceptions. In the RP, cooperatives self-manage to their annually allocated CQ which may not be exceeded, so inseason actions such as a species being placed on PSC status do not apply to vessels fishing these secondary species.[8] Additionally, retention requirements vary by gear type. For fixed-gear CVs, PSC status would require that no amount of that rockfish species may enter commerce through sale, barter, or trade except as fish meal, however, full retention is still required by these vessels. This is due to full retention requirements that went into effect in 2020 (85 FR 9687, 50 CFR 679.20(j)(4)). PSC status may limit the fishing behavior of "topping off" on that species, as there is no incentive for vessels to catch fish they must discard or those they must retain but are unable to sell.

Table 3 displays the instances where NMFS placed species on PSC status because the TAC for a regulatory area or areas was exceeded for shortraker rockfish, thornyhead rockfish, or OROX between 2014 and 2023. There were no instances of subarea TAC exceedances for RE/BS rockfish during this timeframe. Additionally, there were no instances of reaching the GOA-wide ABC (ACL) or OFL for any of these stocks.

[8] The exception to this is OFL closures which NMFS can utilize as an accountability measure for any fishery.

Table 3 PSC Status 2014-2023

Year	Species	Area	PSC Status
2014	Thornyhead rockfish	W	11/13/2014
2016	Shortraker rockfish	W	9/19/2016
2016	Shortraker rockfish	C	9/19/2016
2017	Shortraker rockfish	W	10/16/2017
2018	Shortraker rockfish	C	11/9/2018
2021	Other rockfish	W/C	8/30/2021
2022[9]	Shortraker rockfish	C	10/25/2022
2023	Other rockfish	W/C	11/13/2023

3 Information on Rockfish Stock Structure

Detailed information on rockfish stock status, life history, and stock structure information can be found within the associated Stock Assessment and Fishery Evaluation (SAFE) (Echave et al., 2022; Echave et al., 2023; Omori et al., 2023; Sullivan et al., 2023). Summary tables of available information on stock structure for shortraker rockfish, thornyhead rockfish, RE/BS rockfish, and OROX, as well as the stock structure template, are included in Appendix 2.

These rockfish are long-lived, relatively slow-growing fishes for which life history, behavior, and movement information is lacking in the GOA. Standard bottom trawl and longline surveys conducted by the AFSC provide much of the information about these stocks. Because the trawl and longline surveys differ in the habitats and depths that are sampled, each survey captures a different element of the population. Historically, assessment authors have been uncertain whether the trawl surveys are accurately assessing abundance of shortraker and thornyhead rockfish. Approximately 18% of the GOA trawl survey area consists of steep, rocky habitat (Brian et al., 2023). While this habitat is important for many rockfishes, it is not accessible to the survey trawl gear. Survey estimates of groundfish abundance from trawlable grounds are expanded across the entire GOA region, including across untrawlable habitat. Therefore, survey abundance estimates could potentially be biased as a result of sampling that does not spatially represent all of the available rockfish habitat circumscribed by the GOA study area. In contrast to the survey, trawl gear used in the fishery is designed in such a way that it can access high relief habitat. As a result of this potential for bias, sampling plans for surveying fish in untrawlable habitats in the GOA using acoustics, eDNA, and underwater cameras are being developed for future implementation (N. Laman, AFSC, personal communication). Research on untrawlable habitat will continue to be important for producing the most accurate stock assessments possible for species such as rockfishes that inhabit these inaccessible areas, and that are particularly vulnerable to overfishing because they are long-lived and reproduce late in life.

The AFSC domestic longline survey in the GOA effectively samples stations that are systematically distributed along the upper continental slope and various gullies inhabited by shortraker, thornyhead, and RE/BS rockfish, and provides supplementary information including estimates of relative abundance and spatial distribution.

[9] In 2022, Other Rockfish exceeded the W/C TAC but was not placed on PSC status due to a delayed accounting in catch.

3.1 Shortraker rockfish *(Sebastes borealis)*

Shortraker rockfish ranges from Hokkaido Island, Japan, north into the Sea of Okhotsk and the Bering Sea, and through the Aleutian Islands and GOA south to southern California. Its center of abundance appears to be Alaska waters. In the GOA, adults of this species inhabit a narrow band along the upper continental slope at depths of 300-500 m; outside of this depth interval, abundance decreases considerably (Ito 1999). Growth differences (length and weight at age) among regions in the GOA are insignificant, but there has been evidence of regional differences in size compositions: shortraker rockfish are generally larger in the EGOA (Echave et al., 2023).

The trawl survey indicates that the EGOA and CGOA regions have the highest shortraker rockfish biomass whereas the lowest estimates are in the WGOA region. In contrast, the sampling conducted by the AFSC longline survey in the WGOA and CGOA has historically displayed similar relative population weight (RPW) values, while the EGOA RPW estimates have always been significantly higher.

In recent years, fishing mortality rates have been low and catches are below the ABC (the gulfwide, or "true," ABC for the stock). Fishery effort matches survey catch distribution when looking at both trawl and longline survey data combined. While the overall population trend is relatively stable, biomass estimates for the CGOA have been trending downward. Whether this is an actual decline, or an artifact of faulty surveys is unknown.

Shortraker rockfish catches in the GOA are near 50% of maximum permissible and risk of overfishing is low, however, the subarea ABCs have been exceeded at times in the Western and Central GOA. The estimated amount of shortraker rockfish biomass from the trawl survey in the Western and Central GOA has been decreasing. Reasons for this decrease are unknown, but due to the previously stated concerns over the accuracy of the trawl survey to sample this species, these overages may not be a conservation concern. Shortraker rockfish are more abundant on the longline survey in the WGOA than the trawl survey, and the spatial distribution of longline survey abundance matches fishery effort. While survey and fishery information indicate that abundance levels differ among the regions, mixing and dispersal of fish among areas is unknown.

Recent comparison of genetic samples from Oregon and Washington with those from the BSAI did not find genetic structure, indicating high gene flow in this species across nearly their full species range (W. Larson, AFSC, pers. comm.). Findings in the most recent stock structure template (**unable to differentiate stocks across regions based on demographics; Echave et al., 2016) in addition to the more recent genetic analysis** (W. Larson, AFSC, pers. comm.), **indicate no stock structure for shortraker rockfish in the GOA. The SSC concurred with the authors and GOA GPT that "there is no evidence of conservation concern for this stock at a subarea level at this time and that current subarea ABCs area may be overly conservative"** (NPFMC SSC, 2023; Appendix 3).

Current apportionment of shortraker rockfish ABC utilizes the REMA model fit to area-specific biomass from the trawl survey and RPWs from the longline survey, and subsequent proportions of biomass by area (W/C/EGOA) are informed by the proportion of trawl survey biomass by area.

3.2 Rougheye and blackspotted rockfish (*Sebastes aleutianus* and *Sebastes melanostictus*)

Rougheye and blackspotted (RE/BS) rockfish inhabit the outer continental shelf and upper continental slope of the northeastern Pacific. Their distribution extends around the arc of the North Pacific from Japan to Point Conception, California and includes the Bering Sea (Kramer and O'Connell, 1988). The two species experience extensive geographic overlap, ranging primarily from southeast Alaska through the Aleutian Islands (Gharrett et al., 2005; Orr and Hawkins, 2008); however, rougheye rockfish extend farther south along the Pacific Rim, while blackspotted rockfish extend into the western Aleutian Islands (Orr and Hawkins, 2008). Like shortraker rockfish, adult RE/BS rockfish in the GOA inhabit a narrow band along the upper continental slope at depths of 300-500 m; outside of this depth interval, abundance decreases considerably (Ito, 1999).

The most recent stock structure evaluation for RE/BS rockfish was finalized in 2010 and determined that contemporary survey and fishery data were consistent with population structure by eastern, central, and western GOA management areas (Shotwell and Hanselman, 2010). Their analysis, which was based on data with both species combined, showed opposite trajectories for population trends by area, significantly different age, length, and growth parameters by area, and significant differences in parasite prevalence and intensity by area. Updated time series from the AFSC longline and bottom trawl surveys suggest these results are still valid.

When the 2010 stock structure evaluation was published there were substantial data gaps informing biological differences between the two species. Since this time, several studies have closed these data gaps. For example, Conrath (2017) demonstrated significant differences between their maturation rates, with blackspotted rockfish maturing more slowly and at older ages than rougheye rockfish (median age of maturity for blackspotted and rougheye rockfish is 27.4 y and 19.5 y, respectively). Using genetics data collected on the 2009 AFSC bottom trawl survey, Shotwell et al. (2019) found rougheye rockfish grow significantly faster and typically attain a slightly greater maximum size than blackspotted rockfish. Unpublished analysis of genetics data collected on 2013 and 2015 bottom trawl surveys corroborate these results (J. Sullivan, AFSC, pers. comm). While Shotwell and Hanselman (2010) found significant differences in RE/BS rockfish growth by GOA management area using data with both species combined, no studies have evaluated spatial differences in species-specific growth or maturity for GOA RE/BS rockfish.

Shotwell and Hanselman (2010) also indicated that differences in growth and maturity could result in disproportionate harvest rates. They emphasized misidentification rates as a key challenge for monitoring and the importance of genetics data and other methods for corroborating species-identifications. While genetics remains the gold standard, Harris et al. (2019) found that RE/BS rockfish could be speciated with reasonably high accuracy (86-97% of the time, respectively) using otolith morphometrics, fish weight, and age. This method has the benefit of being more cost effective than genetics but can also be applied retroactively to archived otoliths in order to develop species-specific time series of age compositions.

When the 2010 stock structure evaluation was developed for RE/BS rockfish, genetic studies had primarily focused on the speciation of the RE/BS rockfish complex. At the time, consistencies between the two species suggested population structure by management area (Shotwell and Hanselman, 2010). Specifically, Gharrett et al. (2007) found that dispersal distance for blackspotted rockfish in the GOA was consistent with management areas, while rougheye rockfish in the northeastern GOA may exhibit finer scale population structure. These studies and their findings are no longer believed to reflect best available science (W. Larson, pers. comm). More recently, genetic structure of blackspotted rockfish was reevaluated with low coverage whole genome resequencing using data from millions of markers (W. Larson, pers. comm.). Samples from Oregon and British Columbia were compared with samples from the GOA, BS, and AI, and no genetic structure was detected, indicating high gene flow in this species across nearly their full species range.

Currently, GOA RE/BS rockfish is managed as a Tier 3 species. Despite several layers of precautionary management, including being closed to directed fishing outside of the Rockfish Program (as a secondary species), relatively low MRAs, and subarea ABCs and TACs, recent assessments have reported declining abundance and spawning stock biomass for this stock (Sullivan et al., 2023).

As of 2023/2024, spatial apportionment method for RE/BS rockfish is as follows:

- The ABC is apportioned among the western, central, and eastern GOA management areas based on the REMA model, which smooths trends in both bottom trawl and longline survey indices of abundances (Sullivan et al., 2023).
- The apportionment method averages proportions of both the REMA-predicted biomass from the bottom trawl survey and the REMA predicted relative population weights from the longline survey, thus balancing data conflict between the two surveys (Sullivan et al., 2023).

Consistent differences in RE/BS rockfish abundance trajectories, age, and length compositions by area suggest spatial structuring of the population that warrants continued apportionment of ABCs to the subarea level.

3.3 Thornyhead rockfish (*Sebastolobus alascanus*)

The trawl survey indicates that the EGOA and CGOA have the highest thornyhead rockfish biomass whereas the lowest estimates are in the WGOA. Sampling on the longline survey has shown the WGOA to have a great amount of variability in relative population weight (RPW) values, while both the EGOA and CGOA RPW estimates have been higher and similar.

In recent years, fishing mortality rates have been low and catches are below the ABC (the gulfwide, or "true," ABC for the stock) and below subarea ABCs, with the exception of 2014 in the WGOA (Table 3). Catch occurs gulfwide around the continental slope. Fishery effort matches survey catch distribution when looking at both trawl and longline survey data combined. The overall population trend has been trending downward in all areas. Reasons for this decrease are unknown, but due to the previously stated concerns over the accuracy of the trawl survey to sample this species, these overages may not be a conservation concern. While survey and fishery information indicate that abundance levels differ among the regions, mixing and dispersal of fish among areas is still largely unknown.

One review of tagging data show that the majority of tagged thornyhead rockfish show little to no movement: 19% traveled < 2 nautical miles (nm) between tagging and recovery location, 36% traveled 2 – 5 nm, 18% traveled 6 - 10 nm, 12% traveled 11 – 50 nm, 4% traveled 51 – 100 nm, and 11% traveled >100 nm. There was no significant difference in movement by fish size and all fish included in the analysis were assumed mature. Fish that were tagged and released in the EGOA were more inclined to move than fish from other areas. These regional differences in recapture patterns may highlight an actual propensity for movement from the EGOA, or reflect geographic differences in fishing effort, particularly at depth. Of the 102 recoveries that were released in the EGOA, 76% remained within the EGOA, 18% were recovered in British Columbia, Canada, 5% were recovered in the CGOA, and 1% were recovered on the West Coast. Overall, the majority of recovered thornyhead rockfish remained within their management area of release, and very near their actual release location.

Thornyhead rockfish may live 80–100 years with the larger-growing females reaching sizes up to 80-cm fork length (Love et al. 2002). As with shortraker rockfish, growth differences (length-weight) in thornyhead rockfish among regions in the GOA are insignificant, but there has been evidence of regional differences in length compositions: thornyhead rockfish are generally larger in the EGOA (Echave et al., 2022).

Recent research by the AFSC Auke Bay Genetics Laboratory screened millions of genetic markers in thornyhead rockfish sampled from southeast Alaska to the BSAI as far west as -180° longitude. No spatial structure was observed in this dataset, providing further evidence that gene flow is high in thornyhead rockfish across relatively large spatial scales. This recent genetic research indicates that thornyhead rockfish represent a single genetic stock in Alaskan waters (W. Larson, pers. comm.).

Available information on movement, demographics, and genetics indicates no stock structure for thornyhead rockfish in the GOA. There has been no differentiation in stocks across regions based on demographics, and no spatial structure was observed in genetic markers in thornyhead rockfish sampled in the GOA. Tagging data indicates the majority of fish exhibit low movement rates, yet 11% of tagged fish exhibited movement patterns >100 nm and were observed to move across subarea management regions. Current ABC apportionment utilizes the REMA model fit to area-specific biomass from the trawl survey and RPWs from the longline survey, and subsequent proportions of biomass by area (W/C/EGOA) are informed by the proportion of trawl survey biomass by area. Thornyhead rockfish catches in the GOA are near 17% of maximum permissible and risk of overfishing is low.

3.4 Other Rockfish stock complex

The GOA Other Rockfish (OROX) stock structure document was completed in 2015 (Appendix 16b in Tribuzio and Echave, 2015) and focused on the two main subgroups, slope and demersal shelf, that comprised the OROX complex at that time. Here, the GOA OROX complex consists of 20 *Sebastes* species that have previously been referred to as the 'slope' subgroup in the OROX complex, and the subsequent text summarizes the stock structure of those 20 species that are remaining in the OROX complex.[10] This accounts for changes the Council recommended in 2023 to move the DSR sub-group species out of the OROX complex, which would occur during the 2024 assessment cycle in time for the 2025 and 2026 harvest specifications.

Most of the rockfish in the complex are at their northern range in the GOA, with the center of abundance located further south off British Columbia or the U.S. West Coast (Love et al., 2002). As such, the majority of the Other Rockfish species are most abundant in Southeast GOA, with the exception of harlequin rockfish, which is distributed across the GOA. Likewise, many of these species are known to have patchy distributions and inhabit a range of benthic substrates, including high and low relief rocky habitats (Jones et al., 2012; Tribuzio and Echave, 2015; Conrath et al., 2019). Life history data are sparse for most of the Other Rockfish species and generally are based on studies from lower latitudes. Very little is known about spawning timing, larval dispersal and development, or fecundity. Other Rockfish species display a wide range of life history attributes but tend to be longer lived species. For example, the maximum age for Other Rockfish species ranges from 26 to 106 years (pygmy and redbanded, respectively; Munk, 2001). While no species-specific genetics data are available for Other Rockfish species, there is most commonly no or little genetic structure for *Sebastes* species within the GOA (W. Larson, pers. comm.).

Other Rockfish species are predominately caught in the trawl fisheries, with much of the catch occurring in the rockfish trawl fishery in the CGOA. The CGOA catch consists of an average of about 65% of the total Gulf-wide catch, followed by 15% in the WGOA, 14% in WY, and 7% in SEO. Five species comprise 95% of the total OROX fisheries catch, with on average 30% being harlequin in the CGOA. Conversely, the AFSC GOA bottom trawl survey, which is the main data source for estimating abundance for Other Rockfish species, catches the largest biomass in the EGOA. The survey catches of many of the Other Rockfish species can be highly variable due to the patchy nature of these species and the tendency

[10] Species in the Other rockfish complex: aurora, blackgill, bocaccio, chilipepper, darkblotched, greenstriped, harlequin, northern (in EGOA, otherwise in its own northern rockfish assessment), pygmy, redbanded, redstripe, sharpchin, shortbelly, silvergray, splitnose, stripetail, vermilion, widow, yellowmouth, yellowtail.

to inhabit areas that are inaccessible to the trawl survey gear, which results in poor sampling and high variation in biomass estimates.

The limited data on Other Rockfish from the stock structure document and recent findings suggest there is no indication of area-specific stock structure for the Other Rockfish stock complex within GOA. No significant temporal changes or patterns in the fisheries catch can be discerned, but there is an apparent spatial mismatch between the fishery catch and trawl survey data, particularly for harlequin rockfish. However, based on fishery observations and preliminary observations from ongoing studies, harlequin and other rockfish species are commonly found in untrawlable habitat, which is not sampled by the trawl survey, but is accessible to the trawl fisheries. Although the generation time is considered long, the larval dispersal, physical barriers, GOA-specific growth and age-structure, and other biological data remain unknown for the vast majority of the Other Rockfish species. Likewise, there is little information on the behavior, site fidelity, movement, and genetics. However, based on catch observations and camera studies, some Other Rockfish species tend to aggregate in schools and are patchily distributed (Du Preez and Tunnicliffe, 2011; Jones et al., 2012). While there are some biological concerns for Other Rockfish populations due to their higher levels of vulnerability compared to other GOA groundfish stocks (Ormseth and Spencer, 2011), the concern for localized depletion or other biological concerns are presumably minimal based on: 1. all Other Rockfish species are not targeted by the fishery, 2. there are no apparent temporal changes or patterns in fishery, and 3. known inability for the trawl survey to effectively sample all habitat that OROX species occupy.

The management of this complex has changed several times, including the addition and removal of species, combining W/CGOA apportioned ABC, and the separation of demersal shelf rockfish into a separate assessment (see Table 16.3 in Omori et al., 2023). Prior to 2024, the ABC was apportioned to WY, SEO, and a combined W/CGOA area. The recent catch overages in the combined W/CGOA area prompted a re-examination of apportioned ABC and the Plan Team, SSC, and Council recommended that the apportionment of ABC for WY be combined with the W/CGOA apportionment beginning in the 2024 fishing year.

The decision to combine subareas was based on the above discussion on the minimal concerns for localized depletion and the lack of ability to effectively survey the population. Assessment authors will continue to monitor the spatial population trends and will use any new available data and research to ensure the apportionment subareas are adequately defined for the OROX complex. Area apportionments continue to be calculated from the proportion of estimated area-specific biomass based on the trawl survey.

3.5 Discussion of genetic structure

It is hypothesized that the high gene flow observed in these rockfish is attributed to long distance larval dispersal (W. Larson, pers. comm.). For rockfish with no genetic structure, it is likely that areas that are locally depleted will be replenished by larval transport over longer (i.e., evolutionary) timescales, but in the short term, local depletion could cause reduced abundance because adult movement is likely low. Additionally, the amount of genetic flow that would result in a finding of no genetic structure is typically very low, and genetic methods often have little power to detect migration rates that would result in demographically independent populations (Waples et al. 2008), which is the relevant scale for fisheries management. Thus, a finding of no genetic structure does not imply that populations are demographically coupled and local depletion could cause reduced abundance because adult movement is likely low.

4 Alternative Spatial Apportionments of ABC: Fishery and Management Implications

If the SSC determines that there were no conservation concerns (based on assessment author, Plan Team, and other input) with combining subarea ABC apportionments for these stocks, alternative spatial apportionments of ABC could be considered. Of course, combining subareas can only provide fishery benefits to a certain extent. If catch limits continue to decline, fisheries could necessarily be restricted to avoid stock-level overages. Amidst shifting TACs and changes in fishing behavior in response to market fluctuations, it can be difficult to predict whether combining subareas could reduce or avoid fishery management implications. Below, staff have summarized likely effects of alternative subarea combinations if TACs remain at current levels, and potential considerations for the Council in examining next steps.

As shown in Table 3, **shortraker rockfish** was placed on PSC status in the WGOA in 2016 and 2017 and in the CGOA in 2016, 2018, and 2022. If the WGOA and CGOA areas were combined, future (subarea) TAC overages could be less frequent. However, because 40% of the CGOA shortraker rockfish TAC is allocated to CPs in the RP (Table 28c to 50 CFR Part 679), any changes involving the CGOA would need to consider how these allocations would be determined (discussed further below).

Thornyhead rockfish was placed on PSC status in 2014 in the WGOA (Table 3). Catches in recent years have been well below subarea TACs/ABCs. Therefore, it is not clear what would be achieved by combining subareas.

There were no instances of subarea TAC exceedances for **RE/BS rockfish** from 2014-2023. Therefore, it is not clear what would be achieved by combining subareas for RE/BS rockfish. Furthermore, as mentioned in Section 3.2, existing information on stock structure of RE/BS rockfish indicates that current spatial apportionment (W, C, EGOA) for RE/BS rockfish is appropriate.

While **OROX** were placed on PSC status in the W/CGOA in 2021 and 2023 (Table 3), the recent grouping (beginning fishing year 2024) of WGOA/CGOA/WY apportionments is likely to mitigate potential overages. If catch limits stay relatively stable, this may result in fewer instances of PSC status. Any further combination of subareas would result in no apportionment of ABC/TAC across the GOA. According to the trawl survey, the bulk of OROX biomass is in the SEO, where little fisheries catch occurs. Therefore, it is more conservative to keep the SEO subarea separate from the rest of the GOA. However, as described in Section 3.4, biomass for the OROX complex may be underestimated by this survey. Due to the lack of biological data on these species (and that they are managed as a stock complex), the current apportionment of ABC with W/C/WY separate from SEO is likely appropriate (K. Omori, AFSC, personal communication).

For shortraker rockfish, thornyhead rockfish, and RE/BS rockfish, any combination of subareas involving the CGOA would need to consider impacts to the Rockfish Program. These rockfish are all allocated as secondary species to the RP cooperatives based on a percentage of the CGOA TAC (see Table 28c to 50 CFR Part 679—Allocation of Rockfish Secondary Species). Regulations require allocations of rockfish secondary species to CV and CP cooperatives in the CGOA. Therefore, if a CGOA subarea ABC/TAC for shortraker rockfish, thornyhead rockfish, and/or RE/BS rockfish were to be combined with other GOA subareas, the Council would need to consider how the Rockfish Program allocations would be determined.

Another consideration of alternative spatial apportionments is impacts to the voluntary trawl CP cooperatives in both the WY and WGOA. These cooperatives have agreements on the amounts of certain rockfish species that can be harvested. Any changes to subarea apportionments could result in fishery implications for these cooperatives. Impacts could be explored in a future analysis.

5 Next Steps

In relation to spatial apportionment, the Council has several options for next steps which range from narrow, stock specific responses, to broader changes in the harvest specifications process, described below. The Council does not have to take any action at this time or could ask for more information in an expanded discussion paper or analysis for a specified stock or stock complex.

Potential changes to spatial apportionment of ABC for rockfish

Based on the information in this paper, shortraker rockfish is the only stock that may be likely to face subarea TAC overages (at current levels) and which does not have evidence of stock structure based on the available information. However, the Council could consider changes to spatial apportionment of ABC for other stocks if the SSC determines there are no conservation concerns with doing so. The December 2023 SSC Report includes relevant SSC discussion for some of these rockfish stocks.

If the Council were interested in combining CGOA apportionments with any other subareas for shortraker rockfish, thornyhead rockfish, and/or RE/BS rockfish, the Council would need to specify a TAC for the CGOA so that NMFS can allocate a portion of the TAC to rockfish cooperatives as required in regulation. Specific changes to the RP likely require FMP and regulatory amendments. The Council would need to consider potential impacts to RP participants and non-RP participants, which may necessitate initiation of a NEPA analysis.

The Council could consider whether to further combine OROX subareas without changes to the RP since OROX is not a RP allocated species.

The Council can also maintain current subarea apportionments for all or some of the species discussed.

Regarding process and timeline (both for the issue addressed here and similar apportionment issues in the future): The Council could signal (during Proposed Harvest Specifications at an October meeting), that it is interested in an alternative combination of subarea apportionments for a specific stock or stock complex, and identify what that combination of subareas would be. Assessment authors could bring back apportionments for both status quo and proposed subarea options at the November Plan Team meeting, and the SSC could examine whether there are conservation concerns for the affected stock(s) at the following December meeting during Final Harvest Specifications. Changes involving any RP secondary species would likely necessitate a longer timeline for additional socioeconomic analysis. In general, the October to December timeline may not lend itself to thorough analysis of socioeconomic impacts.

Clarification of apportionment process and Council harvest specification policies

Not included in the Council motion, but pertinent to the topics in this paper (and other agenda items at this meeting) is a more general discussion of how and when impacts to fisheries (i.e., socioeconomic impacts) should be examined and considered as part of the harvest specifications process. In the case of these rockfish stocks and stock complexes, the discussion in this paper is limited to consideration of these impacts as they relate to spatial apportionment of ABCs.

During the December 2023 harvest specifications process, the SSC noted that the impetus for the shortraker rockfish apportionment recommendations at both the Plan Team and the SSC was concern over constraining fisheries as a result of reductions in the CGOA apportionment of ABC. Both the Plan Teams and the SSC acknowledged that they did not have conservation concerns for the stock at a subarea level, and the SSC was unsure whether the Spatial Management Policy applied in that context (Appendix 4).

This process warrants discussion and clarification. Assessment authors, Plan Teams, and the SSC recommend ABCs and subarea ABC apportionments to the Council. While the actual quantity of a stock's ABC apportioned across subareas is intended to be based on biological factors (e.g., survey data, other abundance indices), the spatial aggregation or separation of ABC apportionments (combinations of

subareas) for each stock or stock complex has varied over time and has been influenced by other factors such as aligning management boundaries with other fisheries. To mitigate some of the process challenges that arose during the December 2023 harvest specifications process, the Council could clarify the appropriate process by which impacts to fisheries or other socioeconomic considerations should be considered when recommending subarea apportionments of ABC.

Specifically, the Council could clarify how the Plan Teams and SSC should apply the Council policy that "socio-economic factors should be considered during the TAC setting process at the Council and not incorporated into the ABC recommendations" (Appendix 5) when making spatial management recommendations. Subarea ABCs are not the "true" ABC (i.e., subarea ABCs are not specified at the stock or stock complex level and do not trigger accountability measures that are tied to the ACL (which is set equal to ABC under the GOA FMP). Does the Council intend that these bodies may consider fishery impacts in their recommendations on how to group subarea ABC apportionments (after determining no conservation concern exists, i.e., no stock structure or other biological reason to maintain subarea apportionments)?

If the Council does intend the Plan Teams/SSC to consider fishery impacts when making apportionment decisions, some socioeconomic information (i.e., potential impacts to fisheries) related to how subareas are defined may still come too late in the harvest specifications process for the Plan Teams/SSC to consider when making apportionment decisions for the upcoming fishing year. In the current process, some information may be provided in the form of public comment at Plan Team and SSC meetings, but unless the Council initiates Step 2 of the Spatial Management Policy (Appendix 4) and recommends specific means by economic, social, and management implications should be identified prior to Final Harvest Specifications, there is no formal process for this information to be considered by the Plan Teams and/or SSC.

The Council could determine the suitability of and when to apply the Spatial Management Policy during a harvest specifications cycle. Additionally, the Council may wish to consider other processes when new scientific or fishery information that may inform changes to subarea apportionment is brought forward; exploring these changes on an annual basis is likely not the most efficient process.

The Council could take this as an opportunity to amend regulations and FMP language to explain how subarea ABCs work, the SSC's role in developing them, and how they are used for management. Consistency with the BSAI is recommended. This could involve clarifying or revising the Spatial Management Policy and/or the ABC/TAC Setting Policy.

- One option for the Council could be to recommend an amendment to the GOA (and BSAI) Groundfish FMP(s) that would set out a clear structure for the harvest specifications process and the use of subarea apportionments of ABC. This approach could address when and why the SSC should recommend subarea ABC apportionments and what management measures and responses should be for managing to and/or managing exceedances of those apportionments, since currently there are currently no associated accountability measures. While in some ways this would be formally adopting in the FMP the current process where the authors, Plan Team, and SSC review and recommend subarea ABC apportionments, this option would provide clear guidance to the authors, Plan Team, and SSC and clarity for the public on subarea apportionments. It would also give the Council the option of developing measures for managing and/or responses to exceedances of subarea ABCs that could function as another AM in that the SSC would recommend apportionment of ABC across subareas to address conservation and biological concerns, TAC would be specified to not exceed those "subarea ABCs," and management measures would be used to ensure these apportionments are not exceeded.

- Alternatively, for stocks that are deemed to not have conservation concerns (no stock structure or other biological reason to maintain subarea apportionments) the SSC/Council and NMFS could stop specifying these subarea apportionments in the annual groundfish harvest specifications. Impacts to fisheries and other socioeconomic concerns could then be applied during the AP/Council's TAC setting process, which would comport with the Council's ABC/TAC setting policy. Any Council recommendations for the specification of TAC would still have to be consistent with 50 CFR 679.20(a)(3), based on consideration of the biological condition of the stocks and stock complexes and socioeconomics for TAC determinations. The Council's current harvest specifications process relies on these subarea ABC apportionments in order to develop subarea TACs, therefore, this type of change would require a new process and significant prioritization of time and resources as well as have potentially large impacts.

Potential regulatory/FMP clean up

Lastly, the Council could take this as an opportunity to clarify or revise nomenclature and/or outdated language in the Groundfish FMPs and regulations.

- The terminology in the harvest specifications is arguably confusing on the specification of OFLs, ABCs, and TACs for each stock and stock complex since the harvest specifications include ABCs for subareas like Central, Western, and Eastern GOA as well as TACs for those subareas. The Council could consider a change in terminology to provide transparency and clarity that these subarea apportionments of (GOA-wide stock) ABCs are not the same as the stock or stock complex level ABC in that they do not invoke accountability measures. **To provide clarity and limit confusion, it is recommended that the Council and NMFS no longer use the term "ABC" to refer to subarea apportionments, but instead use a new term for these apportionments.** Consistency with language regarding BSAI apportionments is recommended if this is pursued.

- The Council could task NMFS and Council staff with bringing forward potential updates to outdated or confusing FMP and regulatory language related to harvest specifications and spatial management, to better align with current management practices. The Council could choose to prioritize these changes or direct staff and NMFS to implement any changes on a longer timeline as appropriate, when other related FMP amendments are being considered.

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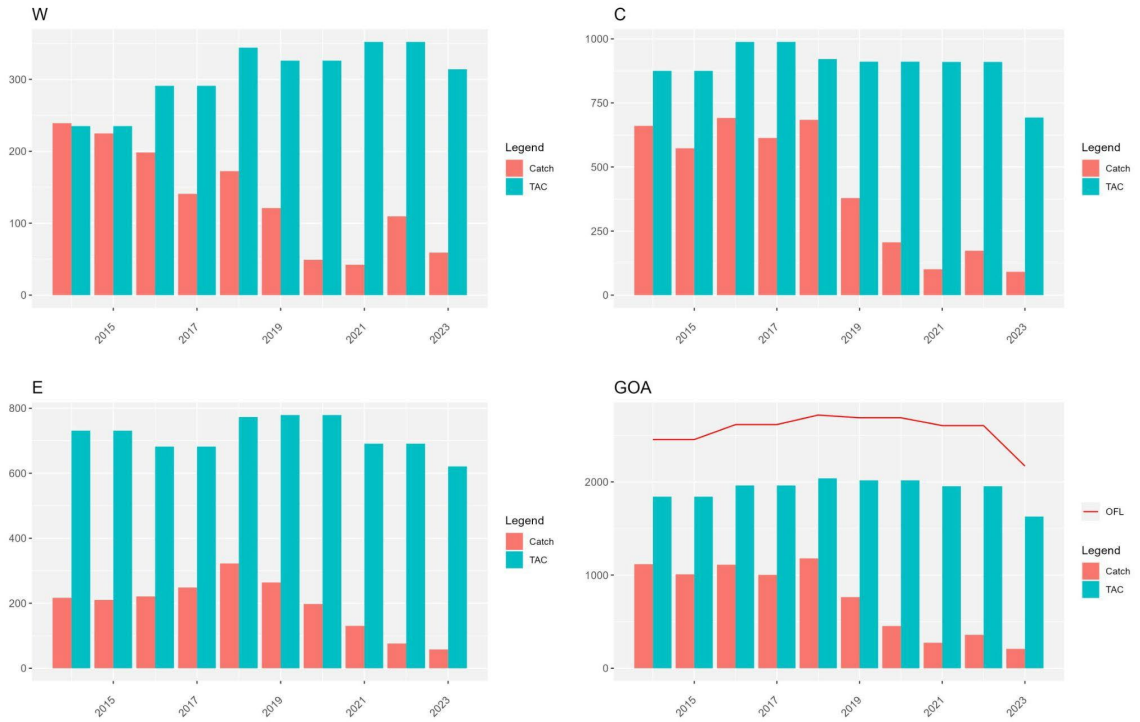
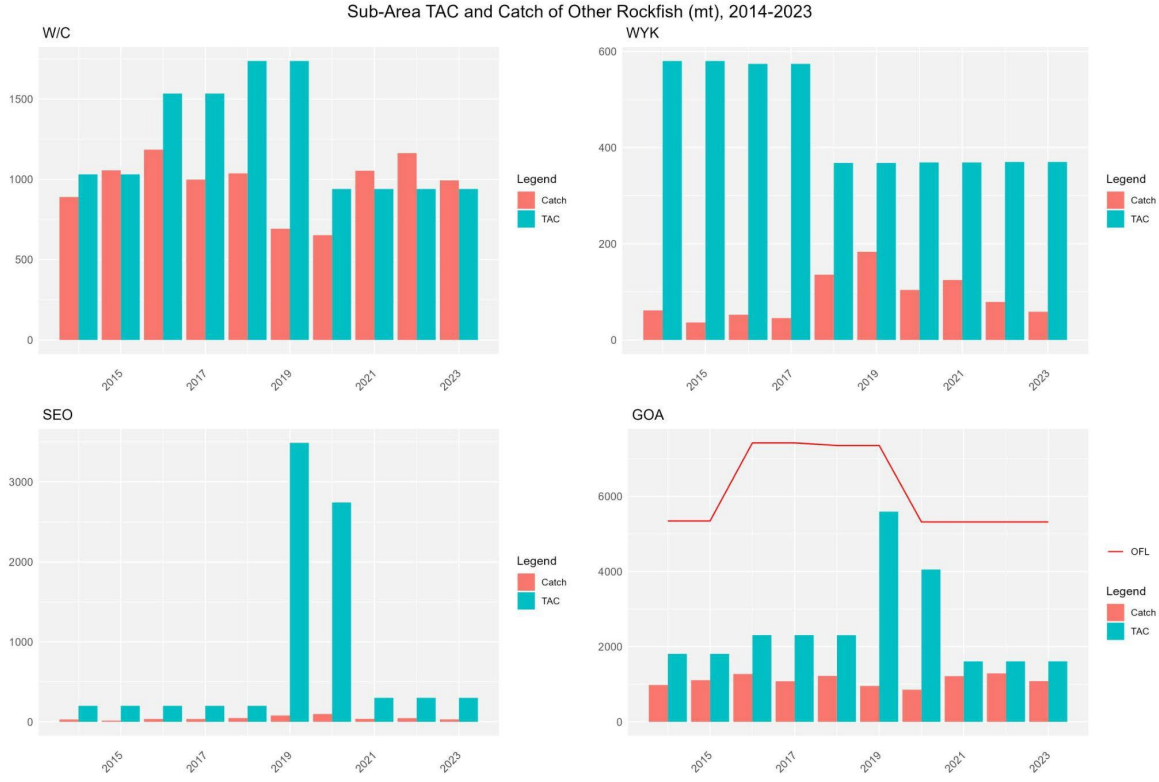
8 Appendices

Appendix 1. OFL, TAC, and catch (all gear types aggregated) from 2014 to 2023 for shortraker rockfish, rougheye/blackspotted rockfish, thornyhead rockfish, and Other rockfish, respectively.

Sub-Area TAC and Catch of Thornyhead Rockfish, 14-23



Sub-Area TAC and Catch of Other Rockfish (mt), 2014-2023



Appendix 2. Summary tables of available data on stock structure for GOA shortraker, RE/BS, thornyhead, and Other rockfish, respectively, and the stock structure template.

Summary of available data on stock structure for GOA shortraker rockfish.

Factor and criterion	Justification
Harvest and trends	
Fishing mortality (5-year average percent of F_{abc} or F_{ofl})	Recent years have low fishing mortality rates and catches are below gulfwide ABC (the gulfwide, or "true," ABC for the stock).
Spatial concentration of fishery relative to abundance (Fishing is focused in areas << management areas)	Fishing effort is distributed gulfwide around the continental slope with areas of high catch near Amatuli Gully and in the Yakutat Area, and trawl survey abundance is aggregated near most gully entrances.
Population trends (Different areas show different trend directions)	Overall population trend is relatively stable or increasing. Biomass estimates for the Western and Central GOA have been trending downward. Changes in biomass by region may be due to high variability of survey.
Barriers and phenotypic characters	
Generation time (e.g., >10 years)	Generation time is long.
Physical limitations (Clear physical inhibitors to movement)	No physical limitations are known, but larval dispersal is poorly understood.
Growth differences (Significantly different LAA, WAA, or LW parameters)	No major differences in growth (LW) among the Eastern GOA, Central GOA, and Western GOA.
Age/size-structure (Significantly different size/age compositions)	Age and size structures driven by major recruitment events. There is evidence of larger sized fish in the Eastern GOA based on trawl survey data.
Spawning time differences (Significantly different mean time of spawning)	Unknown
Maturity-at-age/length differences (Significantly different mean maturity-at-age/ length)	Unknown
Morphometrics (Field identifiable characters)	Unknown
Meristics (Minimally overlapping differences in counts)	Unknown
Behavior & movement	
Spawning site fidelity (Spawning individuals occur in same location consistently)	Unknown
Mark-recapture data (Tagging data may show limited movement)	Mark-recapture data unavailable.
Natural tags (Acquired tags may show movement smaller than management areas)	Unknown
Genetics	
Isolation by distance (Significant regression)	No significant isolation by distance (Matala *et al.* 2004, W. Larsen pers. comm.)

Factor and criterion	Justification
Dispersal distance (<<Management areas)	Not available
Pairwise genetic differences (Significant differences between geographically distinct collections)	Not significant (Cockerham's theta, Matala *et al.* 2004, W. Larsen pers. comm.)

Summary of available data on stock structure for GOA Rougheye and Blackspotted (RE/BS) rockfish.

Factor and criterion	Justification
Harvest and trends	
Fishing mortality (5-year average percent of F_{ABC})	Recent catch in the Western GOA are near F_{ABC}, and far below F_{ABC} in the Central and Eastern GOA
Spatial concentration of fishery relative to abundance (Fishing is focused in areas << management areas)	Catches are distributed similarly to survey abundance, except for a potential nursery area in Amatuli Gully region
Population trends (Different areas show different trend directions)	Population trend is stable for overall Gulf of Alaska, declining toward the Western GOA, and increasing toward the Eastern GOA
Barriers and phenotypic characters	
Generation time (e.g., >10 years)	The generation time is > 19 years
Physical limitations (Clear physical inhibitors to movement)	No known physical barriers; predominant current patterns move from east to west, potential restriction in gullies and canyons
Growth differences (Significantly different LAA, WAA, or LW parameters)	Significantly different growth curves and length-at-age relationships between the Western GOA, Central GOA, and Eastern GOA.
Age/size-structure (Significantly different size/age compositions)	Mean length is significantly higher in WGOA, mean age is significantly higher in WGOA
Spawning time differences (Significantly different mean time of spawning)	Unknown
Maturity-at-age/length differences (Significantly different mean maturity-at-age/ length)	Age at 50% maturity younger for rougheye rockfish (19.6 years) than blackspotted rockfish (27.4 years), no genetic ID confirmation on samples (Conrath 2017)
Time-varying maturity, fecundity, and skip-spawning rates	No changes in maturity or fecundity rates were observed for rougheye rockfish between 2008 and 2015, though estimated skip spawning rates were significantly less in 2016 (22%) than 2010 (37%) (Conrath and Hulson 2021)
Morphometrics (Field identifiable characters)	Unknown within species, hypothesized pigmentation differences between species (Gharrett et al. 2006, Orr and Hawkins 2008)
Meristics (Minimally overlapping differences in counts)	Unknown within species, significantly different means of dorsal spines and gill rakers (Gharrett et al. 2006)

Factor and criterion	Justification
Otolith morpohometrics	New study uses otolith morphometrics, weight, and age to accurately identify RE/BS rockfish 86.2% and 97.3% of the time, respectively (Harris et al. 2019)
Behavior & movement	
Spawning site fidelity (Spawning individuals occur in same location consistently)	Unknown
Mark-recapture data (Tagging data may show limited movement)	Mark-recapture data not available, but potential to reduce barotrauma with new pressure tanks
Natural tags (Acquired tags may show movement smaller than management areas)	Parasite analysis shows structure by INPFC management area and between species (Moles et al. 1998, Hawkins et al. 2005)
Genetics	
Isolation by distance (Significant regression)	No significant isolation by distance for Type I or Type II rougheye (likely blackspotted and rougheye, respectively) (Gharrett et al. 2007)
Dispersal distance (<<Management areas)	Low, but significant F_{st} ..for both types indicates some limits to dispersal (Gharrett et al. 2007)
Pairwise genetic differences (Significant differences between geographically distinct collections)	Adjacency analysis suggests genetic structure on scale of INPFC management areas for Type I (blackspotted) and potentially finer scale structure for Type II (rougheye) (Gharrett et al. 2007)

Summary of available data on stock structure for GOA thornyhead rockfish.

Factor and criterion	Justification
Harvest and trends	
Fishing mortality (5-year average percent of F_{abc} or F_{ofl})	Recent years have low fishing mortality rates and catches are below gulfwide ABC (the gulfwide, or "true," ABC for the stock).
Spatial concentration of fishery relative to abundance (Fishing is focused in areas << management areas)	Fishing effort is distributed gulfwide around the continental slope, matching the distribution of survey abundance.
Population trends (Different areas show different trend directions)	Overall population trend has been declining, in all areas. Changes in biomass by region may be due to high variability of survey.
Barriers and phenotypic characters	
Generation time (e.g., >10 years)	Generation time is long.
Physical limitations (Clear physical inhibitors to movement)	No physical limitations are known, but larval dispersal is poorly understood.
Growth differences (Significantly different LAA, WAA, or LW parameters)	No major differences in growth (LW) among the Eastern GOA, Central GOA, and Western GOA.

Factor and criterion	Justification
Age/size-structure (Significantly different size/age compositions)	Age and size structures driven by major recruitment events. There is evidence of larger sized fish in the Eastern GOA based on trawl survey data.
Spawning time differences (Significantly different mean time of spawning)	Unknown
Maturity-at-age/length differences (Significantly different mean maturity-at-age/ length)	Unknown
Morphometrics (Field identifiable characters)	Unknown
Meristics (Minimally overlapping differences in counts)	Unknown
Behavior & movement	
Spawning site fidelity (Spawning individuals occur in same location consistently)	Unknown
Mark-recapture data (Tagging data may show limited movement)	Tag returns indicate that large movements are possible, but most fish rarely move.
Natural tags (Acquired tags may show movement smaller than management areas)	Unknown
Genetics	
Isolation by distance (Significant regression)	No significant isolation by distance (Matala *et al.* 2004, W. Larsen pers. comm.)
Dispersal distance (<<Management areas)	Not available
Pairwise genetic differences (Significant differences between geographically distinct collections)	Not significant (Cockerham's theta, Matala *et al.* 2004, W. Larsen pers. comm.)

Summary of available data on stock structure for GOA Other rockfish (OROX).

Factor and criterion	Justification
Harvest and trends	
Fishing mortality (5-year average percent of F_{abc} or F_{ofl})	NA, Other Rockfish are Tier 4/5/6 species
Spatial concentration of fishery relative to abundance (Fishing is focused in areas << management areas)	Fishing appears to be distributed differently than survey abundance and distribution for many of the Other Rockfish species.
Population trends (Different areas show different trend directions)	Overall population trend is relatively stable or increasing. No major differences within regions. Changes in biomass by region due to high variability of survey.
Barriers and phenotypic characters	

Factor and criterion	Justification
Generation time (e.g., >10 years)	Generation time is long (>10 years).
Physical limitations (Clear physical inhibitors to movement)	No physical limitations known, but larval dispersal poorly understood.
Growth differences (Sig. different LAA, WAA, or LW parameters)	Unknown if major differences exist among regions in the GOA.
Age/size-structure (Sig. different size/age compositions)	Age and size structures driven by major recruitment events. Unknown if major differences exist among regions in the GOA.
Spawning time differences (Sig. different mean time of spawning)	Unknown
Maturity-at-age/length differences (Sig. different mean maturity-at-age/ length)	Unknown
Morphometrics (Field identifiable characters)	Unknown
Meristics (Minimally overlapping differences in counts)	Unknown
Behavior & movement	
Spawning site fidelity (Spawning individuals occur in same location consistently)	Unknown
Mark-recapture data (Tagging data may show limited movement)	Unknown
Natural tags (Acquired tags may show smaller movement than mngmt areas)	Unknown
Genetics	
Isolation by distance (Significant regression)	Unknown
Dispersal distance (<<Management areas)	Unknown
Pairwise genetic differences (Significant differences between geographically distinct collections)	Unknown

Stock Structure Template (Spencer et al., 2010)

Factor and criterion	Justification
Harvest and trends	
Fishing mortality (5-year average percent of F_{abc} or F_{ofl})	If this value is low, then conservation concern is low
Spatial concentration of fishery relative to abundance (Fishing is focused in areas << management areas)	If fishing is focused on very small areas due to patchiness or convenience, localized depletion could be a problem.
Population trends (Different areas show different trend directions)	Differing population trends reflect demographic independence that could be caused by different productivities, adaptive selection, differing fishing pressure, or better recruitment conditions
Barriers and phenotypic characters	

Factor and criterion	Justification
Generation time (e.g., >10 years)	If generation time is long, the population recovery from overharvest will be increased.
Physical limitations (Clear physical inhibitors to movement)	Sessile organism; physical barriers to dispersal such as strong oceanographic currents or fjord stocks
Growth differences (Significantly different LAA, WAA, or LW parameters)	Temporally stable differences in growth could be a result of either short term genetic selection from fishing, local environmental influences, or longer-term adaptive genetic change.
Age/size-structure (Significantly different size/age compositions)	Differing recruitment by area could manifest in different age/size compositions. This could be caused by different spawning times, local conditions, or a phenotypic response to genetic adaptation.
Spawning time differences (Significantly different mean time of spawning)	Differences in spawning time could be a result of local environmental conditions, but indicate isolated spawning stocks.
Maturity-at-age/length differences (Significantly different mean maturity-at-age/ length)	Temporally stable differences in maturity-at-age could be a result of fishing mortality, environmental conditions, or adaptive genetic change.
Morphometrics (Field identifiable characters)	Identifiable physical attributes may indicate underlying genotypic variation or adaptive selection. Mixed stocks w/ different reproductive timing would need to be field identified to quantify abundance/ catch.
Meristics (Minimally overlapping differences in counts)	Differences in counts such as gillrakers suggest different environments during early life stages.
Behavior & movement	
Spawning site fidelity (Spawning individuals occur in same location consistently)	Primary indicator of limited dispersal or homing
Mark-recapture data (Tagging data may show limited movement)	If tag returns indicate large movements and spawning of fish among spawning grounds, this would suggest panmixia
Natural tags (Acquired tags may show movement smaller than management areas)	Otolith microchemistry and parasites can indicate natal origins, showing amount of dispersal
Genetics	
Isolation by distance (Significant regression)	Indicator of limited dispersal within a continuous population
Dispersal distance (<<Management areas)	Genetic data can be used to corroborate or refute movement from tagging data. If conflicting, resolution between sources is needed.
Pairwise genetic differences (Significant differences between geographically distinct collections)	Indicates reproductive isolation.

Appendix 3. Related SSC comments from December 2023

Shortraker:

The SSC also highlights the data conflict between the longline and trawl survey indices across the Western, Central, and Eastern GOA subareas as an area of concern, and supports future research focused on resolving this conflict. The SSC supports the authors' investigation of potential methods of estimating survey selectivity within the model, and notes that drawing from external sources of information may also

provide insight into potential drivers of spatial variability among the indices across regions. Specific areas for consideration were investigating the spatial overlap of the two surveys with the shortraker species distribution model output from the EFH evaluation, identifying whether there is any evidence for seasonal effects due to fish behavior relative to survey timing, and/or re-evaluating potential effects of hook saturation and competition with sablefish in the longline survey.

A new apportionment method was recommended by the author and GOA GPT this year, which included predicted biomass from both the trawl and longline RPW data, in contrast to the previous method which apportioned the ABC based on the percentage of predicted biomass using only the trawl survey data. The assessment model estimates biomass using both datasets, and logically it makes sense to use both datasets to predict the proportion of that biomass estimate that occurs within each subregion and to provide a balance in the data conflict. The addition of the longline RPW data in the apportionment process leads to a roughly 9% reduction in ABC for the central GOA subarea, shifting the biomass primarily to the western subarea.

Acknowledging that this may constrain fisheries within that subarea, the GOA GPT recommended accepting the new apportionment method but applying a stair-step between the methods to alleviate some of the concern. The SSC received public testimony that even with the stair-step approach, the reduction in subarea ABC would almost certainly result in fishery closure as the subarea ABC has been a constraint even prior to subarea reductions resulting from the apportionment method change. **As there is no immediate conservation concern, the SSC recommends the status quo apportionment method.** The SSC acknowledges that this conflicts with the author and GOA GPT recommendation for this stock, and the SSC recommendation for GOA rougheye/blackspotted, which was to use both trawl and longline indices for apportionment.

Future spatial management for this stock was discussed in-depth at the GOA GPT and again during SSC discussion. For shortraker, subareas appear to be smaller than the spatial structure of the stock and, therefore, subarea ABCs appear to be overly constraining for the fishery despite a lack of conservation concern. Recent population genetics research, presented to the GPT in September 2023, found that shortraker do not exhibit signs of evolutionary-scale population structure, which is hypothesized to be a result of high larval connectivity because shortraker inhabit more offshore environments where larvae are less likely to be entrained in finer-scale oceanographic features. **The SSC concurs with the authors and GOA GPT that there is no evidence of conservation concern for this stock at a subarea level at this time and that current subarea ABCs area may be overly conservative.**
Given that this was the initial rockfish species that involved spatial management of subarea ABCs on the SSC agenda, the conversation expanded to encompass additional GOA rockfish species with potential spatial management issues. Notably, the rougheye/blackspotted complex, along with Other rockfish and thornyhead, are incidentally caught rockfish with varying population structure that are currently managed with subarea ABCs (see the “GOA Other Rockfish” section for the specific discussion for that species).

The SSC highlights that areas used for rockfish harvest specifications in the GOA are rooted in management that occurred in the 1980s and 1990s, as public testimony noted, and are precautionary relative to uncertainty regarding stock structure and biology. Current management programs overlay subarea ABC definitions, which makes changing the subareas complicated due to interactions with regulations and fisheries. The SSC also noted that the spatial management of rockfish, in general, is complicated given multiple species, biological diversity, numerous spatial areas, and variety of management issues (e.g., quota programs versus incidental catch in non-quota programs). From this perspective, addressing spatial management for several species simultaneously may make sense as it allows comparison of biological processes and management goals across species, which may better inform and potentially create alignment of subareas across stocks, and could facilitate public input on multiple stock issues.

The SSC expressed conceptual support for the GOA GPT recommendation urging the Council to consider implementing step 2 of the Stock Structure and Spatial Management Policy for shortraker and other rockfish. However, the SSC highlights that subarea ABCs are consolidated into a GOA-wide assessment for status determination, and there is no conservation concern associated with the existing apportionment scheme. Consequently, the SSC was unclear if the spatial management policy applies in this context. **Should the Council wish to consider a change to the current subarea apportionment for shortraker rockfish before the SSC applies the apportionment method based on the longline and trawl indices, as was recommended by the author and Plan Team and was applied by the SSC for RE/BS (see next section), the SSC recommends the DSR spatial management paper could be used as an example to provide the type of information needed to inform this issue (economic- and management-related impacts of alternative spatial allocation of ABC, as well as the risks of localized depletion). Since similar issues apply to the rougheye/blackspotted complex, thornyhead and other rockfish, the SSC suggests considering all of these species/complexes in a single document or analysis.** However, there may be no need to include other rockfish given SSC recommendations for this complex (--the rec was to SSC combine Western Yakutat subarea ABC with the Western/Central GOA subarea ABC for 2024. This change is considered to be conservation-neutral and would reduce potential for discards if PSC-limits are reached, as has occurred for the past three years. Further, this will align with the ABC apportionment for GOA DSR when they are moved to their separate assessment for the 2025 fishery.

RE/BS:
This assessment apportions the area-wide ABC to the western, central, and eastern GOA subareas. The authors brought forward several refinements in apportionment methodology that averages proportions of both the REMA-predicted biomass from the bottom trawl survey and the REMA-predicted RPW from the longline survey to balance the data conflict between the two surveys. This method was supported by the SSC in October 2023. The SSC supports the author and GPT recommended ABC apportionments.

OROX [spatial management change for 2024 harvest specifications cycle, implemented for 2025 fishing year]:

The SSC's rationale for this recommendation is that these non-target species are poorly sampled by the trawl survey, there are no major changes in fishing behavior, good species-specific catch data is available, and most of the biomass is in the southeast where trawling is not allowed. Further, recent analyses suggest there is little to no genetic structure in rockfish in general, and evidence of local depletion has not been observed. [SSC discussed PT rec and public testimony from industry…] SSC recommends that the Western Yakutat subarea ABC be combined with the Western/Central GOA subarea ABC for 2024. This change is considered to be conservation-neutral and would reduce potential for discards if PSC-limits are reached, as has occurred for the past three years. Further, this will align with the ABC apportionment for GOA DSR when they are moved to their separate assessment for the 2025 fishery.

Appendix 4. NPFMC Spatial Management Policy

In October 2013, the Council adopted the following policy that established a process for determining spatial management (i.e., subarea allocations of annual harvest specifications (OFL, ABC, and/or TAC)) of stocks and stock assemblages for groundfish, crabs, and scallops.

- 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.

- With input from the agency, the public, and its advisory bodies, the Council (and NMFS) should identify the economic, social, 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. In the case of crab and scallop management, ADF&G needs to be part of this process.

- 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.

- Based on the best information available provided through this process, the SSC should continue to recommend OFLs and ABCs that prevent overfishing of stocks.

In October 2022, the Council clarified that if the application of the spatial management policy did not result in the Council adopting management changes, the authors and the Plan Teams should continue to monitor and the SSC should advise the Council if there are associated conservation concerns and any changes in the scale of concern, if identified, during the the next full assessment cycle.

Appendix 5. NPFMC ABC/TAC Setting Policy

At its October 2018 meeting, the Council clarified its policy on the basis for ABC setting vs TAC setting. Specifically:

"*The Council clarifies its policy is that the planning team develop and recommend ABC's which are based on biological and environmental scientific information through the stock assessment and Tier process. Socio-economic factors should be considered during the TAC setting process at the Council and not incorporated into the ABC recommendations*."

This statement from the Council was issued in the context of a September 2018 Groundfish Plan Team review of criteria for recommending when ABC could be set below the maximum permissible ABC under the Council's tier-system approach. At the October 2018 meeting, the Council's SSC reviewed a risk matrix approach that included a suite of biological and ecosystem conditions that may support the reduction of ABC below max ABC. In response to that review, the SSC stated that "…economic considerations should NOT contribute to ABC reductions, but should instead be considered during the TAC setting process."