

A Proposed Range of Alternatives and Associated Management Implications for Defining Stocks Under Amendment 31

Introduction

The Pacific Fishery Management Council (Council) is undertaking Amendment 31 to define groundfish stocks in the Pacific Groundfish Fishery Management Plan (FMP). In March 2022, the National Marine Fisheries Service (NMFS) outlined concerns regarding the FMP in their report to the Council ([Agenda item E.3.a, NMFS Report 1, March 2022](#)). The report noted that while the FMP identifies groundfish species¹ in the fishery, it does not identify stocks and, as a result, NMFS is unable to report status to Congress as required.² The Council was informed NMFS could not complete [status determinations](#) for groundfish species assessed in 2021 until stocks were defined in the FMP. NMFS recommended the Council “...initiate action to ensure that stocks that are managed at a scale other than coastwide for the purposes of status determination, and other stocks, are clearly identified in the FMP” ([Agenda Item E.3.a, NMFS Report 1, March 2022](#)).

The Council initiated scoping in June 2022 for Amendment 31 which will define stocks in the FMP (see [Agenda Item F.4, Attachment 1, June 2022](#)). The Council requested initial analyses to support the Amendment, which was provided in September 2022 ([Agenda Item G.5, Attachment 1](#) and [Attachment 2, September 2022](#)). In September 2022, the Council adopted the following Purpose and Need statement for Amendment 31:

“With Amendment 31 to the Pacific Fishery Management Council’s (Council) Groundfish FMP, the Council intends to enhance the ability to attain sustainability objectives, especially those outlined in National Standard 1 of the Magnuson Stevens Act as guided by National Standard 3 and informed by National Standard 2. Appropriate specification of stocks in need of conservation and management at a geographic and stock complex level for assessing overfished status and determining if overfishing is occurring is a foundational aspect of sustainability, and instrumental in the Council’s ability to attain Optimum Yield objectives. With this Amendment, the Council intends to identify a subset of species within the Groundfish FMP to define stock boundaries for status determination based on key biological, ecological, social, and economic information currently available. It is the Council’s intent that, when this Amendment is completed, NMFS will make the necessary status determinations concerning the identified groundfish stocks managed under the Groundfish FMP.”

G.5 Motion, in writing, September 2022

At its September 2022 meeting, the Council identified the species to be covered under Amendment 31, which are those that were assessed in 2021 and scheduled to be assessed in 2023 (hereinafter priority species). Future Amendments are anticipated to define the remaining species and stock

¹ see Table 3-1 of the FMP

² MSA §[304\(c\)\(1\)](#)

complexes in the FMP. For the priority species, the Council requested a white paper to synthesize the state of knowledge and outline some of the management implications of alternative stock definitions. To this end, Council staff have produced this synthesis white paper to aid in the selection of a range of alternatives (ROA) with input from the staff at NMFS West Coast Region and the NMFS Northwest Fishery Science Center (NWFSC).

The ultimate goal of this process is to create stock definitions for all groundfish species in need of conservation and management. Given time constraints, this process to develop stock definitions for all managed groundfish species will not be fully realized under Amendment 31. The Council, upon guidance from NMFS, decided to focus on a subset of species under Amendment 31, those species assessed in 2021 and those to be assessed in 2023. Amendment 31 will allow the Council to initiate the biennial harvest specifications and management measure process in 2023 based upon new stock definitions. Stock definitions for all remaining species will be completed in future actions. The Council could choose to develop stock definitions for additional species under this action, as recommended by the GMT in Table 1 of [Agenda Item G.5.a, Supplemental GMT Report 1, September 2022](#); however, those species are not discussed in this paper in any detail. This first step has colloquially been designated as “Phase I” and is part of a longer-term multi-phase process. Additionally, this action may require the Council to consider restructuring existing stock complexes, depending on how priority species are defined. It is clear future FMP amendments will be necessary for the Council to complete the entire stock definition process.

Amendment 31 is time-sensitive and must be completed by June 2023, prior to Council adoption of new stock assessments and the initiation of 2025-2026 biennial management decision-making. The Council is scheduled to adopt the ROA in November 2022, preliminary preferred alternative in March 2023, and final preferred alternative in June 2023.

This document consists of four major parts: 1) a summary of known information on stock structure for priority species; 2) a proposed ROA; 3) discussion of management implications for the ROA; and 4) a bibliography including Council briefing books materials, advisory body statements, and peer-reviewed literature.

Order of Decision-making

The following generalized diagram describes our understanding of the order of decision-making in the stock definition process that has been followed thus far for Phase 1 (Figure 1). The overarching message from the outline is that a stock must be defined prior to assessments and management measure considerations to ensure stocks will not be defined on a post hoc basis. It is important for the Council to define stocks in the FMP by considering any scientific information inferring stock structure and the Council’s preference for stock management. Deciding stock management every two years risks the Council reacting to new stock assessment results rather than deciding stock definitions based on fundamental biological attributes and management goals and objectives.

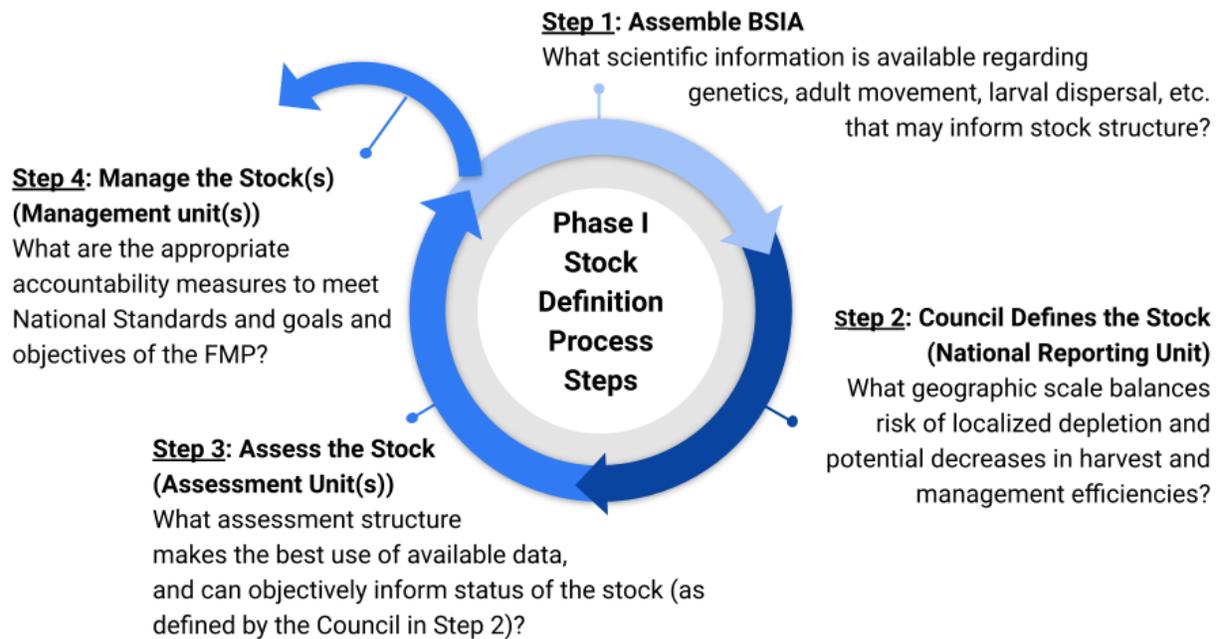


Figure 1. Diagram outlining an interpretation of the order of decision-making for Phase 1 of defining stocks.

1. Summary of Scientific Information to Inform Stock Definitions

The SSC had extensive discussions in [November 2021](#) and recommended at least three tiers of biological attributes to consider when deciding a stock definition. The highest tier of these attributes is a genetic difference among meaningful markers. When members of a fish species are segregated into multiple reproductive stocks, allele frequencies at neutral genetic markers diverge under genetic drift such that the variance in gene frequencies reflects the magnitude of reproductive isolation among these stocks. Thus, gene frequency differences among geographic samples can be used to indirectly estimate patterns of gene flow and hence stock structure of the species.

The next highest tier of information is exchange or movement of adults, followed by larval dispersal between areas. Table 1 provides a summary of insights regarding these biological attributes for the priority species.

Table 1. Overview summary of four types of scientific information that may inform stock structure that has been presented to the Council or SSC, and relevant SSC recommendations regarding stock structure or status determination units for priority groundfish species.

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Black rockfish (2023)	Oregon and California likely lack differentiation; mixed results from studies off WA (Cope, <i>et al.</i> 2015).	Species-specific evidence of strong site fidelity and small home ranges; occasional movement of tagged fish 100+ miles.	Largely unknown; evidence that gravid females are encountered offshore.		Three area assessments were determined as BSIA (WA, OR, CA) in 2016 (Cope, <i>et al.</i> 2015).	
Canary rockfish (2023)	DNA sequencing suggest little support for canary rockfish stock structure along the U.S. West Coast (Andrews, <i>et al.</i> 2018; Budrick 2016; Gomez-Uchida, <i>et al.</i> 2003).	Information suggests significant movement of adults as well as ontogenetic movement offshore.	Juvenile canary rockfish are found in shallow and intertidal areas (Love, <i>et al.</i> 2002). Canary rockfish spawn in the winter, producing pelagic larvae and juveniles.	Recent work conducted by Keller et al. (2018) evaluated differences in canary rockfish life history characteristics among three regions separated at key biogeographic breaks across the U.S. West Coast (north of Cape Mendocino, between Cape Mendocino and Point Conception, south of Point Conception), primarily using samples from the NWFSC bottom trawl survey.	The most recent assessment in 2015 is a three-area coastwide model, corresponding approximately to state boundaries account for spatial variation in exploitation history among strata (Thorson and Wetzel 2015).	

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Copper rockfish (2023 off CA only)	Significant population subdivisions along coast, indicating limited oceanographic exchange among geographically proximate locations.	Limited adult movement, high site fidelity.	Larval and juvenile stages likely low - <u>Buonaccorsi, et al. (2002)</u> estimated this dispersal distance as 13 km or less.	CA: populations off the coast of Santa Barbara and Monterey California identified a genetic break between the north and south, with moderate differentiation (Sivasundar and Palumbi 2010). Slight differences between Oregon and Central CA. Genetically distinct differences between Puget Sound and West Coast stocks.	Four 2021 area assessments - WA, OR, N. CA ³ , S. CA - deemed BSIA (Wetzel, <i>et al.</i> 2021a; Wetzel, <i>et al.</i> 2021b; Wetzel, <i>et al.</i> 2021c; Wetzel, <i>et al.</i> 2021d).	2021 SSC recommended combining WA and OR, and combining N. CA and S. CA, resulting in two status determination units. ⁴
Dover sole (2021)	Dover sole exhibit spatial clustering of genetically similar individuals.	Dover sole off the West Coast appear to have complex movement patterns, moving across depths, likely driven by season, spawning, and by size.	Larvae planktonic. Settlement can take up to two years. Juveniles display ontogenetic behavior	No demographic known differences	Dover sole was assessed in 2021 as a single coastwide stock (Wetzel and Berger 2021).	SSC endorsed the 2021 full assessment of Dover sole as BSIA and suitable for informing management decisions.

³ North of Point Conception to 42° N. lat.

⁴ [E.3.a. Supplemental SSC Report 1, November 2021](#)

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Lingcod (2021)	Stocks are split at 40°10' N lat. based on the results of a genetic analysis (Longo, <i>et al.</i> 2020).	Relatively sedentary though some movement may occur in juvenile fish.	Juveniles display ontogenetic movement.	Individuals north of 40°10' N lat. generally grow faster, live longer, and mature at larger sizes than individuals from southern regions (Lam, <i>et al.</i> 2021; Richards, <i>et al.</i> 1990; Silberberg, <i>et al.</i> 2001).	Lingcod were assessed in two models north and south of 40°10' N lat. In 2021 (Johnson, <i>et al.</i> 2021; Taylor, <i>et al.</i> 2021).	The SSC endorsed the 2021 full assessments of northern and southern lingcod as BSIA.
Petrale sole (2023)	No genetic evidence suggesting distinct biological stocks of petrale sole off the West Coast.	Adult petrale sole can move up to 350-390 miles. They move inshore and northward onto the continental shelf during the spring and summer to feeding grounds and offshore and southward during the fall and winter to deep water spawning grounds.	Larvae are pelagic. Juveniles show little latitudinal or longitudinal movement.		Last assessed as an update assessment of a coastwide stock in 2019 (Wetzel 2019).	

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Quillback rockfish (2021)	Minimal variation between WA and Alaska, suggesting broad larval dispersal; differences observed between Puget Sound and coastal regions.	Limited adult movement with high site fidelity.	Largely unknown.	Recruitment estimates among the assessments indicated some level of coherence in recruitment over space.	Three 2021 area assessments - WA, OR, CA - deemed BSIA (Langseth, <i>et al.</i> 2021a; Langseth, <i>et al.</i> 2021b; Langseth, <i>et al.</i> 2021c).	SSC recommended the assessments as BSIA. They also recommended state-specific stocks ⁵
Rex sole (2023)	Little is known on the stock structure of this species.		Larvae are distributed broadly over the shelf and slope. Larvae exhibit cross-shelf transport, moving to nearshore nursery areas where they remain as juveniles (Abookire and K.M. 2007; Bailey, <i>et al.</i> 2008). Larvae attain a large size and have long pelagic lives (Pearcy, <i>et al.</i> 1977).	Growth differences in Eastern Gulf of Alaska (GOA) relative to Western and Central GOA. Marked difference in growth rates and size at maturity between Oregon and GOA stocks (Abookire 2006).	Coastwide assessment in 2013 (Cope, <i>et al.</i> 2014).	SSC endorsed 2013 stock assessment as BSIA.

⁵ [E.3.a. Supplemental SSC Report 1, November 2021](#)

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Shortspine thornyhead (2023)	Genetic studies of stock structure do not suggest separate stocks along the West Coast.	Studies indicate shortspine migrate ontogenetically down the slope to the oxygen minimum zone.	Pelagic larvae appear to have a long dispersal period. Settle at approx. 1yr.	Shortspine do not appear to be distributed evenly across the West Coast.	Shortspine thornyhead was last assessed in 2013 as a single coastwide stock-though apportioned at Pt Conception for management purposes (Taylor and Stephens 2013).	SSC endorsed 2013 stock assessment as BSIA.
Spiny Dogfish (2021)	Lack of genetic information for this species.	Spiny dogfish make latitudinal and depth migrations to follow an optimal temperature gradient. Evidence of seasonal adult movement along the coast. Appears to form same sex/age school.		Some evidence of inshore vs. offshore populations migratory behavior. Inshore migratory distance may be less than offshore populations (Brodeur, <i>et al.</i> 2009).	Spiny dogfish was assessed in 2021 as a single coastwide stock (Gertseva, <i>et al.</i> 2021).	SSC endorsed the 2021 full assessment of spiny dogfish.
Squarespot rockfish (2021)	No known genetic differentiation in U.S. waters.	99.7% of stock south of 40°10' N lat.		No known demographic differences.	Squarespot rockfish was assessed in 2021 in CA waters (Cope, <i>et al.</i> 2021b).	SSC endorsed the 2021 data-moderate assessment for California as BSIA.

Species (assessment year)	Genetic differentiation	Adult movement	Larval dispersal	Demographic differences	Assessment stratification	SSC comments
Vermilion and Vermilion/sunset rockfishes⁶ (2021)	Significant differentiation throughout the range of vermilion rockfish. Sunset rockfish largely occur south of Pt. Conception.	Adults exhibit high site fidelity.	Low to average larval dispersal distance (Hyde and Vetter 2009). Both species exhibit ontogenetic movement.	Genetic differences suggest four population areas: South of Pt Conception, Pt Conception to Cape Mendocino, Cape Mendocino through OR, and Neah Bay (WA).	Four area assessments determined as BSIA -WA, OR, N CA ⁷ , and S. CA in 2021 (Cope, <i>et al.</i> 2021a; Cope and Whitman 2021; Dick, <i>et al.</i> 2021; Monk, <i>et al.</i> 2021).	SSC endorsed the 2021 endorsed the assessments as BSIA

⁶ Distinct species. Morphologically difficult to distinguish vermilion from sunset. Adult sunset rockfish are mainly distributed at depths greater than 50 fm (100 m) and are predominantly located south of Point Conception (34°27 N. lat.). Assessment aggregated population dynamics -treated as 1 “stock”

⁷ North of Point Conception to 42° N. lat.

2. Range of Alternatives

This paper presents a draft range of alternatives (ROA) for Council consideration. The Council may wish to revise these alternatives as this process progresses. The following provides background to how alternatives were developed.

The draft ROA was informed by Council discussions on this topic at the [November 2021](#) (Agenda Item E.3), [March 2022](#) (Agenda Item E.3), [June 2022](#) (Agenda Item F.4), and [September 2022](#) (Agenda Item G.5) meetings. The ROA structure is purposely wide to acknowledge that the Council may consider additional action alternatives, as appropriate. Further, the ROA assumes that the species/areas that are currently managed in complexes will continue to be managed that way. Given the timeline of this action, modifications to stock complexes are not a priority for Amendment 31, though stock complex revisions may be discussed as part of future amendments.

At the September 2022 meeting, the Council was not interested in dividing copper rockfish or black rockfish at 40°10' N. lat. due to concerns of poor spatial alignment with stock assessments. Therefore, alternative stock definitions stratified at 40°10' N. lat. are not included in this preliminary ROA for those species.

Action Alternatives Structure:

There are two overarching themes for the action alternatives: an aggregated alternative (i.e., coastwide) and disaggregated alternatives (i.e., state by state and north & south of 40°10' N. lat.). We have structured alternatives as species-specific based on past Council discussions and the Groundfish Management Team (GMT) recommendations from Table 1 in [Agenda Item G.5.a, Supplemental GMT Report 1, September 2022](#). This approach does not limit the Council from applying the draft alternatives to other species or developing new alternatives.

Each action alternative is designed to define the stock and allow NMFS to determine stock status – i.e., overfished/not-overfished and depletion relative to the management target (B_{MSY}) and the minimum stock size threshold (MSST), as described in Sections 4.3 through 4.5 of the FMP. In all alternatives, when a stock is determined to be overfished, the Council is required to create a rebuilding plan. Also, under all alternatives, the Council may continue to develop area-specific management measures, regardless of the estimated depletion, during the biennial groundfish process. We have not added this specific language to the descriptions below in order to avoid redundancy; however, the above applies to each of the action alternatives.

Stocks may need area-specific harvest control rules (HCRs) to account for differences in stock structure, management or scientific uncertainty, exploitation history, and estimated depletion. Area-specific HCRs implement area-specific annual catch limits (ACLs) based on the best scientific information available (BSIA). This concept is expanded under the Management Implications section.

Alternatives

Each Alternative is described below with Table 2 summarizing the text.

No Action

Under No Action, the groundfish species would not have a stock definition specified in the FMP. The FMP does not describe the policy framework for defining actively managed species as stocks. No Action is likely an untenable option for the Council to adopt since it does not meet the purpose and need for Amendment 31.

Alternative 1 (coastwide stock definition)

Under Alternative 1, the priority groundfish species under Amendment 31, except lingcod and squarespot rockfish, would be defined as “interrelated coastwide.” An interrelated coastwide stock means the population structure is such that there may be differences in subpopulations but for the purposes of status determination, they are treated as one coastwide stock and the NMFS status determination (i.e., “overfished”/“not overfished” and depletion relative to biomass reference points) would occur at the coastal scale. Depletion estimates for the stock would be presented in stock assessments at a coastwide scale. Whether it is managed in a larger stock complex or individually it would have coastwide HCRs, consistent with the coastwide stock definition.

Alternative 2 (state-by-state stock definitions)

Alternative 2 applies to black, copper, quillback, and vermilion/sunset rockfishes. Under this alternative, each species is defined as a state-specific stock, i.e., a California stock, an Oregon stock, and a Washington stock. Depletion estimates for the stock are presented in stock assessment(s) at a state scale. Each stock would have state-specific HCRs and status determinations under this alternative. Additionally, squarespot rockfish could have a California-only stock definition, consistent with the 2021 assessed area.

Alternative 3 (north and south of 40°10' N. lat. stock definitions)

Under Alternative 3, lingcod, and vermilion and sunset rockfishes stocks would be defined north and south of 40°10' N. lat., consistent with past/present Council actions. Depletion estimates for these stocks are presented in stock assessments for the areas north and south of 40°10' N. lat. Each stock would have independent HCRs since status determination is at the regional level defined under this alternative.

Two lingcod assessments were prepared in 2021 stratified at 40°10' N. lat. given genetic evidence of stock structure north and south of that general area (Longo, *et al.* 2020). The Council has also managed lingcod with region-specific harvest specifications north and south of 40°10' N. lat. since 2013. With such clear evidence of stock structure breaking at that latitude and differential lingcod management north and south of that management line, Alternative 3 is the only one proposed for lingcod.

In order to adopt this alternative for vermilion and sunset rockfishes, the Council would need to consider new full stock assessments as the 2021 assessments did not partition the species in a manner that can be adapted to the 40°10' N. lat. division. Thus, until new assessments are completed, a NMFS status determination could not be made if this alternative was adopted.

Squarespot rockfish could be defined as two stocks north and south of 40°10' N. lat. as has been done in past/present Council management actions. However, it is unlikely that status could be

determined for a northern squarespot rockfish stock given the low biomass (only 0.27 percent of squarespot rockfish biomass is estimated to be north of 40°10' N. lat. based on the 2021 assessment) and lack of data. Therefore, no Alternative 3 is included for squarespot rockfish at this time.

Table 2. Summary of proposed action alternatives for priority species under Amendment 31. Shaded cells with * are included in the proposed ROA; blank/unshaded cells are Alternatives not included at this time for the species.

Species	Alt. 1 Coastwide	Alt. 2 State-specific	Alt. 3 North and South of 40°10' N. lat.
Black rockfish	*	*	
Canary rockfish	*		
Copper rockfish	*	*	
Dover sole	*		
Lingcod			*
Pacific spiny dogfish	*		
Petrale sole	*		
Quillback rockfish	*	*	
Rex sole	*		
Sablefish	*		
Shortspine thornyhead	*		
Squarespot rockfish		* (CA only)	
Vermilion and sunset rockfishes	*	*	* (new assessments needed)

While the Council identified stocks assessed in 2021 and to be assessed in 2023 as priorities for Amendment 31, it may not be overly burdensome to also consider defining those stocks currently managed with stock-specific harvest specifications in this action (see [Table 1](#) of the Decision Road Map provided in September 2022). Most of these stocks have been managed outside of stock complexes with their current area delineations for the last 20 years or so and there is no compelling evidence to suggest changing their stock definitions. Adopting some of these stock definitions with Phase 1 would narrow the scope of species to be addressed in Phase 2. Additionally, the GMT recommended a similar set of species in its September 2022 statement ([G.5.a, Supplemental GMT Report 1](#)). However, some of the species listed in the GMT report may require reconsideration of

certain stock complexes (e.g., species managed in the Other Flatfish complex), which is beyond the scope of this action at this time.

3. Management Implications

Summary

Generally speaking, management implications of too geographically broad a scale for a stocks' definition results in a greater risk of localized depletion in part of the species' range. The SSC has cautioned that presence of certain characteristics (e.g., genetic differentiation, lack of large-scale larval dispersal, etc.) warrants a more precautionary approach to the geographic scope of units used for status determination (i.e., the stock defined in the FMP).⁸ Alternatively, management implications of too geographically fine a scale for a stocks' definition may result in a reduction in economic and/or management efficiency.

No Action

Under the No Action alternative, species would not undergo a formal process to be defined as stocks in the FMP which would be in conflict with the recommendations from NMFS ([Agenda Item E.3.a, NMFS Report 1, March 2022](#)) and would not meet the purpose and need for Amendment 31. The management implication of No Action is that NMFS could not make a status determination for many groundfish stocks and therefore some management efforts to end overfishing and rebuild overfished stocks could be complicated at best, or, at worst, impeded.

Coastwide Stock Definition

A coastwide stock definition would define a species as a single interrelated coastwide stock with coastwide harvest control rules (i.e., coastwide P* and coastwide harvest control rule applied to determine ACL or ACL contribution). A coastwide definition is appropriate when sufficient mixing occurs and harvest in one area could affect the trajectory of the stock in all areas. Additionally, the coastwide harvest control rule would be expected to have the same effect on the stock across its range. Potential impacts to communities and the current level of scientific uncertainty should be considered.

Localized depletion should be managed based on BSIA, per the recommendations of the SSC to have harvest levels proportional to estimated biomass; therefore, estimates of depletion and biomass for substocks (e.g., assessed areas) should continue to be considered in setting localized management measures for a coastwide stock. Further SSC guidance from their June 2022 report is the expectation that "stock designations will not define the spatial resolution of the assessment units; assessment units will need to be structured so that their results can be aggregated to match the stock definitions." Depletion estimates from area assessments may compel area-specific management responses which could mitigate localized depletion concerns.

It is also important to note the influence of localized depletion on the coastwide status determination. Localized depletion could drive a coastwide stock into an overfished condition (See

⁸ [E.3.a. Supplemental SSC Report 1, November 2021](#)

Overfished Determinations and Rebuilding Plans Section) or areas of abundance could mask an area of localized depletion.

The population structure of certain species, notably nearshore rockfish, may not support a coastwide stock definition without area-specific management measures. Nearshore rockfish, like all rockfish, release pelagic larvae though larval dispersal may be limited due to high site fidelity by adults, oceanographic eddy interference, and large scale oceanographic barriers limiting distribution of genetic diversity. In brief, these natural oceanographic and life history characteristics could result in limited mixing and could result in isolating some populations from others. These factors informed the SSC recommendations that status determinations should be considered at a smaller scale than coastwide for multiple nearshore species.⁹ A coastwide stock definition for some nearshore stocks could be in conflict with the National Standard 2 guidelines if area-specific management measures are not implemented.

Considerations for State/Region-Specific Alternatives for Nearshore Stocks

Alternatives other than coastwide presume that areas of the coast with higher abundance would not significantly mix and would have little spillover effects to the benefit of areas of lower biomass. Each stock would have state- or region-specific harvest control rules (i.e., state/region P* and state/region HCRs applied to determine ACL contribution). This definition presumes insufficient mixing across the species' range such that harvest in one area would not impact other areas. Second, a state/region HCR will have the same effect on the stock across the state or region.

In terms of status determination for a state/region specific stock, if it falls below the MSST, a state/region specific rebuilding plan will be required. Likely, management measures could be adopted at a finer scale as needed to address localized depletion but that would not exempt the remaining areas of the state/region of the defined stock from a rebuilding plan.

Depletion estimates for the species would be presented in stock assessment(s) at the geographic scale of the defined stock. NMFS' "overfished" or "not overfished" status determinations would be made for the species at the geographic scale of the defined stock (i.e., not coastwide). Depletion estimates for a stock(s) may trigger a rebuilding plan at the geographic scale of the defined stock(s). In other words, if a stock was declared overfished in one state, only that state would be under a rebuilding plan.

Having a policy framework that requires tailored accountability measures in geographic areas with known differences in exploitation history would create a default scenario where HCRs keep harvest levels proportional to localized estimates of biomass. This would promote equitable harvest privileges for all areas.

Overfished Determinations & Rebuilding Plans

One primary management implication for alternative stock definitions is the geographic scale at which NMFS makes status determinations related to overfished conditions, per the status determination criteria in the FMP and the requirements of MSA. The Section 4.3 of the FMP

⁹[E.2.a. Supp. SSC Rpt. 1, Nov. 2021 and E.3.a. Supp. SSC Rpt. 1, Nov. 2021](#)

specifies that a groundfish stock is overfished if its current estimated spawning biomass (or spawning output) is less than 25% or 12.5% of its unfished level for non-flatfish and flatfish taxa, respectively. MSA (§304(e)(4)(A)(i)), requires that the rebuilding strategy (essentially the target year and related HCR and associated management measures) must rebuild stocks in as short a time as possible, taking into account various factors.¹⁰

If a coastwide stock falls below the MSST, a coastwide rebuilding plan will be required, resulting in coastwide harvest specification reductions. Differential management measures could be implemented to address localized depletion; however, all areas of the coast would be subject to the rebuilding plan.

Localized depletion may or may not be a driver of a coastwide overfished status determination. Regardless of whether localized depletion is the driver of a coastwide stock's overfished status, the status determination and harvest specifications and management measures to achieve the goals of a coastwide rebuilding plan would include all sub-areas, if applicable, because they would be linked to the same coastwide status determination. If localized depletion is recognized as the primary driver of the coastwide stocks' overfished status, areas with less depleted sub-populations would still be subject to rebuilding plan requirements. This is because a coastwide definition implies areas of the coast with higher abundance would mix and have spillover effects to the benefit of areas of lower abundance if suitable habitat and environmental conditions exist in that area. If such mixing and spillover is overestimated, it is likely that the stock is more vulnerable to localized depletion, and that rebuilding measures in areas of higher abundance would be ineffectual for rebuilding the coastwide stock.

The MSA, National Standards, and Section 4.6.2 of the FMP contemplate rebuilding for a defined stock (or stock complex) and not sub-stocks. National Standard 1 guidelines do not state, nor imply, sub-stocks should be considered for a separate rebuilding plan. Based on the process described in Figure 1 Order of Decision-making, the Council defines the stock first, assesses the stock, and then creates management measures designed to achieve optimum yield. If a stock's status was determined to be overfished and the likely driver was localized depletion from a sub-stock, the Council could not redefine the stock post hoc. A stock's definition is immutable until such a time as the Council redefined the stock in the future in an FMP amendment and assessed it according to that new definition.

A management implication exposed in our discussion was the need to address stock complexes and stocks managed within a complex that are determined to be overfished. As we explored management implications of the alternatives, it became clear that the Council needs to consider this possibility and codify a definitive policy on this issue and could do so in Phase 1. Removing a stock from a complex when it is declared overfished has been the Council's practice in the past. Stock-specific status determinations are necessary to ensure rebuilding objectives, such as staying within prescribed overfishing limits and timely rebuilding, are met. The SSC recommended the Council consider specifying in the FMP a policy that if a stock managed in a complex is declared overfished, it should be removed from the complex ([Agenda Item E.3.a, Supplemental SSC Report 1, November 2021](#)).

¹⁰ (1) the status and biology of the stocks, (2) the needs of fishing communities, and (3) interactions of depleted stocks within the marine ecosystem.

Harvest Control Rule Considerations

Default HCRs are influenced by a stock's definition. The stock definition sets geographic boundaries on the depletion estimates generated by a stock assessment. The resulting assessment for the stock would, in turn, trigger different default HCRs (per FMP Section 4.6.1). The FMP describes that the 40-10 and 25-5 adjustments are the default HCRs for stocks below the B_{MSY} target. These adjustments are described as either a precautionary adjustment (stock is below the B_{MSY} target and above the MSST) or an interim rebuilding plan (stock is below MSST). The management implication is that, depending on the estimated depletion of a stock, default precautionary HCRs will be triggered for the stock.

The primary relationship between HCRs and the purpose and need for Amendment 31 is the HCR that meets the obligations of a rebuilding plan for an overfished stock. Because of the strong linkage between the definition of the stock, the potential rebuilding plan, and the default HCR, this paper describes that the HCRs should be set at the stock level (and not the sub-stock level), as is described further in the Overfished Determinations and Rebuilding Plans section.

Literature Cited

- Abookire, A. A. 2006. Reproductive biology, spawning season, and growth of female rex sole (*Glyptocephalus zachirus*) in the Gulf of Alaska. *Fish Bull.* 104:350-359.
- Abookire, A. A. and B. K.M. 2007. The distribution of two deep-water pleuronectids, Dover sole (*Microstomus pacificus*) and rex sole (*Glyptocephalus zachirus*), at the northern extent of their range in the Gulf of Alaska. *J. of Sea Research* 57:198-208.
- Andrews, K. S., K. M. Nichols, A. Elz, N. Tolimieri, C. J. Harvey, R. Pacunski, and coauthors. 2018. Cooperative research sheds light on population structure and listing status of threatened and endangered rockfish species. *Conservation Genetics* 19:865-878.
- Bailey, K. M., A. A. Abookire, and J. T. Duffy-Anderson. 2008. Ocean transport paths for the early life history stages of offshore-spawning flatfishes: a case study in the Gulf of Alaska. *Fish and Fisheries* 9:44-66.
- Brodeur, R. D., I. A. Fleming, J. M. Bennett, and M. A. Campbell. 2009. Summer distribution and feeding of spiny dogfish off the Washington and Oregon coasts. *in* V. F. Gallucci, G. A. McFarlane, and G. G. Bargmann, editors. *Biology and Management of Dogfish Sharks*. American Fisheries Society.
- Budrick, J. E. 2016. Evolutionary Processes contributing to Population Structure in the Rockfishes of the Subgenus *Rosicola*: Implications for Fishery Management, Stock Assessment and Prioritization of Future Analyses of Structure in the Genus *Sebastes*. PhD. University of California, Berkeley, Berkeley, California.
- Buonaccorsi, V. P., C. A. Kimbrell, E. A. Lynn, and R. D. Vetter. 2002. Population structure of copper rockfish (*Sebastes caurinus*) reflects postglacial colonization and contemporary patterns of larval dispersal. *Can. J. Fish. Aquat. Sci.* 59(8):1374-1384.

- Cope, J., E. J. Dick, A. MacCall, M. Monk, B. Soper, and C. Wetzel. 2014. Data-moderate stock assessments for brown, China, copper, sharpchin, stripetail, and yellowtail rockfishes and English and rex soles in 2013. Pacific Fishery Management Council, Portland, OR.
- Cope, J. M., D. Sampson, A. Stephens, M. Key, P. P. Mirick, M. Stachura, and coauthors. 2015. Assessments of Black Rockfish (*Sebastes melanops*) Stocks in California, Oregon, and Washington Coastal Waters. Pacific Fishery Management Council, Portland, OR.
- Cope, J. M., T. Tsou, K. Hinton, and C. Niles. 2021a. Status of Vermilion rockfish (*Sebastes miniatus*) along the U.S. West - Washington State coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Cope, J. M., C. R. Wetzel, B. J. Langseth, and J. E. Budrick. 2021b. Stock Assessment of the Squarespot Rockfish (*Sebastes hopkinsi*) along the California U.S. West Coast in 2021 using catch, length, and fishery-independent abundance data. Pacific Fishery Management Council, Portland, OR.
- Cope, J. M. and A. D. Whitman. 2021. Status of vermilion rockfish (*Sebastes miniatus*) along the U.S. West - Oregon coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Dick, E. J., M. H. Monk, T. L. Rogers, J. C. Field, and E. M. Saas. 2021. The status of Vermilion Rockfish (*Sebastes miniatus*) and Sunset Rockfish (*Sebastes crocotulus*) in U.S. waters off the coast of California south of Point Conception in 2021. Pacific Fishery Management Council, Portland, OR.
- Gertseva, V., I. Taylor, J. Wallace, and S. E. Matson. 2021. Status of the Pacific Spiny Dogfish shark resource off the continental U.S. Pacific Coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Gomez-Uchida, D., E. A. Hoffman, W. R. Ardren, and M. A. Banks. 2003. Microsatellite markers for the heavily exploited canary (*Sebastes pinniger*) and other rockfish species. *Molecular Ecology* 3(3):387-389.
- Hyde, J. R. and R. D. Vetter. 2009. Population genetic structure in the redefined vermilion rockfish (*Sebastes miniatus*) indicates limited larval dispersal and reveals natural management units. *Can. J. Fish. Aquat. Sci.* 66(9):1569-1581.
- Johnson, K. F., I. G. Taylor, B. J. Langseth, A. Stephens, L. S. Lam, M. H. Monk, and coauthors. 2021. Status of lingcod (*Ophiodon elongatus*) along the southern U.S. west coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Keller, A. A., P. H. Frey, J. R. Wallace, M. A. Head, C. R. Wetzel, J. M. Cope, and coauthors. 2018. Canary rockfishes *Sebastes pinniger* return from the brink: catch, distribution and life history along the U.S. West Coast (Washington to California). *Marine Ecology-Progress Series* 599:181-200.

- Lam, L. S., B. L. Basnett, M. A. Haltuch, J. Cope, A. Kelly, K. M. Nichols, and coauthors. 2021. Geographic variability in lingcod (*Ophiodon elongatus*) life-history and demography along the US West Coast: Oceanographic drivers and management implications. *Marine Ecology-Progress Series* 670:203-222.
- Langseth, B. J., C. R. Wetzel, J. M. Cope, and J. E. Budrick. 2021a. Status of quillback rockfish (*Sebastes maliger*) in U.S. waters off the coast of California in 2021 using catch and length data. Pacific Fishery Management Council.
- Langseth, B. J., C. R. Wetzel, J. M. Cope, T.-S. Tsou, and L. K. Hillier. 2021b. Status of quillback rockfish (*Sebastes maliger*) in U.S. waters off the coast of Washington in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.
- Langseth, B. J., C. R. Wetzel, J. M. Cope, and A. D. Whitman. 2021c. Status of quillback rockfish (*Sebastes maliger*) in U.S. waters off the coast of Oregon in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.
- Longo, G. C., L. Lam, B. Basnett, J. Samhour, S. Hamilton, K. Andrews, and coauthors. 2020. Strong population differentiation in lingcod (*Ophiodon elongatus*) is driven by a small portion of the genome. *Evolutionary Adaptations* 13:2536-2554.
- Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. University of California Press, Berkeley, California.
- Monk, M. H., E. J. Dick, J. C. Field, and T. L. Rogers. 2021. The status of Vermilion Rockfish (*Sebastes miniatus*) and Sunset Rockfish (*Sebastes crocotulus*) in U.S. waters off the coast of California north of Point Conception in 2021. Pacific Fishery Management Council, Portland, OR.
- Pearcy, W. G., M. J. Hosie, and S. L. Richardson. 1977. Distribution and duration of pelagic life of larvae of Dover sole, *Microstomus pacificus*; rex sole, *Glyptocephalus zachirus*; and petrale sole, *Eopsetta jordani*, in waters off Oregon. *Fish.Bull.* 75:173-183.
- Richards, L. J., J. T. Schnute, and C. M. Hand. 1990. A multivariate maturity model with a comparative analysis of three lingcod (*Ophiodon elongatus*) stocks. *Can. J. Fish. Aquat. Sci.* 47(5):948-959.
- Silberberg, K. R., T. E. Laidig, P. B. Adams, and D. Albin. 2001. Analysis of maturity in lingcod, *Ophiodon elongatus*. California Department of Fish and Game 87(139-152).
- Sivasundar, A. and S. R. Palumbi. 2010. Life history, ecology and the biogeography of strong genetic breaks among 15 species of Pacific rockfish, *Sebastes*. *Marine Biology* 157(7):1433-1452.

- Taylor, I. G., K. F. Johnson, B. J. Langseth, A. Stephens, L. S. Lam, M. H. Monk, and coauthors. 2021. Status of lingcod (*Ophiodon elongatus*) along the northern U.S. west coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Taylor, I. G. and A. Stephens. 2013. Stock Assessment of Shortpine Thornyhead in 2013. Pacific Fishery Management Council, Portland, OR.
- Thorson, J. T. and C. Wetzel. 2015. The status of canary rockfish (*Sebastes pinniger*) in the California Current on 2015. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R. 2019. Status of petrale sole (*Eopsetta jordani*) along the U.S. west coast in 2019. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R. and A. M. Berger. 2021. Status of Dover sole (*Microstomus pacificus*) along the U.S. West Coast in 2021. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R., B. J. Langseth, J. M. Cope, and J. E. Budrick. 2021a. The status of copper rockfish (*Sebastes caurinus*) in U.S. waters off the coast of California north of Point Conception in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R., B. J. Langseth, J. M. Cope, and J. E. Budrick. 2021b. The status of copper rockfish (*Sebastes caurinus*) in U.S. waters off the coast of California south of Point Conception in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R., B. J. Langseth, J. M. Cope, T.-S. Tsou, and K. E. Hinton. 2021c. Status of copper rockfish (*Sebastes caurinus*) in U.S. waters off the coast of Washington in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.
- Wetzel, C. R., B. J. Langseth, J. M. Cope, and A. D. Whitman. 2021d. The status of copper rockfish (*Sebastes caurinus*) in U.S. waters off the coast of Oregon in 2021 using catch and length data. Pacific Fishery Management Council, Portland, OR.