Stock Definition Considerations for a Range of Alternatives and Associated Management Implications for Stocks to be Assessed in 2025 and 2027

Introduction

The Pacific Fishery Management Council (Council) is undertaking a proposed Amendment to define additional groundfish stocks in the Pacific Coast Groundfish Fishery Management Plan (FMP). Thus far, the priority species initially identified by the Council in March 2024 for potential assessment in 2025 and 2027, which are not yet defined as stocks in the FMP include: rougheye/blackspotted rockfish, yellowtail rockfish, chilipepper rockfish, widow rockfish, yelloweye rockfish, and English sole. The final list of species for assessment in 2025 and preliminary list for 2027 are scheduled to be adopted under Agenda Item F.3.

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 species[1] in the fishery, it does not identify stocks and, as a result, NMFS is unable to report status to Congress as required.[2] 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".

Subsequently, the Council completed a process resulting in Amendment 31 to the Pacific Coast Groundfish FMP, which defined stocks assessed in 2021 and 2023. This included initial scoping in June 2022 (Agenda Item F.4, Attachment 1, June 2022), in September 2022 identification of priority species to be included and analyses to support the Amendment (Agenda Item G.5, Attachment 1 and Attachment 2, September 2022), a range of alternatives (ROA) in November 2022 (Agenda Item H.5, Attachment 1, November 2022), with preliminary preferred alternatives in March 2023 (Agenda Item F.7, Attachment 1, March 2023), and a final alternative in June 2023. Amendment 31 was incorporated into the Pacific Coast Groundfish FMP, as well as provided updates to Council Operating Procedure (COP) 9.

In September 2022, the Council adopted the following Purpose and Need statement for Amendment 31, which may be similar to that considered during the June 2024 Council meeting for the next proposed groundfish stock definition Amendment:

> "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

[1] see Table 3-1 of the FMP
[2] MSA §304(e)(1)

> 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."
>
> Agenda Item G.5 Motion, in writing, September 2022

This white paper is intended to aid in the selection of a range of alternatives (ROA) by synthesizing the state of scientific knowledge and outline some of the management implications of alternative stock definitions. This document follows the format of that provided for Amendment 31 (Agenda Item H.5 Attachment 1, November 2022) and contains excerpted content relevant to the current proposed Amendment.

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 is a longer-term multi-phase process. The process to complete Amendment 31 was referred to as "Phase 1". The Council is pursuing a process for groundfish stock definition under Phase 2, which follows a proposed schedule (see Agenda Item E.8, November 2023), and includes potential revisions to stock complexes and removal or delegation of stocks. The current proposed Amendment slightly overlaps Phase 2 but will allow the Council to initiate the 2027-2028 biennial harvest specifications and management measure process based upon new stock definitions for those species assessed in 2025. Stock definitions for all remaining species will be completed in future actions.

The proposed Amendment is time-sensitive and must be completed by June 2025, prior to Council adoption of new stock assessments and the initiation of 2027-2028 biennial management decision-making. The Council is scheduled to adopt a ROA of stock definitions in June 2024, preliminary preferred alternative in September 2024, and final preferred alternative in November 2024.

Order of Decision-making

The following diagram describes our understanding of the general order of decision-making in the stock definition process (Figure 1), though the exact timing may vary depending on Council priorities for Agenda Items at specific meetings. 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. Thus, the focus of this Amendment would define groundfish stocks planned for assessment in the next cycle.

New scientific information indicating a reconsideration of a species' stock definition(s) is warranted could become available at any time during ongoing fishery management. The stock assessment prioritization process is a logical conduit through which new information on stock definitions can flow. When the Council is considering which stocks to prioritize for assessment, they can also consider whether there is new information to inform the stock definition(s). During stock assessment prioritization, the Council can initiate a three-meeting process to amend the FMP's stock definitions that would conclude through the Council process prior to the results of the assessments. After approving the FMP amendment, NMFS could make subsequent status determinations based on BSIA. This revised timeline was incorporated into COP 9.

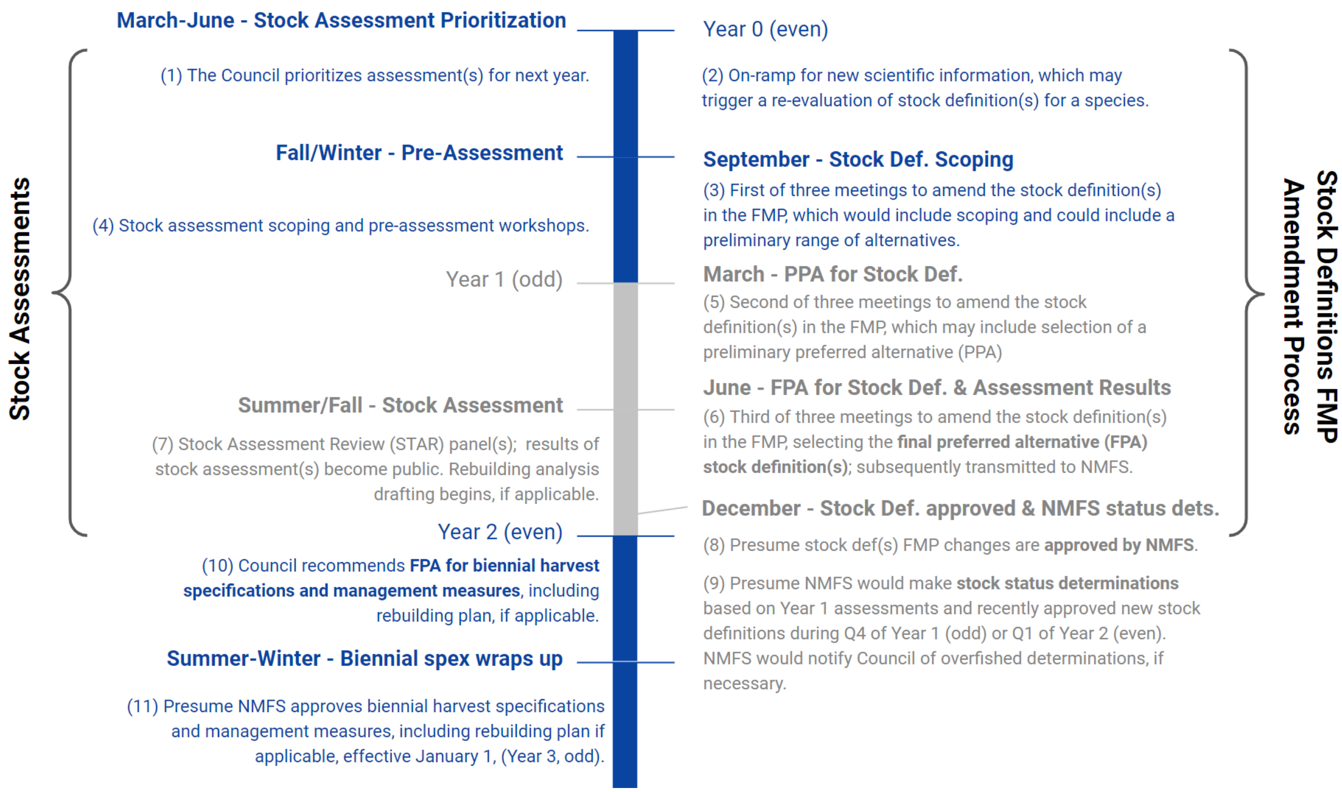

Figure 1. Diagram outlining the 3-year timeline that overlays stock assessments and biennial harvest specifications and management measures (left-hand side of the timeline) with stock definition changes and NMFS' status determinations (right-hand side of the timeline). Exact timing may vary depending on Council priorities for Agenda Items at specific meetings.

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 (Agenda Item E.3.a. Supplemental SSC Report 1 November 2021). 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. The SSC also recommended consideration of variation in life history characteristics (e.g. growth, maturity) when identifying stocks for species (Agenda Item E.8.a Supplemental SSC Report 1 November 2023). Table 1 provides an overview of these biological attributes for priority species for potential assessment in 2025 and 2027, with full scientific literature results in Appendix A.

Table 1. Overview of types of scientific information that may inform stock structure; full results of scientific literature review in Appendix A.

Species (candidates for 2025 assessment year)	**Genetic differentiation**	**Adult movement**	**Larval dispersal**	**Demographic differences**	**Assessment stratification**
Rougheye rockfish (*Sebastes aleutianus*)	Rougheye rockfish are genetically distinct from blackspotted rockfish (Orr and Hawkins 2008).	Rougheye and blackspotted rockfish share broad overlap in depth and geographic distributions. Rougheye rockfish densities peak in shallower areas (~200 m) than blackspotted rockfish (Orr and Hawkins 2008).	Lack of information on larval dispersal.	There is little information on spatial variation in rougheye and blackspotted rockfish life history (Clausen et al. 2003).	Single model, coastwide (Hicks 2013).
Blackspotted rockfish (*Sebastes melanostictus*)	Blackspotted rockfish are genetically distinct from rougheye rockfish (Orr and Hawkins 2008).	Rougheye and blackspotted rockfish share broad overlap in depth and geographic distributions. Blackspotted rockfish densities peak in deeper areas (~350 m) than rougheye rockfish (Orr and Hawkins 2008).	Lack of information on larval dispersal.	There is little information on spatial variation in rougheye and blackspotted rockfish life history (Clausen et al. 2003).	Single model, coastwide (Hicks 2013).

Species (candidates for 2025 assessment year)	**Genetic differentiation**	**Adult movement**	**Larval dispersal**	**Demographic differences**	**Assessment stratification**
Chilipepper rockfish (*Sebastes goodei*)	Lack of genetic information for this species. Wishard et al. (1980) found chilipepper rockfish to be genetically close to canary rockfish (*Sebastes pinniger*).	Exhibit movement to deeper waters as they age (Punt and Methot 2004). Likely move inshore during winter spawning months (Petersen et al. 2010)	Pelagic juvenile stage (avg 3.5 months, up to 6 months; Solinger 2019; Ralston and Stewart 2013). Larvae released earlier in southern CA vs northern CA (Echeverria 1987). Evidence of secondary broods and spatial variation in related female size (Lefebvre et al. 2018).	Winter upwelling negatively impacted recruitment success in northern CA, and positively impacted recruitment success in Morro Bay (Solinger 2019).	Single model, California only (Field et al. 2016).
Widow rockfish (*Sebastes entomelas*)	No genetic evidence suggesting distinct biological stocks off the U.S. West Coast (Sivasundar and Palumbi 2010).	Lack of information on adult movement rates.	Larval duration is approximately 3 to 4 months (Sivasundar and Palumbi 2010). Degree of population connectivity remains unknown (Adams et al. 2019).	Some evidence of biological differences between areas; CA fish tend to mature at a smaller length than those off Oregon (Barss and Echeverria 1987).	Single model, coastwide (Adams et al. 2019).
Yelloweye rockfish (*Sebastes ruberrimus*)	Some evidence of genetic difference between the Strait of Georgia (Canada) and coastal populations ranging down to Oregon, though coastal populations lacked any genetic structure (Siegle et al. 2013).	Lack of information on adult movement rates.	Little is known about the pelagic juvenile stage. An otolith microchemistry study suggested complete mixing of offspring between OR and WA (Gao et al. 2010).		Single coastwide model, with two sub-areas: waters off CA and waters off OR/WA, but linked by common stock-recruit relationship (Gertseva and Cope 2017).

Species (candidates for 2025 assessment year)	**Genetic differentiation**	**Adult movement**	**Larval dispersal**	**Demographic differences**	**Assessment stratification**
Yellowtail rockfish (*Sebastes flavidus*)	Genetic study indicates that there are two stocks, with a genetic cline at Cape Mendocino, California, roughly 40° 10′ N. Lat. (Hess et al. 2011).	Lack of information on adult movement rates.	Pelagic larval duration 3 to 4 months (Hess et al. 2011); actual dispersal distances remain unknown.	Recruitment trends related to physical forcing and coherence along the coast, found the greatest differences among the U.S. and Canadian stocks to be defined by Cape Mendocino (Field and Ralston 2005).	North of 40º N. Lat..(Stephens and Taylor 2017); South of 40º N. Lat..(Dick 2010/Dick 2011)
English sole (*Parophrys vetulus*)	Lack of genetic information for this species.	Adults move into shallow waters (10 to 40 fathoms) in the spring and into deeper waters (20 to 50 fathoms) during winter. In WA and CA, English sole found to migrate south in the fall and north in spring (Barss 1976).	Pelagic phase lasts between 6 and 10 weeks (Laroche et al. 1982) before settle into estuaries and other coastal zones (Gunderson et al. 1990). Nursery areas along OR and WA are thought to support the entire coastwide population (Rooper et al. 2002; Rooper et al. 2004).		Single model, coastwide, data moderate (Cope et al. 2013)

Range of Alternatives

This paper presents an initial draft range of alternatives (ROA) for Council consideration. 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 the current proposed Amendment, though stock complex revisions may be discussed as part of future actions.

Action Alternatives Structure:

There are two overarching themes for the action alternatives: an aggregated alternative (i.e., coastwide) and disaggregated alternatives (i.e., state/region and north & south of 40°10' N. lat.). Alternatives are structured as species-specific, but 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 harvest specifications process. This specific language was not added 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 define stocks prior to assessment nor allow NMFS to make stock status determinations.

Alternative 1 (coastwide stock definition)
Under Alternative 1, the priority groundfish species under the proposed Amendment, except yellowtail 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 coastwide 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/region stock definitions)
Alternative 2 may apply to chilipepper rockfish. Under this alternative, a species is defined as a state-specific stock or a combination of states (i.e., a California stock, an Oregon stock, and a Washington stock or a California stock and an Oregon-Washington stock). For example, the most recent chilipepper rockfish assessment was for California only (Field et al. 2016), and thus a state-specific stock definition alternative is proposed as one option in the range. Depletion estimates for the stock are presented in stock assessment(s) at a state (or state combination) scale. Each stock would have specific HCRs and status determinations under this alternative that align with state or state combination boundaries.

Alternative 3 (north and south of 40°10’ N. lat. stock definitions)
Under Alternative 3, yellowtail rockfish stocks would be defined north and south of 40°10’ N. lat., consistent with past/present Council actions. Depletion estimates for these stocks would be 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 yellowtail rockfish assessments were prepared in 2017 stratified at 40°10’ N. lat. given genetic evidence of stock structure north and south of that general area, though the assessment south of 40°10’ N. lat. was not sufficiently robust for management purposes. The Council has also managed yellowtail rockfish with a region-specific harvest specification north of 40°10’ N. lat. and as part of the Minor Shelf Rockfish complex in the area south of 40°10’ N. lat. With such clear evidence of stock structure breaking at that latitude and differential yellowtail management north and south of that management line, Alternative 3 is the only one proposed for yellowtail rockfish. However, it is unlikely that status could be determined for a southern yellowtail rockfish stock given the lack of data for the 2017 assessment exercise, unless a new assessment was conducted.

Table 2. Summary of proposed action alternatives for priority species under the proposed Amendment. 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/Region	Alt. 3 North and South of 40°10’ N. lat.
Rougheye rockfish	*		
Blackspotted rockfish	*		
Widow rockfish	*		
English sole	*		

Species	Alt. 1 Coastwide	Alt. 2 State/Region	Alt. 3 North and South of 40°10’ N. lat.
Chilipepper rockfish	*	*	
Yelloweye rockfish	*		
Yellowtail rockfish			*

Management Implications

Summary

Generally speaking, management implications of having 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).[3] 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). 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 sub-stocks (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

[3] E.3.a. Supplemental SSC Report 1, November 2021

on final stock assessment planning 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" (Agenda Item F.3.a Supplemental SSC Report 1, June 2022). 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 Overfished Determinations and Rebuilding Plans section) or areas of abundance could mask an area of localized depletion.

Considerations for State/Region-Specific Alternatives

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/region, only that state/region 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 and 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. Section 4.5.3 of the FMP 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.[4]

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, 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.

One management implication is the need to address stock complexes and stocks managed within a complex that are determined to be overfished. As management implications were explored under Amendment 31 alternatives, it became clear that the Council needs to consider this possibility and codify a definitive policy on this issue (scheduled during Phase 2). 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 are met, such as staying within prescribed overfishing limits and timely rebuilding. 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).

[4] (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 (for non-flatfish and flatfish taxa respectively) 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 proposed Amendment 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, it is recommended 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.

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Glossary of Terms

Acceptable Biological Catch (ABC): A harvest specification that accounts for the scientific uncertainty in the estimate of OFL, and any other scientific uncertainty.

Annual Catch Limit (ACL): A harvest specification set equal to or below the ABC in consideration of conservation objectives, socioeconomic concerns, management uncertainty, ecological concerns, and other factors. The ACL is a harvest limit that includes all sources of fishing-related mortality including landings, discard mortality, research catches, and catches in exempted fishing permit activities. Sector-specific ACLs can be specified, especially where a sector has a formal, long-term allocation of the harvestable surplus of a stock or stock complex.

Assessment Unit: The area at which the assessment is conducted/modeled. Assessors often refer to this as **the "stock"**, which is not equivalent to the "stock" under MSA. The stock may be assessed across areas that only comprise segments of the coast or coastwide depending upon the species biology, data availability, exploitation history, etc.

Harvest Control Rule (HCR): In the FMP, HCRs are generally qualified by another term such as the MSY control rule, ABC control rule, etc.

Localized Depletion: Localized depletion is a way of characterizing when a portion of a stock, or within a part of a species' range, has an estimated abundance that is lower than for other portions of the stock or areas of the species' range. Localized depletion may be caused by a number of factors, including but not limited to, fishing pressure, local habitat loss or degradation, ecological changes, environmental conditions, etc. Localized depletion may be mitigated in a number of ways, including but not limited to, spillover of fish from areas of higher abundance, local reductions in fishing pressure, etc.

Overfishing Limit (OFL): The MSY harvest level or the annual abundance of exploitable biomass of a stock or stock complex multiplied by the maximum fishing mortality threshold or proxy thereof and is an estimate of the catch level above which overfishing is occurring.

Population: A group of interbreeding individuals that exist together in time and space that are isolated from other groups (Waples and Gaggiotti, 2006).

Species: A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding (Milius, 2017; Mayr, 2000). Refers to the genus and species; the unit as it is included in the FMP off the U.S. West Coast.

Status: Status is a determination of the health of a stock of fish and is reported to Congress quarterly by NMFS. A stock may be determined by NMFS to have any of the following overfished statuses: "unknown", "overfished", "not overfished", or "approaching an overfished" condition. A stock may be determined by NMFS to have any of the following overfishing statuses: "unknown", "subject to overfishing", or "not subject to overfishing".

Status Determination: The Secretary of Commerce makes formal determinations and the Status of Stocks are reported to Congress quarterly. Status determinations include, but are not limited to, "overfished" (relates to biomass of a stock or stock complex), and "overfishing" (pertains to a rate or level of removal of fish from a stock or stock complex).

Status Determination Criteria (SDC): SCD mean the measurable and objective factors, maximum fishing mortality threshold (MFMT), OFL, and minimum stock size threshold (MSST), or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished. SDC are required to be identified in every FMP. See full description at 50 CFR 600.310(e)(2).

Stock: The term "stock of fish" means a species, subspecies, geographical grouping, or other category of fish capable of management as a unit. (16 U.S.C. 1802 MSA §3(42)). It is a delineation of a species (or group of species) that is made at the discretion of the Council (e.g., a policy decision), based on BSIA and other relevant management needs; stocks are required to be defined in the FMP (i.e., subject to deliberative public process and Secretarial approval), per NS1 guidelines. This is the unit at which status determinations are made and OFLs should be set.

Sub-area assessment: Term to describe an assessment unit when multiple assessment areas are used to assess a single species or a stock (e.g., a single stock may have sub-area assessments for different areas or portions of the stock based on data availability). Sub-area assessment results may be combined to estimate abundance and OFL, for overfished and overfishing status determinations, respectively.

Sub-population: A delineated subset of individuals within a population (Wells and Richmond 1995).

Appendix A

The following Appendix was provided by Madison Bargas (Oregon State University) and represents the results of a scientific literature review for the Council's March 2024 candidate species for potential assessment in 2025 and 2027.

1.1 Species - Rougheye rockfish *(Sebastes aleutianus)* and Blackspotted rockfish *(Sebastes melanostictus)*

Rougheye rockfish (*Sebastes aleutianus*) span the Pacific rim from Japan through the Bering Sea and south to Point Conception, California (Clausen et al. 2003; Shotwell et al. 2009; Sullivan et al. 2021). Their center of abundance is in the eastern Gulf of Alaska (Clausen et al. 2003).

Blackspotted rockfish (*Sebastes melanostictus*) are more common to the north and in the western Gulf of Alaska (Orr and Hawkins 2008). Rougheye rockfish densities peak in shallow areas (~ 200 m) relative to blackspotted rockfish (~ 350 m; Orr and Hawkins 2008). Adults of both species are abundant at depths of 200 to 350 m (Clausen et al. 2003). Juveniles are typically found in inshore and frequent rocky habitats (Shotwell et al. 2009).

1.1.1 Assessment History

Rougheye rockfish are physically similar to shortraker rockfish (*Sebastes borealis*); thus the two species are difficult to differentiate in the field and often grouped (Cluasen et al. 2003). Much of the data available for assessments also combines rougheye and shortraker rockfishes with blackspotted rockfish (Hicks et al. 2014). Rougheye and blackspotted rockfishes along the US West Coast were assessed as a single stock in 2013 (Hicks et al. 2014).

1.1.2 Genetics

Blackspotted rockfish were originally thought to be a distinct "type" of rougheye rockfish (Gharrett et al. 2005; Hawkins et al. 2005). Advancements in technology, however, revealed that blackspotted rockfish is genetically distinct from rougheye rockfish (Orr and Hawkins 2008). There is some evidence of genetic differentiation among rougheye rockfish in the Gulf of Alaska (Seeb 1986; Hawkins et al. 1997; Matala et al. 2003, 2004; Gharrett et al. 2003), though the extent to which is unknown (Clausen et al. 2003).

1.1.3 Larval Dispersal

There is little information about the larval, post-larval, and early juvenile stages of rougheye and blackspotted rockfishes. This is partially because genetic information is necessary to positively identify rougheye and blackspotted rockfish larvae (Gharrett et al. 2001). Post-larval rougheye rockfish have been collected from epipelagic waters in the Gulf of Alaska (Matarese et al. 1989) but there is no information regarding settlement size or age (Clausen et al. 2003).

1.1.4 Adult Movement

Adult rougheye rockfish are demersal and typically inhabit steep, rocky areas of the continental slope, concentrating along the 300 to 500 m depth contours (Ito 1999). Rougheye rockfish may comprise a greater proportion of the rougheye-blackspotted complex off the coasts of Washington and Oregon than in the Gulf of Alaska (Gharrett et al. 2005; Hawkins et al. 2005; Orr and Hawkins 2008).

1.1.5 Other Life History Traits

Rougheye rockfish have protracted reproductive periods with parturition taking place between December and April in Alaska (McDermott 1994). Age-at-50%-maturity in the Gulf of Alaska is 19.6 yr for rougheye rockfish and 27.4 yr for blackspotted rockfish (Conrath 2017). There is little information on spatial variation in rougheye and blackspotted rockfish life history (Clausen et al. 2003).

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2.1 Species - Chilipepper Rockfish (*Sebastes goodei)*

Chilipepper rockfish *(Sebastes goodei)* is a semi-pelagic species of high commercial and recreational value along the West Coast, from the US-Mexico border to the Columbia River in Washington (Field et al. 2016). Although the distribution of this species extends into British Columbia, abundance peaks near Cape Mendocino and declines north of Cape Blanco in Oregon (Beyer et al. 2015). Adult chilipepper rockfish form large schools, tend to live in midwater environments (75 to 325 m), and move into deeper waters as they grow (Beyer et al. 2015). Chilipepper rockfish reach maturity from 3 to 4 yr and live to be 36 yr (Beyer et al. 2015).

2.1.1 Assessment History

The first stock assessment for chilipepper rockfish was conducted at the coastwide scale in 2007 (Field 2007). An update assessment was conducted in 2015 (Field et al. 2016). A selectivity offset for recreational fishing effort was used to account for chilipepper moving into deeper water with age and size. Stock assessment authors recommend that future assessments consider northern and southern models whenever data permit (Field et al. 2016).

2.1.2 Genetics

There is little to no genetic information on chilipepper rockfish. Chilipepper rockfish are genetically similar to canary rockfish (*Sebastes pinniger*) and display a very close relationship for nonsibling species (Wishard et al. 1980).

2.1.3 Larval Dispersal

Chilipepper rockfish spawn from December to March, with peak spawning between January and February (Harvey et al. 2011). In southern California, larvae are released from August to April, with peak abundance in December and January (Echeverria, 1987). In northern California, larvae are released from November to June, with peak spawning in January and February (Echeverria, 1987). Chilipepper rockfish remain in the pelagic juvenile stage for 3.5 to 6 months (Solinger 2019; Ralston and Stewart 2013). Young of the year are most abundant off of central California, though they are encountered at many sites from the southern Channel Islands to north of the Columbia River (Field et al. 2021).

2.1.4 Adult Movement

Chilipepper rockfish tend to move into deeper waters as they age (Punt and Methot 2004). Because chilipepper rockfish spawn in the winter months, adults are likely to move inshore during that time (Petersen et al. 2010). There is no information about movement rates of adult chilipepper rockfish.

2.1.5 Other Life History Traits

Female length-at-50%-maturity is 30 cm off southern California and 34 cm off central and northern California (Wyllie-Echeverria 1987; Beyer et al. 2015). There is evidence of secondary broods that vary by geographic area, season, and year (Beyer et al. 2015). Multiple brooding is known to occur in rockfishes with more southern distributions, perhaps due to more optimal reproductive conditions (Mapes et al. 2023). Lefebvre et al. (2018) found evidence of spatial variation in the size at which females are likely to produce multiple broods. For example, female brooding length was shorter in southern California for females producing multiple broods. Multiple broods were common in central and southern California (Holder and Field 2019) . Winter upwelling negatively impacted recruitment success in northern California, and positively impacted recruitment success in Morro Bay (Solinger 2019). Additional life history information is needed south of Point Conception (Field et al. 2016).

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3.1 Species - Widow Rockfish *(Sebastes entomelas)*

Widow rockfish (*Sebastes entomelas*) range from southeast Alaska to Baja California, Mexico (He et al. 2007a; Hicks et al. 2015; Adams et al. 2019). They are most abundant from British Columbia to northern California (Ressler et al. 2009; Hicks et al. 2015; Adams et al. 2019) and tend to occupy a broader range of depths with increasing latitude.

3.1.1 Assessment History

Widow rockfish were fully assessed on a coastwide basis in 1984, 1989, 1990, 1993, 1997, 2000, 2003, 2005, 2009, 2011, and 2015 (Lenarz 1984, Hightower and Lenarz 1989, 1990; Rogers and Lenarz 1993; Ralston and Pearson 1997; Williams et al. 2000; He et al. 2003; He et al. 2006; He et al. 2011). Update assessments were conducted in 2007 and 2019 (He et al. 2007b; He et al. 2009; Hicks and Wetzel 2015; Adams et al. 2019). The population was declared overfished in 2001, thus rebuilding analyses were conducted in 2003, 2005, 2007, and 2009 (He et al. 2011). A catch-only projection was conducted in 2023 (Wallace 2023).

In 1989, the widow rockfish assessment consisted of a two-area model (delineated at 43°N) with separate fisheries and selectivities (Hightower and Lenarz 1989). In 2011, a coastwide assessment produced results comparable to a two-area model that was based on differences in growth and maturity (He et al. 2011; Hicks and Wetzel 2015). Widow rockfish are assessed as part of the "other rockfish" complex in Alaska (Stanley 1999) and the "shelf rockfish" complex in Canada (Stanley 1999).

3.1.2 Genetics

There is no evidence of distinct genetic populations along the US West Coast (Sivasundar and Palumbi 2010).

3.1.3 Larval Dispersal

The larval duration for widow rockfish is approximately 3 to 4 months (Sivasundar and Palumbi 2010). The degree of population connectivity remains unknown (Adams et al. 2019).

3.1.4 Adult Movement

Adult widow rockfish tend to be active in the water column at night and disperse during the day (Wilkins 1986). There is little information about adult movement rates. NWFSC bottom trawl survey data suggest that widow rockfish may recruit to central or southern California and move north as they age (Adams et al. 2019).

3.1.5 Other Life History Traits

Widow rockfish off California mature at smaller lengths than those off of Oregon (Barss and Echeverria 1984; Echeverria 1987). Age-at-50%-maturity has been estimated at 5.47 yr (Adams et al. 2019). Parturition occurs from December to March off California and in April off British Columbia (Barss and Echeverria 1987; Adams et al. 2019).

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4.1 Species - Yelloweye Rockfish *(Sebastes ruberrimus)*

Yelloweye rockfish (*Sebastes ruberrimus*) are distributed from the western Gulf of Alaska to northern Baja California (Hart 1973; Eschmeyer and Herald 1983). They are most abundant from southeast Alaska to central California. Adults are typically found along the continental shelf, to 400 m. Juveniles are often found in shallower waters (Gertseva and Cope 2017).

4.1.1 Assessment History

Before 2000, yelloweye rockfish were managed as part of the Sebastes complex. From 2000 to 2002, yelloweye rockfish were considered part of the "minor shelf" group. Yelloweye rockfish were fully assessed in 2005, 2006, 2009, and 2017 (Wallace et al. 2005; Wallace et al. 2006; Stewart et al. 2009; Gertseva and Cope 2017). Update assessments were conducted in 2007 and 2011 (Wallace 2008; Taylor and Wetzel 2011). Due to low movement rates and differences in fishing pressures, the 2009 assessment modeled three sub-areas: California, Oregon, and Washington (Stewart et al. 2009; Gertseva and Cope 2017). The most recent assessment used region-specific catch histories to model two sub-areas: California and Oregon/Washington (Gertseva and Cope 2017).

4.1.2 Genetics

There may be genetic separation between yelloweye rockfish in the Strait of Georgia (British Columbia) and outer coasts of Washington and Oregon (Yamanaka et al. 2001; Siegle et al. 2013). The coastal populations, however, are not genetically distinct.

4.1.3 Larval Dispersal

Little is known about the pelagic juvenile stage for yelloweye rockfish (Taylor and Wetzel 2011). The pelagic larval phase may last up to one year in Alaska (Olson et al. 2018). This extended period promotes some mixing of reproductive output, which is dependent upon environmental factors such as upwelling (Gertseva and Cope 2017).

Yelloweye rockfish do not settle within a well-defined depth range (Stewart et al. 2009). An otolith microchemistry study suggested complete mixing of offspring between Oregon and Washington (Gao et al. 2010).

4.1.4 Adult Movement

There is little to no information about the movement rates of adult yelloweye rockfish.

4.1.5 Other Life History Traits

Spawning output is greatest off Oregon, followed by California and Washignon (Stewart et al. 2009). The age-at-50%-maturity for female yelloweye rockfish is between 20 and 25 yr (O'Connell and Fujioka 1991). Parturition occurs from February to September in Alaska, with shorter spawning periods south of British Columbia (O'Connell 1987; Olson et al. 2018). Length-at-50%-maturity is estimated at 46 cm for females and 54 cm for males in British Columbia (Olson et al. 2018). There is insufficient information with which to evaluate spatial differences in life history traits for yelloweye rockfish.

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5.1 Species - Yellowtail Rockfish *(Sebastes flavidus)*

Yellowtail rockfish (*Sebastes flavidus*) are commercially valuable throughout the California Current. They are distributed from Aleutian Islands to Baja California, abundant from British Columbia to Oregon, and rare south of Point Conception (Tagart et al. 2000; Wallace and Lai 2005). Adults occur in the water column near rocky reefs (49 to 98 fathoms) and are commonly caught in the commercial trawl fishery (60 to 110 fathoms) (Tagart and Kimura 1982; Wallace and Lai 2005; Hess et al. 2011).

5.1.1 Assessment History

The first benchmark assessment for yellowtail rockfish was conducted in 1999 (Tagart et al. 2000). This stock assessment pertained only to the northern stock, which was divided into three sub-area models: Southern Vancouver (from Cape Elizabeth, 47°20'N, to ~49°N), Northern Columbia (from Cape Falcon, 45°46'N, to Cape Elizabeth), and Eureka-South Columbia (from Cape Mendocino to Cape Falcon). An update assessment was conducted in 2004 (Wallace and Lai 2005). A data-moderate assessment was conducted in 2013, given that abundance indices but no length or age data were available for inclusion in the model (Cope et al. 2015). A depletion-based stock reduction analysis was used to assess yellowtail rockfish south of Cape Mendocino in 2011 (Dick and MacCall 2011).

Yellowtail rockfish were most recently assessed in 2017 as two stocks separated by Cape Mendocino, CA (40°10′N; Stephens and Taylor 2017). The northern stock extends from Cape Mendocino to the US-Canada border. The southern stock is managed as part of the "minor shelf rockfish" complex from Cape Mendocino to the US-Mexico border (Stephens and Taylor 2017). The reduction from three to two sub-area models was due to a lack of available fine-scale data.

5.1.2 Genetics

Yellowtail rockfish are closely related to black rockfish (*Sebastes melanops*) (Baetscher 2019). Wishard et al. (1980) and McGauley (1991) found no evidence of genetic differences among yellowtail rockfish along the US West Coast. Hess et al. (2011), however, found a genetic break at Cape Mendocino with greater genetic diversity to the south.

5.1.3 Larval Dispersal

Yellowtail rockfish larvae exhibit an extended pelagic duration of 3 to 4 months, which provides potential for high rates of dispersal along the US West Coast (Hess et al. 2011). Actual dispersal distances remain unknown.

5.1.4 Adult Movement

A mark-recapture study (n = 36) estimated that 75% of yellowtail rockfish caught in Canadian waters moved ≤ 25 km from their release location (Stanley et al. 1994). Notably, three individuals traveled over 100 km. Of the fish tagged off Alaska, all five recaptures moved between 425 and 1400 km to the south (Stanley et al. 1994).

5.1.5 Other Life History Traits

Females at Cordell Bank in California have been observed with developing ovaries and/or embryos between October and January (Eldridge et al. 1990). Parturition typically occurs in March and April, with eyed embryos found in January and February. Males develop quickly in July and August and stop producing sperm in October (Eldridge et al. 1990). Larger, older yellowtail rockfish tend to spawn earlier in the season (Eldridge et al. 1990; Bobko and Berkely 2004).

Yellowtail rockfish reproduction varies spatially along the California coast (Beyer et al. 2015). However, spatial differences are confounded with temporal variation. Length-at-50% maturity for females from the northern stock is estimated at 42.49 cm but limited sample sizes to the south prevent spatial comparisons of maturation rates (Stephens and Taylor 2017).

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6.1 Species - English sole *(Parophrys vetulus)*

English sole (*Parophrys vetulus*) can be found in shallow waters (less than 200 m) from Unimak Island in Alaska to Baja California, Mexico (Fargo and Kronlund 2000). A commercial trawl fishery was initiated along the US West Coast in the late 1800s, with peak catch following World War II (Fargo and Kronlund 2000). Although the commercial value of English sole has since declined, high rates of productivity and relatively short lifespans provide very low vulnerability to overfishing (Cope et al. 2015).

There is limited information about stock structure for this species.

6.1.1 Assessment History
A coastwide data-moderate stock assessment for English sole was completed in 2013 (Cope et al. 2015). Previous assessments include a full benchmark assessment in 2005 (Stewart 2005) and an update in 2007 (Stewart 2007). All stock assessment models were conducted at the coastwide scale.

6.1.2 Genetics
There is little information about the genetics of English sole. One study, which was conducted in the Salish Sea, found little genetic diversity among sampled individuals (Winans et al. 2022).

6.1.3 Larval Dispersal
The pelagic phase (egg and larval) lasts between 6 and 10 weeks (Laroche et al. 1982) before English sole settle into estuaries and other coastal zones (Gunderson et al. 1990). Nursery areas along Oregon and Washington are thought to support the entire coastwide population (Rooper et al. 2002; Rooper et al. 2004). There is limited information to inform larval dispersal distances.

6.1.4 Adult Movement
English sole tend to emigrate from estuaries when they are approximately 75 mm and 2 yr (Gunderson et al. 1990). Adults move into shallow waters (10 to 40 fathoms) in the spring and into deeper waters (20 to 50 fathoms) during winter (Barss 1976). In Washington and California, English sole have been found to migrate south in the fall and north in spring (Barss 1976).

6.1.5 Other Life History Traits
English sole exhibit sexually dimorphic growth (Fargo and Kronlund 2000). The sexes grow at similar rates until age three, after which female growth rates surpass that of males (Fargo and Kronlund 2000). There is no information about spatial variation in growth rates for English sole.

English sole exhibit interannual variation in growth and maturity (Fargo and Tyler 1994; Fargo and Kronlund 2000). In Oregon, females mature after 3 yr and males mature after 4 yr (Barss 1976). There is uncertainty about the length-at-50% maturity for females. Although Harry (1959) found that females mature at 31 cm, Stewart (2005) used data from the National Marine Fisheries Service's triennial groundfish survey to estimate female maturity at 23.3 cm (coastwide).
English sole have a protracted spawning season, with reproductive activity occurring between September and April (Barss 1976; Kruse and Tyler 1983). Smaller fish tend to spawn later than larger individuals (Fargo and Kronlund 2000). There is no information about spatial variation in maturation rates or reproductive phenology.

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