Status of the Rougheye and Blackspotted Rockfishes stock off the U.S. West Coast in 2025

Jason M. Cope[1], Vladlena Gertseva[1], R. Claire Rosmond[2] and Alison D. Whitman[3]

1. NOAA Fisheries Northwest Fisheries Science Center, 2725 Montlake Boulevard East
2. NOAA Fisheries Northwest Fisheries Science Center, 2032 SE Osu Drive
3. Oregon Department of Fish and Wildlife, 2040 Southeast Marine Science Drive

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Science Center

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Please cite this publication as:

Cope, J.M., V. Gertseva, R.C. Rosemond, F. Caltabellotta, A.D. Whitman. Status of the Rougheye and Blackspotted Rockfishes stock off the U.S. West Coast in 2025.2025. Prepared by [COMMITTEE]. [XX] p.

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quiet = TRUE) #cat(a, sep = '\n') #
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Disclaimer

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1 Introduction

This document presents the stock assessment for the Rougheye (*Sebastes aleutianus*) and Blackspotted (*Sebastes melanostictus*) rockfishes, two species that form one management complex. This report is for the year 2025 in state and federal waters from California to Washington State, excluding consideration of the Puget Sound and Salish Sea. It seeks to use available catch, biological compositions in the for of lengths and ages, and potential indices of abundance.

1.1 Stock Structure

Rougheye rockfish were first described in 1811 as *Perca variabilis* by German zoologist Peter Simon Pallas (Jordan and Evermann 1898), and assigned to various taxa at least 15 times since (Love et al. 2002). Some descriptions noted both light and dark color morphs, which, along with possible confusion with several morphologically similar co-occurring species (e.g., S. borealis and S. melanostomus) have contributed to the persistent ambiguity in formal descriptions of Rougheye Rockfish (Orr and Hawkins 2008). The first genetic studies conducted in the late 1960s and early 1970s (e.g., Tsuyuki et al. 1968, Tsuyuki and Westrheim 1970) observed diversity suggestive of two genetic types within specimens identified as Rougheye Rockfish. Allozyme studies conducted over the next two decades (e.g., Seeb 1986, Hawkins et al. 1997, Hawkins et al. 2005) provided additional evidence suggesting two separate genetic types within field-identified Rougheye Rockfish. Genetic variation between the two types, supported by both nuclear and mitochondrial DNA, was determined to be sufficiently conclusive to separate two species: “Type I” and “Type II” Rougheye Rockfish (Gharrett et al. 2005). Meristic and morphometric comparisons of the two species suggested certain characters such as gill raker counts and length, snout length, anal base length, and pectoral fin base were significantly different, and in combination could reliably, though not definitively, distinguish between the species (Gharrett et al. 2006). The two separate species were formally re-described by Orr and Hawkins (2008) with the Type II group retaining *S. aleutianus* and the common name Rougheye Rockfish. Blackspotted rockfish was proposed as the common name for the Type I group along with the scientific name of *S. melanostictus*, re-establishing nomenclature from one of the species complex’s earlier descriptions (cf. Matsubara 1934).

Though Rougheye and Blackspotted rockfishes are genetically distinct, they remain difficult to visually distinguish, thus most data historically and contemporaneously are only available for the Rougheye/Blackspotted rockfish complex, not at the species level. They both range from northern California up to and throughout Alaska. They both greatly overlap in latitude and depth, and are generally considered slope rockfish, with an otogentic shift from shallower to deeper, and adults commonly found at 360 m. Rougheye seems to be proportionally more abundant when survey samples are genetically identified, and Blackspotted tend to be found, on average, deeper than Rougheye. They can school and may segregate by size and age. While we treat these species as one assessed stock from this point forward, we recognize and are mindful of the above distinctions as we conduct our analyses.

There are at least two questions to think about when considering stock structure for Rougheye and Blackspotted rockfishes.

1. Rougheye and Blackspotted rockfishes are two different species– can we separate them as two stocks and conduct separate assessments? These two species remain difficult to differentiate visually in the catch, thus remain reported as a species complex. Frey et al. (in prep.) provided insight into the ability of the Northwest Fisheries Science Center West Coast Groundfish Bottom Trawl Survey biologists to identify the two species, with 90% of genetically identified Rougheye rockfish being correctly identified in the field. When mis-identifications occured, it was usually a Blackspotted rockfish being mis-identified as a Rougheye rockfish. There were few mis-identifications when a fish was identified as a Blackspotted rockfish. While this is promising for potential future species-specific data coming from the survey, it does not alleviate the historical problem of separating fishery data into the two species. Frey et al. (in prep.) therefore also considered whether ecological factors like depth or latitude could help separate samples by species. They found that both species occur within the range of this assessment's considered areas (California to Washington), and heavily spatially overlap. Interestingly, there seem to be relative hot spots for these species where one species is more common than the other, and in general, Rougheye rockfish seems to be more common than Blackspotted rockfish (however, Blackspotted rockfish may be the more common of the two in parts of Alaska). Overall, there seems to be little ability to separate current or historical fishery data reliably in order to separate these two species into two stocks, so we will maintain a species complex approach, though given absolute presence off the U.S. West coast, this may be considered more of a Rougheye than Blackspotted stock assessment. We also note that throughout the range of these stocks, all assessments have maintained a species complex approach.
2. Both species range into Canada and Alaska– are they one stock? While genetics studies have focused mostly on identification of the two species, little is known about the population structure of either species. This assessment and the 2013 assessment represent the most southerly range of these species. Comparing the absolute abundance of the 2013 assessment to the most current estimates of the Alaskan stocks, the absolute number in this southerly range is much smaller than in the Gulf of Alaska (GOA), but higher than the Bering Sea/Aleutian Island (BSAI) stock (Figure 2). The two smaller stocks have similar trend of decline and stabilization, whereas the higher biomass GOA stock looks to have not dropped at all over the time period considered (Figure 3).

These two species may hybridize on occasion (Love 2011). These species are closely related to shortraker rockfish (S. borealis) and are sometimes difficult to distinguish from shortraker rockfish without looking at the gill rakers.

1.2 Life History Information

Rougheye and blackspotted rockfish share broad overlap in their depth and geographic distributions from the Eastern Aleutian Islands along the North American continental margin to southern Oregon, with blackspotted rockfish's range extending east beyond the Aleutian chain to the Pacific Coast of Japan (Gharrett et al. 2005, Hawkins et al. 2005, Orr and Hawkins 2008). Both species are encountered at depths shallower than 100 m to at least 439 m, however, blackspotted rockfish tend to be more prevalent in deeper waters (Hawkins et al. 2005, Orr and Hawkins 2008). Genetic information is not available to provide positive species identification in historical survey and landings information, but these data indicate that density of the nominal rougheye rockfish complex decreases sharply south of the Oregon-California border (42° N). Studies suggest that rougheye rockfish account for a greater proportion of the species complex along the coast of Washington and Oregon than in Alaskan waters (Gharrett et al. 2005, Hawkins et al. 2005, Orr and Hawkins 2008). Recent discussions with port samplers in southern Oregon suggest that both rougheye and blackspotted rockfish are encountered with some regularity in the commercial trawl and fixed-gear landings in Charleston, Port Orford, and Brookings, with blackspotted rockfish composing approximately one third to one half of identified specimens (C. Good and N. Wilsman, ODFW, pers. comm.).

The west coast of the U.S. is the southern portion of the range of rougheye rockfish, and it is likely that the population north of the U.S.-Canada border is not a separate stock. The connectivity of rougheye populations throughout its range is unknown.

1.3 Life History

1.4 Ecosystem considerations

1.5 Historical and Current Fishery Information

1.6 Management History

1.7 Management performance

1.8 Fisheries off Canada and Alaska

2 Data

Data from a wide range of programs were available for possible inclusion in the current assessment model. Descriptions of each data source included in the model (Figure) and sources that were explored but not included in the base model are provided below. Data that were excluded from the base model were excluded only after being explicitly explored during the development of this stock assessment and found to be inappropriate for use or had not changed since their past exploration for previous Rougheye/Blackspotted rockfishes stock assessments when they were not used.

2.1 Fishery-dependent data

2.1.1 Landings

2.1.1.1 Trawl

2.1.1.2 Non-trawl

2.1.1.3 At-sea-hake fishery

2.1.2 Discards

2.1.2.1 Trawl

2.1.2.2 Non-trawl

2.1.3 Biological data

2.1.3.1 Length and Age Sample Sizes

2.1.3.1.1 Multinomial Sample Sizes

Initial input values for the multinomial samples sizes determine the relative weights applied in fitting the annual composition data within the set of observations for each fishing fleet in the model. The initial input values in this assessment were based on the following equation developed by I. Stewart and S. Miller (NWFSC), and presented at the 2006 Stock Assessment Data and Modeling workshop. The input sample sizes for all commercial data were calculated based on a combination of trips and fish sampled:

$$\text{Input effN} = N_{\text{trips}} + 0.138 * N_{\text{fish}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is} < 44$$
$$\text{Input effN} = 7.06 * N_{\text{trips}} \text{ if } N_{\text{fish}}/N_{\text{trips}} \text{ is} \geq 44$$

2.1.3.2 Trawl

2.1.3.3 Non-trawl

2.1.3.4 At-sea-hake fishery

2.2 Fishery-independent data

2.2.1 Abundance indices

2.2.1.1 NWFSC West Coast Groundfish Bottom Trawl Survey

2.2.1.2 NWFSC Slope Survey

2.2.1.3 AFSC Slope Survey

2.2.1.4 AFSC/NWFSC West Coast Triennial Shelf Survey

2.2.2 Biological data

2.2.2.1 NWFSC West Coast Groundfish Bottom Trawl Survey

2.2.2.2 NWFSC Slope Survey

2.2.2.3 AFSC Slope Survey

2.2.2.4 AFSC/NWFSC West Coast Triennial Shelf Survey

2.3 Biological Parameters

2.3.1 Natural Mortality

$$M = \frac{5.4}{A_{\max}}$$

where M is natural mortality and $A_{\max}$ is the assumed maximum age. The prior is defined as a lognormal distribution with mean $ln(5.4/A_{\max})$ and standard error = 0.31.

2.3.2 Age and Growth Relationship

$$\text{Females } L_\infty = \text{cm; } k = \text{per year; } t_0 =$$
$$\text{Males } L_\infty = \text{cm; } k = \text{per year; } t_0 =$$

2.3.3 Ageing Bias and Precision

2.3.4 Length-Weight Relationship

2.3.5 Maturity

2.3.6 Fecundity

2.3.7 Stock-Recruitment Function and Compensation

2.3.8 Sex Ratio

No information on the sex ratio at birth was available so it was assumed to be 50:50.

2.4 Environmental and ecosystem data

This stock assessment does not explicitly incorporate trophic interactions, habitat factors or environmental factors into the assessment model. More predation, diet and habitat work, and mechanistic linkages to environmental conditions would be needed to incorporate these elements into the stock assessment and should remain a priority. McClure et al. (**mcclure_vulnerability_2023?**) report the climate vulnerability for several west coast groundfishes, including Rougheye/Blackspotted rockfishes. Rougheye/Blackspotted rockfishes demonstrated both high biological sensitivity and high climate exposure risk, to give it an overall high vulnerability score to climate change. This result should also be considered with the fact that, like many rockfishes, periods of low productivity is not unusual to Rougheye/Blackspotted rockfishes and their extended longevity (though admittedly this seems shorter than previously believed and should be reconsidered) has historically allowed them to wait for advantageous productivity periods. Stressors such as habitat degradation and climate change could bring significant challenges to population sustainability. Regardless, no environmental or ecosystem data are directly incorporated into the stock assessment model.

2.5 Assessment

2.5.1 History of Modeling Approaches

2.5.2 Most Recent STAR Panel Recommendations

2.5.3 Response to SSC Groundfish Subcommittee Recommendations

2.6 Current Modelling Platform

Stock Synthesis version 3.30.22.1 was used as the statistical catch-at-age modelling framework. This framework allows the integration of a variety of data types and model specifications. The Stock Assessmetn Continuum tool (https://github.com/shcaba/SS-DL-tool) was used also used to explore model effciency, likelihood profiling, retrospective analyses, and plotting sensitivities. The companion R package r4ss (version 1.38.0) along with R version 4.2.2 were used to investigate and plot model fits.

2.6.1 Bridging the Assessment Model from Stock Synthesis 3.24 (2013) to 3.30 (2025)

Since several years have passed from the last assessment model, the Stock Synthesis (SS3) modelling framework has undergone many changes. While the specific changes in the model can be found in the model change log, here we simply update the model from the older 3.24O version to the newer 3.30.22.1 version. The point here is to present any differences in the model outputs when using the same information. This was first done by migrating the data and parameter specifications from the former files to the newer files. This migration was assisted using the SS-DL tool. Once the old data was transferred to the SS 3.30.22.1 file, the model was run allowing the same parameters estimation specification as in the 2013 model.

These model comparisons are adequate to move ahead using the newest version of SS3 3.30.21 without expecting large differences in reference models being due to versions of SS3.

2.7 Model Structure, Evaluation, and Specification

2.7.1 Fleet and Survey Designations

The Washington model is structured to track several fleets and include data from several surveys:

- Fleet 1: Commerical trawl fishery
- Fleet 2: Commercial non-trawl (mostly jig) fishery
- Fleet 3: Recreational boat fishery

- Survey 1: Private boat

- Survey 2: Charter
- Survey 3: Tagging
- Survey 4: Nearshore
- Survey 5: OCNMS subadult-adult survey
- Survey 6: OCNMS young-of-the-year survey

The specifications of the assessment are listed in Table **??**.

2.8 Model Likelihood Components

There are five primary likelihood components for each assessment model:

1. Fit to survey indices of abundance.
2. Fit to length composition samples.
3. Fit to age composition samples (all fit as conditional age-at-length).
4. Penalties on recruitment deviations (specified differently for each model).
5. Prior distribution penalties

2.9 Reference Model Exploration, Key Assumptions and Specification

The reference model for Washington Rougheye/Blackspotted rockfishes was developed to balance parsimony and realism, and the goal was to estimate a spawning output trajectory and relative stock status for the population of Rougheye/Blackspotted rockfishes in state and federal waters off Washington. The model contains many assumptions to achieve parsimony and uses different data types and sources to estimate reality. A series of investigative model runs were done to achieve the final base model. Constructing integrated models (i.e., those fitting many data types) takes considerable model exploration using different configurations of the following treatments:

- Data types
- Parameter treatments: which parameter can, cannot and do not need to be estimated
- Phasing of parameter estimation
- Data weighting
- Exploration of local vs global minima (see Model Convergence and Acceptability section below)

The different biological data with and without the catch time series (and no additional data weighting) were first included to obtain an understanding of the signal of stock status coming from the data (Figure). The length and age only models assume a constant catch over the entire time series, while estimating the selectivity of each fleet. Under this constraint, the lengths suggest a stock a bit lower than the reference model, while the ages consider the stock is extremely depleted. Putting the two data sources together produce an intermediate stock status in the lower precautionary zone. Adding the catch time series substantially changes the stock status trajectory, with length or age only model above the reference stocks status. Combining the two came out just under the reference model. Only one model includes recruitment deviations, and demonstrates more dynamics behavior similar to that seen when biological compositions are unweighted (see Model Specification Sensitivities section).

Stock scale was comparable once removal history was included, and demonstrates a large sensitivity to the scale of the stock given the data with no additional weighting included (Figure).

Numerous exploratory models that included all data types and a variety of model specifications were subsequently explored and too numerous to fully report. In summary, the estimation of which life history parameters to estimate and fix was liberally explored.

The following is a list of things that were explored, typically in combination with one another

- Estimate or fix M
- Estimate or fix any of the three growth parameter for each sex
- Estimate or fix the stock-recruit relationship
- Estimate or assume constant recruitment. If estimating recruitment, for what years?
- Estimate or fix survey catchability for each survey
- Estimate additional survey variance for which survey
- Estimate or fix selectivity parameters
- Logistic or dome-shaped selectivity?

After much consideration, it was determined that some parameters were inestimable (M, L_{min} for both sexes), some did not move much for initial values and could be fixed (e.g., CV at length values, some selectivity parameters), and others could be estimated (e.g., L_{∞}, k, lnR_0). Estimation of L_min returned very high estimates of L_{∞} for both sexes, thus the L_{min} value for both females and males was fixed to the external estimates. No priors were used on any of the estimated parameters except female L_{∞} which used a normal prior and a standard deviation set a bit higher from the external fit to the growth curve (0.2). Length-at-maturity, fecundity-weight, and length-weight relationship, steepness (h) and recruitment variance were all fixed.

The selectivity of all fisheries were estimated as logistic even if dome-shaped selectivity was an option (and starting values begin at a strong dome-shaped position). Constant selectivity was assumed for the whole time period as there was no reason to suggest otherwise, and is consistent with the previous stock assessment treatment.

The full list of estimate and fixed parameters are found in Table }.

The biggest uncertainty was in the treatment of sex-specific M, as estimation came in very low for both sexes versus observed ages in the population and the treatment in the last assessment. This parameter affects both scale and status, and thus is a valuable parameter to consider for characterizing model specification error and defining states of nature. Both likelihood profiles and sensitivities explore the influence of this parameter on derived model outputs.

General attributes of the reference model are that indices of abundance are assumed to have lognormal measurement errors. Length compositions and conditional age at length samples are all assumed to follow a multinomial sampling distribution, where the sample size is fixed at the input sample size calculated during compositional example, and where this input sample size is subsequently reweighted to account for additional sources of overdispersion (see below). Recruitment deviations were also estimated are assumed to follow a lognormal distribution, where the standard deviation of this distribution is tuned as explained below.

Sensitivity scenarios and likelihood profiles (on lnR_0, steepness, and natural mortality) were used to explore uncertainty in the above model specifications and are reported below.

2.9.1 Data Weighting

The reference model allowed for the estimation of additional variance on all surveys except the taggin and OCNMS adult survey, both of which already had very high input variances. The ability to add variance to indices allows the model to balance model fit to that data while acknowledging that variances may be underestimated in the index standardization. A sensitivity was run with no extra variance estimated, as well as removal of the index data were explored.

Initial sample sizes for the commercial and recreational fleet length and conditional age-at-length compositions were based on the number of input effective samples sizes. The method of Francis (2011), equation TA1.8, was then used to balance the length and conditional age-at-length composition data among other inputs and likelihood components. The Francis method treats mean length and age as indices, with effective sample size defining the variance around the mean. If the variability around the mean does not encompass model predictions, the data should be down-weighted until predictions fit within the intervals. This method accounts for correlation in the data (i.e., the multinomial distribution), but can be sensitive to years that are outliers, as the amount of down-weighting is applied to all years within a data source, and are not year-specific. Sensitivities were performed examining different data-weighting treatments: 1) the Dirichlet-Multinomial approach (Thorson et al. 2017), 2) the McAllister-Ianelli Harmonic Mean approach (McAllister and Ianelli 1997), or 3) no data-weighting of lengths.

2.9.2 Model Changes from the Last Assessment

Besides the additional of eight years of data and some changes in the estimation of some parameters, the biggest changes to the 2015 assessment are:

- Change in the removal history, especially the trawl fishery 3A catches from Astoria.
- Breaking the dockside survey into separate private and charter boat surveys. This allowed the ability to exclude years in the charter boat fishery that showed more effects from bag limits.
- Addition of the nearshore survey, and both OCNMS surveys.

2.9.3 Reference Model Diagnostics and Results

2.9.3.1 Model Convergence and Acceptability

2.9.4 Base Model Results

2.9.4.1 Fits to the Data

2.9.4.1.1 Lengths

2.9.4.2 Conditional Age at Length and Marginal Ages

2.9.4.3 Fits to Indices of Abundance

2.9.5 Reference Model Outputs

2.9.5.1 Parameter Estimates

2.9.5.2 Population Trajectory

2.10 Characterizing uncertainty

2.10.1 Sensitivity Analyses

Sensitivity analyses were conducted to evaluate model sensitivity to alternative data treatment and model specifications.

2.10.1.1 Data treatment sensitivities

Data treatments explored were as follows:

- Treatment of abundance indiecs 1. 2015 dockside survey

  2. 2015 dockside survey, no extra variance estimated
  3. No extra variance on private boat index

  - Data weighting

  11. No data-weighting
  12. Dirichlet data-weighting
  13. McAllister-Ianelli data weighting

- Other

  14. 2015 removal history

Likelihood values and estimates of key parameters and derived quantities from each sensitivity are available in Table . Derived quantities relative to the reference model are provided in Figure . Time series of spawning output and relative spawning output are shown in Figures and .

2.10.1.2 Model Specification Sensitivities

Model specifications looked at the estimation of individual and combinations of life history parameters, the estimation of recruitment, and the treatment of fecundity and selectivity. All scenarios match the reference model specifications in all other aspects unless otherwise stated.

- Life history estimation

  - Natural mortality (M)
    1. Estimate M
    2. Lorenzen age varying M
    3. Use Oregon 2023 assessment sex-specific M values (females = 0.19; males = 0.17)
    4. Maintain sex ratio in age and length data (sex option 3) and estimate M

- Growth parameters
    6. Fix all growth parameters to external values
    7. Fix all growth parameters to external values, estimate M
    8. Estimate $L_m in$
    9. Fix $t_0 = 0$
    10. Estimate CV_{young} and CV_{old}
- Reproductive Biology
    10. Use biological maturity ogive
    11. Use functional maturity ogive
    12. Fecundity proportional to weight
- Recruitment estimation
    13. No recruitment estimation
    14. Estimate recruitment for all years in the model

Other

Likelihood values and estimates of key parameters and derived quantities from each sensitivity are available in Table . Derived quantities relative to the reference model are provided in Figure . Time series of spawning output and relative spawning output are shown in Figures and . None of the sensitivities indicated an overfished stock.

2.10.2 Likelihood Profiles

2.10.3 Retrospective Analysis

A five-year retrospective analysis was conducted by running the model and sequentially removing one year of data up through minus 5 years. Retrospective spawning output (Figure) and relatives stock status (Figure) estimates show a generally consistent pattern in population scale and trend, within the error of the reference model. All models show the population increasing. This results in a stock status in the precautionary zone over the 5 year consideration. The Mohn's rho evaluation of the degree of retrospective pattern in given in Table and shown in Figure . The relative error in the data peels are below significant levels.

2.10.4 Unresolved Problems and Major Uncertainties

There are no major unresolved problems in the stock assessment, but there are many sources of uncertainty. Natural mortality remains a large source of uncertainty. The estimation of growth also required fixing certain parameters, leading to an underestimation of uncertainty in the model. The stock-recruit relationship is assumed to be a Beverton-Holt relationship with a fixed steepness of 0.72. Large uncertainty was shown if the nature of this relationship varies either deterministically or over time. The full time series of recruitment deviations were not informed, which creates some historical and contemporary uncertainty. Likewise, all life history values are assumed constant, so any time-varying issues that are directional could create more uncertainty.

3 Management

3.1 Reference Points

Reference points were based on the rockfish FMSY proxy ($SPR_{50\%}$), target relative biomass (40%), and estimated selectivity and catch for each fleet (Table **??**). The Rougheye/Blackspotted rockfishes population in Washington at the start of 2023 is estimated to be just above the target biomass, and fishing intensity during 2022 is estimated to be just below the fishing intensity target (Figure **??**). The yield values are lower than the previous assessment for similar reference points due to updated life history estimates and estimates of the total scale of the population, despite the overall stock status being a bit higher. The proxy MSY values of management quantities are by definition more conservative compared to the estimated MSY and MSY relative to 40% of unfished spawning output because of the assumed steepness value. Sustainable total yield, removals, using the proxy $SPR_{50\%}$ is 471 mt. The spawning output equivalent to 40% of the unfished spawning output ($SO_{40\%}$) calculated using the SPR target ($SPR_{50\%}$) was 7,828 billions of eggs.

Recent removals since 2017 have been at or below the point estimate of potential long-term yields calculated using an $SPR_{50\%}$ reference point (Figure **??**), leading to a population that has continued to increase over recent years with the assistance of above average recruitment between 2003-2014, despite below average recruitment starting in 2015. The equilibrium estimates of yield relative to biomass based on a steepness value fixed at are provided in Figure **??**, where vertical dashed lines indicate the estimate of fraction unfished at the start of 2027 (current) and the estimated management targets calculated based on the relative target biomass (B target), the SPR target, and the maximum sustainable yield (MSY).

The 2023 spawning biomass relative to unfished equilibrium spawning biomass, based on the 2022 fishing year, is 80.5397%, above the management target of 40% of unfished spawning output. The relative biomass and the ratio of the estimated SPR to the management target ($SPR_{50\%}$) across all model years are shown in Figure **??** where warmer colors (red) represent early years and colder colors (blue) represent recent years. There have been periods where the stock status has decreased below the target and limit relative biomass, and fishing intensity has been higher than the target fishing intensity based on $SPR_{50\%}$.

3.2 Management performance

Rougheye/Blackspotted rockfishes removals have been below the equivalent Annual Catch Limit (ACL) over the recent decade (Table **??**). The ACL declined in 2017 relative to earlier years based on the 2015 assessment of Rougheye/Blackspotted rockfishes (Cope et al. 2016). In the last ten years, catches peaked in 2016 at 369 mt. Since then catches have declined to a recent low of 130 mt in 2020 with the catches in the final two model years remaining low with 197 mt in 2021 and 166 mt in 2022. The OFL has not been exceeded in any year over the past 10 years.

3.3 Harvest Projections and Decision Tables

The Rougheye/Blackspotted rockfishes assessment is being considered as a category 1 assessment with a $P^* = 0.45$, $\sigma = 0.50$, and a time-varying buffer applied to set the ABC below the OFL. These multipliers are also combined with the rockfish MSY proxy of SPR_{50} and the 40-10 harvest control rule to calculate OFLs and ACLs. A twelve-year (2023-2034) projection of the reference model using these specifications along with input removals for 2023 and 2024 provided by the Groundfish Management Team (Katie Pierson, ODFW, pers. comm.) is provided in Table **??**.

Uncertainty in management quantities for the reference model was characterized by exploring various model specifications in a decision table, with the desire for states of nature to represent uncertainty in both scale and relative stock status Initial explorations considering alternative specifications of natural mortality. This was based on using the estimated M scenario as a low state of nature and applying the sex-specific M values from the 2023 Oregon model as the high state of nature. These produced wide states of nature (Figure **??** and Figure **??**). Discussion with the STAR panel led to defining two other states of nature based on the reference model uncertainty in ending spawning output. Low and high states of nature were determined by applying an initial recruitment (lnR_0) value that lead to current spawning output values equivalent to the 12.5% and 87.5% percentile values from the current spawning output distribution (Figure **??** and Figure **??**) that are not as widely spread as the initial states of nature, but are constructed from the current model specifications. The resultant decision table (Table **??**) was built around the initial lnR_0 states of nature approach. The catch rows assume P* values of 0.45 and 0.4, then a constant catch using the yield at FSPR=0.5.

3.4 Evaluation of Scientific Uncertainty

#The model-estimated uncertainty around the 2027 spawning biomass was $\sigma = 100$ and the uncertainty around the OFL was $\sigma =$ NA. This is likely underestimate of overall uncertainty because of the necessity to fix some life history parameters such as natural mortality and steepness, as well as a lack of explicit incorporation of model structural uncertainty. The alternative states of nature used to bracket uncertainty in the decision table assist with encapsulating model structure uncertainty.

3.5 Research and Data Needs

This section briefly highlights progress on research and data needs identified in the most recent (2015) Rougheye/Blackspotted rockfishes assessment, and then provides recommendations for future research.

Research and data needs identified in the last assessment (italics) are listed here followed by a brief response for each.

3.6 Acknowledgements

3.7 References

3.8 Tables

3.9 Figures

3.9.1 Introduction

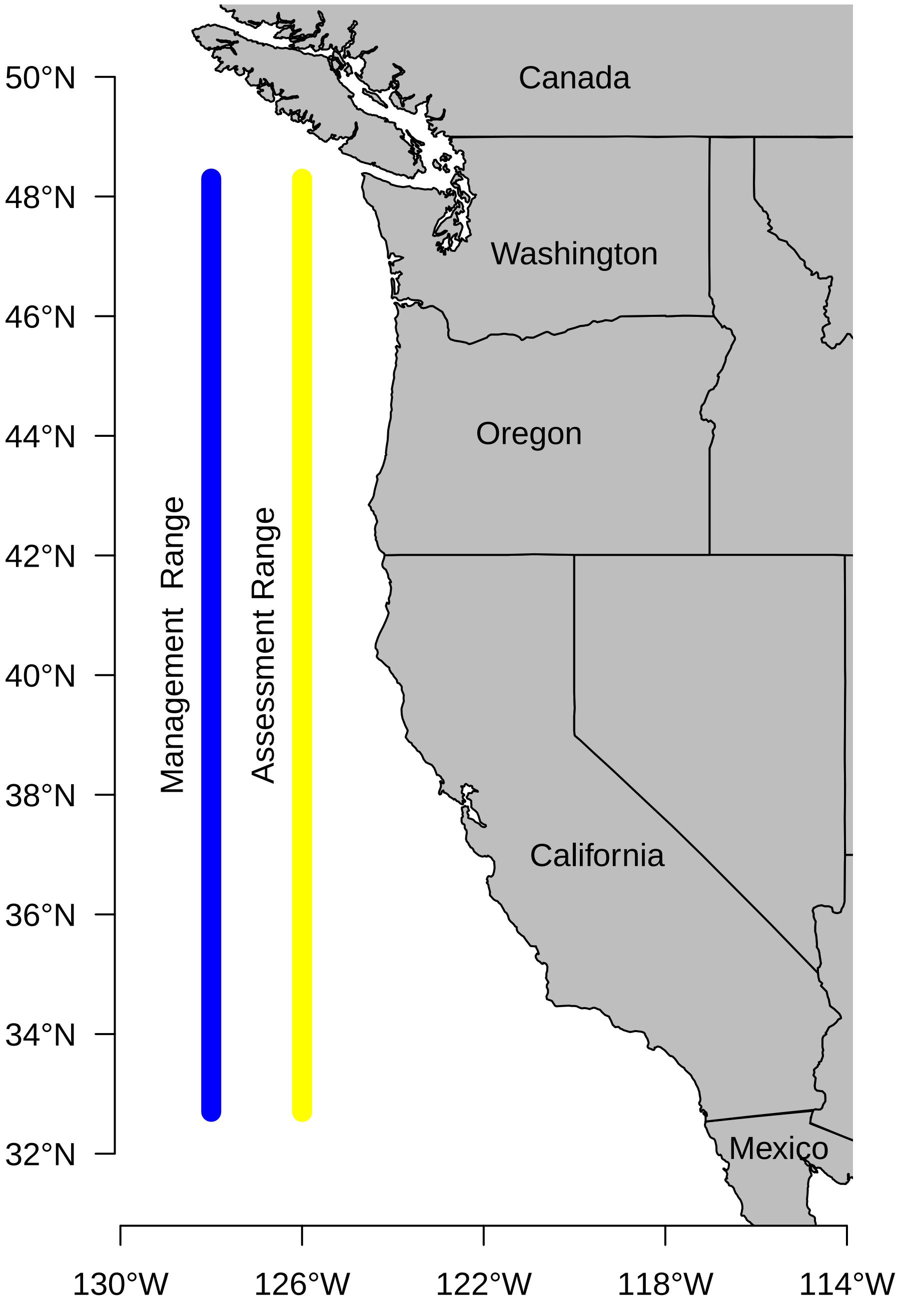

Figure 1: Map of the assessment area.

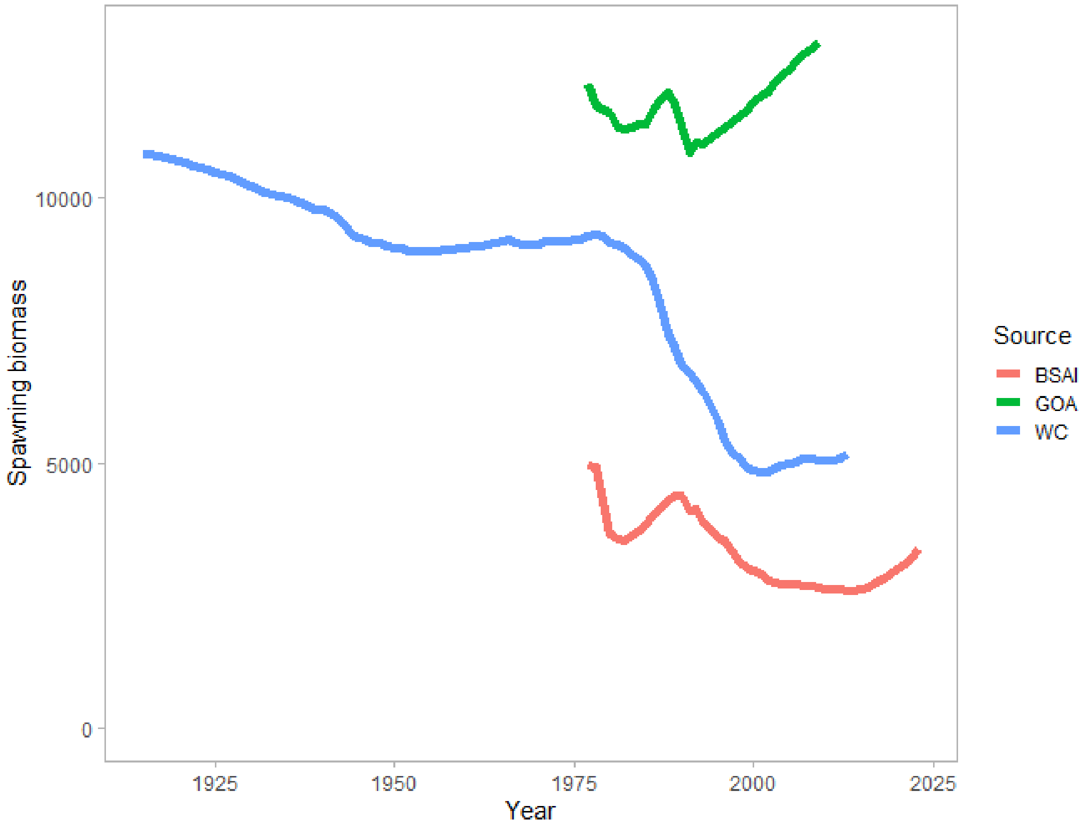

Figure 2: Estimates of spawning biomass (current spawning output/unfished spawning output) for the Rougheye/Blackspotted rockfish complex from the two most recent Alaska (Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA)) and the 2013 U.S. west coast stock assessment.

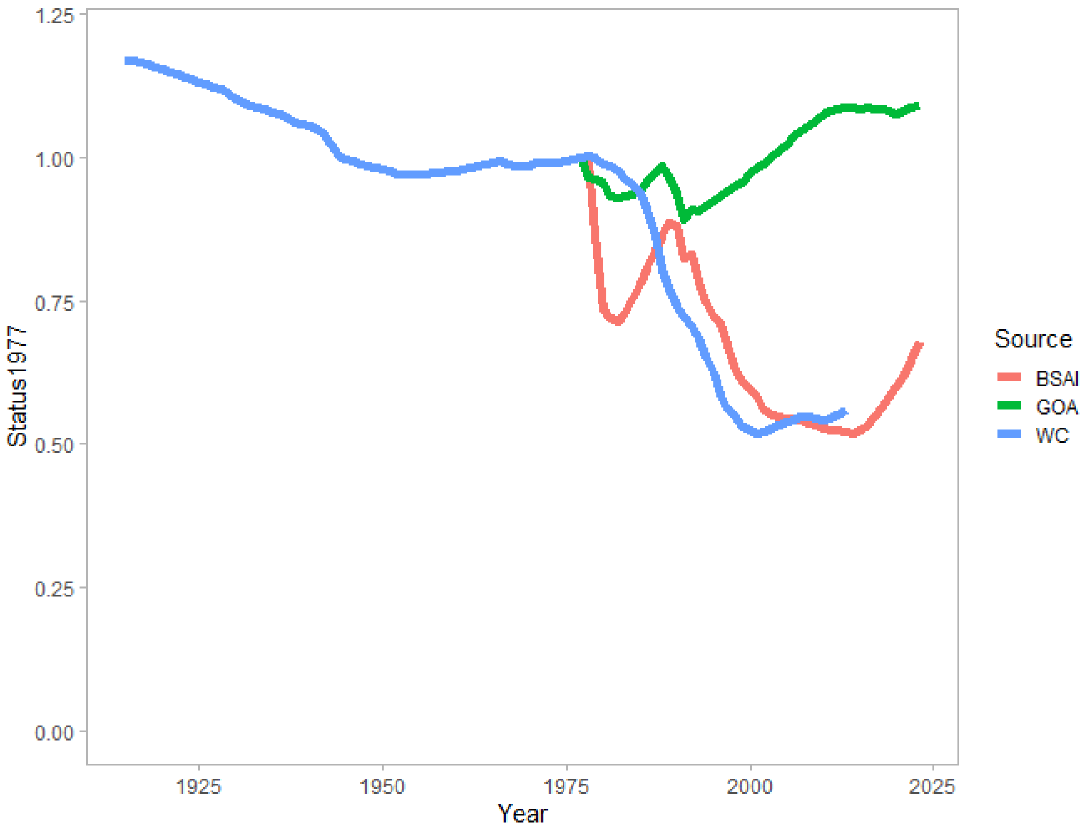

Figure 3: Estimates of relative stock size (current spawning output/unfished spawning output) relative to 1977 (the common year in all stock assessments compared) for the Rougheye/Blackspotted rockfish complex from the two most recent Alaska (Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA)) and the 2013 U.S. west coast stock assessment.

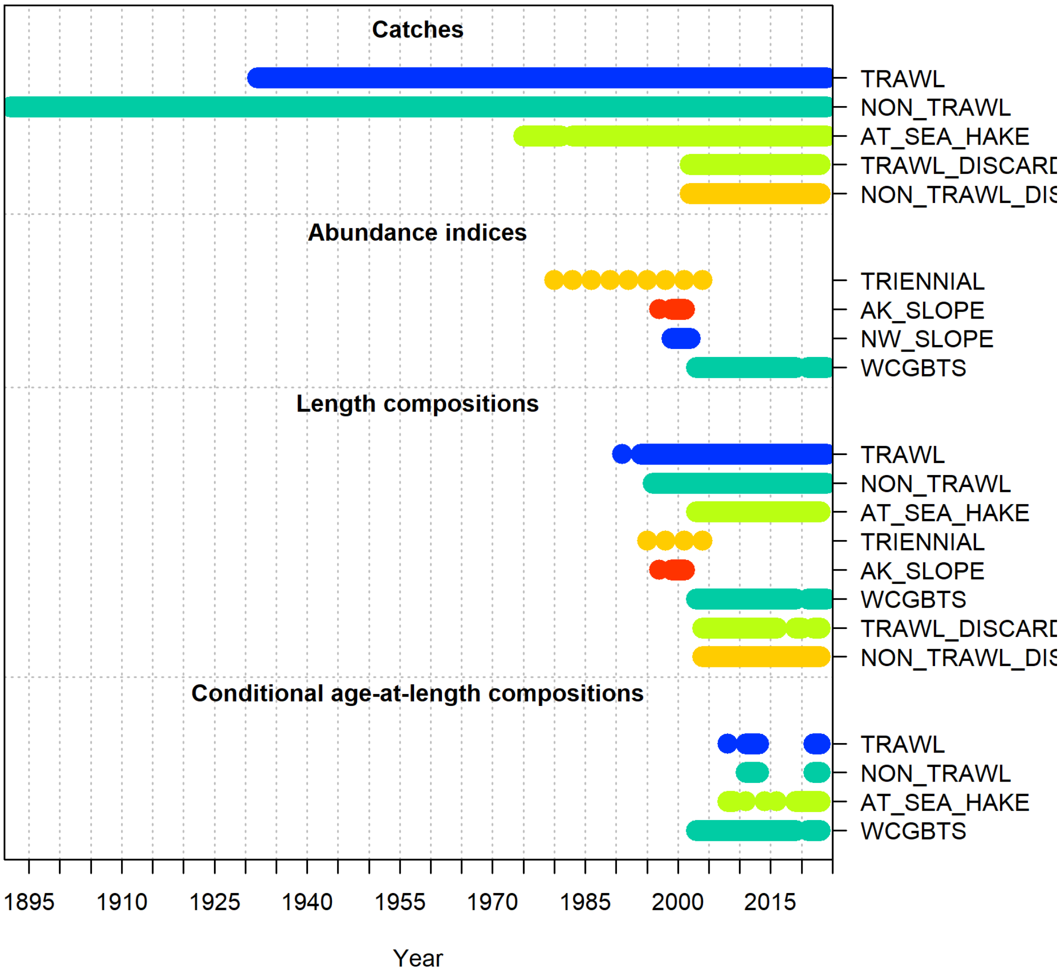

Figure 4: Data used in the base model.

3.10 Notes

Appendices

Cope, J. M., David B. Sampson, Andi Stephens, Meisha Key, Patrick P. Mirick, Megan M. Stachura, Tien-Shui Tsou, et al. 2016. "Assessments of California, Oregon, and Washington Stocks of Black Rockfish (*Sebastes Melanops*) in 2015." Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR 97220: Pacific Fishery Management Council.

Francis, R. I. C. Chris. 2011. "Data Weighting in Statistical Fisheries Stock Assessment Models." *Canadian Journal of Fisheries and Aquatic Sciences* 68 (6): 1124–38. https://doi.org/10.1139/f2011-025.

McAllister, M. K., and J. N. Ianelli. 1997. "Bayesian Stock Assessment Using Catch-Age Data and the Sampling — Importance Resampling Algorithm." *Canadian Journal of Fisheries and Aquatic Sciences* 54 (2): 284–300. https://doi.org/10.1139/f96-285.

Thorson, James T., Kelli F. Johnson, R. D. Methot, and I. G. Taylor. 2017. "Model-Based Estimates of Effective Sample Size in Stock Assessment Models Using the Dirichlet-Multinomial Distribution." *Fisheries Research* 192: 84–93. https://doi.org/10.1016/j.fishres.2016.06.005.