Status of Vermilion rockfish (*Sebastes miniatus*) along the US West - Oregon coast in 2021

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June 2021

Correct citation for this publication:

Cope, J.M., T.-. Tsou, K. Hinton, C. Niles. 2021. Status of Vermilion rockfish (*Sebastes miniatus*) along the US West - Oregon coast in 2021. Pacific Fisheries Management Council, Portland, Oregon. 11 p.

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Stock

This assessment reports the status of Vermilion rockfish (*Sebastes miniatus*) off the US West - Oregon coast using data through xxxx.

Landings

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Data and Assessment

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Stock Biomass

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Recruitment

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Exploitation Status

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Reference Points

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Management Performance

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Unresolved Problems and Major Uncertainties

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Decision Table

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Research and Data Needs

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1 Introduction

1.1 Basic Information

This assessment reports the status of Vermilion rockfish (*Sebastes miniatus*) off the US West - Oregon coast using data through xxxx.

1.2 Life History

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1.3 Ecosystem Considerations

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1.4 Historical and Current Fishery Information

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1.5 Summary of Management History and Performance

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1.6 Foreign Fisheries

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2 Data

A description of each data source is provided below (Figure 1).

2.1 Fishery-Dependent Data

2.2 Fishery-Independent Data

2.2.1 AFSC Slope Survey

The AFSC Slope Survey (Slope Survey) operated during the months of October to November aboard the R/V *Miller Freeman*. Partial survey coverage of the US west coast occurred during the years 1988-1996 and complete coverage (north of 34°30'S) during the years 1997 and 1999-2001. Typically, only these four years that are seen as complete surveys are included in assessments.

2.2.2 California Collaborative Fisheries Research Program

Since 2007, the California Collaborative Fisheries Research Program (CCFRP) has monitored several areas in California to evaluate the performance of Marine Protected Area (MPA)s and understand nearshore fish populations (Wendt and Starr 2009; Starr et al. 2015). In 2017, the survey expanded beyond the four MPAs in central California (Año Nuevo, Point Lobos, Point Buchon, and Piedras Blancas) to include the entire California coast. Fish are collected

by volunteer anglers aboard Commercial passenger fishing vessel (CPFV)s guided by one of the following academic institutions based on proximity to fishing location: Humboldt State University; Bodega Marine Laboratories; Moss Landing Marine Laboratories; Cal Poly San Luis Obispo; University of California, Santa Barbara; and Scripps Institution of Oceanography.

Surveys consist of fishing with hook-and-line gear for 30-45 minutes within randomly chosen 500 by 500 m grid cells within and outside MPAs. Prior to 2017, all fish were measured for length and release or descended to depth; since then, some were sampled for otoliths and fin clips.

2.2.3 AFSC/NWFSC West Coast Triennial Shelf Survey

The AFSC/NWFSC West Coast Triennial Shelf Survey (Triennial Survey) was first conducted by the Alaska Fisheries Science Center (AFSC) in 1977, and the survey continued until 2004 (Weinberg et al. 2002). Its basic design was a series of equally-spaced east-to-west transects across the continential shelf from which searches for tows in a specific depth range were initiated. The survey design changed slightly over time. In general, all of the surveys were conducted in the mid summer through early fall. The 1977 survey was conducted from early July through late September. The surveys from 1980 through 1989 were conducted from mid-July to late September. The 1992 survey was conducted from mid July through early October. The 1995 survey was conducted from early June through late August. The 1998 survey was conducted from early June through early August. Finally, the 2001 and 2004 surveys were conducted from May to July.

Haul depths ranged from 91-457 m during the 1977 survey with no hauls shallower than 91 m. Due to haul performance issues and truncated sampling with respect to depth, the data from 1977 were omitted from this analysis. The surveys in 1980, 1983, and 1986 covered the US West Coast south to 36.8°N latitude and a depth range of 55-366 m. The surveys in 1989 and 1992 covered the same depth range but extended the southern range to 34.5°N (near Point Conception). From 1995 through 2004, the surveys covered the depth range 55-500 m and surveyed south to 34.5°N. In 2004, the final year of the Triennial Survey series, the Northwest Fisheries Science Center (NWFSC) Fishery Resource and Monitoring division (FRAM) conducted the survey following similar protocols to earlier years.

2.2.4 NWFSC West Coast Groundfish Bottom Trawl Survey

The NWFSC West Coast Groundfish Bottom Trawl Survey (WCGBTS) is based on a random-grid design; covering the coastal waters from a depth of 55-1,280 m (Bradburn, Keller, and Horness 2011). This design generally uses four industry-chartered vessels per year assigned to a roughly equal number of randomly selected grid cells and divided into two 'passes' of the coast. Two vessels fish from north to south during each pass between late May to early October. This design therefore incorporates both vessel-to-vessel differences in catchability, as well as variance associated with selecting a relatively small number (approximately 700) of possible cells from a very large set of possible cells spread from the Mexican to the Canadian borders.

2.3 Biological Data

2.3.1 Growth (Length-at-Age)

The length-at-age was estimated for female and male Vermilion rockfish using data from collections sampling the commerical and recreational fisheries off the coast of Washington from years xx-xx (Table **??**. Figure **??** shows the lengths and ages for all years by sex and data source as well as predicted von Bertalanffy growth function (VBGF) fits to the data. Females grow larger than males and sex-specific growth parameters were estimated at the following values:

$$\text{Females } L_\infty = 57.1 \text{ cm}; \; k = 0.093; \; t_0 = \text{-}2.78$$

$$\text{Males } L_\infty = 54.2 \text{ cm}; \; k = 0.109; \; t_0 = \text{-}1.96$$

The estimated VBGF parameters provided initial values for the estimation of growth in the model, as all age and length data are included in the model. The resultant growth curves estimated by the model are presented in Figure **??**. Sensitivity to the treatment of growth parameters (fixed or estimated) are explored through sensitivity analyses.

2.3.2 Ageing Precision and Bias

2.3.3 Natural Mortality

Natural mortality was not directly measured, so life-history based empirical relationships were used. The Natural Mortality Tool (NMT; https://github.com/shcaba/Natural-Mortality-Tool), a Shiny-based graphical user interface allowing for the application of a variety of natural mortality estimators based on measures such as longevity, size, age and growth, and maturity, was used to obtain estimates of natural mortality. The NMT currently provides 22 options, including the Hamel (2015) method, which is a corrected form of the Then et al. (2015) functional regression model and is a commonly applied method for west coast groundfish. The NMT also allows for the construction of a natural mortality prior weighted across methods by the user.

We assumed the age of 54 years to represent the practical longevity (i.e., 90% of the common seen maximum age of 60) for both females and males, though the oldest ages in OR and WA were >60 years, and ages of 80+ were encountered in California. Empirical M estimators using the von Bertalanffy growth parameters were also considered (Figure **??**), but they produced unreasonably high estimates (2-3 times higher than the longevity estimates). This is likely explained by the fact that while Vermilion rockfish have protracted longevity at L_{∞}. Additionally, the FishLife (**thorson__predicting__2017?**) estimate was included, though, given the source of FishLife data is FishBase, there is a good chance the estimates of M are also from methods using longevity, though the actual source of longevity in FishLife was unknown. The final composite M distributionn (Figure **??**) are based on 4 empirical estimators, and result in a median value of 0.1. We assume a lognormal distribution with a standard deviation of 0.438 (Hamel (2015)) for the purposes of the prior used to estimate M. This creates a wide prior to allow the data in the model to also influence the final estimated value of M.We also explore sensitivity to these assumptions of natural mortality through likelihood profiling.

2.4 Environmental and Ecosystem Data

3 Assessment Model

3.1 Summary of Previous Assessments and Reviews

3.1.1 History of Modeling Approaches (not required for an update assessment)

3.1.2 Most Recent STAR Panel and SSC Recommendations (not required for an update assessment)

3.1.3 Response to Groundfish Subcommittee Requests (not required in draft)

3.2 Model Structure and Assumptions

3.2.1 Model Changes from the Last Assessment (not required for an update assessment)

3.2.2 Modeling Platform and Structure

General model specifications (e.g., executable version, model structure, definition of fleets and areas)

3.2.3 Model Parameters

Describe estimated vs. fixed parameters, priors

3.2.4 Key Assumptions and Structural Choices

3.3 Base Model Results

3.3.1 Parameter Estimates

3.3.2 Fits to the Data

3.3.3 Population Trajectory

3.3.4 Reference Points

3.4 Model Diagnostics

Describe all diagnostics

3.4.1 Convergence

3.4.2 Sensitivity Analyses

3.4.3 Retrospective Analysis

3.4.4 Likelihood Profiles

3.4.5 Unresolved Problems and Major Uncertainties

4 Management

4.1 Reference Points

4.2 Unresolved Problems and Major Uncertainties

4.3 Harvest Projections and Decision Tables

4.4 Evaluation of Scientific Uncertainty

4.5 Research and Data Needs

5 Acknowledgments

Here are all the mad props!

6 References

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7 Tables

8 Figures

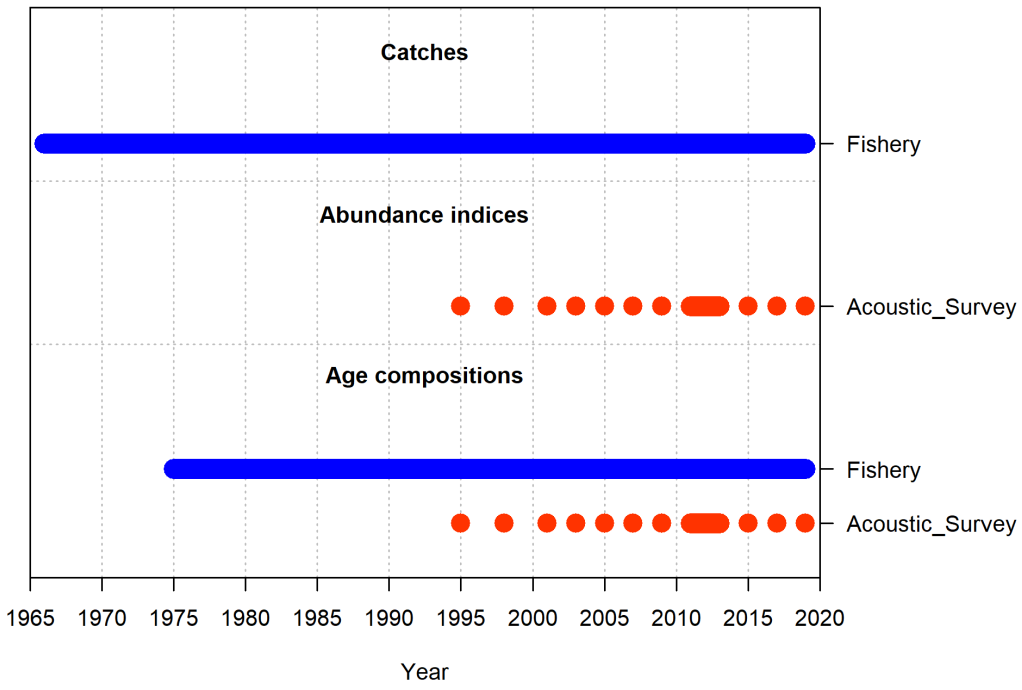

Figure 1: Summary of data sources used in the base model.