Copper Rockfish (*Sebastes caurinus*) along the Washigton US West coast in 2020

by
Chantel R. Wetzel[1]
Brian J. Langseth[1]
Jason M. Cope[1]
Tien-Shui Tsou[2]
Kristen E. Hinton[2]

[1]Northwest Fisheries Science Center, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, Washington 98112
[2]Washington Department of Fish and Wildlife, 600 Capital Way North, Olympia, Washington 98501

December 2020

Correct citation for this publication:

Wetzel, C.R., B.J. Langseth, J.M. Cope, T. Tsou, K.E. Hinton. 2020. Copper Rockfish (*Sebastes caurinus*) along the Washigton US West coast in 2020. Pacific Fisheries Management Council, Portland, Oregon. 14 p.

Contents

List of Figures

List of Tables

Executive Summary

Stock

This assessment reports the status of Copper Rockfish (*Sebastes caurinus*) off the US West coast using data through 2020.

The years is 2020

Landings

Replace text.

Table ii.

Table i: Removals by fleet for the last 10 years.

Year	Recreational (mt)	Commercial (mt)	Total Mortality
2009	3	0.00	2.72
2010	2	0.00	2.13
2011	3	0.00	2.63
2012	2	0.00	1.75
2013	3	0.00	2.55
2014	2	0.00	2.34
2015	1	0.00	1.32
2016	2	0.00	1.85
2017	1	0.01	1.30
2018	3	0.00	3.02
2019	4	0.00	4.27
2020	3	0.00	2.77

Here is a reference to the catches (Table i)

Data and Assessment

Replace text.

Stock Biomass

Replace text.

Table ii: Estimated spawning output and the fraction unfished and the 95 percent confidence intervals.

Year	Spawning Output	Lower Interval	Upper Interval	Fraction Unfished	Lower Interval	Upper Interval
2009	3	3	3	0.393	0.393	0.393
2010	3	3	3	0.387	0.387	0.387
2011	3	3	3	0.389	0.389	0.389
2012	3	3	3	0.386	0.386	0.386
2013	3	3	3	0.393	0.393	0.393
2014	3	3	3	0.391	0.391	0.391
2015	3	3	3	0.391	0.391	0.391
2016	3	3	3	0.404	0.404	0.404
2017	3	3	3	0.411	0.411	0.411
2018	3	3	3	0.424	0.424	0.424
2019	3	3	3	0.415	0.415	0.415
2020	3	3	3	0.388	0.388	0.388
2021	3	3	3	0.381	0.381	0.381

Recruitment

Replace text.

Table iii: Estimated recruitment and recruitment deviations (recruit devs.) and the 95 percent confidence intervals.

Year	Recruit-ment	Lower Interval	Upper Interval	Recruit Devs.	Lower Interval	Upper Interval
2009	7	7	7	0	0	0
2010	7	7	7	0	0	0
2011	7	7	7	0	0	0
2012	7	7	7	0	0	0
2013	7	7	7	0	0	0
2014	7	7	7	0	0	0
2015	7	7	7	0	0	0
2016	7	7	7	0	0	0
2017	7	7	7	0	0	0
2018	7	7	7	0	0	0
2019	7	7	7	0	0	0
2020	7	7	7	0	0	0
2021	7	7	7	0	0	0

Exploitation Status

Replace text.

Table iv: Estimated 1-SPR in percent and the exploitation rate (Exploit. Rate) and the 95 percent confidence intervals.

Year	1-SPR	Lower Interval	Upper Interval	Exploit. Rate	Lower Interval	Upper Interval
2009	60.0	60.0	60.0	0.081	0.081	0.081
2010	53.1	53.1	53.1	0.064	0.064	0.064
2011	59.1	59.1	59.1	0.079	0.079	0.079
2012	47.5	47.5	47.5	0.053	0.053	0.053
2013	58.0	58.0	58.0	0.076	0.076	0.076
2014	55.5	55.5	55.5	0.070	0.070	0.070
2015	39.3	39.3	39.3	0.039	0.039	0.039
2016	47.9	47.9	47.9	0.054	0.054	0.054
2017	37.8	37.8	37.8	0.038	0.038	0.038
2018	61.0	61.0	61.0	0.085	0.085	0.085
2019	71.2	71.2	71.2	0.122	0.122	0.122
2020	60.8	60.8	60.8	0.084	0.084	0.084

Reference Points

Replace text.

Table v: Reference points

Metric	Estimate	Lower Inteval	Upper Interval
Unfished Spawning Output	7.63	7.63	7.63
Unfished Age 3+ Biomass (mt)	72.84	72.84	72.84
Unfished Recruitment (R0)	7.90	7.90	7.90
Spawning Output (2021)	2.91	2.91	2.91
Fraction Unfished (2021)	0.38	0.38	0.38
Reference Points Based SB40 Percent	NA	NA	NA
Proxy Spawning Output(SB40 Percent	3.05	3.05	3.05
SPR Resulting in SB40 Percent	0.46	0.46	0.46
Exploitation Rate Resulting in SB40 Percent	0.07	0.07	0.07
Yield with SPR Based On SB40 Percent (mt)	2.27	2.27	2.27
Reference Points Based on SPR Proxy for MSY	NA	NA	NA
Proxy Spawning Output (SPR50)	3.41	3.41	3.41
SPR50	50.00	NA	NA
Exploitation Rate Corresponding to SPR50	0.06	0.06	0.06
Yield with SPR50 at SB SPR (mt)	2.16	2.16	2.16
Reference Points Based on Estimated MSY Values	NA	NA	NA
Spawning Output at MSY (SB MSY)	2.07	2.07	2.07
SPR MSY	0.34	0.34	0.34
Exploitation Rate Corresponding to SPR MSY	0.10	0.10	0.10
MSY (mt)	2.42	2.42	2.42

Management Performance

Replace text.

Table vi: The OFL, ABC, ACL, and Landings for the last 10 years.

Year	OFL	ABC	ACL	Catch
2009	fill in	fill in	fill in	2.73
2010	fill in	fill in	fill in	2.13
2011	fill in	fill in	fill in	2.63
2012	fill in	fill in	fill in	1.75
2013	fill in	fill in	fill in	2.55
2014	fill in	fill in	fill in	2.34
2015	fill in	fill in	fill in	1.32
2016	fill in	fill in	fill in	1.85
2017	fill in	fill in	fill in	1.30
2018	fill in	fill in	fill in	3.02
2019	fill in	fill in	fill in	4.27
2020	fill in	fill in	fill in	2.77

Unresolved Problems and Major Uncertainties

Replace text.

Decision Table

Add the projection table

Table vii: Projections

Year	OFL	ABC	3+ Biomass	Spawning Output	Fraction Unfished
2021	1.9	1.4	32.5	2.9	0.381
2022	1.9	1.4	33.5	3.0	0.392
2023	2.0	2.0	34.4	3.1	0.405
2024	2.0	2.0	34.6	3.1	0.409
2025	2.0	2.0	34.9	3.2	0.413
2026	2.0	2.1	35.1	3.2	0.417
2027	2.1	2.1	35.3	3.2	0.420
2028	2.1	2.1	35.5	3.2	0.423
2029	2.1	2.1	35.6	3.2	0.425
2030	2.1	2.1	35.8	3.3	0.427
2031	2.1	2.1	35.9	3.3	0.429
2032	2.1	2.1	36.0	3.3	0.431

Replace text.

Research and Data Needs

Replace text.

1 Introduction

1.1 Basic Information

This assessment reports the status of Copper Rockfish (*Sebastes caurinus*) off the US West coast using data through 2020. Copper Rockfish is a medium- to large-sized nearshore rockfish found from Mexico to Alaska. The core range is comparatively large, from northern Baja Mexico to the Gulf of Alaska, as well as in Puget Sound. They occur mostly on low relief or sand-rock interfaces. Copper Rockfish have historically been a part of both commercial (mainly in the live-fish fishery) and recreational fisheries throughout its range.

1.2 Life History

Genetic work has revealed significant differences between Puget Sound and coastal stocks, but not among the coastal stocks (XXX Buonaccorsi et al. 2002). 'r spp' live at least 50 years (XX add reference XX) and have the highest vulnerability (V = 2.27) of any west coast groundfish (XX add reference XX).

1.3 Ecosystem Considerations

Replace text.

1.4 Historical and Current Fishery Information

Replace text.

1.5 Summary of Management History and Performance

Replace text.

1.6 Foreign Fisheries

Replace text.

1.7 Historical and Current Fishery Information

Replace text.

1.8 Summary of Management History and Performance

Replace text.

1.9 Foreign Fisheries

Replace text.

2 Data

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

2.1 Fishery-Dependent Data

(Ralston et al. 2010)

2.2 Fishery-Independent Data

2.2.1 NWFSC Slope

2.2.2 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.

2.2.3 NWFSC Slope

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 Natural Mortality

Hamel (2015) developed a method for combining meta-analytic approaches relating the M rate to other life-history parameters such as longevity, size, growth rate, and reproductive effort to provide a prior on M. In that same issue of *ICES Journal of Marine Science*, Then et al. (2015) provided an updated data set of estimates of M and related life history parameters across a large number of fish species from which to develop an M estimator for fish species in general. They concluded by recommending M estimates be based on maximum age alone, based on an updated Hoenig non-linear least squares estimator $M = 4.899 A_{max}^{-0.916}$. The approach of basing M priors on maximum age alone was one that was already being used for West Coast rockfish assessments. However, in fitting the alternative model forms relating M to $A_{\max}$, Then et al. (2015) did not consistently apply their transformation. In particular, in real space, one would expect substantial heteroscedasticity in both the observation and process error associated with the observed relationship of M to $A_{\max}$. Therefore, it would be reasonable to fit all models under a log transformation. This was not done. Re-evaluating the data used in Then et al. (2015) by fitting the one-parameter $A_{\max}$ model under a log-log transformation (such that the slope is forced to be -1 in the transformed space Hamel (2015)), the point estimate for M is:

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

The above is also the median of the prior. The prior is defined as a lognormal distribution with mean $ln(5.4/A_{\max})$ and SE = 0.438. Using a maximum age of 50, the point estimate and median of the prior is 0.108 per year The maximum age was selected based on available

age data from all West Coast data sources and literature values. The oldest aged rockfish was 51 years with two observations, off the coast of Washington and Oregon in 2019. However, age data are subject to ageing error which could impact this estimate of longevity. The selection of 50 years was based on the range of other ages available with multiple observations of fish between 44 and 51 years of age and literature examining the longevity of `spp` (Love 1996).

2.3.2 Maturation and Fecundity

NEED TO UPDATE WHEN MELISSA IS DONE

Maturity-at-length based on the work of Hannah XXX which estimated the 50% size-at-maturity of 34.83 cm off the coast of Oregon with maturity asymptoting to 1.0 for larger fish (Figure ADD FIGURE).

This assessment assumed a logistic maturity-at-length curve based on analysis of XXX fish maturity samples collected from the NWFSC WCGBT and NWFSC Hook & Line surveys. The new maturity-at-length curve is based on the estimate of functional maturity, an approach that classifies rockfish maturity with developing oocytes as mature or immature based on the proportion of vitellogenin in the cytoplasm and the measured frequency of atretic cells (Melissa Head, personal communication, NWFSC, NOAA). The 50% size-at-maturity was estimated at XX cm with maturity asymptoting to 1.0 for larger fish (Figure ADD FIGURE).

The fecundity-at-length was based on research Dick et al. (2017). The fecundity relationship for Copper Rockfish was estimated equal to 3.362e-07$L^{3.68}$ in millions of eggs where L is length in cm. Fecundity-at-length is shown in Figure ADD FIGURE.

2.3.3 Sex Ratio

2.3.4 Length-Weight Relationship

2.3.5 Growth (Length-at-Age)

2.3.6 Ageing Precision and Bias

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 Tables

Table 8: Removals by fleet for all model years.

Year	Recreational (mt)	Commercial (mt)	Total Mortality
1935	0.02	0.00	0.02
1936	0.05	0.00	0.05
1937	0.09	0.00	0.09
1938	0.12	0.00	0.12
1939	0.16	0.00	0.16
1940	0.19	0.00	0.19
1941	0.23	0.00	0.23
1942	0.26	0.00	0.26
1943	0.30	0.00	0.30
1944	0.33	0.00	0.33
1945	0.37	0.00	0.37
1946	0.40	0.00	0.40
1947	0.44	0.00	0.44
1948	0.47	0.00	0.47
1949	0.51	0.00	0.51
1950	0.54	0.00	0.54
1951	0.58	0.00	0.58
1952	0.61	0.00	0.61
1953	0.64	0.00	0.64
1954	0.68	0.00	0.68
1955	0.71	0.00	0.71
1956	0.75	0.00	0.75
1957	0.78	0.00	0.78
1958	0.81	0.00	0.81
1959	0.85	0.00	0.85
1960	0.88	0.00	0.88
1961	0.91	0.00	0.91
1962	0.95	0.00	0.95
1963	0.98	0.00	0.98
1964	1.01	0.00	1.01
1965	1.05	0.00	1.05
1966	1.08	0.00	1.08
1967	1.11	0.00	1.11
1968	1.14	0.00	1.14
1969	1.18	0.00	1.18
1970	1.21	0.00	1.21
1971	1.24	0.00	1.24
1972	1.27	0.00	1.27
1973	1.31	0.00	1.31
1974	1.34	0.00	1.34
1975	1.37	0.00	1.37
1976	0.99	0.00	0.99
1977	0.61	0.00	0.61
1978	1.13	0.00	1.13

Table 8: Removals by fleet for all model years. *(continued)*

Year	Recreational (mt)	Commercial (mt)	Total Mortality
1979	1.50	0.00	1.50
1980	0.88	0.00	0.88
1981	1.96	0.00	1.96
1982	2.06	0.00	2.06
1983	1.26	0.00	1.26
1984	2.00	0.00	2.00
1985	1.72	0.20	1.92
1986	2.07	0.19	2.26
1987	2.48	0.93	3.42
1988	2.31	0.25	2.56
1989	2.34	0.00	2.34
1990	2.99	0.03	3.02
1991	2.19	0.00	2.19
1992	3.55	0.00	3.55
1993	2.77	0.01	2.78
1994	1.93	0.00	1.93
1995	2.48	0.00	2.48
1996	2.87	0.00	2.87
1997	2.72	0.00	2.72
1998	2.77	0.00	2.77
1999	2.81	0.00	2.81
2000	2.94	0.00	2.94
2001	2.96	0.00	2.96
2002	1.91	0.00	1.91
2003	2.25	0.00	2.25
2004	2.22	0.00	2.22
2005	6.20	0.00	6.20
2006	2.87	0.00	2.87
2007	2.89	0.00	2.89
2008	3.04	0.00	3.04
2009	2.72	0.00	2.72
2010	2.13	0.00	2.13
2011	2.63	0.00	2.63
2012	1.75	0.00	1.75
2013	2.55	0.00	2.55
2014	2.34	0.00	2.34
2015	1.32	0.00	1.32
2016	1.85	0.00	1.85
2017	1.29	0.01	1.30
2018	3.02	0.00	3.02
2019	4.27	0.00	4.27
2020	2.77	0.00	2.77

7 Figures

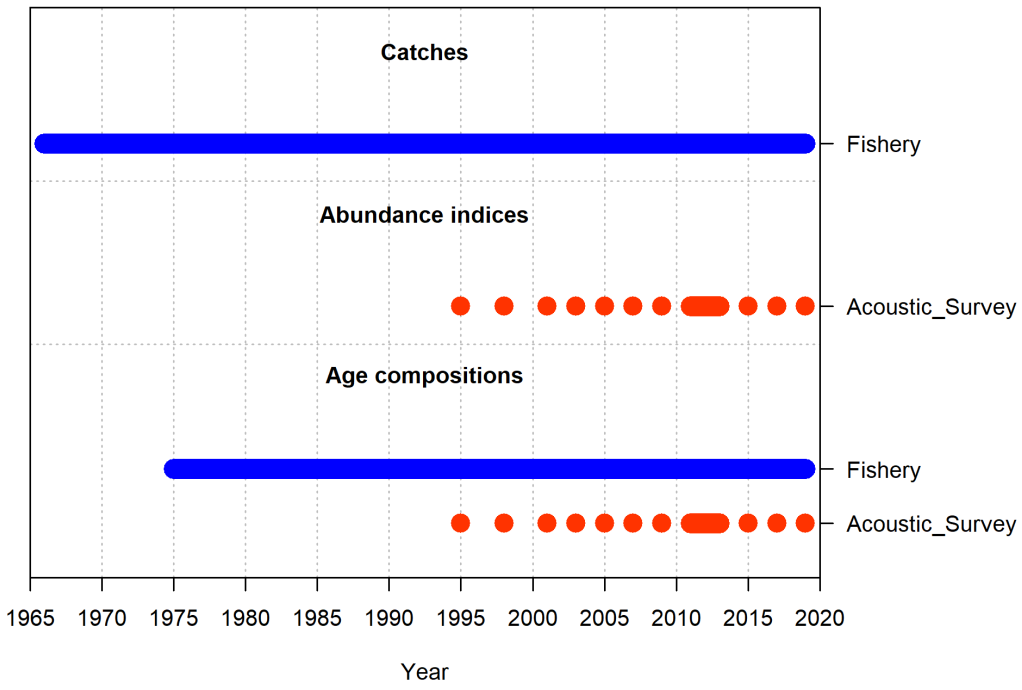

Figure 1: Summary of data sources used in the base model.

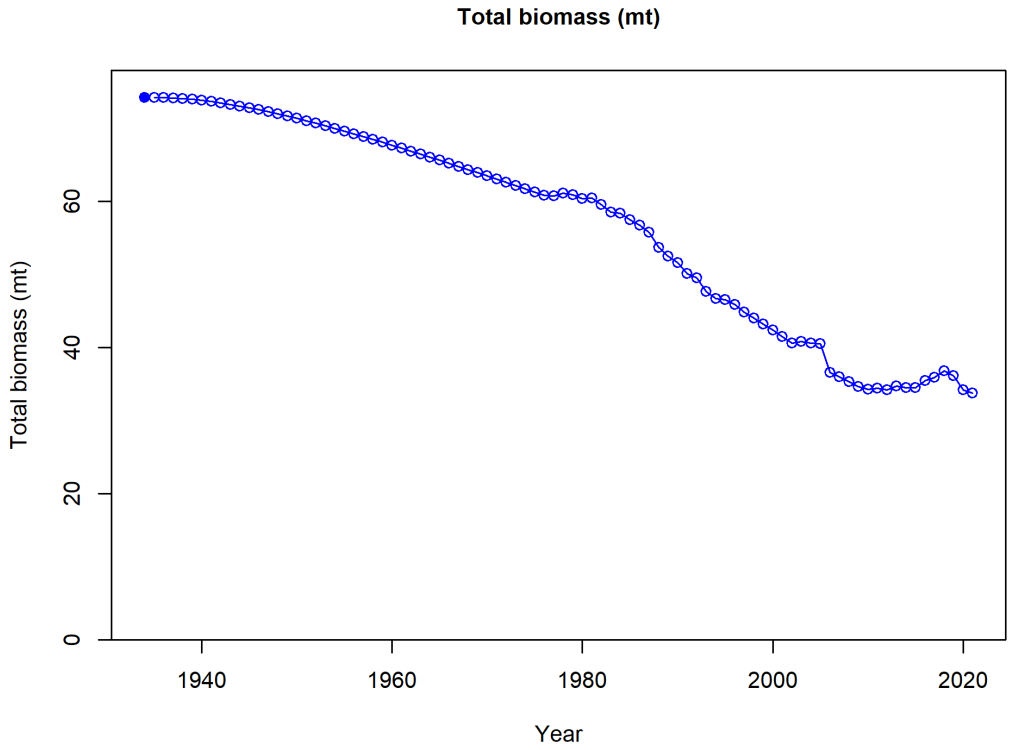

Figure 2: Estimated time-series of total biomass for Copper Rockfish.

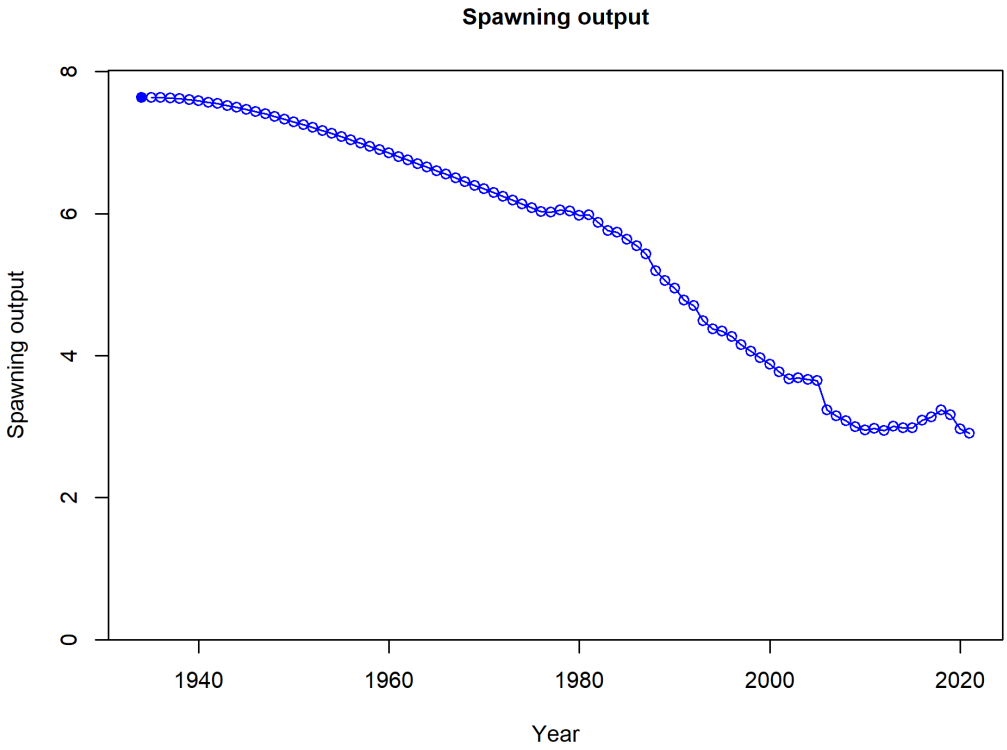

Figure 3: Test figure.

8 References

Bradburn, M. J., A. A Keller, and B. H. Horness. 2011. "The 2003 to 2008 US West Coast Bottom Trawl Surveys of Groundfish Resources Off Washington, Oregon, and California: Estimates of Distribution, Abundance, Length, and Age Composition." US Department of Commerce, National Oceanic; Atmospheric Administration, National Marine Fisheries Service.

Dick, E. J., Sabrina Beyer, Marc Mangel, and Stephen Ralston. 2017. "A Meta-Analysis of Fecundity in Rockfishes (Genus *Sebastes*)." *Fisheries Research* 187 (March): 73–85. https://doi.org/10.1016/j.fishres.2016.11.009.

Hamel, Owen S. 2015. "A Method for Calculating a Meta-Analytical Prior for the Natural Mortality Rate Using Multiple Life History Correlates." *ICES Journal of Marine Science: Journal Du Conseil* 72 (1): 62–69. https://doi.org/10.1093/icesjms/fsu131.

Love, Milton. 1996. *Probably More Than You Want to Know About the Fishes of the Pacific Coast*. Santa Barbara, California: Really Big Press.

Ralston, Stephen, Don E. Pearson, John C. Field, and Meisha Key. 2010. "Documentation of the California Catch Reconstruction Project." US Department of Commerce, National Oceanic; Atmospheric Adminstration, National Marine.

Then, A. Y., J. M. Hoenig, N. G. Hall, and D. A. Hewitt. 2015. "Evaluating the Predictive Performance of Empirical Estimators of Natural Mortality Rate Using Information on over 200 Fish Species." *ICES Journal of Marine Science* 72 (1): 82–92. https://doi.org/10.1093/icesjms/fsu136.

Weinberg, K. L., M. E. Wilkins, F. R. Shaw, and M. Zimmermann. 2002. "The 2001 Pacific West Coast Bottom Trawl Survey of Groundfish Resources: Estimates of Distribution, Abundance and Length and Age Composition." NOAA Technical Memorandum NMFS-AFSC-128. U.S. Department of Commerce.