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

by
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Executive Summary

Stock

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

The years is 2020

Landings

Replace text.

Table 2.

Table 1: Removals by fleet for the last 10 years.

Year	Recreational (mt)	Commercial (mt)	Total Mortality
2009	2732	0.00	2731.91
2010	2132	0.00	2132.14
2011	2642	0.00	2641.62
2012	1760	0.00	1759.56
2013	2562	0.00	2561.77
2014	2343	0.00	2343.20
2015	1319	0.00	1318.84
2016	1854	0.00	1853.86
2017	1294	0.01	1293.99
2018	3025	0.00	3024.60
2019	4274	0.00	4273.52
2020	0	0.00	0.00

Here is a reference to the catches (Table 1)

Data and Assessment

Replace text.

Stock Biomass

Replace text.

Table 2: 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	3786	3786	3786	0.451	0.451	0.451
2010	3738	3738	3738	0.445	0.445	0.445
2011	3756	3756	3756	0.447	0.447	0.447
2012	3726	3726	3726	0.444	0.444	0.444
2013	3786	3786	3786	0.451	0.451	0.451
2014	3766	3766	3766	0.449	0.449	0.449
2015	3767	3767	3767	0.449	0.449	0.449
2016	3872	3872	3872	0.461	0.461	0.461
2017	3922	3922	3922	0.467	0.467	0.467
2018	4029	4029	4029	0.480	0.480	0.480
2019	3956	3956	3956	0.471	0.471	0.471
2020	3750	3750	3750	0.447	0.447	0.447
2021	3979	3979	3979	0.474	0.474	0.474

Recruitment

Replace text.

Table 3: 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	7760	7760	7760	0	0	0
2010	7741	7741	7741	0	0	0
2011	7748	7748	7748	0	0	0
2012	7736	7736	7736	0	0	0
2013	7760	7760	7760	0	0	0
2014	7752	7752	7752	0	0	0
2015	7753	7753	7753	0	0	0
2016	7793	7793	7793	0	0	0
2017	7812	7812	7812	0	0	0
2018	7851	7851	7851	0	0	0
2019	7825	7825	7825	0	0	0
2020	7746	7746	7746	0	0	0
2021	7833	7833	7833	0	0	0

Exploitation Status

Replace text.

Table 4: 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	54.5	54.5	54.5	0.067	0.067	0.067
2010	47.5	47.5	47.5	0.053	0.053	0.053
2011	53.6	53.6	53.6	0.065	0.065	0.065
2012	42.0	42.0	42.0	0.043	0.043	0.043
2013	52.4	52.4	52.4	0.062	0.062	0.062
2014	49.9	49.9	49.9	0.057	0.057	0.057
2015	34.1	34.1	34.1	0.032	0.032	0.032
2016	42.5	42.5	42.5	0.044	0.044	0.044
2017	32.8	32.8	32.8	0.031	0.031	0.031
2018	55.7	55.7	55.7	0.070	0.070	0.070
2019	66.5	66.5	66.5	0.101	0.101	0.101
2020	0.0	0.0	0.0	0.000	0.000	0.000

Reference Points

Replace text.

Table 5: Reference points

Metric	Estimate	Lower Inteval	Upper Interval
Unfished Spawning Output	8395.78	8395.78	8395.78
Unfished Age 3+ Biomass (mt)	80028.40	80028.40	80028.40
Unfished Recruitment (R0)	8678.67	8678.67	8678.67
Spawning Output (2021)	3978.78	3978.78	3978.78
Fraction Unfished (2021)	0.47	0.47	0.47
Reference Points Based SB40 Percent	NA	NA	NA
Proxy Spawning Output(SB40 Percent	3358.31	3358.31	3358.31
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)	2451.87	2451.87	2451.87
Reference Points Based on SPR Proxy for MSY	NA	NA	NA
Proxy Spawning Output (SPR50)	3745.81	3745.81	3745.81
SPR50	50.00	NA	NA
Exploitation Rate Corresponding to SPR50	0.06	0.06	0.06
Yield with SPR50 at SB SPR (mt)	2336.95	2336.95	2336.95
Reference Points Based on Estimated MSY Values	NA	NA	NA
Spawning Output at MSY (SB MSY)	2259.48	2259.48	2259.48
SPR MSY	0.34	0.34	0.34
Exploitation Rate Corresponding to SPR MSY	0.10	0.10	0.10
MSY (mt)	2616.45	2616.45	2616.45

Management Performance

Replace text.

Table 6: The OFL, ABC, ACL, and Landings for the last 10 years.

Years	OFL	ABC	ACL	Landings
2009	fill in	fill in	fill in	2,731.91
2010	fill in	fill in	fill in	2,132.14
2011	fill in	fill in	fill in	2,641.62
2012	fill in	fill in	fill in	1,759.56
2013	fill in	fill in	fill in	2,561.77
2014	fill in	fill in	fill in	2,343.20
2015	fill in	fill in	fill in	1,318.84
2016	fill in	fill in	fill in	1,853.86
2017	fill in	fill in	fill in	1,293.99
2018	fill in	fill in	fill in	3,024.60
2019	fill in	fill in	fill in	4,273.52
2020	fill in	fill in	fill in	0.00

Unresolved Problems and Major Uncertainties

Replace text.

Decision Table

Add the projection table

Table 7: Projections

Year	OFL	ABC	3+ Biomass	Spawning Output	Fraction Unfished
2021	2464.1	60.1	42774.5	3978.8	0.474
2022	2595.7	60.4	44920.2	4208.4	0.501
2023	2724.0	2724.0	46987.6	4440.5	0.529
2024	2688.4	2688.4	46401.4	4394.1	0.523
2025	2651.9	2651.9	45839.6	4341.6	0.517
2026	2617.4	2617.4	45324.6	4286.0	0.510
2027	2586.6	2586.6	44855.2	4231.5	0.504
2028	2559.8	2559.8	44433.3	4181.2	0.498
2029	2536.5	2536.5	44056.3	4136.3	0.493
2030	2516.3	2516.3	43720.3	4096.7	0.488
2031	2498.6	2498.6	43420.5	4061.8	0.484
2032	2482.9	2482.9	43152.7	4030.8	0.480

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 xxxx.

1.2 Life History

Replace text.

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.

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 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. (XXX) 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. (XXX) 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. (XXX) 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 XXX), 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. The oldest aged rockfish was XXX years, captured off the coast of XXX in XXX. 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 XXX and XXX years of age and literature examining the longevity of `spp`.

2.3.2 Maturation and Fecundity

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
1933	0.00	0.00	0.00
1934	0.00	0.00	0.00
1935	15.93	0.00	15.93
1936	50.99	0.00	50.99
1937	84.45	0.00	84.45
1938	119.49	0.00	119.49
1939	152.92	0.00	152.92

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

Year	Recreational (mt)	Commercial (mt)	Total Mortality
1940	187.92	0.00	187.92
1941	221.29	0.00	221.29
1942	256.22	0.00	256.22
1943	289.52	0.00	289.52
1944	324.36	0.00	324.36
1945	357.56	0.00	357.56
1946	390.70	0.00	390.70
1947	425.36	0.00	425.36
1948	458.37	0.00	458.37
1949	492.90	0.00	492.90
1950	525.77	0.00	525.77
1951	560.14	0.00	560.14
1952	592.86	0.00	592.86
1953	627.08	0.00	627.08
1954	659.63	0.00	659.63
1955	693.68	0.00	693.68
1956	726.06	0.00	726.06
1957	758.36	0.00	758.36
1958	792.14	0.00	792.14
1959	824.25	0.00	824.25
1960	857.85	0.00	857.85
1961	889.78	0.00	889.78
1962	923.18	0.00	923.18
1963	954.92	0.00	954.92
1964	988.13	0.00	988.13
1965	1019.68	0.00	1019.68
1966	1052.68	0.00	1052.68
1967	1082.48	0.00	1082.48
1968	1115.28	0.00	1115.28
1969	1147.98	0.00	1147.98
1970	1179.02	0.00	1179.02
1971	1211.51	0.00	1211.51
1972	1242.34	0.00	1242.34
1973	1274.61	0.00	1274.61
1974	1305.23	0.00	1305.23
1975	1335.74	0.00	1335.74
1976	965.21	0.00	965.21
1977	594.35	0.00	594.35
1978	1103.78	0.00	1103.78
1979	1468.23	0.00	1468.23
1980	863.21	0.00	863.21
1981	1919.81	0.00	1919.81
1982	2014.78	0.00	2014.78
1983	1229.42	0.00	1229.42
1984	1951.63	0.00	1951.63

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

Year	Recreational (mt)	Commercial (mt)	Total Mortality
1985	1681.33	0.20	1681.53
1986	2026.98	0.19	2027.17
1987	2435.16	0.93	2436.09
1988	2273.74	0.25	2273.99
1989	2308.58	0.00	2308.58
1990	2947.83	0.03	2947.86
1991	2163.85	0.00	2163.85
1992	3507.92	0.00	3507.92
1993	2736.86	0.01	2736.87
1994	1908.93	0.00	1908.93
1995	2458.39	0.00	2458.39
1996	2848.46	0.00	2848.46
1997	2699.30	0.00	2699.30
1998	2753.32	0.00	2753.32
1999	2793.68	0.00	2793.68
2000	2919.71	0.00	2919.71
2001	2945.16	0.00	2945.16
2002	1897.13	0.00	1897.13
2003	2244.10	0.00	2244.10
2004	2208.98	0.00	2208.98
2005	6184.02	0.00	6184.02
2006	2869.38	0.00	2869.38
2007	2892.66	0.00	2892.66
2008	3039.41	0.00	3039.41
2009	2731.91	0.00	2731.91
2010	2132.14	0.00	2132.14
2011	2641.62	0.00	2641.62
2012	1759.56	0.00	1759.56
2013	2561.77	0.00	2561.77
2014	2343.20	0.00	2343.20
2015	1318.84	0.00	1318.84
2016	1853.86	0.00	1853.86
2017	1293.98	0.01	1293.99
2018	3024.60	0.00	3024.60
2019	4273.52	0.00	4273.52
2020	0.00	0.00	0.00

7 Figures

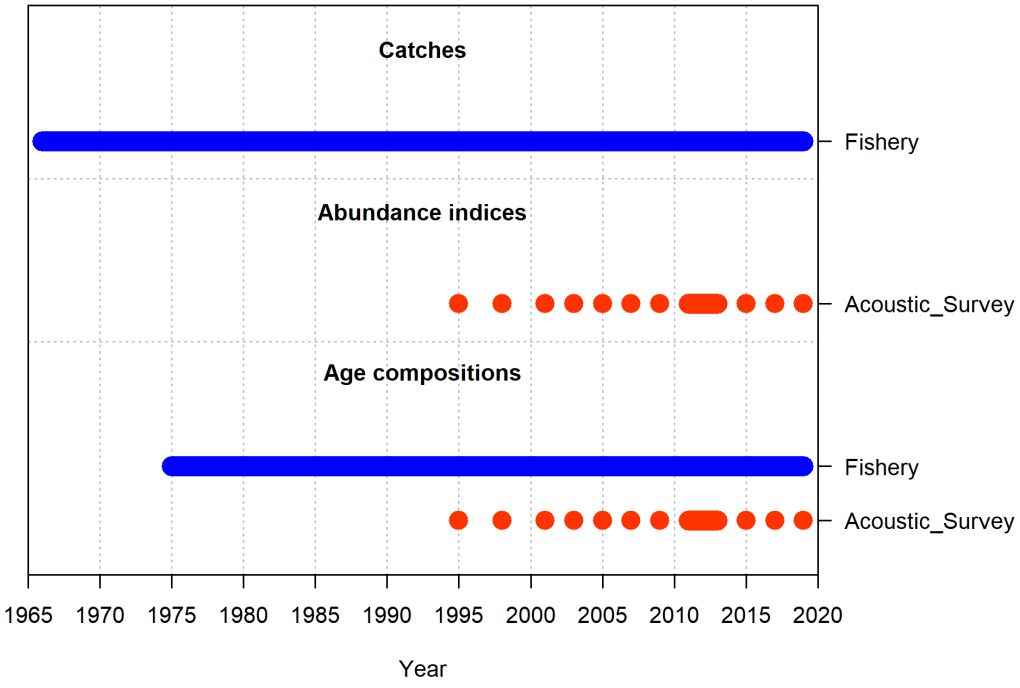

Figure 1: Summary of data sources used in the base model.

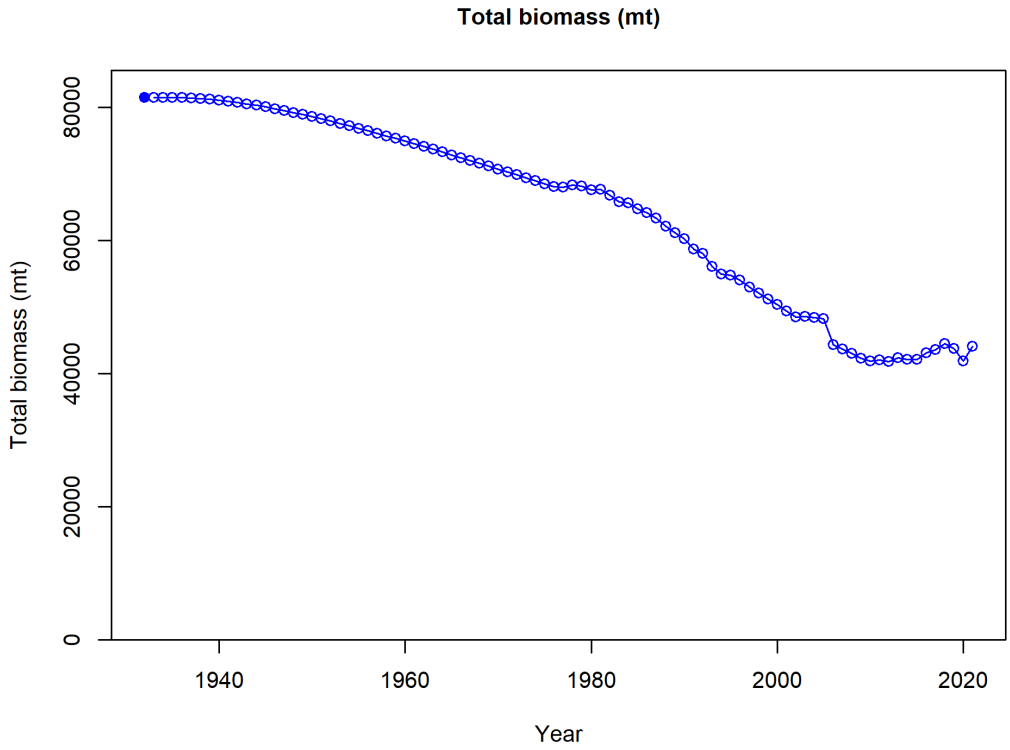

Figure 2: Estimated time-series of total biomass for Copper Rockfish.

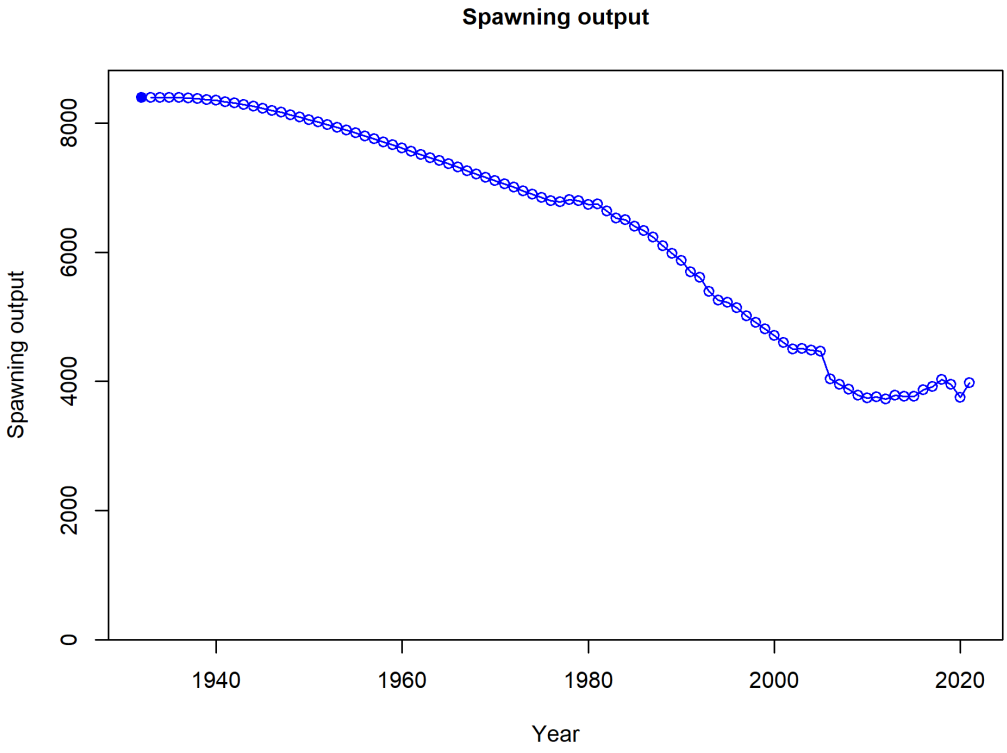

Figure 3: Test figure.

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.

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.

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.