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

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 [4] "Warning 3 : fleet: 6 AT_SEA_HAKE  is a fishing fleet but forecast relF not read"
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 [6] "Warning 5 : First_Mature_Age read as:  0, which is unusual. Check logic of spawn_mo
 [7] "Warning 6 : Minimum pop size bin:_4; is > L at Amin for sex: 1; Gpat: 1; L= 0"
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 [9] "Warning 8 : Final gradient: 0.0011111 is larger than final_conv: 1e-
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[10] "Note 2 Information: A revised protocol for the Fcast_yr specification is available
[11] " 8 warnings  and 2 notes "

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Survey               -2.02847e+01      NA
Length_comp           4.16137e+02      NA
```

```
Age_comp               7.62815e+03      NA
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Forecast_Recruitment  0.00000e+00       1
Parm_priors            1.92896e-01       1
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202      Catch_like  8.81549e-11  1.83785e-11          9.43780e-12 2.57804e-
11
203 Init_equ_lambda           NA  1.00000e+00          1.00000e+00 1.00000e+00
204   Init_equ_like  0.00000e+00  0.00000e+00          0.00000e+00 0.00000e+00
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1.03014
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216       0.00000e+00    6.00000e+00 9.00000e+00   0.00000  0.000000  0.00000
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CV_old_Mal_GP_1	0.0762461	2	0.000001
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NatM_uniform_Fem_GP_1	0.00320901	-0.000369107000
L_at_Amin_Fem_GP_1	0.68123500	0.001102460000
L_at_Amax_Fem_GP_1	0.35269000	0.000728679000
VonBert_K_Fem_GP_1	0.00201367	0.000773940000
CV_young_Fem_GP_1	0.01435840	0.000025334000
CV_old_Fem_GP_1	0.00286919	0.000240384000
NatM_uniform_Mal_GP_1	0.00317116	-0.000468454000
L_at_Amin_Mal_GP_1	1.10808000	0.000376119000
L_at_Amax_Mal_GP_1	0.30575800	0.000231694000
VonBert_K_Mal_GP_1	0.00275434	0.000274889000
CV_young_Mal_GP_1	0.01985330	0.000016505200
CV_old_Mal_GP_1	0.00282148	0.000031271900
SR_LN(R0)	0.63888900	0.000650231000
Q_extraSD_TRIENNIAL(7)	0.12208100	0.000006652540
Size_DblN_peak_BOTTOM_TRAWL(1)	2.30261000	0.000002571050
Size_DblN_ascend_se_BOTTOM_TRAWL(1)	0.34400500	0.000007545120
Size_DblN_peak_BOTTOM_TRAWL_DISCARD(2)	5.87770000	-0.000014128200
Size_DblN_ascend_se_BOTTOM_TRAWL_DISCARD(2)	0.63420400	0.000089007200
Size_DblN_descend_se_BOTTOM_TRAWL_DISCARD(2)	1.24133000	-0.000035181700

Size_DblN_peak_NON_TRAWL(3)	4.90359000	-0.000045828900
Size_DblN_ascend_se_NON_TRAWL(3)	1.68444000	0.000065106900
Size_DblN_peak_NON_TRAWL_DISCARD(4)	1.76153000	0.000028914200
Size_DblN_ascend_se_NON_TRAWL_DISCARD(4)	0.48217100	-0.000025257300
Size_DblN_descend_se_NON_TRAWL_DISCARD(4)	66.83740000	0.000000578901
Size_DblN_peak_MIDWATER_TRAWL(5)	3.96875000	0.000021341700
Size_DblN_ascend_se_MIDWATER_TRAWL(5)	0.40146100	-0.000089851400
Size_DblN_peak_AT_SEA_HAKE(6)	1.59751000	0.000155772000
Size_DblN_ascend_se_AT_SEA_HAKE(6)	0.40986100	-0.000149877000
Size_DblN_peak_TRIENNIAL(7)	1.97295000	-0.000007920550
Size_DblN_ascend_se_TRIENNIAL(7)	1.52441000	-0.000003368400
Size_DblN_descend_se_TRIENNIAL(7)	0.26541000	-0.000029650200
Size_DblN_peak_AK_SLOPE(8)	2.48931000	-0.000019990900
Size_DblN_ascend_se_AK_SLOPE(8)	0.50088800	0.000040535100
Size_DblN_descend_se_AK_SLOPE(8)	0.40621100	0.000055404000
Size_DblN_peak_WCGBTS(10)	3.13111000	0.000009898340
Size_DblN_ascend_se_WCGBTS(10)	1.81470000	-0.000013396500
Size_DblN_descend_se_WCGBTS(10)	1.54727000	0.000030966600
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2002	1.86221000	-0.000000737205
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2011	3.45533000	-0.000003875410
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2002	0.48839000	-0.000001859080
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2011	0.65652300	-0.000023852300
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2002	1.20658000	0.000026531900
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2011	1.28401000	0.000102836000
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2020	2.49955000	0.000017920200
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2002	0.61816100	-0.000018302100
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2011	0.35274600	-0.000103611000
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2020	0.51442500	0.000005031830

	Pr_type	Prior	Pr_SD
NatM_uniform_Fem_GP_1	Log_Norm	-3.3918	0.5424
L_at_Amin_Fem_GP_1	No_prior	NA	NA
L_at_Amax_Fem_GP_1	No_prior	NA	NA
VonBert_K_Fem_GP_1	No_prior	NA	NA
CV_young_Fem_GP_1	No_prior	NA	NA
CV_old_Fem_GP_1	No_prior	NA	NA
NatM_uniform_Mal_GP_1	Log_Norm	-3.3918	0.5424
L_at_Amin_Mal_GP_1	No_prior	NA	NA
L_at_Amax_Mal_GP_1	No_prior	NA	NA
VonBert_K_Mal_GP_1	No_prior	NA	NA
CV_young_Mal_GP_1	No_prior	NA	NA
CV_old_Mal_GP_1	No_prior	NA	NA
SR_LN(R0)	No_prior	NA	NA
Q_extraSD_TRIENNIAL(7)	No_prior	NA	NA

Size_DblN_peak_BOTTOM_TRAWL(1)	No_prior	NA	NA
Size_DblN_ascend_se_BOTTOM_TRAWL(1)	No_prior	NA	NA
Size_DblN_peak_BOTTOM_TRAWL_DISCARD(2)	No_prior	NA	NA
Size_DblN_ascend_se_BOTTOM_TRAWL_DISCARD(2)	No_prior	NA	NA
Size_DblN_descend_se_BOTTOM_TRAWL_DISCARD(2)	No_prior	NA	NA
Size_DblN_peak_NON_TRAWL(3)	No_prior	NA	NA
Size_DblN_ascend_se_NON_TRAWL(3)	No_prior	NA	NA
Size_DblN_peak_NON_TRAWL_DISCARD(4)	No_prior	NA	NA
Size_DblN_ascend_se_NON_TRAWL_DISCARD(4)	No_prior	NA	NA
Size_DblN_descend_se_NON_TRAWL_DISCARD(4)	No_prior	NA	NA
Size_DblN_peak_MIDWATER_TRAWL(5)	No_prior	NA	NA
Size_DblN_ascend_se_MIDWATER_TRAWL(5)	No_prior	NA	NA
Size_DblN_peak_AT_SEA_HAKE(6)	No_prior	NA	NA
Size_DblN_ascend_se_AT_SEA_HAKE(6)	No_prior	NA	NA
Size_DblN_peak_TRIENNIAL(7)	No_prior	NA	NA
Size_DblN_ascend_se_TRIENNIAL(7)	No_prior	NA	NA
Size_DblN_descend_se_TRIENNIAL(7)	No_prior	NA	NA
Size_DblN_peak_AK_SLOPE(8)	No_prior	NA	NA
Size_DblN_ascend_se_AK_SLOPE(8)	No_prior	NA	NA
Size_DblN_descend_se_AK_SLOPE(8)	No_prior	NA	NA
Size_DblN_peak_WCGBTS(10)	No_prior	NA	NA
Size_DblN_ascend_se_WCGBTS(10)	No_prior	NA	NA
Size_DblN_descend_se_WCGBTS(10)	No_prior	NA	NA
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2002	No_prior	NA	NA
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2011	No_prior	NA	NA
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2002	No_prior	NA	NA
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2011	No_prior	NA	NA
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2002	No_prior	NA	NA
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2011	No_prior	NA	NA
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2020	No_prior	NA	NA
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2002	No_prior	NA	NA
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2011	No_prior	NA	NA
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2020	No_prior	NA	NA

	Pr_Like	Afterbound
NatM_uniform_Fem_GP_1	0.1468230	OK
L_at_Amin_Fem_GP_1	NA	OK
L_at_Amax_Fem_GP_1	NA	OK
VonBert_K_Fem_GP_1	NA	OK
CV_young_Fem_GP_1	NA	OK
CV_old_Fem_GP_1	NA	OK
NatM_uniform_Mal_GP_1	0.0460738	OK
L_at_Amin_Mal_GP_1	NA	OK
L_at_Amax_Mal_GP_1	NA	OK

```
VonBert_K_Mal_GP_1                                  NA        OK
CV_young_Mal_GP_1                                   NA        OK
CV_old_Mal_GP_1                                     NA        OK
SR_LN(R0)                                           NA        OK
Q_extraSD_TRIENNIAL(7)                              NA        OK
Size_DblN_peak_BOTTOM_TRAWL(1)                      NA        OK
Size_DblN_ascend_se_BOTTOM_TRAWL(1)                 NA        OK
Size_DblN_peak_BOTTOM_TRAWL_DISCARD(2)              NA        OK
Size_DblN_ascend_se_BOTTOM_TRAWL_DISCARD(2)         NA        OK
Size_DblN_descend_se_BOTTOM_TRAWL_DISCARD(2)        NA        OK
Size_DblN_peak_NON_TRAWL(3)                         NA        OK
Size_DblN_ascend_se_NON_TRAWL(3)                    NA        OK
Size_DblN_peak_NON_TRAWL_DISCARD(4)                 NA        OK
Size_DblN_ascend_se_NON_TRAWL_DISCARD(4)            NA        OK
Size_DblN_descend_se_NON_TRAWL_DISCARD(4)           NA        OK
Size_DblN_peak_MIDWATER_TRAWL(5)                    NA        OK
Size_DblN_ascend_se_MIDWATER_TRAWL(5)               NA        OK
Size_DblN_peak_AT_SEA_HAKE(6)                       NA        OK
Size_DblN_ascend_se_AT_SEA_HAKE(6)                  NA        OK
Size_DblN_peak_TRIENNIAL(7)                         NA        OK
Size_DblN_ascend_se_TRIENNIAL(7)                    NA        OK
Size_DblN_descend_se_TRIENNIAL(7)                   NA        OK
Size_DblN_peak_AK_SLOPE(8)                          NA        OK
Size_DblN_ascend_se_AK_SLOPE(8)                     NA        OK
Size_DblN_descend_se_AK_SLOPE(8)                    NA        OK
Size_DblN_peak_WCGBTS(10)                           NA        OK
Size_DblN_ascend_se_WCGBTS(10)                      NA        OK
Size_DblN_descend_se_WCGBTS(10)                     NA        OK
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2002        NA        OK
Size_DblN_peak_BOTTOM_TRAWL(1)_BLK1repl_2011        NA        OK
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2002   NA        OK
Size_DblN_ascend_se_BOTTOM_TRAWL(1)_BLK1repl_2011   NA        OK
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2002           NA        OK
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2011           NA        OK
Size_DblN_peak_NON_TRAWL(3)_BLK2repl_2020           NA        OK
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2002      NA        OK
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2011      NA        OK
Size_DblN_ascend_se_NON_TRAWL(3)_BLK2repl_2020      NA        OK

$maximum_gradient_component
[1] 0.0011111

$parameters_with_highest_gradients
```

```
                           Value     Gradient
L_at_Amin_Fem_GP_1    -3.7354800  0.001102460
VonBert_K_Fem_GP_1     0.0838902  0.000773940
L_at_Amax_Fem_GP_1    58.1724000  0.000728679
SR_LN(R0)              6.7089200  0.000650231
NatM_uniform_Mal_GP_1  0.0396704 -0.000468454

$Length_Comp_Fit_Summary
     Data_type Fleet Recommend_var_adj #  N Npos min_Nsamp max_Nsamp
4806         4     1          0.378903 # 30   30  0.335725  18.56970
4807         4     2          0.115144 # 17   17  0.221565  10.94530
4808         4     3          0.266023 # 28   28  0.421121  28.76370
4809         4     4          0.577310 # 20   20  1.314700  27.38950
4810         4     5          0.794997 # 17   17  1.397660  30.38460
4811         4     6          0.360431 # 21   21  1.790050  29.61720
4812         4     7          0.650185 #  4    4  8.650560  10.20920
4813         4     8          1.356450 #  4    4 24.000000  31.00000
4814         4    10          0.734690 # 21   21  2.171620   7.69114
     mean_Nsamp_in mean_Nsamp_adj mean_Nsamp_DM err_method err_index
4806      152.0600        9.36704            NA          0        NA
4807       56.8235        2.51802            NA          0        NA
4808      216.6550       14.22030            NA          0        NA
4809       35.8000        7.84435            NA          0        NA
4810       31.1956       11.49210            NA          0        NA
4811      457.5710       12.41030            NA          0        NA
4812      120.5000        9.39093            NA          0        NA
4813       26.0000       26.00000            NA          0        NA
4814       64.0000        5.79098            NA          0        NA
            par1 val1 par2 val2 mean_effN   HarMean Curr_Var_Adj
4806 multinomial   NA   NA   NA  130.1860  57.61600     0.061601
4807 multinomial   NA   NA   NA   20.2096   6.54291     0.044313
4808 multinomial   NA   NA   NA  100.9270  57.63500     0.065636
4809 multinomial   NA   NA   NA   43.1939  20.66770     0.219116
4810 multinomial   NA   NA   NA   73.4964  24.80050     0.368387
4811 multinomial   NA   NA   NA  292.3350 164.92300     0.027122
4812 multinomial   NA   NA   NA   94.6432  78.34730     0.077933
4813 multinomial   NA   NA   NA   46.3936  35.26760     1.000000
4814 multinomial   NA   NA   NA   56.2752  47.02020     0.090484
               Fleet_name
4806         BOTTOM_TRAWL
4807 BOTTOM_TRAWL_DISCARD
4808            NON_TRAWL
4809    NON_TRAWL_DISCARD
```

```
4810       MIDWATER_TRAWL
4811          AT_SEA_HAKE
4812            TRIENNIAL
4813             AK_SLOPE
4814               WCGBTS

$Age_Comp_Fit_Summary
     Data_type Fleet Recommend_var_adj # Nsamp_adj Npos min_Nsamp max_Nsamp
6777         5     1          0.301604 #       361  350  0.095767   4.78835
6778         5     3          0.264786 #       346  335  0.075234   6.54536
6779         5     5          0.463400 #       141  135  0.136598   3.14175
6780         5     6          0.291201 #       312  303  1.000000  51.00000
6781         5    10          0.655640 #       796  775  0.602828   9.64525
     mean_Nsamp_in mean_Nsamp_adj mean_Nsamp_DM err_method err_index
6777       8.15429       0.780911            NA          0        NA
6778       9.37612       0.705403            NA          0        NA
6779       4.22222       0.576747            NA          0        NA
6780      11.33330      11.333300            NA          0        NA
6781       2.49290       1.502790            NA          0        NA
            par1 val1 par2 val2 mean_effN HarMean Curr_Var_Adj     Fleet_name
6777 multinomial   NA   NA   NA   7.32676 2.45937     0.095767   BOTTOM_TRAWL
6778 multinomial   NA   NA   NA   7.87891 2.48266     0.075234      NON_TRAWL
6779 multinomial   NA   NA   NA   3.99695 1.95658     0.136598 MIDWATER_TRAWL
6780 multinomial   NA   NA   NA  11.98590 3.30028     1.000000    AT_SEA_HAKE
6781 multinomial   NA   NA   NA   2.83505 1.63445     0.602828         WCGBTS

$SBzero
[1] 9514.84

$current_depletion
[1] 0.7024606

$SPRratioLabel
[1] "(1-SPR)/(1-SPR_50%)"

$sigma_R_in
[1] 0.5

$sigma_R_info
            period N_devs SD_of_devs Var_of_devs   mean_SE mean_SEsquared
1             Main    124  0.2414008  0.05827437 0.4615837      0.2163039
2       Early+Main    124  0.2414008  0.05827437 0.4615837      0.2163039
3 Early+Main+Late    125  0.2404255  0.05780441 0.4618910      0.2165734
```

```
  sqrt_sum_of_components SD_of_devs_over_sigma_R sqrt_sum_over_sigma_R
1              0.5240021               0.4828017              1.048004
2              0.5240021               0.4828017              1.048004
3              0.5238109               0.4808510              1.047622
  alternative_sigma_R
1   0.524002136150957
2   0.524002136150957
3   0.523810894671802

$rmse_table
    ERA   N     RMSE RMSE_over_sigmaR mean_BiasAdj
1  main 124 0.240426         0.231218     0.171774
2 early   0 0.000000         0.000000     0.000000

$RecDev_method
[1] 2
```

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0.1 Executive Summary

0.1.1 Stock Description

This document presents the stock assessment for the Rougheye (*Sebastes aleutianus*) and Blackspotted (*Sebastes melanostictus*) Rockfishes, two species that form one management complex. Despite some identification advances and Rougheye and Blackspotted rockfishes are clearly genetically distinct species, data historically and contemporaneously remain available mostly for the Rougheye/Blackspotted Rockfish complex, not consistently at the species level. While we treat these species as one assessed stock complex, we recognize and are mindful of the above species distinctions as we conduct our analyses. 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 (Figure 1). It seeks to use available catch, biological compositions in the for of lengths and ages, and potential indices of abundance and is the first assessment since the 2013 stock assessment (Hicks, Wetzel, and Harms 2013).

0.1.2 Catches

0.1.3 Data and Assessments

0.1.4 Stock Output and Dynamics

0.1.5 Recruitment

0.1.6 Exploitation Status

0.1.7 Ecosysystem Consideration

0.1.8 Reference Points

0.1.9 Management Performance

0.1.10 Evaluation of Scientific Uncertainty

0.1.11 Harvest Projections and Decision Tables

0.1.12 Unresolved Problems and Major Uncertainties

0.1.13 Research and Data Needs

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 (Figure 1). It seeks to use available catch, biological compositions in the for of lengths and ages, and potential indices of abundance and is the first assessment since the 2013 stock assessment (Hicks, Wetzel, and Harms 2013).

1.1 Stock Structure

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

1. Rougheye and Blackspotted rockfishes are two different species– can we separate them as two stocks and conduct separate assessments? 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, Yoklavich, and Thorsteinson 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 (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 (Seeb 1986; S. Hawkins, Heifetz, and Pohl 1997; S. L. 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 (Anthony J. 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(A. J. 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 (Matsubara 1934).

These two species remain difficult to consistently differentiate visually in the catch, thus are still commonly reported and treated as a species complex. Otolith morphometrics (e.g., shape, size, weight) have shown some promise in possibly identifying these species in Alaskan waters (97.3% Blackspotted and 86.2% of Rougheye rockfishes were accurately identified) and possibly using older otoliths to break out historical information by species (Harris, Hutchinson, and Wildes 2019). 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 occurred, 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; Anthony J. Gharrett et al. (2005); S. L. Hawkins et al. (2005); Orr and Hawkins (2008)). 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 current assessments to this point have maintained a species complex approach.

Despite some identification advances and Rougheye and Blackspotted rockfishes are clearly genetically distinct species, data historically and contemporaneously remain available only for the Rougheye/Blackspotted Rockfish complex, not at the species level. While we treat these species as one assessed stock complex, we recognize and are mindful of the above species distinctions as we conduct our analyses.

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 (Hicks, Wetzel, and Harms 2013) 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 in 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). We

assume here that the west coast stocks of Rougheye/Blackspotted rockfishes are distinct management units from those in Alaska.

1.2 Life History

Rougheye and Blackspotted Rockfishes range from northern California up to and throughout Alaska and into Japan (Anthony J. Gharrett et al. 2005; S. L. Hawkins et al. 2005; Orr and Hawkins 2008). Both are long-lived (>100 years), with Rougheye Rockfish having the distinction of the oldest ever aged *Sebastes* species at 205 years old. They both greatly overlap in latitude and depth (shallower than 100 m to at least 439 m), and are generally considered slope rockfish, with an ontogenetic shift from shallower to deeper, and adults commonly found at 360 m (around 200 fathoms). Rougheye seems to be proportionally more abundant when survey samples are genetically identified, and Blackspotted Rockfish tend to be found, on average, deeper than Rougheye Rockfish (S. L. Hawkins et al. 2005; Orr and Hawkins 2008).

Rougheye/Blackspotted Rockfishes are often associated with structure, such as hard, rocky bottoms and steep habitats. They are rarely found on the deep flats. They can be found alone or in aggregations (Love, Yoklavich, and Thorsteinson 2002), with aggregations often differentiated by age. Younger fish may school and are often found in shallower waters on the shelf, junveiles and subadults can be found together, and larger fish may form larger aggregations in the Pacific Northwest during the autumn and winter. These two species may also 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. One major distinguishing feature of Rougheye Rockfish are the 2–10 spines along the lower rim of their eyes, hence the common name "rougheye".

Like all *Sebastes* species, Rougheye and Blackspotted Rockfishes give birth to live young. Larvae released has been documented between February and June and extrusion lengths are between 4.5-5.3 mm (Love, Yoklavich, and Thorsteinson 2002). There are no studies on the fecundity of rougheye rockfish on the west coast of the U.S.

A wide range of prey items make up the diet of rougheye rockfish. Crangid and pandalid shrimps make up the majority of their diets, and larger individuals, greater than 30 cm, feeding upon other fishes (Love 2011). They are also known to feed upon gammarid amphipods; mysids, crabs, polychaetes, and octopuses (Love, Yoklavich, and Thorsteinson 2002; Love 2011).

1.3 Ecosystem considerations

1.4 Historical and Current Fishery Information

Rougheye/Blackspotted Rockfishes are not often targeted by a specific fishery, but are desirable and marketable, thus are typically retained when captured. They are often captured in bottom trawl, mid-water trawl, and longline fisheries. Small numbers have been observed in pot, shrimp, and recreational fisheries.

After many attempts to start trawl fisheries off the west coast of the United States in the late 1800's, the availability of the otter trawl and the diesel engine in the mid-1920's helped the trawl fisheries expand (Douglas and Division 1998). The trawl fisheries really became established during World War II when demand increased for shark livers and bottomfish. A mink food fishery also developed during World War II (Jones and Harry 1961), and post-war catches for rockfishes, including Rougheye/Blackspotted Rockfishes, increased (Niska 1976). Foreign fleets began fishing for rockfish in the mid 1960's until the EEZ was implemented in 1977 (J. B. Rogers 2003). Since 1977, landings of rockfish were high until management restrictions were implemented in 2000. Longline catches of rougheye rockfish are present from the turn of the century and continue in recent years, targeting sablefish and halibut. The catches by state for the trawl and hook & line fleets as well as for the Pacific whiting at-sea fleet are shown in ******.

A long-term directed fishery has not occurred for rougheye rockfish and historical discarding practices are not well known. Rougheye rockfish inhabit deeper water as adults, which were fished less often historically. More detailed information of the fisheries by state is given in Section ******* where the reconstructed landings are discussed.

1.5 Management History and Performance

Rougheye/Blackspotted Rockfishes has been a small component of groundfish fisheries and catches of Rougheye/Blackspotted Rockfishes have been governed by restrictions on assemblages of species, of which these species are a member. However, the distribution of fishing effort in areas where Rougheye/Blackspotted Rockfishes might be encountered has also been affected by catch restrictions on co-occurring, rebuilding species, as well as associated area closures instituted to promote rebuilding. The first imposed landings limits on a coastwide Sebastes complex (Rougheye/Blackspotted Rockfishes being one of the 50 rockfishes in the complex) were instituted in 1983. Ongoing concern that shelf and slope rockfishes may be undergoing overfishing led the attempt by J. S. Rogers et al. (1996) to describe the status of most rockfishes contained in the Sebastes complex. Rougheye/Blackspotted Rockfishes information content was low, and using the Triennial survey to calculate an average biomass and assuming that fishing mortality equals natural mortality provided estimates of exploitation rates that indicated the stock was undergoing very high exploitation rates in both management areas. The dividing line between the northern and southern management areas was shifted to 40º 10' N latitude in 1999 and the Sebastes complex was subsequently divided into nearshore, shelf, and slope complexes in 2000. Rougheye/Blackspotted Rockfishes has been managed under trip limits for the minor slope rockfish complex in both north and south management areas since this time.

Table (**?**) summarizes major management changes since 2000. Some important changes include the implementation of Rockfish Conservation Areas (RCA's) in 2002, the beginning of trawl rationalization in 2011, and the lifting of the RCAs beginning in 2020 with the removal of the trawl RCA in Oregon and California and loosening restrictions in the non-trawl RCAs in 2023 and 2024.

Though managed as part of a complex, OFL contributions for Rougheye/Blackspotted Rockfishes were calculated using DB-SRA in 2010 for the 2011-2012 management cycle. This lead to the observation that recent catches had frequently exceeded the OFL contribution estimated using data-poor, catch-only methods provided a strong indication that a more thorough evaluation of Rougheye/Blackspotted Rockfishes stock status and sustainable harvest levels be undertaken, using all available data. A full assessment of Rougheye/Blackspotted Rockfishes was undertaken in 2013 and indicated the stock complex was above management target levels (Hicks, Wetzel, and Harms (2013)). Recent management performance for Rougheye/Blackspotted Rockfishes as a part of the nothern minor slope rockfish complex is provided in Table (**?**) (ALI IS STILL CREATING THIS TABLE - WILL ADD TEXT FOR IT LATER).

1.6 Fisheries off Canada and Alaska

Rougheye Rockfish are distributed throughout Canada and Alaska and are commonly caught in trawl and hook & line fisheries. Alaska conducts assessments biennially for the Rougheye/Blackspotted complex, and two have been recently done: one for the Bering Sea and Aluetian Islands (Spencer, Ianelli, and Laman 2003) and the other for the Gulf of Alaska (Sullivan et al. 2023). Canada completed an assessment in 2020 (Starr and Haigh 2020). The fisheries and assessments for each country are described below.

Rougheye rockfish have been managed as a bycatch only species in Alaska since 1991 with catches ranging between 130 and 2,418 mt and peaking in the late 1980s and early 1990s (Sullivan et al. 2023). Generally, about 55-75% of the catch are trawl-caught and 30-45% from hook-and-line (mainly, longline) fisheries. Since 2017 the move to pot gear in the sablefish fishery has decreased the longline catches. Discards since 2013 have ranged from 11.6% (in 2023) and 45% (in 2018). The Rougheye/Blackspotted complex catch levels generally are between 20% and 60% of the Total Allowable Catch since the 2005 when the complex began to be managed separately. The most recent age-structured integrated stock assessments of this complex in the Bering Sea and Aluetian Islands (Spencer, Ianelli, and Laman 2003) and for the Gulf of Alaska (Sullivan et al. 2023) do not indicate either overfishing or the stocks being overfished.

Canada identified two species of rougheye rockfish (Type I and Type II) in 2007 and designated both species of special concern, which means that they may become threatened or endangered because of a combination of biological characteristics and identified threats (Report 2007). This designation was given because biomass estimates are uncertain and no strong trends are observed, there is evidence of truncation of the age distribution and overall mortality has doubled, it is a long-lived, low-fecundity Sebastes species, which is susceptible to population collapse and slow recovery, and because the difficulty in separating the two species may result in potential impacts on one of the species going unnoticed. Subsequently, the species were identified as rougheye rockfish and blackspotted rockfish and a management plan was created in 2012 with a goal of sustaining the populations of rougheye and blackspotted rockfishes (Canada 2012). Five high priority and seven low priority actions have been identified to address the threats to the populations and support the management goal.

The first Canadian stock assessment for these species, using a integrated catch-at-age model, was conducted in 2022 to estimated stock status of two Rougheye/Blackspotted (REBS) rockfishes management units (REBS north and REBS south) a the beginning of 2021. The REBS north stock was in the healthy zone in the reference model. The REBS south stock was likely in the healthy zone, but with an elevated possibility of being in the cautious zone.

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 4) 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 stock assessments when they were not used.

2.1 Fishery-dependent data

Fishery depended data for Rougheye/Blackspotted complex in this assessment are divided among six fleets, which include: * Fleet 1: Commercial bottom trawl fishery * Fleet 2: Commercial non-trawl gear (mainly the long-line fishery) fishery * Fleet 3: Dead discard bottom trawl fleet * Fleet 4: Dead discard non-trawl fleet * Fleet 5: Contemporary mid-water fishery * Fleet 6: Bycatch within the at-sea hake fishery

There are no recreational landings of this complex on the West coast.

2.1.1 Landings

2.1.1.1 Recent landings

Recent commercial landings of rougheye rockfish (2000-2024 for Washington, 1987–2022 for Oregon and 1981–2022 for California,) were obtained from PacFIN, a regional fisheries database that manages fishery-dependent information in cooperation with West Coast state agencies and National Marine Fisheries Service (NMFS). Catch data were extracted from PacFIN on April 21, 2015, by state and then combined into the fishing fleets used in the assessment. Time series of recent landings by fleet and state are reported in Table X and shown in Figures X to X.

2.1.1.2 Historical Landings

Historical landings of Rougheye/Blackspotted rockfish were reconstructed by state, by year.

The Washington historical landings (1889–2000) were provided by Washington Department of Fish and Wildlife (WDFW), who recently conducted historical catch reconstruction for rockfish special including rougheye rockfish (pers. comm. T. Tsou, WDFW). The three main sources used in this reconstruction (SpeciesSumOutput2_2017.csv- ADD TABLE) are from the US Fish Commission Report (UFSC), Washington Bound Volumes, and Washington Statistical Bulletin. The historical species composition is based on the various historical reports and interviews of old-time fishermen and dockside samplers. The 1981 to 2000 landings are different from PacFIN records due to a revised approach for apportioning out more unidentified rockfish (“URCK”) in fish tickets to the species level. This revised approach relaxed the borrowing rules for missing data currently used in the WDFW species allocation algorithm (Tsou at al., 2015 - CAN'T FIND IN BIB). New Washington historical landings represent improvement to the assessment.

The Oregon historical landings (1896–1986) were obtained from Oregon historical catch reconstruction, conducted by Oregon Department of Fish and Wildlife in collaboration with NWFSC (Karnowski, Gertseva, and Stephens (2014)). The Oregon PacFIN landings for the period between 1987 and 1999 were supplemented with the additional estimates of Rougheye/Blackspotted rockfish landings reported within unspecified rockfish market categories, provided by the ODFW (i.e., URCK and POP1; (**?**)).

The California historical landings were informed by several sources. Landings from the most recent “historical” period (between 1969 and 1980) were available from the CalCOM database for the California Cooperative Survey (CalCOM) database. Earlier landing records (between 1931 and 1968) were reconstructed by the Southwest Fisheries Science Center (Ralston et al. (2010)).

Comparison of Rougheye/Blackspotted rockfish historical landings by state and fleet between this and 2013 assessment is provided in Figure 5.

The largest differences in this assessment from 2013 model are in Washington landings (Figure 8), with newly estimated landings being generally lower than those used in previous assessment. The new WDFW catch reconstruction completed by WDFW is considered an improvement.

Historical California and Oregon landings did not change substantially (Figure 6 and Figure 7), with the exception of the magnitude of hte catch in a few years. Discrepancies in California and Oregon non-trawl landings between the 2013 and 2025 assessments are caused by the fact that non-trawl fleet in 2013 assessment was limited to only fixed gear, when in 2025 assessment non-trawl includes all non-trawl gear groups. Slight discrepancies in Oregon trawl landings between 1987 and 1999, are from adding previously non-reported landings of Rougheye/Blackspotted in the unspecified rockfish market categories (see details above).

Comparing the update historical data with that used in the 2013 stock assessment shows only minor differences (Figure 9; Figure 10).

2.1.1.3 Recent Landings

ADD FLEET STRUCTURE

Recent commercial landings of rougheye rockfish (2001-2024 for Washington, 1987–2024 for Oregon and 1981–2024 for California,) were obtained from PacFIN, a regional fisheries database that manages fishery-dependent information in cooperation with West Coast state agencies and National Marine Fisheries Service (NMFS). Catch data were extracted from PacFIN on April 21, 2025, by state and then combined into the fishing fleets used in the assessment. Time series of recent landings by fleet and state are reported in Table X and shown in Figures X to X. (ADD THESE TABLE/FIGURES)

2.1.1.4 At-Sea Hake Landings

NOTE - Ali added heading but I'm guessing Vlada should write?

2.1.2 Discards

2.1.2.1 Trawl

NOTE - Ali removed the fleet subheadings under this but add back if needed!

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:

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

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

2.2 Fishery-independent data

2.2.1 Abundance indices

Given Rougheye/Blackspotted are associated with deep, structured habitats, it can be difficult to survey them with trawl gear. Four general fishery-independent bottom trawl surveys were used in the 2013 assessment, and are again included in this assessment:

- Triennial (every three years) survey (1980-2004)
- Alaska Fishery Science Center Slope survey (1997-2001)
- Northwest Fisheries Science Center Slope Center (1999-2001)

- West Coast Groundfish Bottom Trawl Survey (WCGBTS; 2003-2024)

Only the WCGBTS has new data for this assessment, but new methods (spatial and spatiotemporal GLMMs with TMB or sdmTMB) to develop an index of abundance were applied to all surveys to update all indices. Two distributions (gamma and lognormal) were considered, as was the case in 2013 model when a non-spatial generalized linear mixed model was used to develop indices of abundance.

Comparing the standardized versions (i.e., Z-scores, which puts all the indices on the same scale for better comparison of trends) of the indices shows very similar trends among each model output, suggesting little difference in choice of model type. The variance in the indices is generally high (0.3-0.5), suggesting the information content in these indices is low. This is not a surprise given the challenge of sampling these species with trawl gear. Overall, catches densities are highest in northern Oregon and Washington.

2.2.1.1 NWFSC West Coast Groundfish Bottom Trawl Survey

The data were truncated to depths less than 875 m prior to modelling given that there were zero positive encounters in depths deeper than 875 m. The prediction grid was also truncated to only include available survey locations in depths between 55-875 m to limit extrapolating beyond the data and edge effects.

The response variable in the model was catch (mt) with an offset of area (km2) to account for differences in effort. Fixed effects were estimated for each year. The following additional covariate was included: pass.

Spatial variation, but not spatiotemporal variation, was included in the encounter probability and the positive catch rate model. Spatial variation was approximated using 200 knots, where more knots led to non-estimable standard errors.

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

The triennial survey was first conducted by the AFSC in 1977 and spanned the timeframe from 1977– 2004. The survey's design and sampling methods are most recently described in **Weinberg et al. (2002)**. Its basic design was a series of equally-spaced transects from which searches for tows in a specific depth range were initiated **(Figure X)**. The survey design has changed slightly over the period of time **(Table X, Figure X)**. 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 ran from mid-July to late September; the 1992 survey spanned from mid-July through early October; the 1995 survey was conducted from early June to late August; the 1998 survey ran from early June through early August; and the 2001 and 2004 surveys were conducted in May-July **(Figure X)**.

Haul depths ranged from 91–457 m during the 1977 survey with no hauls shallower than 91 m. The surveys in 1980, 1983, and 1986 covered the West Coast south to 36.8°N latitude and a depth range of 55–366 meters. 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 meters and surveyed south to 34.5°N. In the final year of the triennial series (2004), the NWFSC's Fishery Resource and Monitoring division (FRAM) conducted the survey and followed very similar protocols as the AFSC.

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

The major biological inputs to the models are natural mortality, age and growth parameters, weight-length, maturity and stock-recruitment parameters. The following sections outline the treatment of each section. One change from the previous assessment is moving to a two sex from the one-sex specification from 2013. The 2013 stock assessment one-sex specification was based on the observation that the biology of females and males was very similar, thus justifying the simplifying assumption of one sex. The following sections below demonstrates that females and males do generally have similar growth, though there are differences, but may have different natural mortality values. The current assessment will use a two sex configuration that allows for flexibility to set female and male parameters either equal (i.e., functionally equivalent to a one sex model) and or sex-specific. Figure 11 and Figure 12 show that using a two sex configuration with the same life history parameters for females and males is equivalent to the one sex model. Note that the one sex model sums up both female and male biomass, thus why it is twice the size as the two sex female-only spawning output (Figure 12).

2.3.1 Natural Mortality

Natural mortality is a highly influential parameter in age-structured stock assessments. It defines the rate of natural death by age, and thus establishes a stable age-structure and expectation of longevity, and interacts with growth and reproduction to determine stock productivity. It is a very difficult parameter to directly measure, thus empirical relationships based on life history parameters are often used to indirectly determine its value or build prior distributions in belief of what it is in the event we do attempt to estimate it in the model (Jason M. Cope and Hamel (2022); Hamel and Cope (2022); Maunder et al. (2023)). If length and age data are available, it may be possible to estimate it in the model.

An estimate of maximum age tends to be the most reliable life history parameter related to natural mortality to inform its estimation. Jason M. Cope and Hamel (2022) (The Natural Mortality Tool) provide the most up-to-date examination of the relationship between maximum age and 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. This is the equation typically used to estimate a natural mortality point estimate, but is underpinned by the choice of the value of $A_{\max}$. This equation assumes that the proportion of the stable population at this maximum age is 0.4517%. If we take humans as an example, the longest lived human is 122 years. This is not the maximum age, but the oldest ever recorded age. The maximum age that corresponds to 0.4517% of the population is around 100 years. For Rougheye/Blackspotted, the oldest ever aged individual is 205 years with unknown ageing error. We did not consider this as a realistic maximum age.

The 2013 U.S. west coast stock assessment used a prior built around a mean of 0.034 (corresponding to a maximum age of 163), but estimated natural mortality at 0.042 (maximum age between 128-129 years; Figure M). The 2023 Gulf of Alaska assessment built a prior conditional on a estimate of natural mortality from their 5 oldest aged individuals that ranged from 126-135 years. This resulted in a mean value of 0.042, similar to the 2013 U.S. west coast stock assessment. The 2023 Bering Sea/Aleutian Islands assessment used M = 0.05 (assumed longevity of 108), and the recent Canadian assessments considered a range of M values from 0.03 to 0.055 (assumed maximum ages of 180 to 98 years; Figure 13).

We attempt to estimate natural mortality, as was done in the 2013 U.S. West coast assessment. Examining the available age data, the oldest 10 individuals range from 139 to 165 and were all males. For females, the 10 oldest individuals range from 130 to 121 years. If those oldest ages were used in the Hamel and Cope (2022) longevity estimator, these ages would correspond to a range of natural mortality values of 0.033 to

0.039 for males, which include the mean of the prior used in the 2013 assessment. For females, it corresponds to natural mortality values of 0.039 to 0.045. All these assume that the sampled population has enough of an age structure still available for sampling, as opposed to having some level of age truncation from the theoretical unfished stable age distribution.

Related to this issue of possible age truncation, applying a catch curve analysis (taking the log of the abundance of numbers of samples in available age classes) on the aggregated ages across all age sources by sex, the total mortality (Natural + Fishing mortality= Total mortality) is 0.046 for females and 0.035 for males, which may indicate the natural mortality could be lower than that used in the 2013 assessment, but within the range of values considered in other areas (Figure 14). This also indicates the possibility of estimating sex-specific natural mortality, as natural mortality may differ by sex. The two sex model allows for this type of model specification exploration. Further exploration was done my truncating the upper ages considered, with the assumption that the older ages may also not be sampled fully (i.e., dome-shaped selectivity). We considered both 100 (Figure 15) and 80 (Figure 16) as upper age cut-offs. The less older individuals included, the higher the estimate of total mortality, and this a higher natural mortality. But we can see a general overestimate of how many older individuals are expected using these higher Z values, thus dome-shapeness does not see to explain the sampling of these older individuals.

One challenge to estimating natural mortality within the model is the interaction of estimating dome-shaped selectivity with estimating natural mortality. If all fleets assume some level of dome-shaped selectivity, it is difficult to determine if the unseen larger, older individuals are due to natural death or fishing mortality. Typically, at least one major fleet needs to achieve full selectivity for the larger, older individuals. The 2013 assessment suggested some dome-shaped selectivity in the two major fleets, thus any natural mortality estimates are evaluated depending on the forms of fleet selectivity.

2.3.2 Age and Growth Relationship

Age and length data are used to estimate important growth parameters. Figure 17 has the currently available age and length data. Female and male sample sizes are very similar. Estimated growth curves are also presented in Figure 17 and the parameters are provided in Table AL_1. The West Coast Groundfish Bottom Trawl Survey clearly and importantly samples the smallest, youngest individuals compared to the other two data sources. This allows for a better estimate of the age at size 0 (t_0) and growth coefficient (k). The female asymptotic size (L_∞) is estimated notably higher from the PacFIN data, though male estimates of Linf are similar across the data sets. The overall externally derived estimates of female and male Rougheye/Blackspotted Rockfishes are

$$\text{Females } L_\infty = 58.81 \text{ cm; } k = 0.08\text{; } t_0 = \text{-1.19}$$

$$\text{Males } L_\infty = 57.13 \text{ cm; } k = 0.09\text{; } t_0 = \text{-1.26}$$

The coefficient of variation (CV) of length by age and sex are shown in Figure 18. This is a measure of the variation in length for a given age class. Sample sizes are highest from the youngest ages up to around 70 (females) to 80 (males) years. The smoothed line shows the average response, and indicates similar CVs values for females and males, with the highest at the youngest ages, but generally 0.1. The amount and range of age samples, along with repeated length samples within an age class, allows growth parameters (L_∞, k, t_0, and CVs at age) to be estimated in the model. Ages are conditioned on lengths in the model in order to estimate growth within the model. We also explore sensitivity in growth values by pre-specifying growth to different values.

We note that the growth values being estimated in our data are notably different than those used in Alaska. For instance, the growth parameters for the BSAI stock is L_∞ = 51.43, k = 0.06 and t_0 = -3.30 and L_∞ = 54.2 cm, k = 0.07, t_0= -1.5 for the GOA population (both sexes combined). These growth parameters shows a larger size and faster growth of the West Coast stock complex versus those in Alaska, though the West Coast stock complex is more similar to the GOA complex.

2.3.3 Ageing Bias and Precision

Counting ages from ageing structures in long-lived, temperate fishes is challenging. Ages derived from these structures can be hard to reproduce within and between readers (i.e., imprecision), and may not contain the true age (i.e., bias). Stock assessment outputs can be affected by bias and imprecision in ageing, thus it is important to quantify and integrate this source of variability when fitting age data in assessments. In Stock Synthesis 3, this is done by including ageing error matrices that include the mean age (row 1) and standard deviation in age (row 2). Ageing bias is implemented when the inputted mean age deviates from the expected middle age for any given age bin (e.g., 1.75 inputted versus 1.5 being the true age for the age 1 bin); ageing imprecision is given as the standard deviation for each age bin.

There are eight primary readers that provided the available ages, two of which often split the ageing duties. Figure 19 shows which reader assignments are given to each year of ages by data source. Reader 7 is the mix of two readers that shared reading duties within years.

Estimation of ageing error matrices used the approach of -Punt et al. (2008) in two different forms: one developed in AD Model Builder (nwfscAgeingError (J. T. Thorson, Stewart, and Punt 2012)) and one adapted to Template Model Builder framework (TMB). The ageing error matrix offers a way to calculate both bias and imprecision in age reads. Reader 1 is always considered unbiased, but may be imprecise. Bias relative to the primary reader is given for the second reader. There were three age readers that were assumed to be unbiased. In those cases, 12 model configurations based on different assumptions of imprecision (constant CV, curvilinear standard deviation, or curvilinear CV, along with an option to either share or independently estimate imprecision between readers) were considered. For the other four age readers that could be biased and/or imprecise, thirty-six total model configurations were explored that included the above imprecision models as well as an exploration of the functional form of bias (e.g., no bias, constant coefficient of variation, or non-linear bias) in the second reader.

Model selection criteria included AIC corrected for small sample size (AICc), which converges to AIC when sample sizes are large, and Bayesian Information Criterion (BIC). Both ADMB and TMB were run using an (ageing error shiny app). Model selection was then compared between ADMB and TMB, which did not always agree, so model selection criteria was added across the two modeling approaches to get an overall model selection criteria. Ageing error matrices were also inspected for behavior in the best supported models to make sure outrageously large precision or bias was not chosen (effectively rendering the ages worthless, which is not an assumption of the quality of the ages). Figure 20 and Figure 21 show the bias and imprecision assumptions applied for each ageing error (AE) matrix.

2.3.4 Length-Weight Relationship

Female and male length-weight relationships were determined using data from the PacFIN database, West Coast Groundfish Bottom Trawl Survey, and ASHOP samples. Samples size by sex were: female (N=13839), males (13625), and unknown sex (53). Each of the data sources estimated very similar length-weight relationships (Figure 22).

The resultant sex-specific length-weight relationships are given in Figure 23, with the following individual values:

- Females: W = 0.000008L^3.15
- Males: W = 0.000012L^3.07

These values are very similar to the previous assessment that used a combine sex value of a=0.0000096 and b=3.12000 (Figure 23).

2.3.5 Maturity

An updated maturity analysis for the Rougheye/Blackspotted rockfish complex with additional samples to estimate the length at which 50% of females in the population are mature (L50) is completed. Biological maturity identifies females that are physiologically capable of spawning. Functional maturity identifies females that are physiologically capable of spawning and will likely spawn in a given year. The most recent L50 estimate (not yet updated) of biological maturity is 43.84 cm and the most recent L50 estimate (not yet updated) of functional maturity is 48.44 cm.

2.3.6 Fecundity

The 2013 U.S. west coast stock assessment assumed that fecundity was proportional to weight. Dick et al. (2017) provided a study on rockfishes showing that rockfishes routinely have a non-proportional relationship of fecundity to weight, with larger individuals producing more eggs than expected only by weight. Neither Rougheye or Blackspotted rockfishes have a species- of subfamily-specific estimate for this relationship, so this stock assessment uses the unobserved Genus Sebastes values of a = 6.538e-06 and b = 4.043 using the F=aL^b relationship.

2.3.7 Stock-Recruitment Function and Compensation

The Beverton-Holt stock recruit relationship is assumed, as it was in the 2013 assessment, to describe the relationship between spawning biomass and recruitment. The steepness parameter may be considered for estimation, but it is notoriously difficult to estimate in assessment models. The 2013 stock assessment used the previous rockfish steepness mean value of 0.77, but this has subsequently been updated to 0.72, to a value that represents a stock with somewhat lower recruitment compensation. Natural variation in recruitment (i.e., not deterministically taken from the stock-recruit curve) is apparent in the length and age data (as notable length or age classes growing/ageing over time), so deviations in recruitment are estimated.

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. (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

A previous Category 3 stock assessment was conducted for the U.S. Pacific Coast stock of Rougheye Rockfish (not including Blackspotted) in 2010 by Dick and MacCall (2010) using depletion-based stock reduction analysis (DB-SRA). That model estimated the population had greater than a 50% probability of exceeding the estimated proxy overfishing level in 2010 if the harvest remained at the observed levels. DB-SRA estimated a proxy OFL for rougheye rockfish of 78.7 mt with a 95% confidence interval between 4.7-587 metric tons.

A 2013 benchmark stock assessment (Hicks, Wetzel, and Harms 2013) updated the modeling framework to the integrated statistical catch-at-age model Stock Synthesis 3, which is different from the delay-difference model with an assumed stock status prior in 2010 used in the DB-SRA analysis. The 2013 assessment used a substantially updated catch history, indices of abundance, and biological compositions (lengths and ages). The natural mortality value was also updated to be higher than that used in the DB-SRA model. The stock assessment was accepted for management as a Category 2 stock assessment.

2.5.2 Most Recent STAR Panel Recommendations

There were several recommendations from the 2013 STAR panel, broken into two categories

2.5.2.1 General recommendations

1. Investigate data-weighting options. *This has been an ongoing research topic in stock assessments since this panel, and several options are no available for consideration.*
2. A workshop for constructing abundance indices from survey GLMMs. *This is another topic that has developed greatly since this time. Our use of spatio-temporal models are described in the data section on abundance indices.*
3. Continue collection of ages. *This had been done, and this assessment benefits from several more years of age data.*
4. Exploring historical catches. *This again has been an ongoing topic and addressed for many of our groundfishes. We use the latest estimates in this assessment.*
5. SSC guidance on decision tables. *Decision table discussion evolve after every stock assessment cycle, and we are using the latest approaches to decision tables in this assessment.*
6. Investigate fishery-independent slope surveys, such as submersibles. *These surveys are not currently available for slope species.*

2.5.2.2 Stock-specific recommendations

1. Collecting additional age data. *This has been done and included in this stock assessment.*
2. Collecting genetic material to explore distinguishing Rougheye and Blackspotted Rockfishes. *This work has been done as was presented earlier in the document when discussing stock structure decisions.*
3. The cause of the re-occurring decrease in sizes around 40cm. $$$$$$$$$$$$$$$$
4. Additional maturity and fecundity studies. *While no fecundity studies are available, updated maturity is presented in the maturity section of the document.*
5. Age validation. *While no age validation study has been completed, the agers are confident what annuli represent a year's worth of growth. Multiple ages are available and ageing error is characterized in this stock assessment.*
6. Understanding stock structure. *Discussed in the stock structure section of this document.*
7. Connectivity of stocks across the species ranges. *This is also discussed in the stock structure section of the document.*

2.5.3 Response to SSC Groundfish Subcommittee Recommendations

2.6 Current Modelling Platform

Stock Synthesis version 3.30.23.1 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 Assessment Continuum tool (https://github.com/shcaba/SS-DL-tool) was used also used to explore model efficiency, likelihood profiling, retrospective analyses, and plotting sensitivities. The companion R package r4ss (version 1.51.0) along with R version 4.4.3 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)

More than 10 years have passed from the last assessment and in that time, the model and the Stock Synthesis 3 (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. We want to ensure that any update to the newest SS3 model software is not a cause of any changes in model outputs when we hold all data and model specifications to be exactly the same as in 2013. We therefore transferred all the older data and model specifications to the newest version of SS3 and compared the outputs. The status (Figure 24) and scale (Figure 25) of both models are exactly the same, as are the estimates of within model uncertainty. This allows us to conclude that we can move forward using the latest version of SS3 without concern of inheriting any model difference due solely to the choice of the SS3 version.

2.7 Model Structure, Evaluation, and Specification

2.7.1 Fleet and Survey Designations

The model is structured to track several fleets and include data from several surveys. Defining fleets is largely based on differing fleet selectivity (i.e., how the fishery captures fish by length and/or age). In the stock assessment model, selectivity translates into how the removals are taken via length and/or age out of the population. Currently, the following fleet structure is being used to model commercial fishery removals as there is no record of a recreational fishery for this stock complex:

- Fleet 1: Commercial trawl fishery
- Fleet 2: Commercial fixed gear (mainly the long-line fishery) fishery
- Fleet 3: At-sea hake fishery
- Fleet 4: Contemporary mid-water fishery
- Fleet 5: Dead discard trawl
- Fleet 6: Dead discard non-trawl

In 2013 assessment, fisheries removals were split among three fleets –trawl, hook-and-line and at-sea hake fishery bycatch. For the first two fleets (trawl and hook-and-line), removals were divided between landings and discards, with selectivity and retention curves estimated within the model.

For this assessment, we plan to treat discards in trawl and non-trawl fisheries as separate fleets from landings fleets. This approach provides several advantages, including:

- With separate discard fleets, we can easily track relative amounts of landings and discards within a fishery (they are not being combined into the total catch).
- This approach provides more flexibility to explore different selectivity assumptions for both landed and discarded fish –dome-shaped vs asymptotic, mirroring one to the other, etc.
- We can easily compare how similar (or different) selection curves for retained and discarded fish (easier than in case of selectivity and retention curves estimated within a single fleet).
- The biological data for landings and discards are collected independently (port sampling vs on-board observers), using different sampling approaches. Treating landings and discards as separate fleets in the model allows us to weight these data separately as well, to balance the representation of samples.

The change in treating discards as separate fleets does not impact model results (Figure 26 and Figure 27), regardless of the selectivity form being assumed for the discard fleets. This provides evidence moving to using discard fleets will not induce *a prior* differences in the model outputs, but it will offer more modelling flexibility.

We use length-based selectivity curves for all fleets for the current stock assessment model (as was done in the 2013 assessment), as there is no reason to believe significant age-based selectivity is occurring. We will consider logistic and dome-shaped selectivity options.

As reported in the data section, the following surveys are included in the model:

- Survey 1: Triennial (every three years) survey (1980-2004)

- Survey 2: Alaska Fishery Science Center Slope survey (1997-2001)
- Survey 3: Northwest Fisheries Science Center Slope Center (1999-2001)
- Survey 4: West Coast Groundfish Bottom Trawl Survey (WCGBTS; 2003-2024)

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

In addition, there is a catch component to the likelihood, but catches are essentially fit without error. Additionally, there is a crash penalty that is invoked if true catches would cause the stock to go extinct. The penalty would alter catches to avoid extinction, but any presence of a crash penalty is used as in indication that the model has been mispecified, so this likelihood contribution should always be 0.

2.9 Reference Model Exploration, Key Assumptions and Specification

The reference model for 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 stocks of Rougheye/Blackspotted Rockfishes in state and federal waters off the U.S. west coast. 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 minima vs global minimum (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 XXXXXX). 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. 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 length and conditional age-at-length compositions were also considered for additional data-weighting. The method of Francis (2011), specifically equation TA1.8, was used to re-weight the length and conditional age-at-length composition data against 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 (James T. Thorson et al. 2017), 2) the McAllister-Ianelli Harmonic Mean approach (McAllister and Ianelli 1997), or 3) no additional data-weighting.

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, particularly updates to historical data and new catches since 2013.
- Adding discard fleets instead of using retention curves.
- Using spatio-temporal approaches (sdmTMB) to define indices of abundance versus the former GLMM approach.
- Adding more biological compositions, mainly in years since 2013, but also some historical ages.
- Specifying a two sex instead of one sex model.

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 (J. M. 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

Canada, Fisheries and Oceans. 2012. "Management Plan for the Rougheye/Blackspotted Rockfish Complex (Sebastes Aleutianus and S. Melanostictus) and Longspine Thornyhead (Sebastolobus Altivelis) in Canada [Final]."

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.

Cope, Jason M., and Owen S. Hamel. 2022. "Upgrading from M Version 0.2: An Application-Based Method for Practical Estimation, Evaluation and Uncertainty Characterization of Natural Mortality." *Fisheries Research* 256 (December): 106493. https://doi.org/10.1016/j.fishres.2022.106493.

Dick, E. J., and A. D MacCall. 2010. "Estimates of Sustainable Yield for 50 Data-Poor Stocks in the Pacifc Coast Ground Fishery Management Plan." *NOAA Technical Memorandum NMFS* NOAA-TM-NMFS-SWFSC-460.

Douglas, David A., and Oregon Fish Division. 1998. "Species Composition of Rockfish in Catches by Oregon Trawlers, 1963-93." Marine {Program}.

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.

Gharrett, A. J., C. W. Mecklenburg, L. W. Seeb, Z. Li, A. P. Matala, A. K. Gray, and J. Heifetz. 2006. "Do Genetically Distinct Rougheye Rockfish Sibling Species Differ Phenotypically?" *Transactions of the American Fisheries Society* 135 (3): 792–800. https://doi.org/10.1577/T05-136.1.

Gharrett, Anthony J., Andrew P. Matala, Eric L. Peterson, Andrew K. Gray, Zhouzhou Li, and Jonathan Heifetz. 2005. "Two Genetically Distinct Forms of Rougheye Rockfish Are Different Species." *Transactions of the American Fisheries Society* 134 (1): 242–60. https://doi.org/10.1577/T04-055.1.

Hamel, Owen S., and Jason M. Cope. 2022. "Development and Considerations for Application of a Longevity-Based Prior for the Natural Mortality Rate." *Fisheries Research* 256 (December): 106477. https://doi.org/10.1016/j.fishres.2022.106477.

Harris, Jeremy P., Charles Hutchinson, and Sharon Wildes. 2019. "Using Otolith Morphometric Analysis to Improve Species Discrimination of Blackspotted Rockfish (Sebastes Melanostictus) and Rougheye Rockfish (S. Aleutianus)." *Fishery Bulletin* 117 (3): 234–45. https://go.gale.com/ps/i.do?p=AONE&sw=w&issn=00900656&v=2.1&it=r&id=GALE%7CA603632222&sid=googleScholar&linkaccess=abs.

Hawkins, Sharon L., Jonathan Heifetz, Christine M. Kondzela, John Pohl, Richard L. Wilmot, Oleg N. Katugin, and Vladimir N. Tuponogov. 2005. "Genetic Variation of Rougheye Rockfish (Sebastes Aleutianus) and Shortraker Rockfish (S. Borealis) Inferred from Allozymes." *Fishery Bulletin* 103 (3): 524–35.

Hawkins, Sharon, Jonathan Heifetz, and John Pohl. 1997. "Genetic Population Structure of Rougheye Rockfish (Sebastes Aleutianus) Inferred from Allozyme Variation." National {Marine} {Fisheries} {Service}, {Alaska} {Fishery} {Science} {Quarterly} {Report} July - August - September.

Hicks, Allan C, Chantell Wetzel, and John Harms. 2013. "The Status of Rougheye Rockfish (Sebastes Aleutianus) and Blackspotted Rockfish (S. Melanostictus) as a Complex Along the U.S. West Coast in 2013." Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR 97220.

Jones, W. A., and G. Y. Harry Jr. 1961. "The Oregon Trawl Fishery for Mink Food-1948-1957." 8 (1).

Jordan, David Starr, and Barton Warren Evermann. 1898. "The Fishes of North and Middle America: A Descriptive Catalogue of the Species of Fish-Like Vertebrates Found in the Waters of North America, North of the Isthmus of Panama, Pt. II." *Bulletin of the United States National Museum* 47: 1241–2183.

Karnowski, M., V. V. Gertseva, and Andi Stephens. 2014. "Historical Reconstruction of Oregon's Commercial Fisheries Landings." Salem, OR: Oregon Department of Fish; Wildlife.

Love, M. S. 2011. *Certainly More Than You Want to Know About the Fishes of the Pacific Coast*. Really Big Press.

Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. *The Rockfishes of the Northeast Pacific*. 1st Edition. Berkeley: University of California Press.

Matsubara, K. 1934. "Studies on the Scorpaenoid Fishes of Japan. I. Descriptions of One New Genus and Five New Species." *Journal of the Imperial Fishery Institute* 30: 199. https://cir.nii.ac.jp/crid/1370283693151216527.

Maunder, Mark N., Owen S. Hamel, Hui-Hua Lee, Kevin R. Piner, Jason M. Cope, André E. Punt, James N. Ianelli, Claudio Castillo-Jordán, Maia S. Kapur, and Richard D. Methot. 2023. "A Review of Estimation Methods for Natural Mortality and Their Performance in the Context of Fishery Stock Assessment." *Fisheries Research* 257 (January): 106489. https://doi.org/10.1016/j.fishres.2022.106489.

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.

McClure, Michelle M., Melissa A. Haltuch, Ellen Willis-Norton, David D. Huff, Elliott L. Hazen, Lisa G. Crozier, Michael G. Jacox, et al. 2023. "Vulnerability to Climate Change of Managed Stocks in the California Current Large Marine Ecosystem." *Frontiers in Marine Science* 10. https://doi.org/10.3389/fmars.2023.1103767.

Niska, Edwin L. 1976. "Species Compositionof Rockfish in Catches by Oregon Trawlers, 1963-71." Informational {Report} 76-7.

Orr, James W., and Sharon Hawkins. 2008. "Species of the Rougheye Rockfish Complex: Resurrection of Sebastes Melanostictus (Matsubara, 1934) and a Redescription of Sebastes Aleutianus (Jordan and Evermann, 1898)(Teleostei: Scorpaeniformes)." *Fishery Bulletin* 106 (2): 111–34. http://aquaticcommons.org/8844/.

Punt, A. E., D. C. Smith, K. KrusicGolub, and S. Robertson. 2008. "Quantifying Age-Reading Error for Use in Fisheries Stock Assessments, with Application to Species in

Australia's Southern and Eastern Scalefish and Shark Fishery." *Canadian Journal of Fisheries and Aquatic Sciences* 65 (9): 1991–2005. https://doi.org/10.1139/F08-111.

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.

Report, COSEWIC Status. 2007. "COSEWIC Assessment and Status Report on the Rougheye Rockfish Sebastes Sp. Type i and Sebastes Sp. Type II in Canada." Ottawa.

Rogers, J. B. 2003. "Species Allocation of *Sebastes* and *Sebastolobus* Species Caught by Foreign Countries Off Washington, Oregon, and California, U.S.A. In 1965-1976." Unpublished document.

Rogers, J. S., M. Wilkins, D. Kamakawa, Farron R. Wallace, T. Builder, M. Zimmerman, M. Kander, and B. Culver. 1996. "Status of the Remaining Rockfish in the Sebastes Complex in 1996 and Recommendations for Management in 1997." Pacific Fishery Management Council 2130 SW fifth Ave. Suite 224, Portland, Ore. 97210.

Seeb, L. W. 1986. *Biochemical Systematics and Evolution of the Scorpaenid Genus Sebastes*. University of Washington. https://books.google.com/books?id=CfJ6nQEACAAJ.

Spencer, Paul D, James N Ianelli, and Ned Laman. 2003. "Assessment of the Blackspotted and Rougheye Rockfish Stock Complex in the Bering Sea and Aleutian Islands." {NPFMC} {Bering} {Sea} and {Aleutian} {Islands} {SAFE}.

Starr, P J, and R Haigh. 2020. "Rougheye/Blackspotted Rockfish (Sebastes Aleutianus/Melanostictus) Stock Assessment for British Columbia in 2020." *DFO Can. Sci. Advis. Sec. Res. Doc.* 2020/020: 384.

Sullivan, J. Y., J. A. Zahner, M. C. Siple, and B. E. Ferriss. 2023. "Assessment of the Rougheye and Blackspotted Rockfish Stock Complex in the Gulf of Alaska." {NPFMC} {Gulf} of {Alaska} {SAFE}.

Thorson, J. T., Ian J. Stewart, and A. E. Punt. 2012. "nwfscAgeingError: A User Interface in R for the Punt *Et Al.* (2008) Method for Calculating Ageing Error and Imprecision." *Available from: Http://Github.com/Pfmc-Assessments/nwfscAgeingError/*.

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.

Tsuyuki, H., E. Roberts, R. H. Lowes, W. Hadaway, and S. J. Westrheim. 1968. "Contribution of Protein Electrophoresis to Rockfish (Scorpaenidae) Systematics." *Journal of the Fisheries Research Board of Canada* 25 (11): 2477–2501. https://doi.org/10.1139/f68-216.

Tsuyuki, H., and S. J. Westrheim. 1970. "Analyses of the Sebastes Aleutianus–S. Melanostomus Complex, and Description of a New Scorpaenid Species, Sebastes Caenaematicus, in the Northeast Pacific Ocean." *Journal of the Fisheries Research Board of Canada* 27 (12): 2233–54. https://doi.org/10.1139/f70-252.

3.8 Tables

Table 1: Landings in metric tons (mt) by year for each fleet.

Year	Total (mt)	Trawl (mt)	Trawl Discard (mt)	Non-trawl (mt)	Non-trawl discard (mt)	Midwater trawl (mt)	At-sea-
1891	0	0	0	0	0	0	
1892	19	0	0	19	0	0	
1893	19	0	0	19	0	0	
1894	19	0	0	19	0	0	
1895	5	0	0	5	0	0	
1896	1	0	0	1	0	0	
1897	1	0	0	1	0	0	
1898	1	0	0	1	0	0	
1899	1	0	0	1	0	0	
1900	2	0	0	2	0	0	
1901	2	0	0	2	0	0	
1902	3	0	0	3	0	0	
1903	3	0	0	3	0	0	
1904	4	0	0	4	0	0	
1905	4	0	0	4	0	0	
1906	4	0	0	4	0	0	
1907	5	0	0	5	0	0	
1908	8	0	0	8	0	0	
1909	6	0	0	6	0	0	
1910	6	0	0	6	0	0	
1911	7	0	0	7	0	0	
1912	7	0	0	7	0	0	
1913	8	0	0	8	0	0	
1914	8	0	0	8	0	0	
1915	10	0	0	10	0	0	
1916	9	0	0	9	0	0	
1917	10	0	0	10	0	0	
1918	55	0	0	55	0	0	
1919	26	0	0	26	0	0	
1920	23	0	0	23	0	0	
1921	23	0	0	23	0	0	
1922	18	0	0	18	0	0	
1923	20	0	0	20	0	0	
1924	32	0	0	32	0	0	
1925	38	0	0	38	0	0	
1926	54	0	0	54	0	0	
1927	69	0	0	69	0	0	
1928	72	0	0	72	0	0	
1929	66	0	0	66	0	0	
1930	67	0	0	67	0	0	
1931	44	0	0	44	0	0	
1932	25	0	0	25	0	0	
1933	35	0	0	35	0	0	
1934	42	0	0	42	0	0	
1935	34	0	0	34	0	0	
1936	61	0	0	61	0	0	
1937	53	0	0	53	0	0	
1938	55	0	0	55	0	0	
1939	28	0	0	28	0	0	
1940	60	1	0	59	0	0	
1941	102	1	0	101	0	0	

Table 1: Landings in metric tons (mt) by year for each fleet. *(continued)*

Year	Total (mt)	Trawl (mt)	Trawl Discard (mt)	Non-trawl (mt)	Non-trawl discard (mt)	Midwater trawl (mt)	At-sea-I
1942	126	2	0	124	0	0	
1943	258	7	0	251	0	0	
1944	85	11	0	74	0	0	
1945	50	20	0	30	0	0	
1946	69	11	0	58	0	0	
1947	42	7	0	35	0	0	
1948	44	5	0	39	0	0	
1949	31	5	0	26	0	0	
1950	52	6	0	46	0	0	
1951	59	6	0	53	0	0	
1952	38	6	0	32	0	0	
1953	21	5	0	16	0	0	
1954	36	6	0	30	0	0	
1955	32	6	0	26	0	0	
1956	21	8	0	13	0	0	
1957	35	9	0	26	0	0	
1958	15	7	0	8	0	0	
1959	23	7	0	16	0	0	
1960	23	10	0	13	0	0	
1961	26	11	0	15	0	0	
1962	32	14	0	18	0	0	
1963	24	13	0	11	0	0	
1964	31	11	0	20	0	0	
1965	31	23	0	8	0	0	
1966	117	111	0	6	0	0	
1967	108	98	0	10	0	0	
1968	172	165	0	7	0	0	
1969	50	25	0	25	0	0	
1970	23	19	0	4	0	0	
1971	68	67	0	1	0	0	
1972	76	75	0	1	0	0	
1973	75	69	0	6	0	0	
1974	76	58	0	18	0	0	
1975	43	35	0	5	0	0	
1976	19	16	0	2	0	0	
1977	166	1	0	164	0	0	
1978	69	33	0	36	0	0	
1979	185	63	0	121	0	0	
1980	99	56	0	43	0	0	
1981	131	61	0	68	0	0	
1982	167	99	0	68	0	0	
1983	126	55	0	70	0	0	
1984	144	75	0	67	0	0	
1985	298	139	0	158	0	0	
1986	428	154	0	273	0	0	
1987	570	198	0	368	0	0	
1988	351	173	0	162	0	0	
1989	418	287	0	131	0	0	
1990	244	167	0	76	0	0	
1991	299	235	0	59	0	0	
1992	306	186	0	110	0	0	
1993	327	166	0	159	0	0	
1994	306	127	0	173	0	0	
1995	744	165	0	576	0	0	
1996	339	127	0	204	0	0	

Table 1: Landings in metric tons (mt) by year for each fleet. *(continued)*

Year	Total (mt)	Trawl (mt)	Trawl Discard (mt)	Non-trawl (mt)	Non-trawl discard (mt)	Midwater trawl (mt)	At-sea-
1997	303	107	0	186	0	0	
1998	441	110	0	313	0	0	
1999	256	81	0	166	0	0	
2000	183	79	0	29	0	4	
2001	114	74	0	18	0	1	
2002	75	31	15	27	1	0	
2003	100	58	15	23	2	0	
2004	122	58	10	34	5	1	
2005	142	45	6	50	5	0	
2006	132	48	17	59	1	0	
2007	197	60	37	59	10	2	
2008	226	54	36	56	3	1	
2009	229	67	46	104	1	2	
2010	267	79	64	71	25	6	
2011	237	53	27	63	9	4	
2012	268	47	24	74	20	49	
2013	163	64	7	59	12	3	
2014	93	34	2	37	10	4	
2015	143	31	10	47	14	19	
2016	158	31	8	60	13	16	
2017	167	22	12	59	34	2	
2018	287	16	45	47	15	3	
2019	240	22	14	39	31	9	
2020	117	10	11	24	1	29	
2021	116	10	24	21	2	21	
2022	142	12	24	19	3	19	
2023	118	13	22	19	0	26	
2024	149	10	22	10	0	69	

Table 2: Recent trend in the overfishing limits (OFL), the acceptable biological catches (ABCs), the annual catch limits (ACLs), and the total catch all in metric tons (mt).

Year	OFL (mt)	ABC (mt)	ACL (mt)	Catch (mt)
2015	NA	NA	NA	142
2016	NA	NA	NA	157
2017	NA	NA	NA	168
2018	NA	NA	NA	286
2019	NA	NA	NA	241
2020	NA	NA	NA	117
2021	NA	NA	NA	117
2022	NA	NA	NA	141
2023	NA	NA	NA	119

#“‘{r, results = “asis”} ##| label: tbl-area-spex ##| warning: false ##| echo: false ##| tbl-cap: “Adopted coastwide OFL (mt) and ABC (mt) values and the area-based ACL (mt) north and south of 36 N. latitude by year.” ##| tbl-pos: H

#area_management_table |> # gt::gt() |> # gt::fmt_number(# columns = c(2:5), # decimals = 0 #) |> # gt::tab_options(# table.font.size = 12, # latex.use_longtable = TRUE #) |> # gt::as_latex()

#“‘

Table 3: Specifications and structure of the model.

Section	Configuration
Maximum age	140
Sexes	Females, males
Population bins	4-84 cm by 2 cm bins
Summary biomass (mt) age	10+
Number of areas	1
Number of seasons	1
Number of growth patterns	1
Start year	1892
End year	2024
Data length bins	10-80 cm by 2 cm bins
Data age bins	1-100 by 1 year

Table 4: Estimated parameters in the model.

Type	Count
Natural Mortality (M)	2
M time-variation	0
Growth mean	6
Growth variability	4
Growth time-variation	0
Stock-recruit	1
Stock-recruit variation	0
Rec. dev. time series	125
Rec. dev. initial age	0
Rec. dev. forecast	12
Index	1
Index time-variation	0
Size selectivity	23
Size selectivity time-variation	10
Retention	0
Retention time-variation	0
Age selectivity	0
Age selectivity time-variation	0

Table 5: Likelihood components by source.

Label	Total
TOTAL	8,023.8
Catch	0.0
Equil catch	0.0
Survey	-20.3
Length comp	416.1
Age comp	7,628.1
Recruitment	-0.4
InitEQ Regime	0.0
Forecast Recruitment	0.0
Parm priors	0.2
Parm softbounds	0.0
Parm devs	0.0
Crash Pen	0.0

Table 6: Parameter estimates, estimation phase, parameter bounds, estimation status estimated standard deviation (SD), prior information [distribution(mean, SD) used in the base model.

Label	Value	Phase	Bounds	Status	SD	Prior
NatM_uniform_Fem_GP_1	0.0451	2	(0.001, 0.2)	ok	0.00321	lognormal(0.034, 0.542)
L_at_Amin_Fem_GP_1	-3.74	2	(-100, 25)	ok	0.681	none
L_at_Amax_Fem_GP_1	58.2	2	(40, 90)	ok	0.353	none
VonBert_K_Fem_GP_1	0.0839	2	(0.01, 0.15)	ok	0.00201	none
CV_young_Fem_GP_1	0.0642	2	(1e-06, 1)	ok	0.0144	none
CV_old_Fem_GP_1	0.0848	2	(1e-06, 1)	ok	0.00287	none
Wtlen_1_Fem_GP_1	8.78e-06	-3	(-3, 3)	fixed	0	none
Wtlen_2_Fem_GP_1	3.15	-3	(-3, 4)	fixed	0	none
Mat50%_Fem_GP_1	46.5	-3	(1, 60)	fixed	0	none
Mat_slope_Fem_GP_1	-0.254	-3	(-30, 3)	fixed	0	none
Eggs/kg_inter_Fem_GP_1	1	-3	(-3, 3)	fixed	0	none
Eggs/kg_slope_wt_Fem_GP_1	0	-3	(-3, 3)	fixed	0	none
NatM_uniform_Mal_GP_1	0.0397	2	(0.001, 0.2)	ok	0.00317	lognormal(0.034, 0.542)
L_at_Amin_Mal_GP_1	-3.68	2	(-100, 25)	ok	1.11	none
L_at_Amax_Mal_GP_1	56.2	2	(40, 90)	ok	0.306	none
VonBert_K_Mal_GP_1	0.09	2	(0.01, 0.15)	ok	0.00275	none
CV_young_Mal_GP_1	0.11	2	(1e-06, 1)	ok	0.0199	none
CV_old_Mal_GP_1	0.0762	2	(1e-06, 1)	ok	0.00282	none
Wtlen_1_Mal_GP_1	1.18e-05	-3	(-3, 3)	fixed	0	none
Wtlen_2_Mal_GP_1	3.07	-3	(-3, 4)	fixed	0	none
CohortGrowDev	1	-4	(0, 1)	fixed	0	none
FracFemale_GP_1	0.5	-5	(1e-06, 1)	fixed	0	none
SR_LN(R0)	6.71	1	(1, 15)	ok	0.639	none
SR_BH_steep	0.72	-3	(0.25, 0.99)	fixed	0	beta(0.720, 0.152)
SR_sigmaR	0.5	-4	(0, 2)	fixed	0	none

Label	Value	Phase	Bounds	Status	SD	Prior
SR_regime	0	-4	(-5, 5)	fixed	0	none
SR_autocorr	0	-99	(0, 0)	fixed	0	none
Main_RecrDev_1900	0.000723	3	(-5, 5)	dev	0.5	normal(0.00, 0.50)
Main_RecrDev_1901	0.00126	3	(-5, 5)	dev	0.5	normal(0.00, 0.50)
Main_RecrDev_1902	0.00187	3	(-5, 5)	dev	0.5	normal(0.00, 0.50)
Main_RecrDev_1903	0.00258	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1904	0.00338	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1905	0.00428	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1906	0.00528	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1907	0.00639	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1908	0.0076	3	(-5, 5)	dev	0.502	normal(0.00, 0.50)
Main_RecrDev_1909	0.00892	3	(-5, 5)	dev	0.502	normal(0.00, 0.50)
Main_RecrDev_1910	0.0103	3	(-5, 5)	dev	0.502	normal(0.00, 0.50)
Main_RecrDev_1911	0.0118	3	(-5, 5)	dev	0.503	normal(0.00, 0.50)
Main_RecrDev_1912	0.0134	3	(-5, 5)	dev	0.503	normal(0.00, 0.50)
Main_RecrDev_1913	0.0151	3	(-5, 5)	dev	0.504	normal(0.00, 0.50)
Main_RecrDev_1914	0.0169	3	(-5, 5)	dev	0.504	normal(0.00, 0.50)
Main_RecrDev_1915	0.0187	3	(-5, 5)	dev	0.504	normal(0.00, 0.50)
Main_RecrDev_1916	0.0205	3	(-5, 5)	dev	0.505	normal(0.00, 0.50)
Main_RecrDev_1917	0.0224	3	(-5, 5)	dev	0.505	normal(0.00, 0.50)
Main_RecrDev_1918	0.0243	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1919	0.0262	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1920	0.028	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1921	0.0297	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1922	0.0312	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1923	0.0325	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1924	0.0334	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1925	0.034	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)

Label	Value	Phase	Bounds	Status	SD	Prior
Main_RecrDev_1926	0.034	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1927	0.0334	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1928	0.0321	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1929	0.03	3	(-5, 5)	dev	0.505	normal(0.00, 0.50)
Main_RecrDev_1930	0.0271	3	(-5, 5)	dev	0.504	normal(0.00, 0.50)
Main_RecrDev_1931	0.0234	3	(-5, 5)	dev	0.503	normal(0.00, 0.50)
Main_RecrDev_1932	0.0188	3	(-5, 5)	dev	0.501	normal(0.00, 0.50)
Main_RecrDev_1933	0.0136	3	(-5, 5)	dev	0.5	normal(0.00, 0.50)
Main_RecrDev_1934	0.00778	3	(-5, 5)	dev	0.498	normal(0.00, 0.50)
Main_RecrDev_1935	0.0016	3	(-5, 5)	dev	0.497	normal(0.00, 0.50)
Main_RecrDev_1936	-0.0047	3	(-5, 5)	dev	0.495	normal(0.00, 0.50)
Main_RecrDev_1937	-0.0109	3	(-5, 5)	dev	0.493	normal(0.00, 0.50)
Main_RecrDev_1938	-0.0166	3	(-5, 5)	dev	0.492	normal(0.00, 0.50)
Main_RecrDev_1939	-0.0215	3	(-5, 5)	dev	0.491	normal(0.00, 0.50)
Main_RecrDev_1940	-0.0254	3	(-5, 5)	dev	0.49	normal(0.00, 0.50)
Main_RecrDev_1941	-0.0279	3	(-5, 5)	dev	0.489	normal(0.00, 0.50)
Main_RecrDev_1942	-0.0287	3	(-5, 5)	dev	0.489	normal(0.00, 0.50)
Main_RecrDev_1943	-0.0275	3	(-5, 5)	dev	0.489	normal(0.00, 0.50)
Main_RecrDev_1944	-0.0239	3	(-5, 5)	dev	0.49	normal(0.00, 0.50)
Main_RecrDev_1945	-0.0179	3	(-5, 5)	dev	0.491	normal(0.00, 0.50)
Main_RecrDev_1946	-0.00922	3	(-5, 5)	dev	0.493	normal(0.00, 0.50)
Main_RecrDev_1947	0.00232	3	(-5, 5)	dev	0.495	normal(0.00, 0.50)
Main_RecrDev_1948	0.0167	3	(-5, 5)	dev	0.499	normal(0.00, 0.50)
Main_RecrDev_1949	0.0338	3	(-5, 5)	dev	0.503	normal(0.00, 0.50)
Main_RecrDev_1950	0.0534	3	(-5, 5)	dev	0.507	normal(0.00, 0.50)
Main_RecrDev_1951	0.0748	3	(-5, 5)	dev	0.513	normal(0.00, 0.50)
Main_RecrDev_1952	0.0971	3	(-5, 5)	dev	0.518	normal(0.00, 0.50)
Main_RecrDev_1953	0.119	3	(-5, 5)	dev	0.524	normal(0.00, 0.50)

Label	Value	Phase	Bounds	Status	SD	Prior
Main_RecrDev_1954	0.138	3	(-5, 5)	dev	0.528	normal(0.00, 0.50)
Main_RecrDev_1955	0.154	3	(-5, 5)	dev	0.532	normal(0.00, 0.50)
Main_RecrDev_1956	0.163	3	(-5, 5)	dev	0.535	normal(0.00, 0.50)
Main_RecrDev_1957	0.164	3	(-5, 5)	dev	0.535	normal(0.00, 0.50)
Main_RecrDev_1958	0.157	3	(-5, 5)	dev	0.532	normal(0.00, 0.50)
Main_RecrDev_1959	0.143	3	(-5, 5)	dev	0.528	normal(0.00, 0.50)
Main_RecrDev_1960	0.122	3	(-5, 5)	dev	0.522	normal(0.00, 0.50)
Main_RecrDev_1961	0.0944	3	(-5, 5)	dev	0.514	normal(0.00, 0.50)
Main_RecrDev_1962	0.0616	3	(-5, 5)	dev	0.506	normal(0.00, 0.50)
Main_RecrDev_1963	0.0235	3	(-5, 5)	dev	0.496	normal(0.00, 0.50)
Main_RecrDev_1964	-0.0192	3	(-5, 5)	dev	0.486	normal(0.00, 0.50)
Main_RecrDev_1965	-0.0649	3	(-5, 5)	dev	0.476	normal(0.00, 0.50)
Main_RecrDev_1966	-0.11	3	(-5, 5)	dev	0.467	normal(0.00, 0.50)
Main_RecrDev_1967	-0.152	3	(-5, 5)	dev	0.459	normal(0.00, 0.50)
Main_RecrDev_1968	-0.187	3	(-5, 5)	dev	0.452	normal(0.00, 0.50)
Main_RecrDev_1969	-0.214	3	(-5, 5)	dev	0.447	normal(0.00, 0.50)
Main_RecrDev_1970	-0.233	3	(-5, 5)	dev	0.443	normal(0.00, 0.50)
Main_RecrDev_1971	-0.245	3	(-5, 5)	dev	0.44	normal(0.00, 0.50)
Main_RecrDev_1972	-0.249	3	(-5, 5)	dev	0.439	normal(0.00, 0.50)
Main_RecrDev_1973	-0.247	3	(-5, 5)	dev	0.438	normal(0.00, 0.50)
Main_RecrDev_1974	-0.237	3	(-5, 5)	dev	0.439	normal(0.00, 0.50)
Main_RecrDev_1975	-0.218	3	(-5, 5)	dev	0.44	normal(0.00, 0.50)
Main_RecrDev_1976	-0.191	3	(-5, 5)	dev	0.443	normal(0.00, 0.50)
Main_RecrDev_1977	-0.163	3	(-5, 5)	dev	0.445	normal(0.00, 0.50)
Main_RecrDev_1978	-0.136	3	(-5, 5)	dev	0.449	normal(0.00, 0.50)
Main_RecrDev_1979	-0.109	3	(-5, 5)	dev	0.451	normal(0.00, 0.50)
Main_RecrDev_1980	-0.0801	3	(-5, 5)	dev	0.453	normal(0.00, 0.50)
Main_RecrDev_1981	-0.0568	3	(-5, 5)	dev	0.454	normal(0.00, 0.50)

Label	Value	Phase	Bounds	Status	SD	Prior
Main_RecrDev_1982	-0.0532	3	(-5, 5)	dev	0.453	normal(0.00, 0.50)
Main_RecrDev_1983	-0.0627	3	(-5, 5)	dev	0.448	normal(0.00, 0.50)
Main_RecrDev_1984	-0.0864	3	(-5, 5)	dev	0.442	normal(0.00, 0.50)
Main_RecrDev_1985	-0.12	3	(-5, 5)	dev	0.437	normal(0.00, 0.50)
Main_RecrDev_1986	-0.11	3	(-5, 5)	dev	0.438	normal(0.00, 0.50)
Main_RecrDev_1987	0.0135	3	(-5, 5)	dev	0.449	normal(0.00, 0.50)
Main_RecrDev_1988	0.216	3	(-5, 5)	dev	0.448	normal(0.00, 0.50)
Main_RecrDev_1989	0.153	3	(-5, 5)	dev	0.445	normal(0.00, 0.50)
Main_RecrDev_1990	-0.0213	3	(-5, 5)	dev	0.425	normal(0.00, 0.50)
Main_RecrDev_1991	-0.0242	3	(-5, 5)	dev	0.404	normal(0.00, 0.50)
Main_RecrDev_1992	-0.0465	3	(-5, 5)	dev	0.4	normal(0.00, 0.50)
Main_RecrDev_1993	0.127	3	(-5, 5)	dev	0.371	normal(0.00, 0.50)
Main_RecrDev_1994	-0.0904	3	(-5, 5)	dev	0.353	normal(0.00, 0.50)
Main_RecrDev_1995	-0.602	3	(-5, 5)	dev	0.354	normal(0.00, 0.50)
Main_RecrDev_1996	-0.661	3	(-5, 5)	dev	0.342	normal(0.00, 0.50)
Main_RecrDev_1997	-0.655	3	(-5, 5)	dev	0.344	normal(0.00, 0.50)
Main_RecrDev_1998	-0.457	3	(-5, 5)	dev	0.364	normal(0.00, 0.50)
Main_RecrDev_1999	0.545	3	(-5, 5)	dev	0.271	normal(0.00, 0.50)
Main_RecrDev_2000	0.222	3	(-5, 5)	dev	0.353	normal(0.00, 0.50)
Main_RecrDev_2001	0.122	3	(-5, 5)	dev	0.327	normal(0.00, 0.50)
Main_RecrDev_2002	-0.225	3	(-5, 5)	dev	0.344	normal(0.00, 0.50)
Main_RecrDev_2003	-0.568	3	(-5, 5)	dev	0.378	normal(0.00, 0.50)
Main_RecrDev_2004	-0.0555	3	(-5, 5)	dev	0.37	normal(0.00, 0.50)
Main_RecrDev_2005	0.0823	3	(-5, 5)	dev	0.377	normal(0.00, 0.50)
Main_RecrDev_2006	-0.149	3	(-5, 5)	dev	0.422	normal(0.00, 0.50)
Main_RecrDev_2007	0.278	3	(-5, 5)	dev	0.421	normal(0.00, 0.50)
Main_RecrDev_2008	0.816	3	(-5, 5)	dev	0.363	normal(0.00, 0.50)
Main_RecrDev_2009	0.172	3	(-5, 5)	dev	0.472	normal(0.00, 0.50)

Label	Value	Phase	Bounds	Status	SD	Prior
Main_RecrDev_2010	0.859	3	(-5, 5)	dev	0.349	normal(0.00, 0.50)
Main_RecrDev_2011	0.153	3	(-5, 5)	dev	0.399	normal(0.00, 0.50)
Main_RecrDev_2012	1.12	3	(-5, 5)	dev	0.279	normal(0.00, 0.50)
Main_RecrDev_2013	0.011	3	(-5, 5)	dev	0.372	normal(0.00, 0.50)
Main_RecrDev_2014	-0.338	3	(-5, 5)	dev	0.4	normal(0.00, 0.50)
Main_RecrDev_2015	-0.42	3	(-5, 5)	dev	0.427	normal(0.00, 0.50)
Main_RecrDev_2016	-0.117	3	(-5, 5)	dev	0.438	normal(0.00, 0.50)
Main_RecrDev_2017	0.864	3	(-5, 5)	dev	0.389	normal(0.00, 0.50)
Main_RecrDev_2018	0.276	3	(-5, 5)	dev	0.421	normal(0.00, 0.50)
Main_RecrDev_2019	0.17	3	(-5, 5)	dev	0.419	normal(0.00, 0.50)
Main_RecrDev_2020	-0.243	3	(-5, 5)	dev	0.443	normal(0.00, 0.50)
Main_RecrDev_2021	-0.145	3	(-5, 5)	dev	0.464	normal(0.00, 0.50)
Main_RecrDev_2022	-0.0532	3	(-5, 5)	dev	0.491	normal(0.00, 0.50)
Main_RecrDev_2023	-6.88e-06	3	(-5, 5)	dev	0.5	normal(0.00, 0.50)
Late_RecrDev_2024	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2025	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2026	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2027	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2028	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2029	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2030	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2031	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2032	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2033	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2034	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2035	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
ForeRecr_2036	0	5	(-5, 5)	dev	0.5	normal(0.00, 0.50)
LnQ_base_TRIENNIAL(7)	-1.87	-1	(-10, 2)	fixed	0	none

Label	Value	Phase	Bounds	Status	SD	Prior
Q_extraSD_TRIENNIAL(7)	0.212	2	(0, 2)	ok	0.122	none
LnQ_base_AK_SLOPE(8)	-2.6	-1	(-15, 15)	fixed	0	none
LnQ_base_NW_SLOPE(9)	-1.54	-1	(-15, 15)	fixed	0	none
LnQ_base_WCGBTS(10)	-2.56	-1	(-15, 15)	fixed	0	none
Size_DblN_peak_BOTTOM_TRAWL(1)	49	3	(15, 79)	ok	2.3	none
Size_DblN_top_logit_BOTTOM_-TRAWL(1)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_BOTTOM_-TRAWL(1)	4.92	3	(-4, 12)	ok	0.344	none
Size_DblN_descend_se_BOTTOM_-TRAWL(1)	20	-4	(-2, 20)	fixed	0	none
Size_DblN_start_logit_BOTTOM_-TRAWL(1)	-999	-3	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_BOTTOM_-TRAWL(1)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_BOTTOM_TRAWL_-DISCARD(2)	43.6	3	(15, 79)	ok	5.88	none
Size_DblN_top_logit_BOTTOM_-TRAWL_DISCARD(2)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_BOTTOM_-TRAWL_DISCARD(2)	6.32	3	(-4, 12)	ok	0.634	none
Size_DblN_descend_se_BOTTOM_-TRAWL_DISCARD(2)	4.99	4	(-2, 20)	ok	1.24	none
Size_DblN_start_logit_BOTTOM_-TRAWL_DISCARD(2)	-999	-3	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_BOTTOM_-TRAWL_DISCARD(2)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_NON_TRAWL(3)	45.8	3	(15, 70)	ok	4.9	none
Size_DblN_top_logit_NON_TRAWL(3)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_NON_-TRAWL(3)	3.26	3	(-4, 12)	ok	1.68	none

Label	Value	Phase	Bounds	Status	SD	Prior
Size_DblN_descend_se_NON_-TRAWL(3)	20	-4	(-2, 20)	fixed	0	none
Size_DblN_start_logit_NON_TRAWL(3)	-999	-3	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_NON_TRAWL(3)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_NON_TRAWL_-DISCARD(4)	50	3	(15, 70)	ok	1.76	none
Size_DblN_top_logit_NON_TRAWL_-DISCARD(4)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_NON_TRAWL_-DISCARD(4)	3.74	3	(-4, 12)	ok	0.482	none
Size_DblN_descend_se_NON_-TRAWL_DISCARD(4)	15.6	4	(-2, 20)	ok	66.8	none
Size_DblN_start_logit_NON_TRAWL_-DISCARD(4)	-999	-3	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_NON_TRAWL_-DISCARD(4)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_MIDWATER_-TRAWL(5)	58.9	3	(15, 79)	ok	3.97	none
Size_DblN_top_logit_MIDWATER_-TRAWL(5)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_MIDWATER_-TRAWL(5)	5.1	3	(-4, 12)	ok	0.401	none
Size_DblN_descend_se_MIDWATER_-TRAWL(5)	20	-4	(-2, 20)	fixed	0	none
Size_DblN_start_logit_MIDWATER_-TRAWL(5)	-999	-3	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_MIDWATER_-TRAWL(5)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_AT_SEA_HAKE(6)	50.9	3	(15, 70)	ok	1.6	none
Size_DblN_top_logit_AT_SEA_HAKE(6)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_AT_SEA_-HAKE(6)	3.77	3	(-4, 12)	ok	0.41	none

Label	Value	Phase	Bounds	Status	SD	Prior
Size_DblN_descend_se_AT_SEA_-HAKE(6)	20	-4	(-2, 20)	fixed	0	none
Size_DblN_start_logit_AT_SEA_-HAKE(6)	-999	-2	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_AT_SEA_-HAKE(6)	-999	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_TRIENNIAL(7)	16.4	3	(13, 50)	ok	1.97	none
Size_DblN_top_logit_TRIENNIAL(7)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_TRIENNIAL(7)	1.4	3	(-4, 12)	ok	1.52	none
Size_DblN_descend_se_TRIENNIAL(7)	6.12	3	(-2, 20)	ok	0.265	none
Size_DblN_start_logit_TRIENNIAL(7)	-15	-2	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_TRIENNIAL(7)	-15	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_AK_SLOPE(8)	37.5	3	(13, 50)	ok	2.49	none
Size_DblN_top_logit_AK_SLOPE(8)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_AK_SLOPE(8)	5.01	3	(-4, 12)	ok	0.501	none
Size_DblN_descend_se_AK_SLOPE(8)	4.66	4	(-2, 20)	ok	0.406	none
Size_DblN_start_logit_AK_SLOPE(8)	-15	-2	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_AK_SLOPE(8)	-15	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_WCGBTS(10)	17.6	3	(13, 50)	ok	3.13	none
Size_DblN_top_logit_WCGBTS(10)	-15	-3	(-15, 20)	fixed	0	none
Size_DblN_ascend_se_WCGBTS(10)	2.36	3	(-4, 12)	ok	1.81	none
Size_DblN_descend_se_WCGBTS(10)	8.38	4	(-2, 20)	ok	1.55	none
Size_DblN_start_logit_WCGBTS(10)	-15	-2	(-1000, 20)	fixed	0	none
Size_DblN_end_logit_WCGBTS(10)	-15	-4	(-1000, 20)	fixed	0	none
Size_DblN_peak_BOTTOM_-TRAWL(1)_BLK1repl_2002	47.1	3	(15, 70)	ok	1.86	none
Size_DblN_peak_BOTTOM_-TRAWL(1)_BLK1repl_2011	49.6	3	(15, 70)	ok	3.46	none
Size_DblN_ascend_se_BOTTOM_-TRAWL(1)_BLK1repl_2002	4.23	3	(-4, 12)	ok	0.488	none

Label	Value	Phase	Bounds	Status	SD	Prior
Size_DblN_ascend_se_BOTTOM_-TRAWL(1)_BLK1repl_2011	4.61	3	(-4, 12)	ok	0.657	none
Size_DblN_peak_NON_TRAWL(3)_-BLK2repl_2002	45.3	3	(15, 70)	ok	1.21	none
Size_DblN_peak_NON_TRAWL(3)_-BLK2repl_2011	49.1	3	(15, 70)	ok	1.28	none
Size_DblN_peak_NON_TRAWL(3)_-BLK2repl_2020	52.6	3	(15, 70)	ok	2.5	none
Size_DblN_ascend_se_NON_-TRAWL(3)_BLK2repl_2002	2.88	3	(-4, 12)	ok	0.618	none
Size_DblN_ascend_se_NON_-TRAWL(3)_BLK2repl_2011	3.79	3	(-4, 12)	ok	0.353	none
Size_DblN_ascend_se_NON_-TRAWL(3)_BLK2repl_2020	4.03	3	(-4, 12)	ok	0.514	none

Table 7: Summary of reference points and management quantities, including estimates of the 95 percent intervals.

Reference Point	Estimate	Lower Interval	Upper Interval
Unfished Spawning Biomass (mt)	9,515	-102	19,132
Unfished Age 10+ Biomass (mt)	26,677	-797	54,151
Unfished Recruitment (R0)	820	-207	1,846
2024 Spawning Biomass (mt)	6,594	-2,814	16,003
2024 Fraction Unfished	0.693	0.394	0.992
Reference Points Based SB40%	—	—	—
Proxy Spawning Biomass (mt) SB40%	3,806	-41	7,653
SPR Resulting in SB40%	0.458	0.458	0.458
Exploitation Rate Resulting in SB40%	0.030	0.027	0.033
Yield with SPR Based On SB40% (mt)	359	-47	764
Reference Points Based on SPR Proxy for MSY	—	—	—
Proxy Spawning Biomass (mt) (SPR50)	4,245	-45	8,536
SPR50	0.500	—	—
Exploitation Rate Corresponding to SPR50	0.026	0.023	0.028
Yield with SPR50 at SB SPR (mt)	343	-44	730
Reference Points Based on Estimated MSY Values	—	—	—
Spawning Biomass (mt) at MSY (SB MSY)	2,616	-3	5,235
SPR MSY	0.345	0.340	0.351
Exploitation Rate Corresponding to SPR MSY	0.043	0.038	0.047
MSY (mt)	381	-50	812

Table 8: Time series of population estimates from the base model.

Year	Total Biomass (mt)	Spawning Biomass (mt)	Total Biomass 10+ (mt)	Fraction Unfished	Age-0 Recruits (1,000s)	Total Mortality (mt)	(1-SPR)/(1-SPR_-50%)	Exploitation Rate
1892	27739.7	9515	26677.3	1.000	820	19	0.045	0.001
1893	27721.0	9508	26658.6	0.999	820	19	NA	0.001
1894	27702.6	9501	26640.2	0.999	820	19	NA	0.001
1895	27684.7	9494	26622.3	0.998	820	5	NA	0.000
1896	27681.1	9492	26618.7	0.998	819	1	NA	0.000
1897	27681.4	9492	26619.0	0.998	819	1	NA	0.000
1898	27681.6	9492	26619.3	0.998	819	1	NA	0.000
1899	27682.5	9492	26620.1	0.998	819	1	NA	0.000
1900	27682.9	9492	26620.6	0.998	820	2	NA	0.000
1901	27682.9	9492	26620.6	0.998	821	2	NA	0.000
1902	27682.4	9492	26620.2	0.998	821	3	NA	0.000
1903	27681.6	9491	26619.3	0.998	822	3	NA	0.000
1904	27680.3	9491	26618.1	0.997	822	4	NA	0.000
1905	27678.8	9490	26616.3	0.997	823	4	NA	0.000
1906	27676.9	9489	26614.2	0.997	824	4	NA	0.000
1907	27674.7	9488	26611.7	0.997	825	5	NA	0.000
1908	27672.3	9487	26608.8	0.997	826	8	NA	0.000
1909	27667.3	9485	26603.0	0.997	827	6	NA	0.000
1910	27664.6	9483	26599.6	0.997	828	6	NA	0.000
1911	27662.0	9482	26596.1	0.997	829	7	NA	0.000
1912	27659.3	9480	26592.5	0.996	830	7	NA	0.000
1913	27656.7	9478	26588.8	0.996	832	8	NA	0.000
1914	27654.3	9477	26585.2	0.996	833	8	0.019	0.000
1915	27652.0	9475	26581.7	0.996	835	10	0.024	0.000
1916	27648.5	9472	26576.8	0.996	836	9	0.022	0.000
1917	27646.9	9470	26573.7	0.995	838	10	0.023	0.000
1918	27645.6	9468	26570.8	0.995	839	55	0.124	0.002
1919	27601.0	9449	26524.6	0.993	841	26	0.060	0.001
1920	27587.0	9442	26508.7	0.992	842	23	0.054	0.001
1921	27576.8	9435	26496.8	0.992	844	23	0.054	0.001
1922	27568.6	9430	26486.6	0.991	845	18	0.042	0.001
1923	27566.6	9426	26482.7	0.991	846	20	0.047	0.001
1924	27563.9	9422	26478.1	0.990	847	32	0.073	0.001
1925	27551.4	9415	26463.6	0.989	847	38	0.087	0.001
1926	27534.5	9405	26444.8	0.988	847	54	0.123	0.002
1927	27503.3	9390	26411.9	0.987	846	69	0.154	0.003
1928	27460.0	9370	26367.0	0.985	845	72	0.161	0.003
1929	27416.2	9350	26321.7	0.983	843	66	0.149	0.003
1930	27380.4	9333	26284.7	0.981	841	67	0.151	0.003
1931	27345.8	9316	26249.3	0.979	837	44	0.101	0.002
1932	27335.9	9309	26239.0	0.978	833	25	0.058	0.001
1933	27345.5	9310	26248.9	0.978	829	35	0.081	0.001
1934	27346.2	9308	26250.4	0.978	824	42	0.098	0.002
1935	27340.0	9303	26246.0	0.978	819	34	0.079	0.001
1936	27342.2	9303	26250.6	0.978	814	61	0.138	0.002
1937	27317.9	9293	26229.5	0.977	809	53	0.122	0.002
1938	27301.0	9286	26216.8	0.976	804	56	0.127	0.002
1939	27281.4	9280	26201.9	0.975	800	28	0.067	0.001
1940	27287.3	9284	26213.1	0.976	797	59	0.135	0.002
1941	27261.3	9276	26193.1	0.975	795	102	0.223	0.004
1942	27192.8	9254	26130.7	0.973	794	125	0.269	0.005

Table 8: Time series of population estimates from the base model. *(continued)*

Year	Total Biomass (mt)	Spawning Biomass (mt)	Total Biomass 10+ (mt)	Fraction Unfished	Age-0 Recruits (1,000s)	Total Mortality (mt)	(1-SPR)/(1-SPR_-50%)	Exploitation Rate
1943	27100.3	9223	26044.5	0.969	795	257	0.496	0.010
1944	26878.9	9143	25829.1	0.961	797	85	0.193	0.003
1945	26827.2	9128	25782.9	0.959	802	50	0.118	0.002
1946	26808.6	9126	25769.1	0.959	809	69	0.159	0.003
1947	26770.2	9117	25734.4	0.958	818	41	0.097	0.002
1948	26757.8	9118	25724.2	0.958	830	44	0.104	0.002
1949	26741.5	9117	25708.5	0.958	844	31	0.073	0.001
1950	26737.7	9121	25703.4	0.959	861	53	0.123	0.002
1951	26712.4	9115	25674.5	0.958	880	59	0.136	0.002
1952	26682.5	9107	25638.4	0.957	899	38	0.090	0.001
1953	26674.8	9105	25621.8	0.957	919	20	0.050	0.001
1954	26687.2	9110	25622.1	0.957	937	36	0.086	0.001
1955	26688.2	9107	25608.1	0.957	952	32	0.076	0.001
1956	26698.4	9106	25600.6	0.957	960	20	0.050	0.001
1957	26725.9	9108	25607.9	0.957	962	35	0.083	0.001
1958	26746.4	9105	25606.5	0.957	955	15	0.037	0.001
1959	26794.1	9109	25631.5	0.957	941	22	0.054	0.001
1960	26842.2	9111	25657.6	0.958	922	23	0.056	0.001
1961	26897.2	9113	25693.0	0.958	897	26	0.064	0.001
1962	26956.4	9115	25736.8	0.958	868	32	0.077	0.001
1963	27016.2	9117	25787.2	0.958	836	23	0.057	0.001
1964	27089.0	9125	25858.3	0.959	801	32	0.076	0.001
1965	27156.3	9132	25932.3	0.960	765	31	0.076	0.001
1966	27224.6	9142	26015.9	0.961	729	117	0.262	0.004
1967	27207.0	9125	26021.6	0.959	698	108	0.244	0.004
1968	27194.8	9115	26039.4	0.958	672	172	0.368	0.007
1969	27113.9	9084	25993.9	0.955	652	51	0.119	0.002
1970	27145.1	9102	26064.0	0.957	638	22	0.055	0.001
1971	27192.2	9132	26152.7	0.960	630	68	0.158	0.003
1972	27181.6	9148	26184.5	0.961	625	76	0.177	0.003
1973	27148.0	9162	26192.4	0.963	625	75	0.173	0.003
1974	27100.7	9176	26183.3	0.964	630	77	0.176	0.003
1975	27036.4	9188	26152.2	0.966	641	43	0.101	0.002
1976	26989.9	9211	26132.2	0.968	656	19	0.045	0.001
1977	26951.7	9238	26113.3	0.971	674	166	0.343	0.006
1978	26755.5	9207	25929.3	0.968	690	69	0.159	0.003
1979	26643.5	9206	25823.1	0.968	708	185	0.383	0.007
1980	26408.5	9157	25588.0	0.962	726	99	0.223	0.004
1981	26252.0	9133	25425.9	0.960	741	131	0.289	0.005
1982	26058.6	9090	25221.5	0.955	741	167	0.360	0.007
1983	25828.2	9027	24975.4	0.949	732	126	0.283	0.005
1984	25638.4	8974	24766.6	0.943	713	144	0.321	0.006
1985	25432.9	8908	24540.8	0.936	687	299	0.586	0.012
1986	25079.6	8779	24168.8	0.923	691	428	0.764	0.018
1987	24608.1	8599	23681.6	0.904	778	571	0.932	0.024
1988	24007.6	8364	23069.5	0.879	947	351	0.691	0.015
1989	23637.3	8211	22692.0	0.863	886	418	0.796	0.018
1990	23214.9	8035	22266.9	0.844	741	244	0.547	0.011
1991	22979.7	7926	22030.5	0.833	735	299	0.646	0.014
1992	22704.4	7799	21750.8	0.820	716	306	0.660	0.014
1993	22437.3	7674	21472.0	0.806	848	327	0.698	0.015
1994	22164.0	7544	21176.1	0.793	679	306	0.670	0.014

Table 8: Time series of population estimates from the base model. *(continued)*

Year	Total Biomass (mt)	Spawning Biomass (mt)	Total Biomass 10+ (mt)	Fraction Unfished	Age-0 Recruits (1,000s)	Total Mortality (mt)	(1-SPR)/(1-SPR_-50%)	Exploitation Rate
1995	21925.7	7427	20900.7	0.781	406	745	1.158	0.036
1996	21272.2	7152	20208.4	0.752	380	339	0.745	0.017
1997	21029.7	7035	19963.1	0.739	382	303	0.695	0.015
1998	20825.5	6937	19834.9	0.729	465	441	0.894	0.022
1999	20486.8	6795	19570.4	0.714	1262	256	0.627	0.013
2000	20326.3	6727	19446.8	0.707	913	183	0.480	0.009
2001	20238.6	6693	19401.1	0.703	825	114	0.330	0.006
2002	20218.9	6690	19418.4	0.703	583	74	0.237	0.004
2003	20239.5	6706	19528.0	0.705	414	100	0.304	0.005
2004	20237.4	6717	19551.8	0.706	691	122	0.351	0.006
2005	20215.1	6721	19442.1	0.706	794	142	0.393	0.007
2006	20173.9	6717	19285.7	0.706	630	132	0.382	0.007
2007	20142.9	6716	19121.8	0.706	965	197	0.539	0.010
2008	20049.4	6688	18911.7	0.703	1651	225	0.591	0.012
2009	19934.4	6647	18985.4	0.699	867	230	0.620	0.012
2010	19829.0	6601	18948.0	0.694	1721	266	0.700	0.014
2011	19706.1	6542	18854.3	0.688	854	237	0.612	0.013
2012	19646.9	6491	18705.3	0.682	2270	268	0.664	0.014
2013	19591.0	6429	18457.4	0.676	750	163	0.456	0.009
2014	19679.4	6409	18409.5	0.674	532	93	0.282	0.005
2015	19874.5	6416	18473.6	0.674	494	142	0.409	0.008
2016	20051.0	6409	18432.0	0.674	673	157	0.442	0.009
2017	20234.7	6399	18509.5	0.673	1807	168	0.469	0.009
2018	20419.9	6391	18869.2	0.672	1010	286	0.709	0.015
2019	20504.4	6350	18854.2	0.667	914	241	0.612	0.013
2020	20649.3	6334	19235.0	0.666	609	117	0.343	0.006
2021	20924.6	6378	19440.9	0.670	677	117	0.349	0.006
2022	21200.0	6438	20213.6	0.677	743	141	0.403	0.007
2023	21447.6	6505	20425.9	0.684	784	119	0.347	0.006
2024	21706.9	6594	20556.6	0.693	786	150	0.411	0.007

#"'{r, results = "asis"} ##| label: tbl-projections ##| warning: false ##| echo: false ##| eval: !expr eval_tables ##| tbl-cap: !expr if(eval_tables) projections_cap ##| tbl-pos: H

#projections_table |> # gt::gt() |> # gt::fmt_number(# columns = c(2:5, 7:9), # decimals = 0 #) |> # gt::fmt_number(# columns = c(6, 10), # decimals = 3 #) |> # gt::tab_options(# table.font.size = 12, # latex.use_longtable = TRUE #) |> # gt::sub_missing(# columns = tidyselect::everything(), # missing_text = "—" #) |> # gt::cols_align(# align = "center" #) |> # gt::cols_width(# tidyselect::everything() ~ px(75) #) |> # gt::as_latex()

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3.9 Figures

3.9.1 Introduction

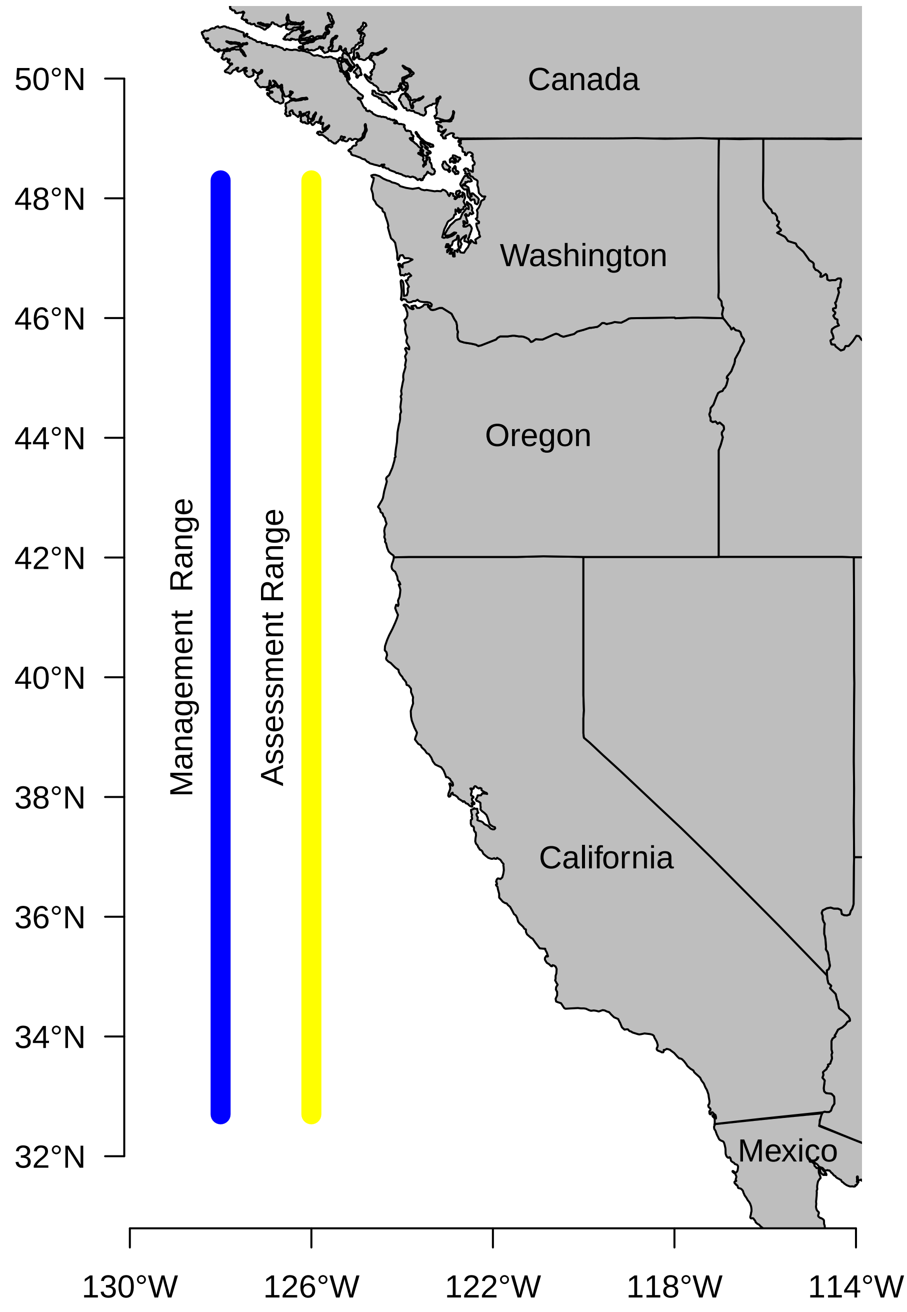

Figure 1: Map of the assessment area.

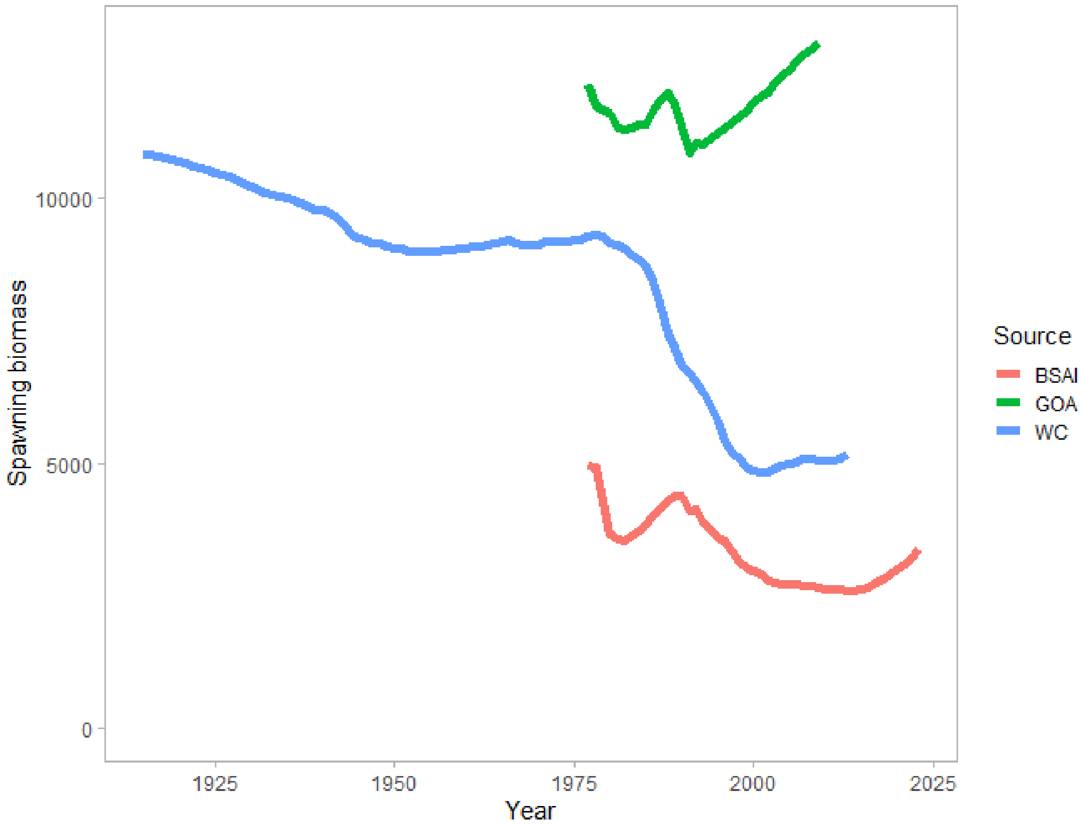

Figure 2: Estimates of spawning biomass (current spawning output/unfished spawning output) for the Rougheye/Blackspotted rockfish complex from the two most recent Alaska (Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA)) and the 2013 U.S. west coast stock assessment.

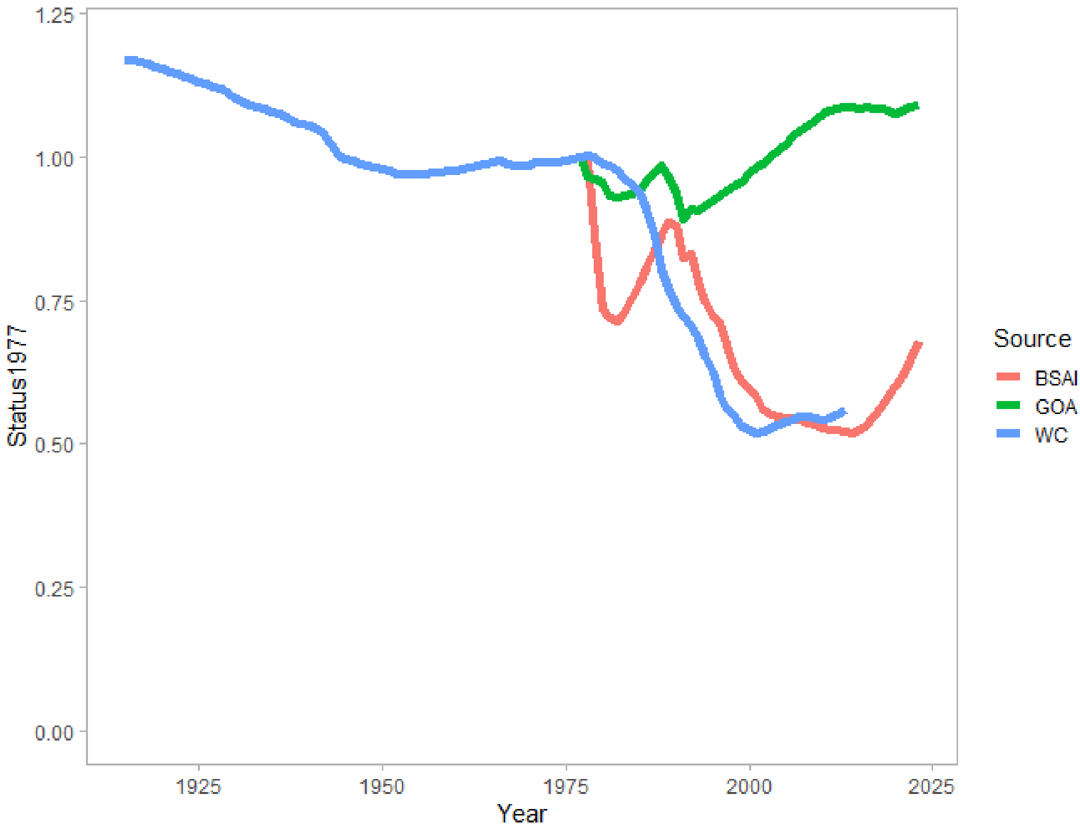

Figure 3: Estimates of relative stock size (current spawning output/unfished spawning output) relative to 1977 (the common year in all stock assessments compared) for the Rougheye/Blackspotted rockfish complex from the two most recent Alaska (Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA))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

3.9.2 Data

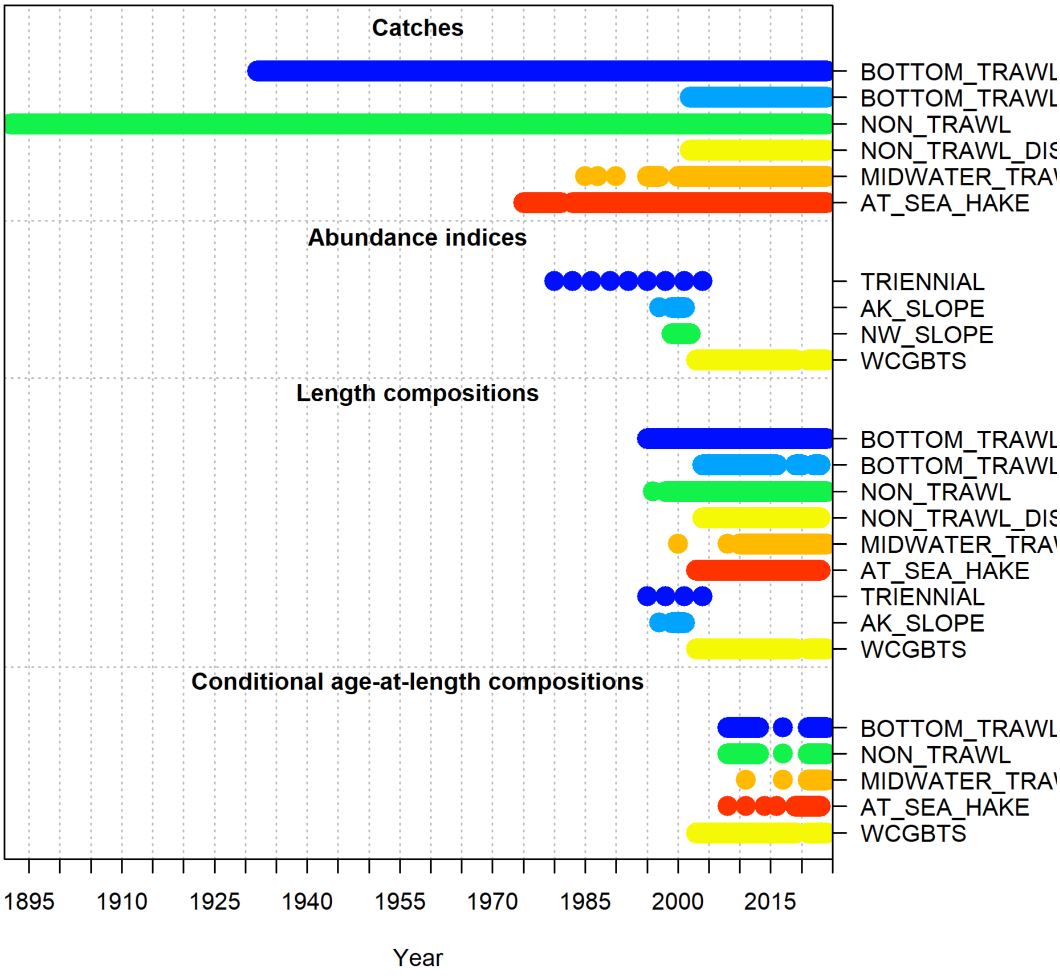

Figure 4: Data used in the base model.

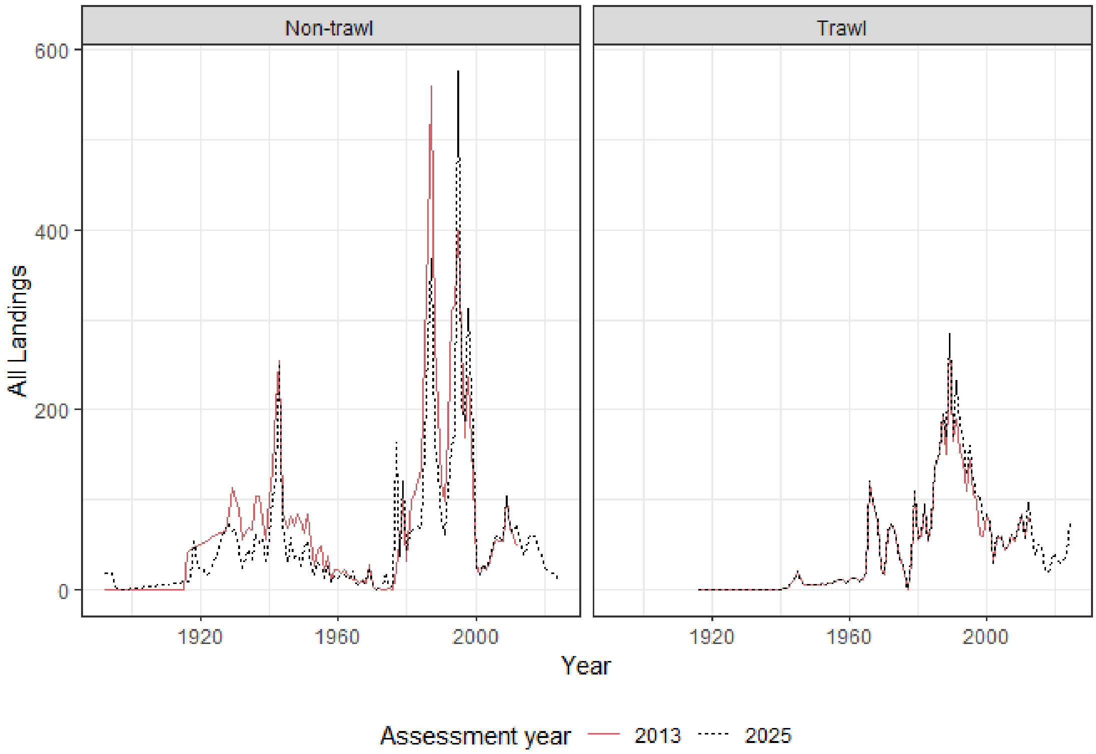

Figure 5: Landings across all states for non-trawl and trawl fisheries compared between the 2013 assessment and updated landings for the 2025 stock assessment model.

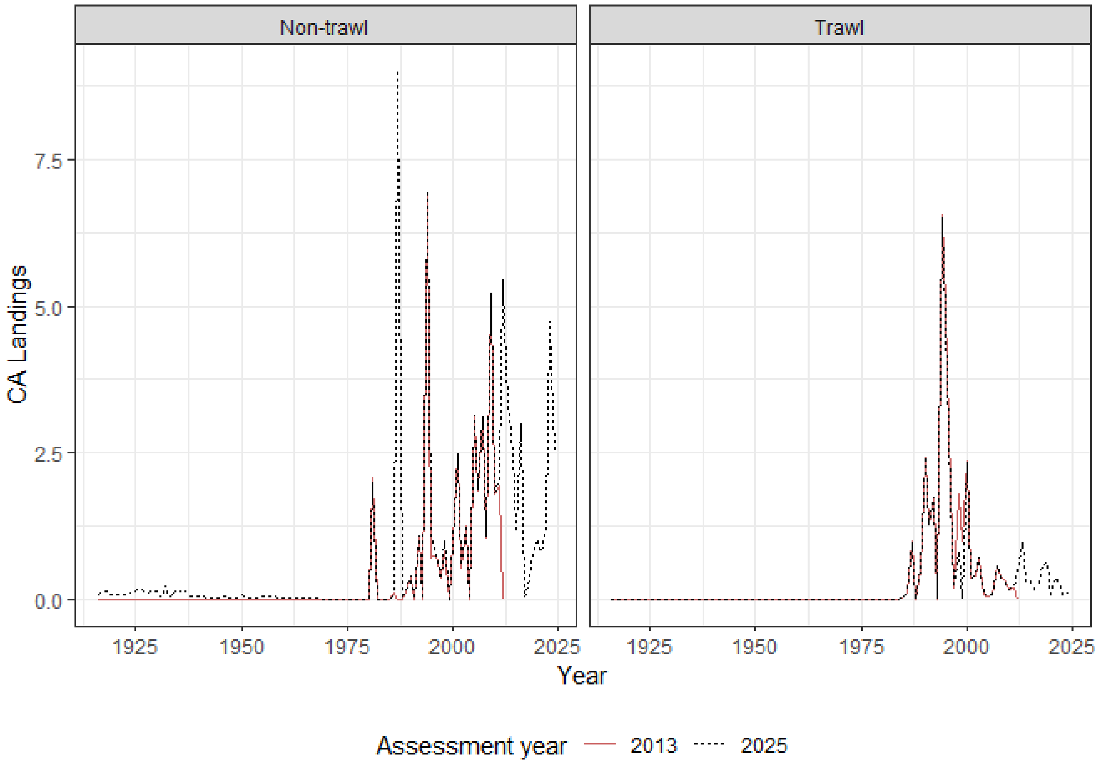

Figure 6: California state landings for non-trawl and trawl fisheries compared between the 2013 assessment and updated landings for the 2025 stock assessment model.

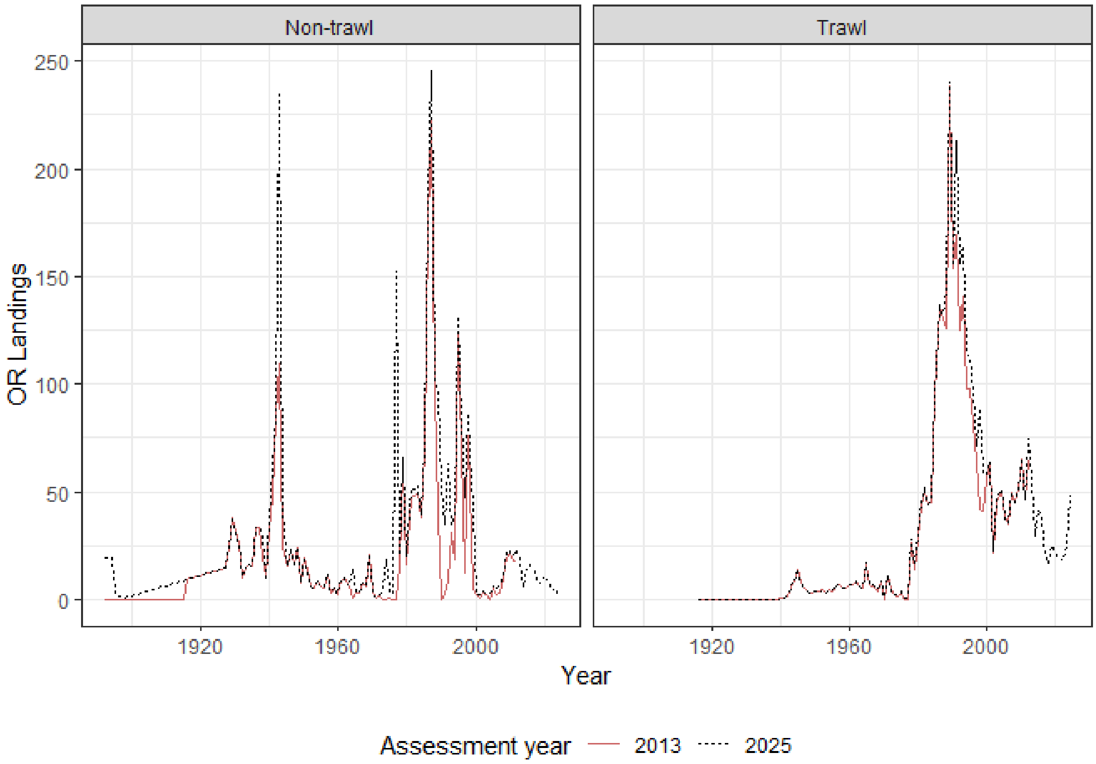

Figure 7: Oregon state landings for non-trawl and trawl fisheries compared between the 2013 assessment and updated landings for the 2025 stock assessment model.

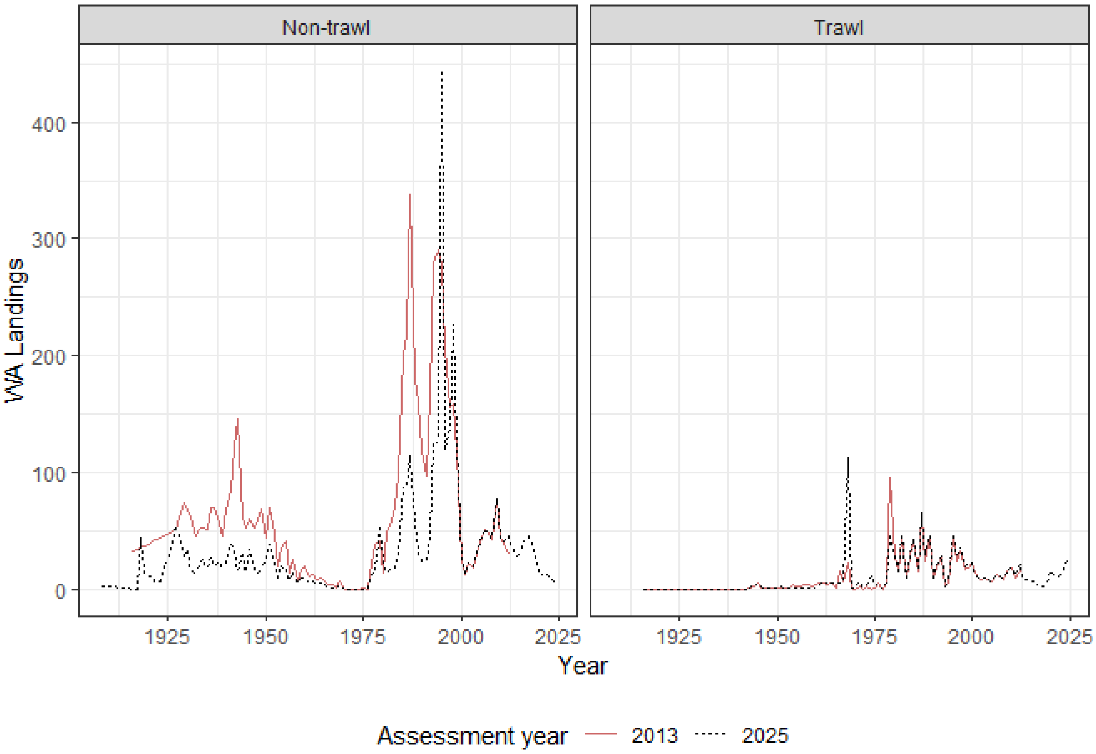

Figure 8: WA. Washington state landings for non-trawl and trawl fisheries compared between the 2013 assessment and updated landings for the 2025 stock assessment model.

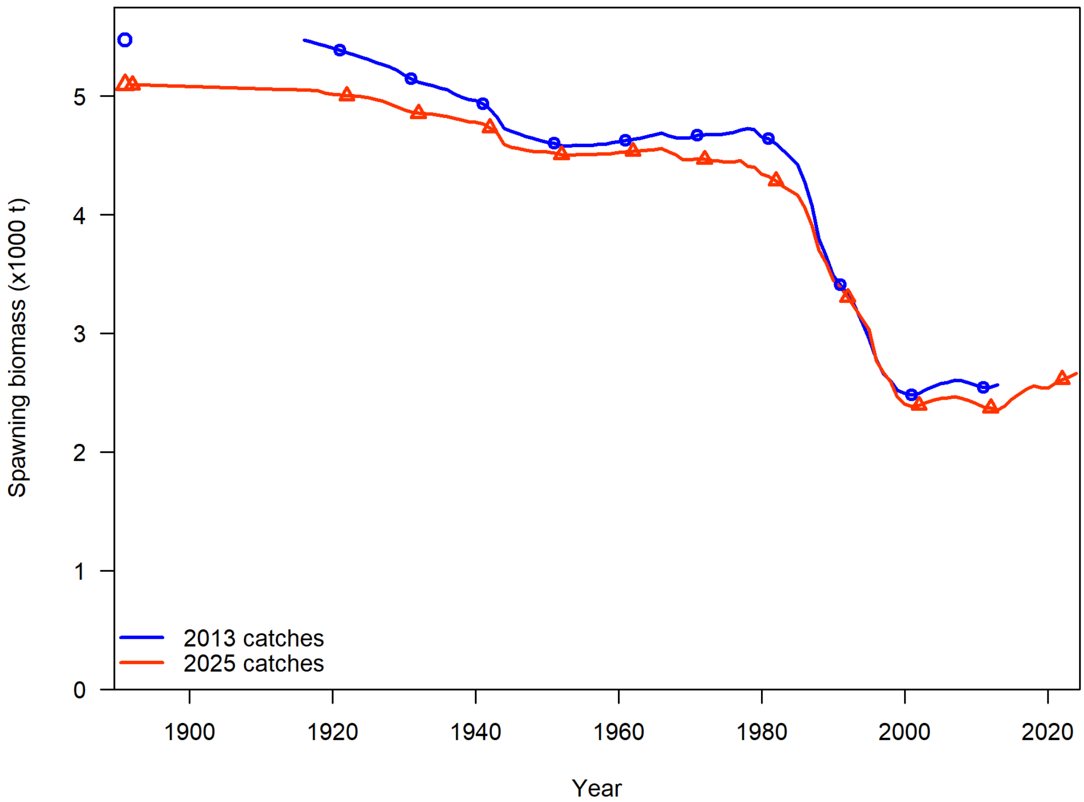

Figure 9: Comparison of spawning output using updated catches vs using catches from the 2013 Rougheye/Blackspotted Rockfishes assessment.

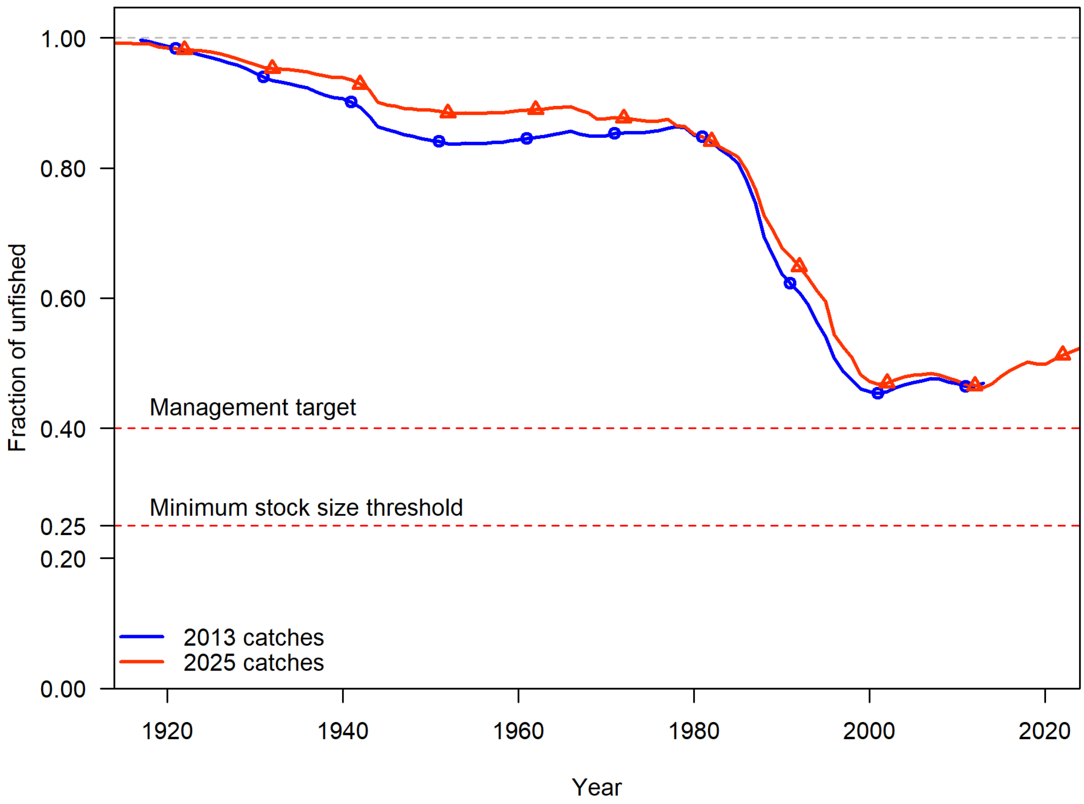

Figure 10: Comparison of relative spawning output using updated catches vs using catches from the 2013 Rougheye/Blackspotted Rockfishes assessment.

3.9.3 Biology

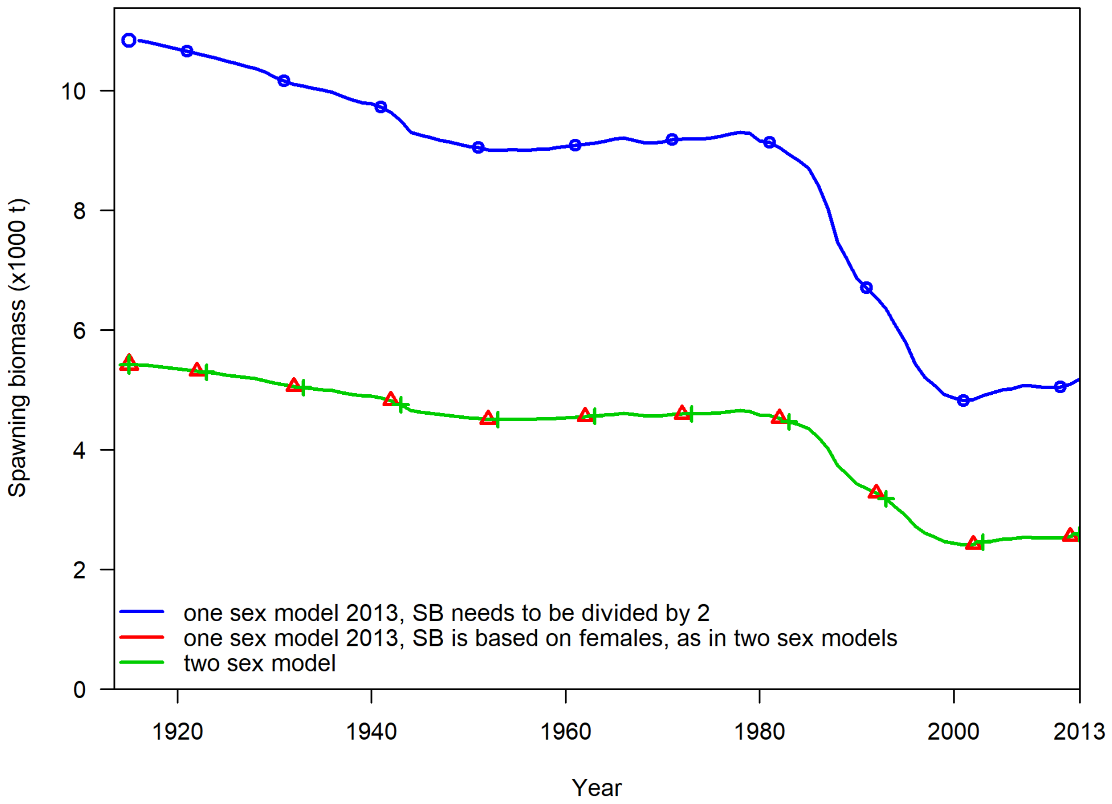

Figure 11: Comparison of spawning output using the 1 sex and 2 sexes set to equal values models based on the 2013 Rougheye/Blackspotted Rockfishes assessment data. The 1 sex model has double the biomass because it includes both females and males.

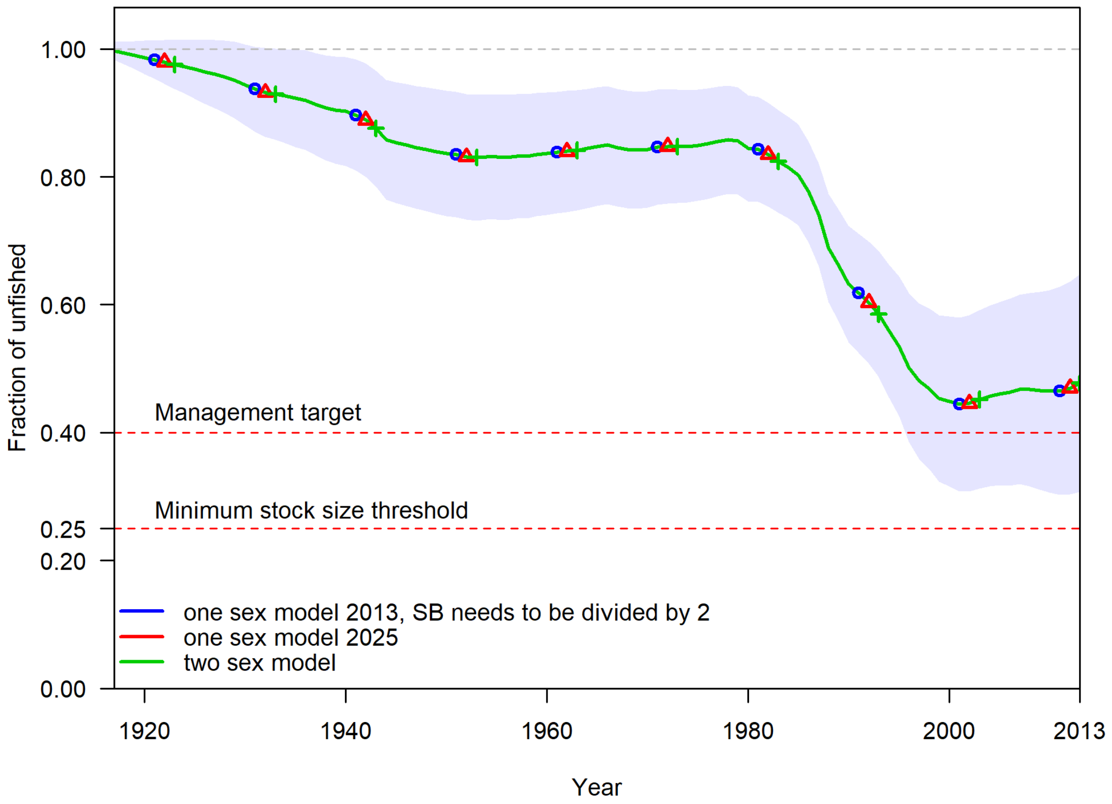

Figure 12: Comparison of spawning output using the 1 sex and 2 sexes set to equal values models based on the 2013 Rougheye/Blackspotted Rockfishes assessment data.

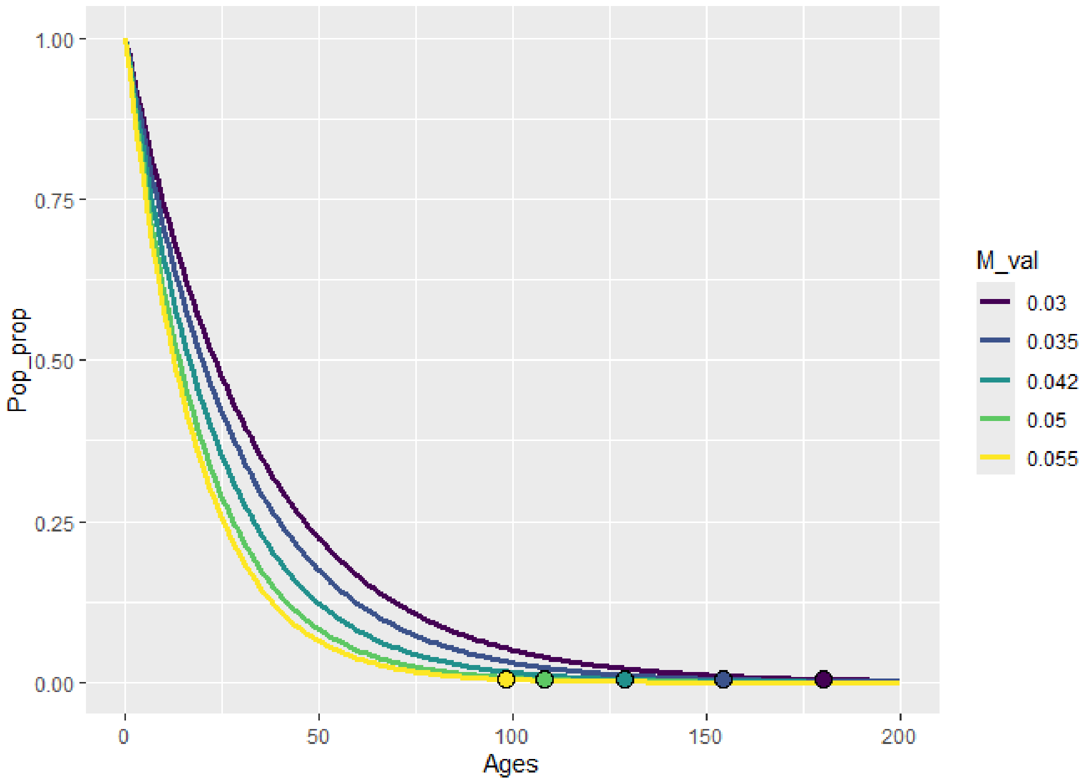

Figure 13: Natural mortality curves by age in years for values of natural mortality used in various Rougheye/Blackspotted Rockfish stock assessments. Dots indicate the range of assumed maximum ages using the equation from Hamel and Cope 2022.

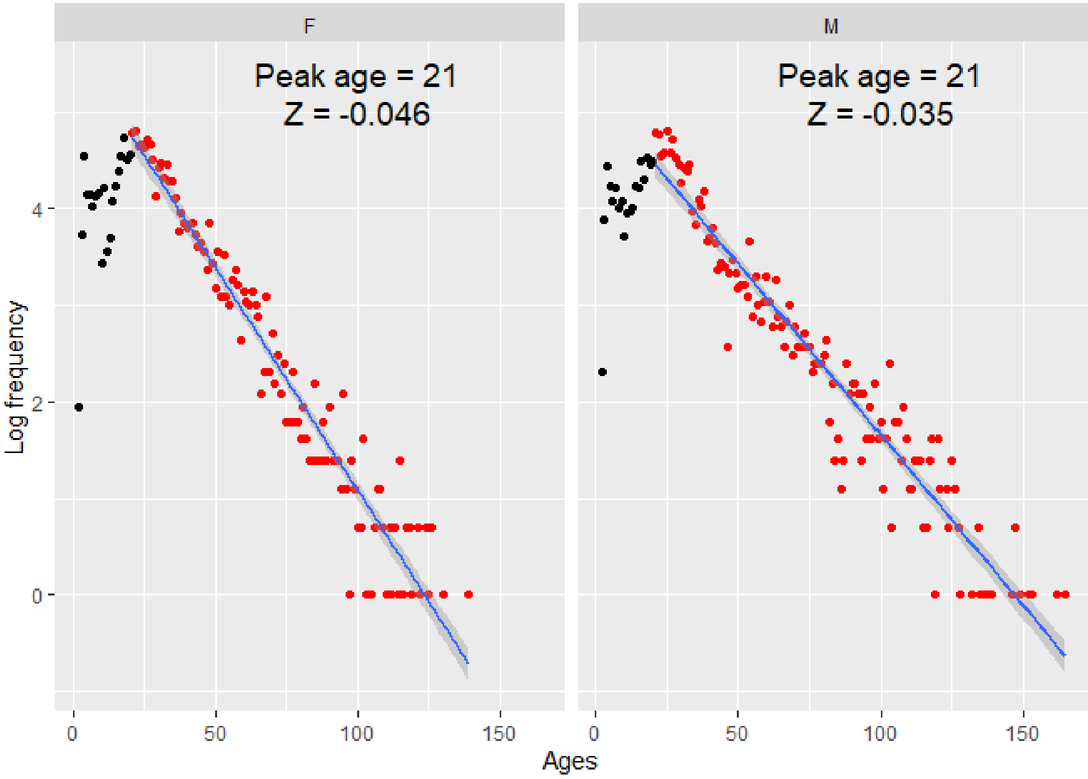

Figure 14: Catch curve (log abundance by age) analysis on aggregated ages over all age sources by sex (black points). The peak selected age was 21 for both sexes, so the linear model was run from age 21 until the oldest age (red points). The slope of the linear model is equal to the estimate of an aggregate total mortality (Z).

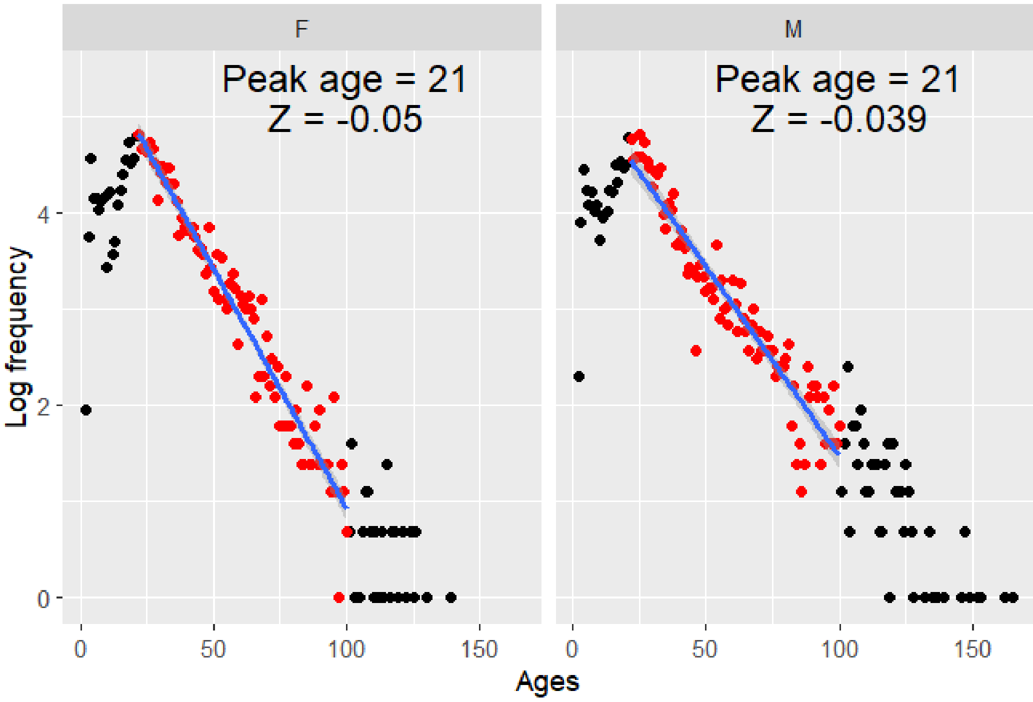

Figure 15: Catch curve (log abundance by age) analysis on aggregated ages over all age sources by sex (black points). The peak selected age was 21 for both sexes with a max age of 100, so the linear model was run from age 21 until age 100 (red points). The slope of the linear model is equal to the estimate of an aggregate total mortality (Z).

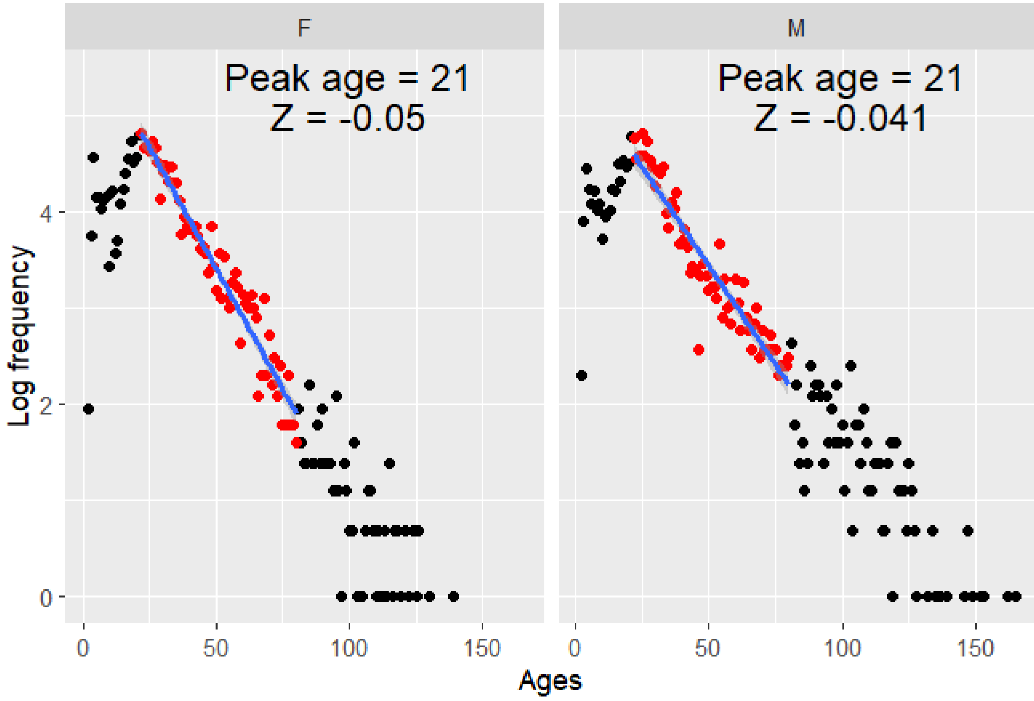

Figure 16: Catch curve (log abundance by age) analysis on aggregated ages over all age sources by sex (black points). The peak selected age was 21 for both sexes with a max age of 80, so the linear model was run from age 21 until age 80 (red points). The slope of the linear model is equal to the estimate of an aggregate total mortality (Z).

Figure 17: Age and length data, with fitted von Bertalanffy growth curves, by sex and data source for the Rougheye/Blackspotted rockfish complex. Sample sizes (N) are also provided.

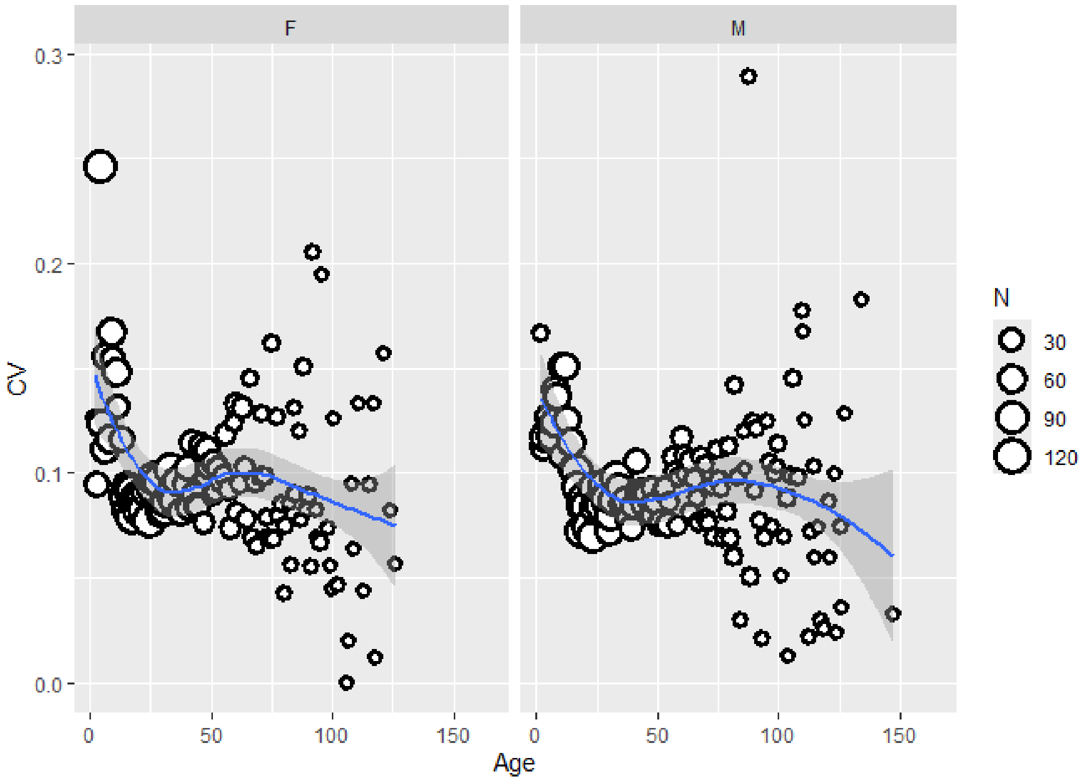

Figure 18: Coefficient of variation by age and sex for all sources of Rougheye/Blackspotted rockfishes ages. Sample sizes (N) are also indicated by size of the point. The line is a smoothed loess (polynomial) line that gives a moving average of CV by age and sex.

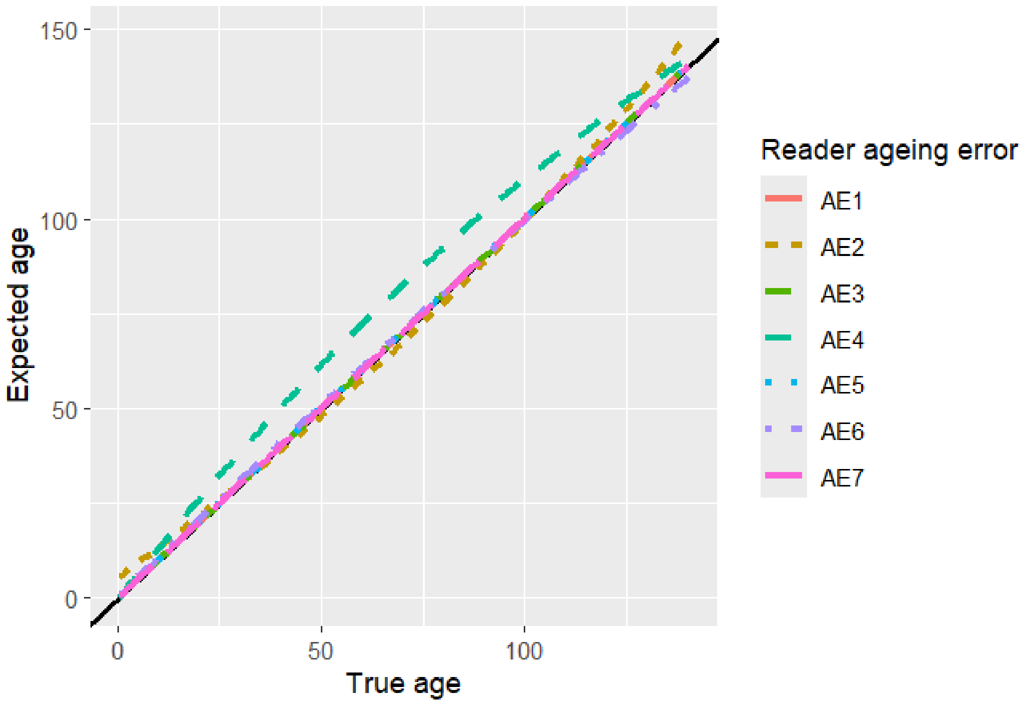

Figure 19: Ageing error matrix assignments by year and data source. The number indicates which ageing error matrix was used for conditional ages within those years and data sources. Commercial is a combination of all commercial fleets.

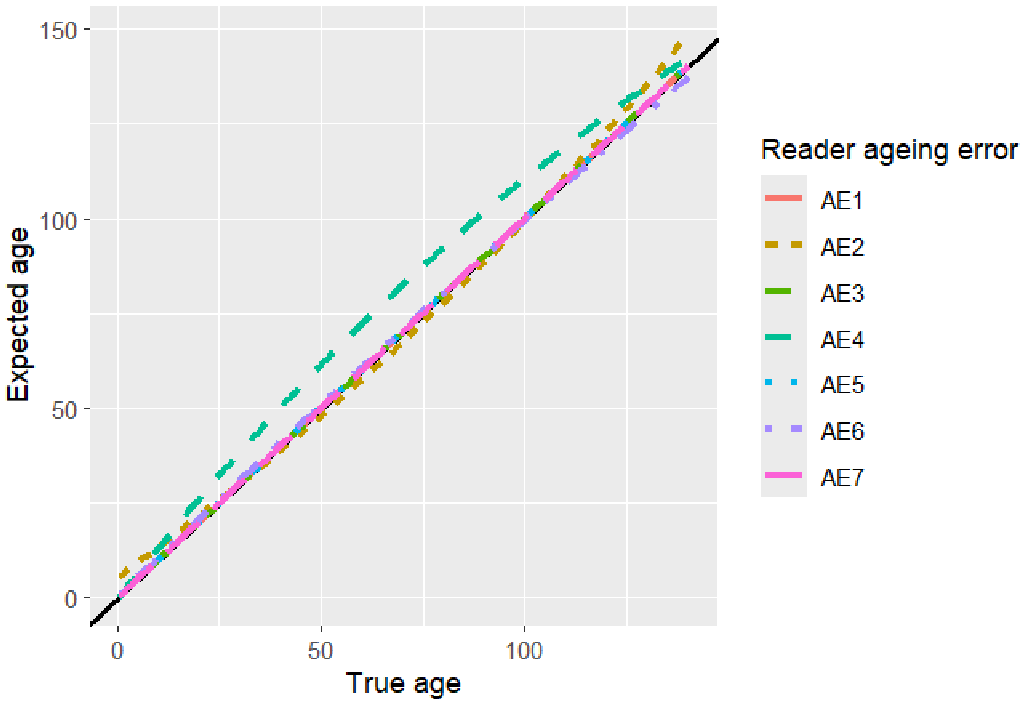

Figure 20: Estimated bias used for each of the seven ageing error matrices.

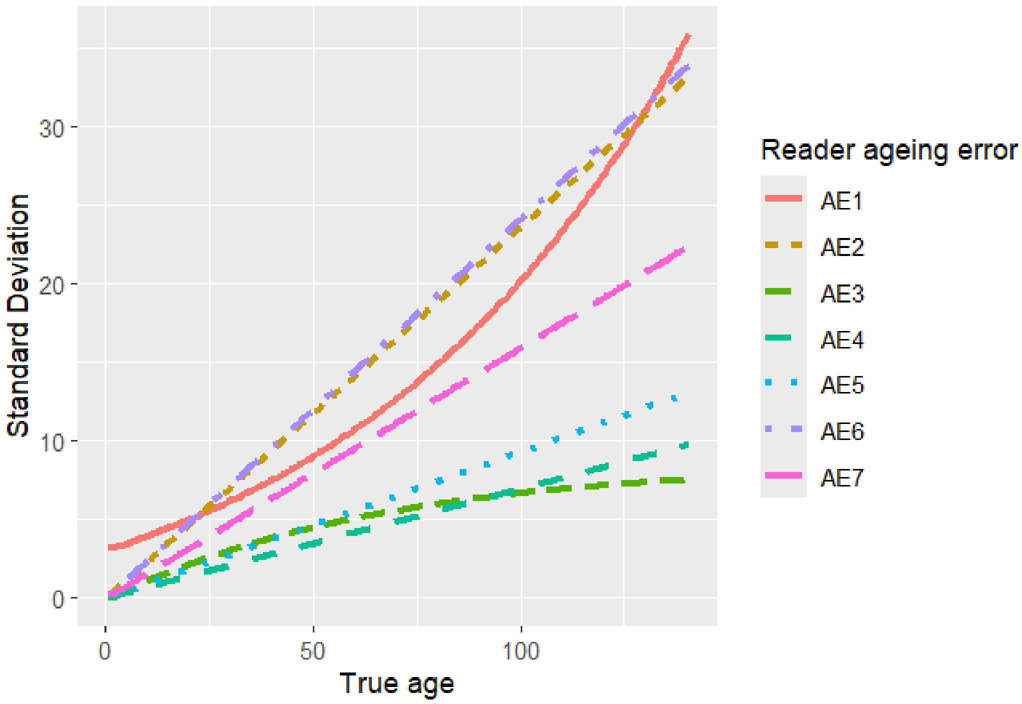

Figure 21: Estimated imprecision (as a standard deviation) used for each of the seven ageing error matrices.

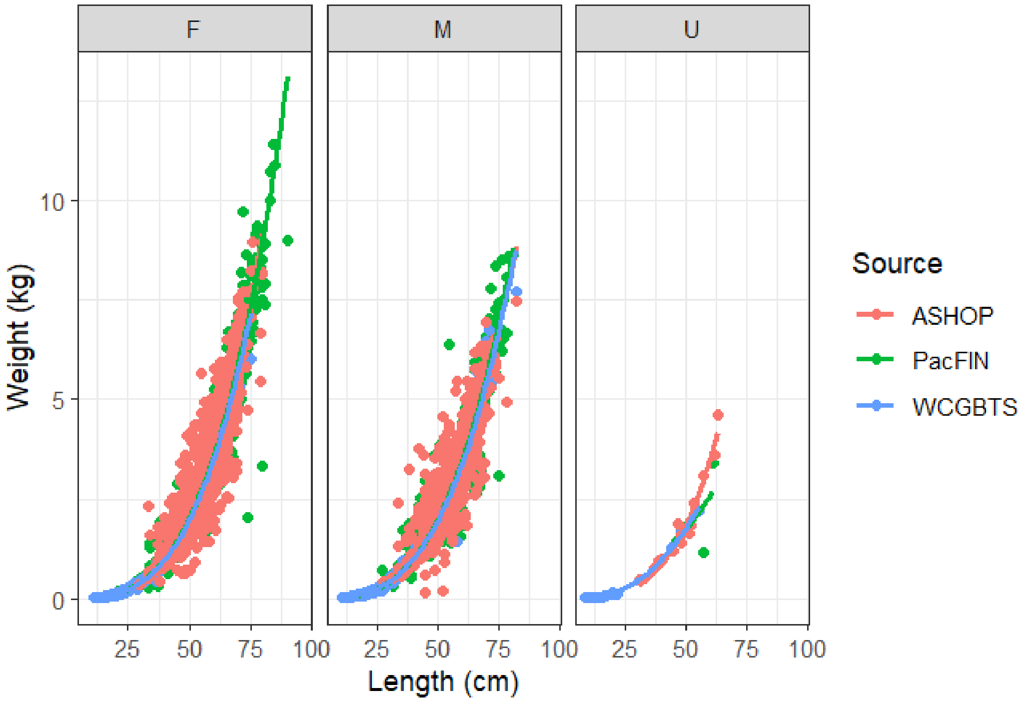

Figure 22: Length and weight samples by sex and data source. Lines are the power function fits by data source.

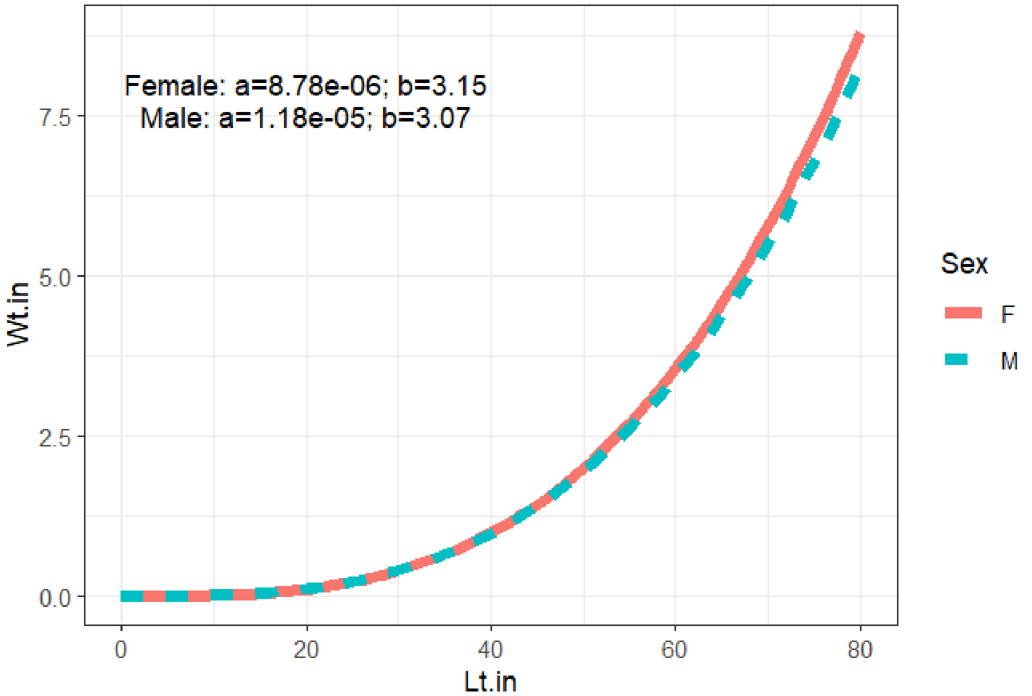

Figure 23: Realized length and weight relationships for female and male Rougheye/Blackspotted Rockfishes.

3.9.4 Model Bridging

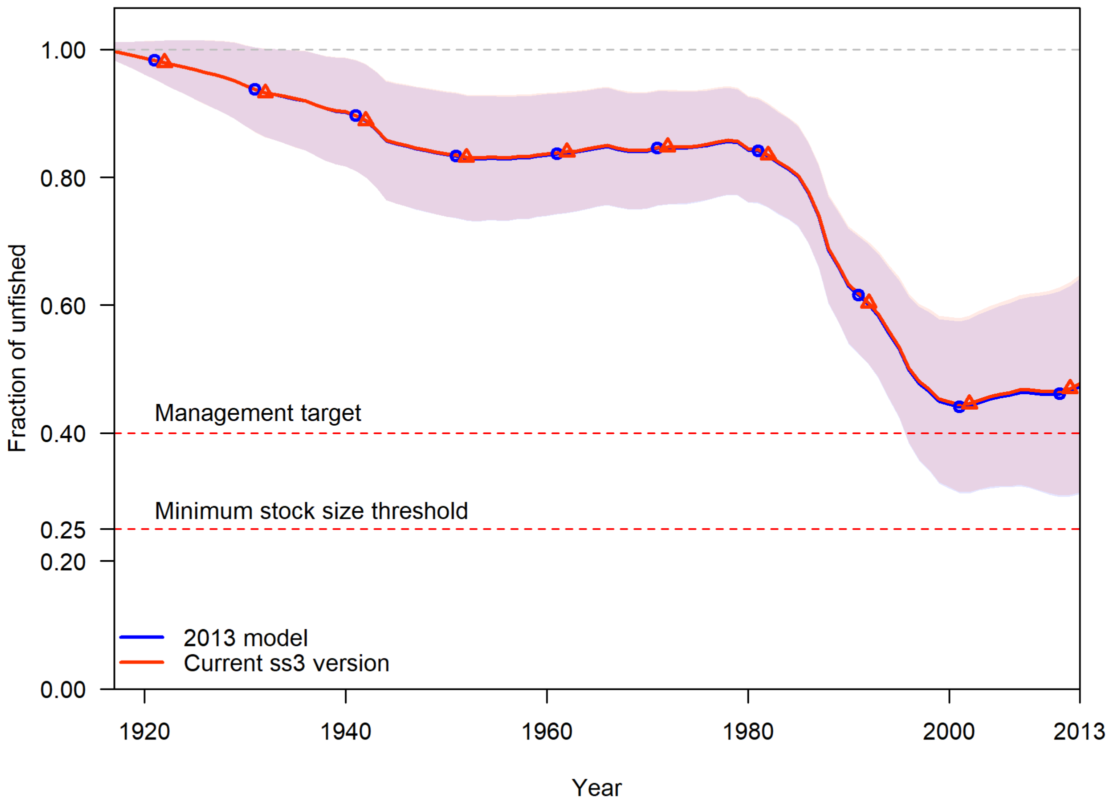

Figure 24: Estimates of relative stock size (current spawning output/unfished spawning output) for the Rougheye/Blackspotted rockfish complex in U.S. west coast waters from the 2013 assessment, and compared to the using the same data in the newest version of SS3 (3.30.22.1).

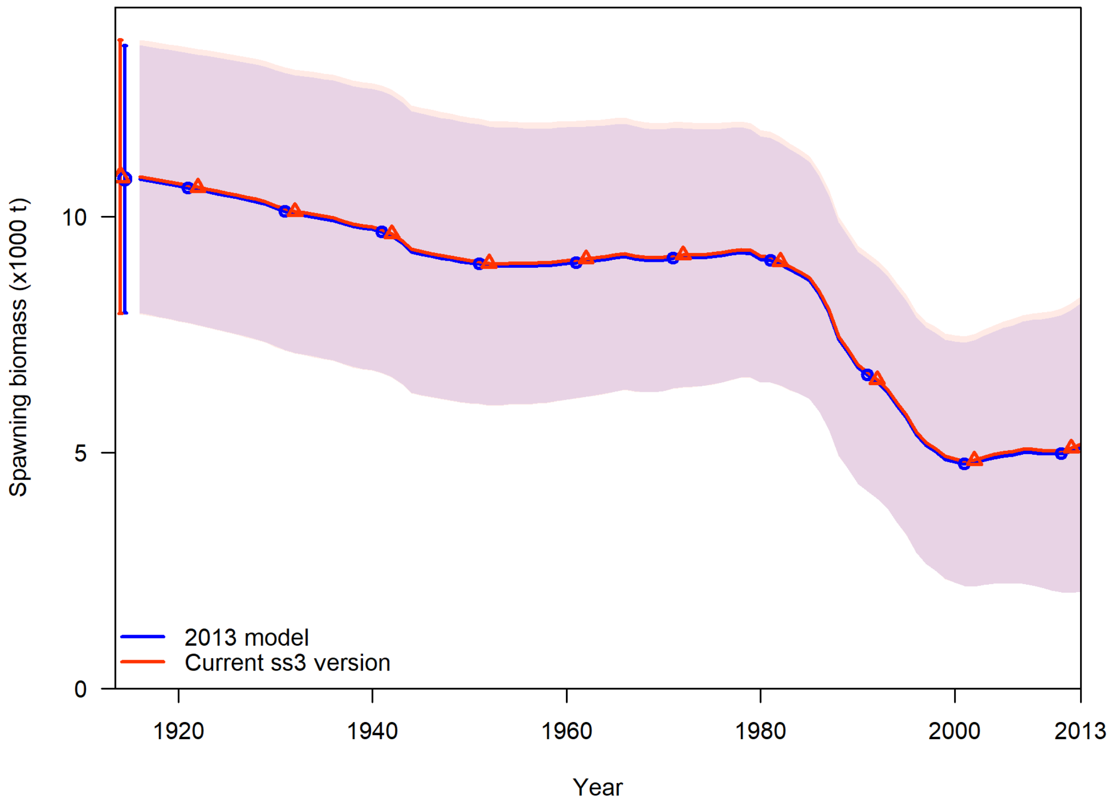

Figure 25: Estimates of spawning output for the Rougheye/Blackspotted rockfish complex in U.S. west coast waters from the 2013 assessment, and compared to the same data in the newest version of SS3 (3.30.22.1). Shading denotes 95% confidence intervals. Shading denotes 95% confidence intervals.

3.9.5 Model Specification

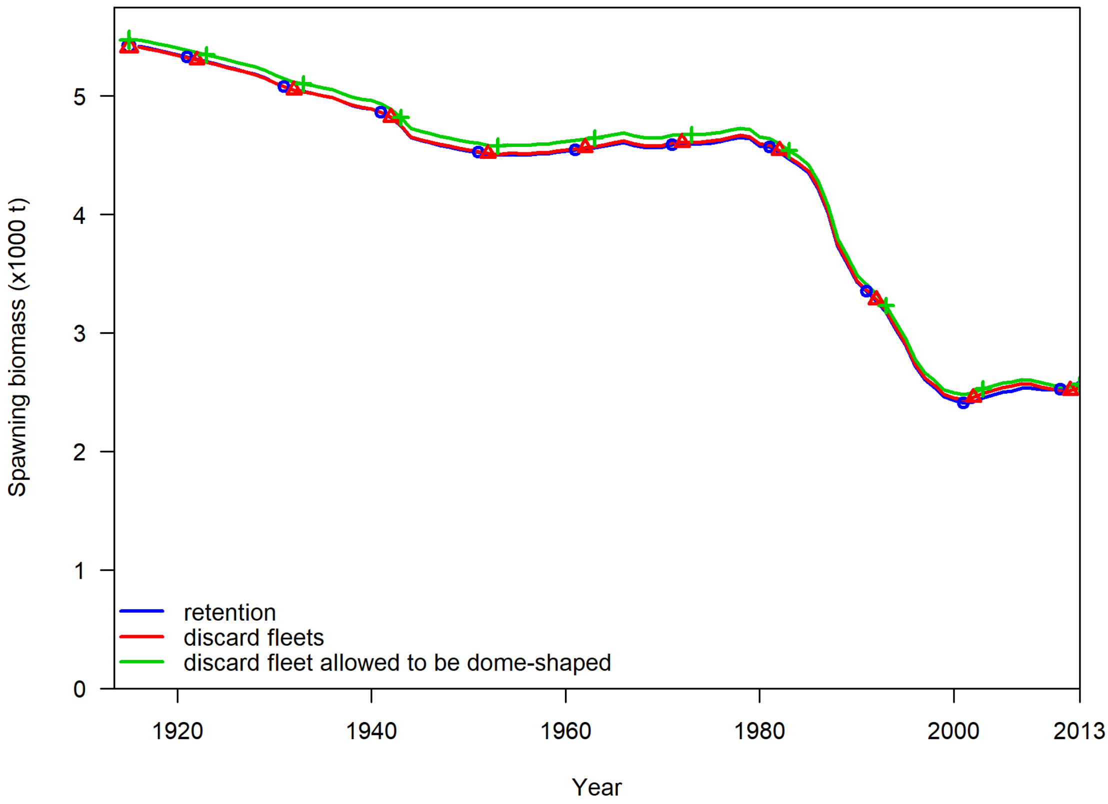

Figure 26: Comparison of spawning output using retention curves or discard fleets using the 2013 Rougheye/Blackspotted Rockfishes assessment.

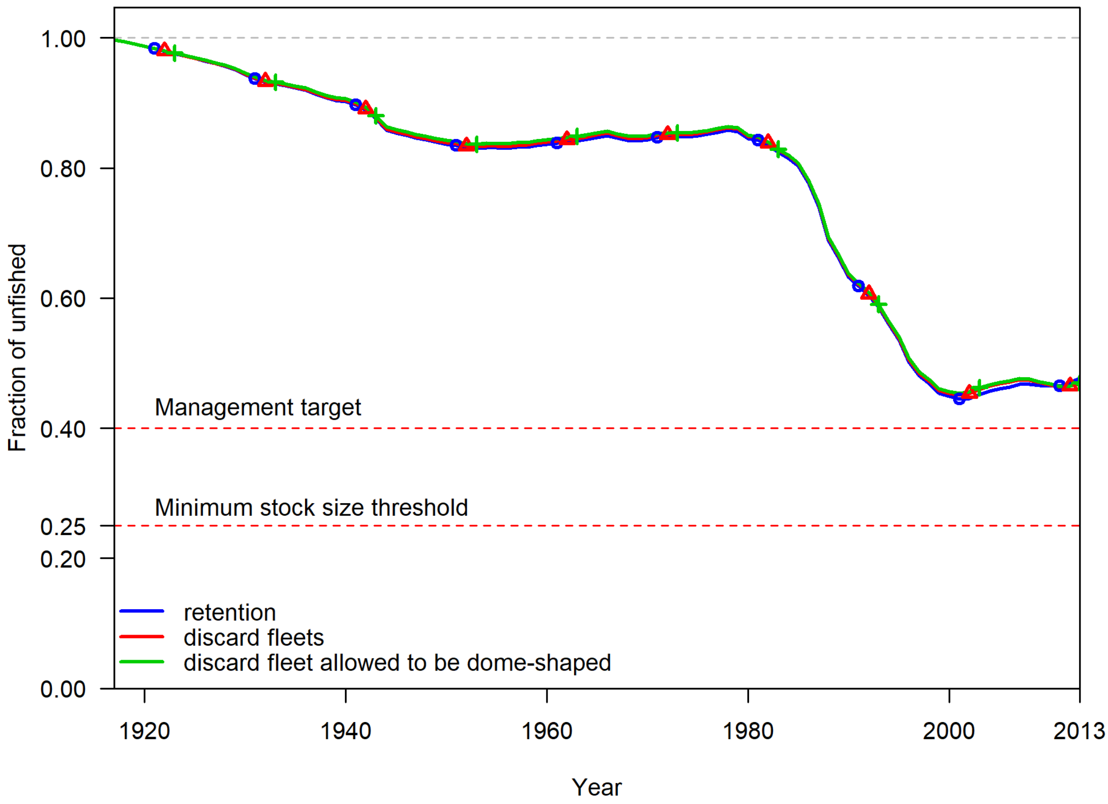

Figure 27: Comparison of relative spawning output using retention curves or discard fleets using the 2013 Rougheye/Blackspotted Rockfishes assessment.

3.9.6 Time-series

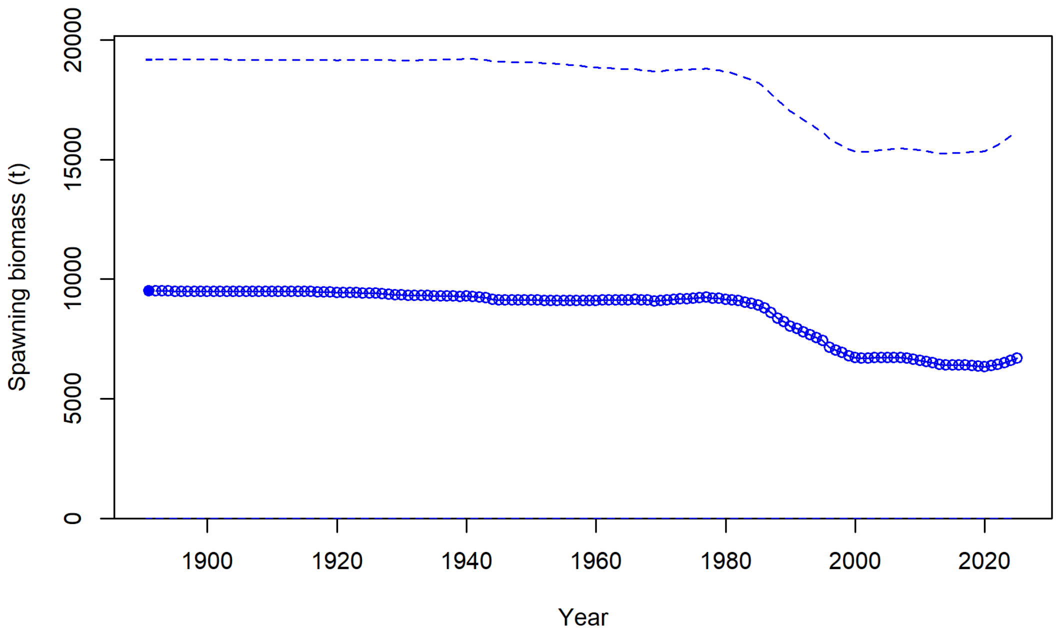

Figure 28: Estimated time series of spawning biomass for the base model.

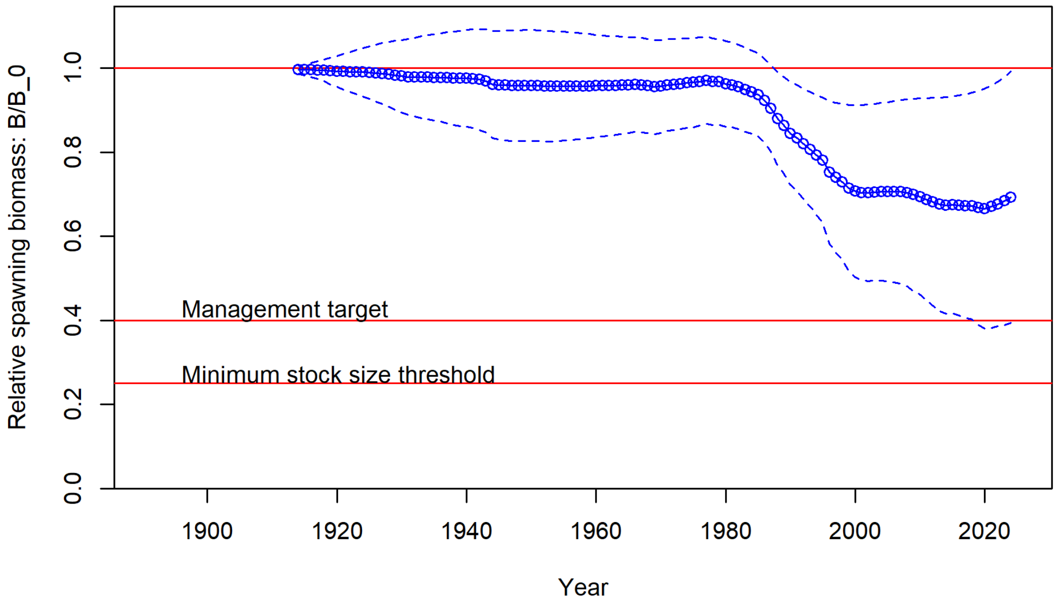

Figure 29: Estimated time series of fraction of unfished spawning biomass for the base model.

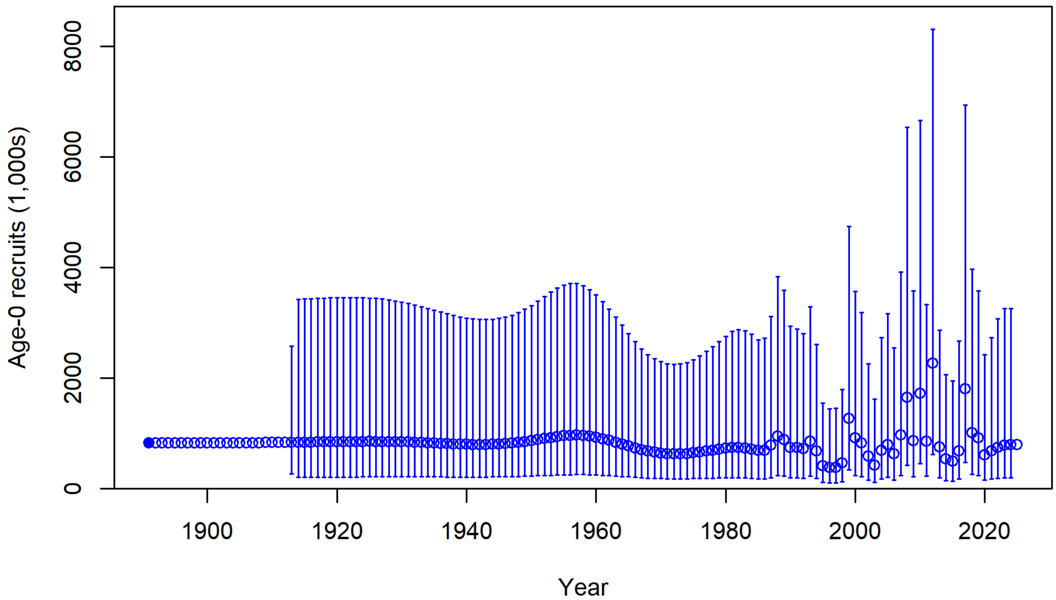

Figure 30: Estimated time series of age-0 recruits for the base model.

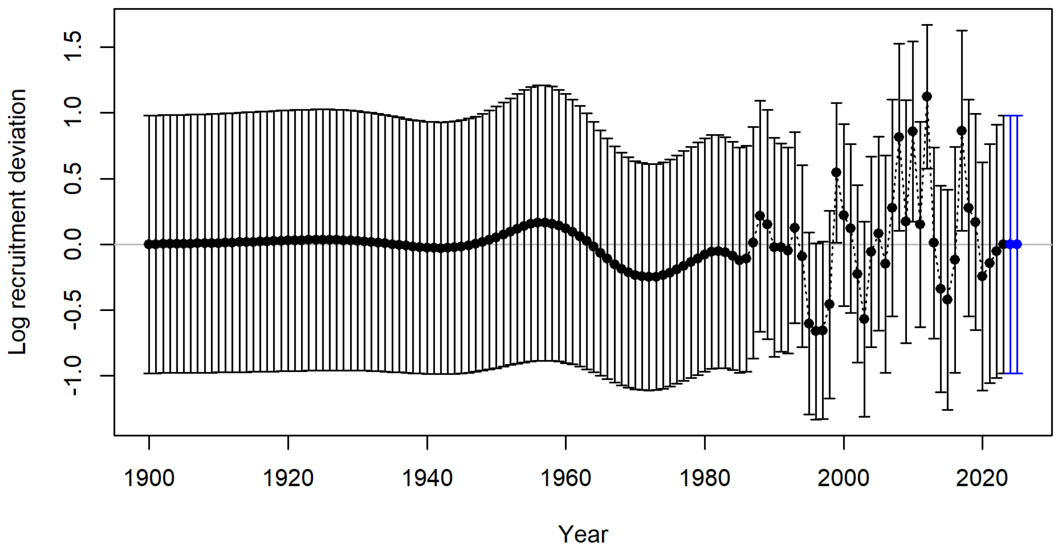

Figure 31: Estimated time series of recruitment deviations for the base model.

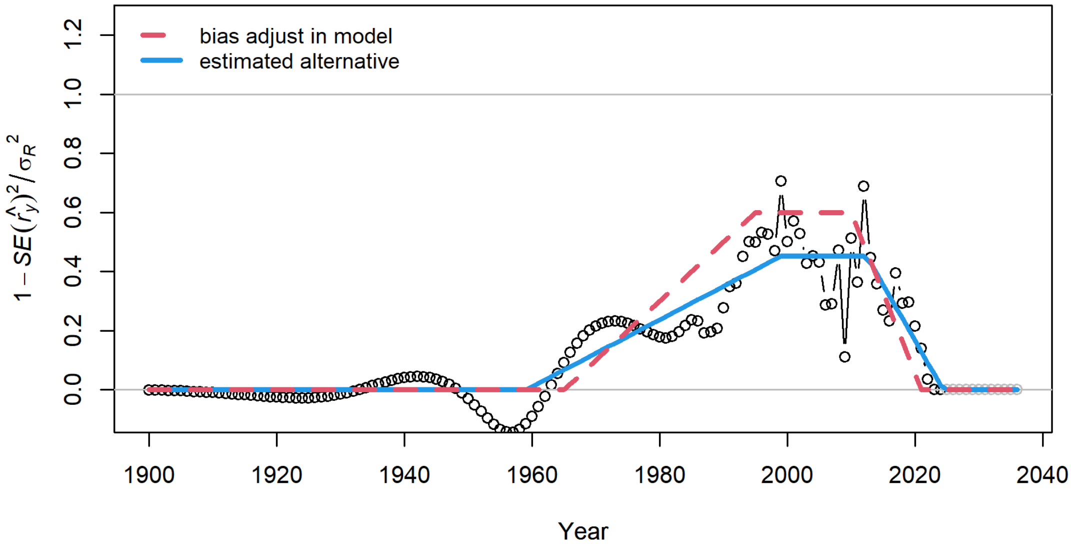

Figure 32: Bias adjustment applied to the recruitment deviations (red line). Points are transformed variances relative to the assumed variance of recruitment.

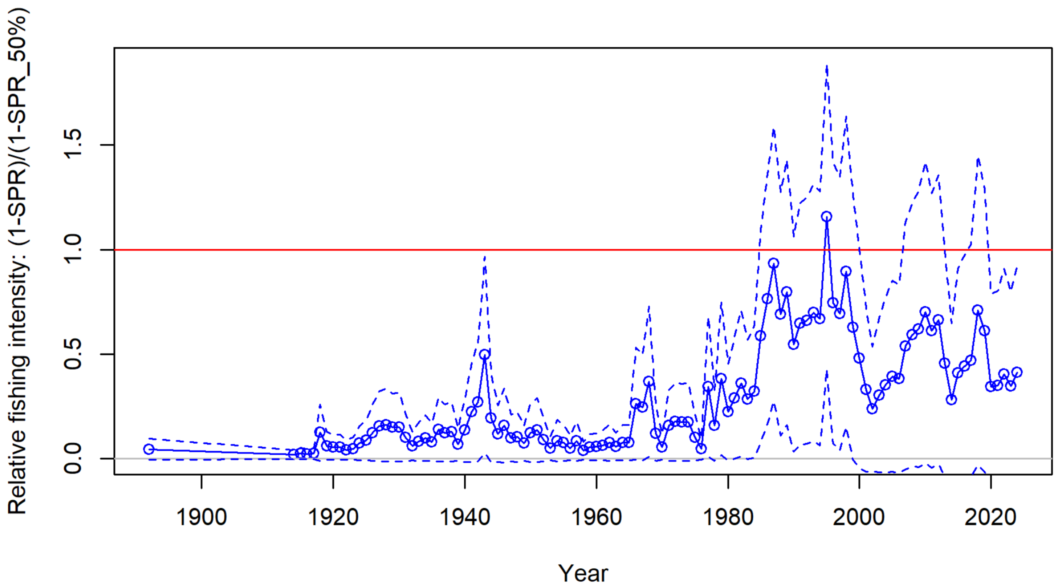

Figure 33: Estimated time series of fishing intensity for the base model.

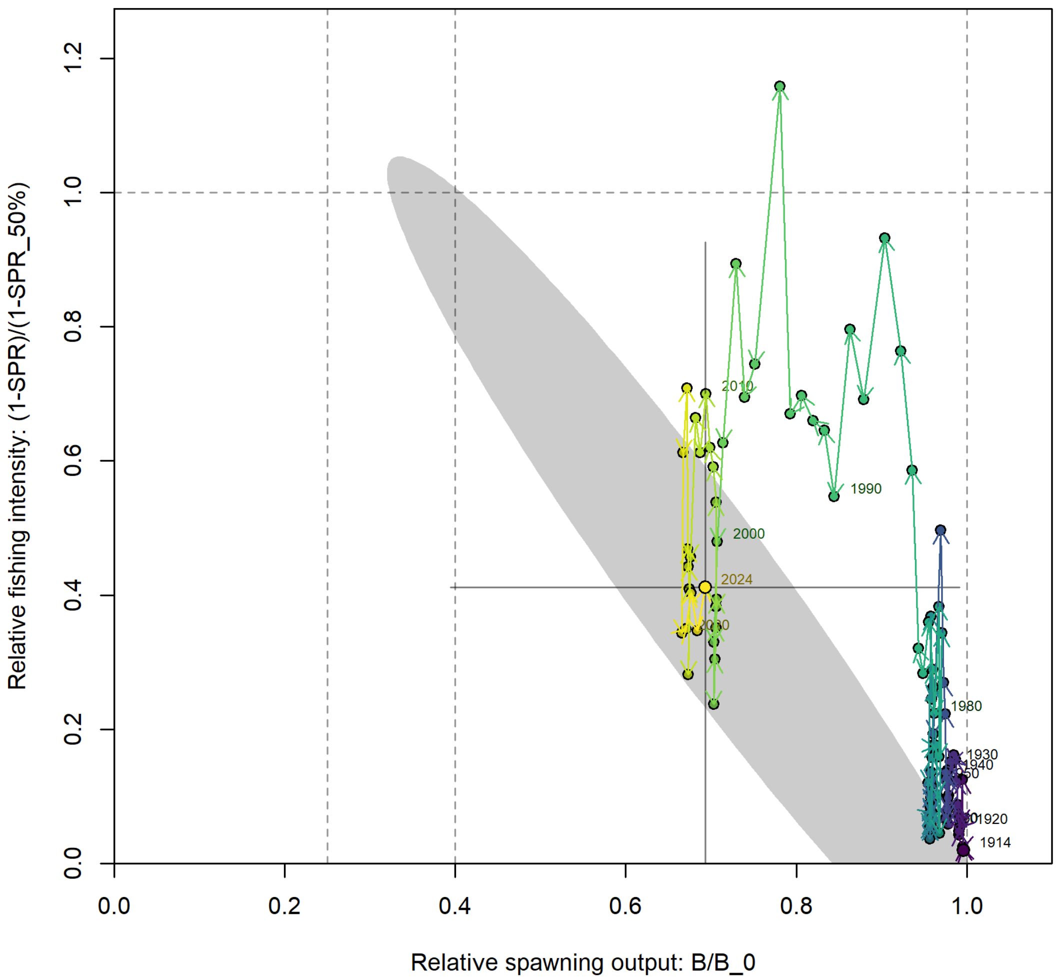

Figure 34: Phase plot of fishing intensity versus fraction unfished for the base model.

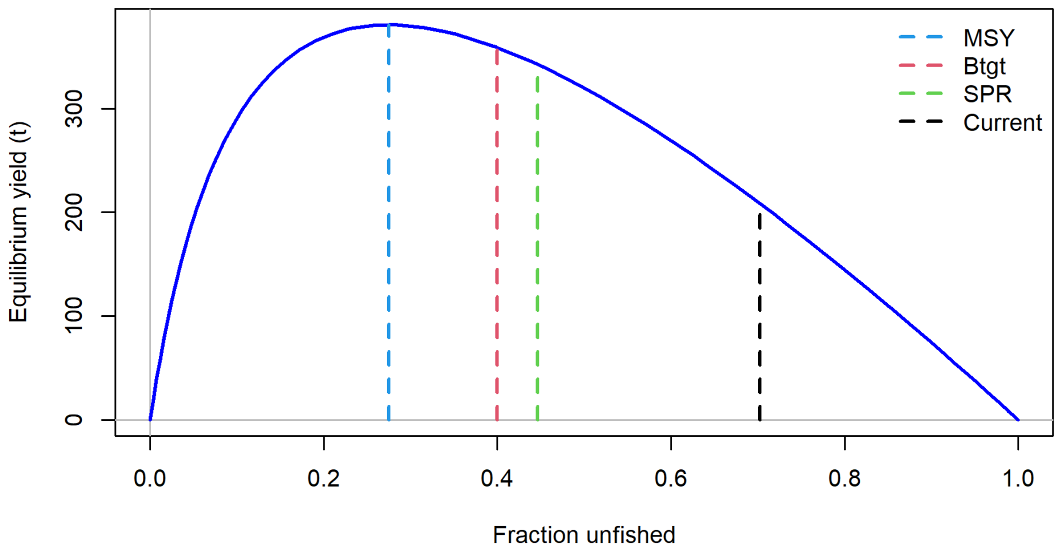

Figure 35: Estimated yield curve with reference points for the base model.

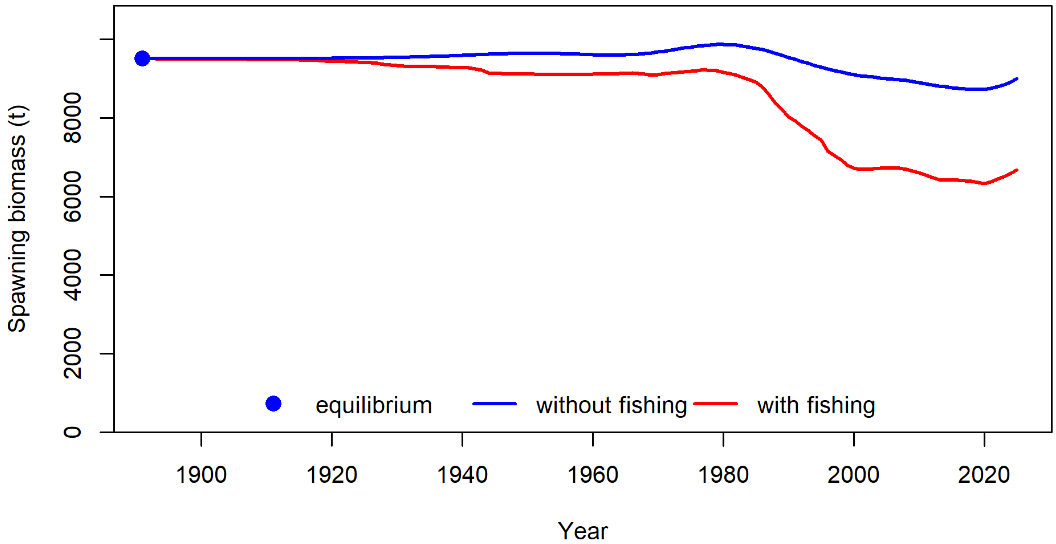

Figure 36: Dynamic B0 plot. The lower line shows the time series of estimated spawning output in the presence of fishing mortality. The upper line shows the time series that could occur under the same dynamics (including deviations in recruitment), but without fishing. The point at the left represents the unfished equilibrium.

3.10 Sensitivity Analyses and Retrospectives

3.11 Likelihood Profiles

3.12 Reference Points and Forecasts

3.13 Notes

3.14 Appendices