2011 Rebuilding Analysis for Darkblotched Rockfish

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1. Introduction

The Pacific Fishery Management Council (PFMC) adopted Amendment 11 to its Groundfish Management Plan in 1998. This amendment established a definition for an overfished stock of 25% of the unfished spawning biomass ($0.25B_0$). Darkblotched rockfish (*Sebastes crameri)* was declared overfished in January 2001 based on the most recent stock assessment at that time (Rogers et al. 2000). Rebuilding analyses were first conducted in mid-year 2001 (Methot and Rogers 2001) and included a partial update of the 2000 stock assessment.

The stock assessment for darkblotched rockfish was updated in 2003 (Rogers 2003). Full assessments were conducted in 2005 (Rogers 2005) and 2007 (Hamel 2007), using Stock-Synthesis II. An assessment update was done in 2009 (Wallace and Hamel 2009) using version 3 of Stock-Synthesis. The most recent assessment, also using version 3 of Stock-Synthesis, was performed in 2011 (Stephens, *et al.*, 2011). In 2005 the natural mortality rate used in the assessment was changed from the previously used value of 0.05 (based largely on Hoenig's method) to 0.07 (as a balance between Hoenig's method and Gunderson's method based on gonadosomatic index (GSI)). This latter value was used in the 2007 assessment and the 2009 and 2011 assessments as well.

The largest change in assumptions between the 2005 and 2007 assessments was the value of stock-recruitment steepness. In 2005, steepness was estimated at 1.0, and was set at 0.95. In 2007, a large amount of new age data was included in the assessment, largely as conditional age-at length compositions, and steepness was estimated (using the prior from meta-analysis of rockfish steepness conducted by Martin Dorn) at 0.6. That value of steepness was then fixed in the 2007 assessment and hence also used in the 2009 update. More recent meta-analysis results suggest a higher value for steepness (Martin Dorn, *pers. comm*), and for the 2011 assessment, steepness was fixed at 0.76.

The SPR chosen following the 2005 rebuilding analysis (0.607) corresponded to a T_{target} (median rebuilding year) of 2011, which was much earlier than for previous rebuilding analyses, due largely to the high value of steepness (and thus high productivity at low stock sizes) assumed in the 2005 assessment. Based on the 2007 rebuilding analysis, the darkblotched rockfish stock was projected to recover 19 years later (2030) than anticipated from the 2005 rebuilding analysis. This then lead to the adoption by the PMFC of a new T_{TARGET} equal to 2028. Following the 2009 assessment update and rebuilding analysis, T_{TARGET} was revised to 2025, and SPR_{Target} to 0.649.

Table 1 shows the management history by assessment year. The cumulative estimated catch over the cumulative OY/ACL over the period since rebuilding began (2002-2010) is 94.5%. So management under rebuilding has been generally effective, although individual year overages may have occurred, they have been balanced by years with less catch than allocated.

Table 1. Management history since 2002. The modeled catch is the sum of the landings and the model-estimated discards based on discard rate and discard size composition information. These do not always match the Total Mortality report, the metric used to determine whether overfishing has occurred.

Year	OFL	ACL	Total Mortality Report	Modeled Catch
2002	187	168	-	263
2003	205	172	-	199
2004	240	240	230.9	242
2005	269	269	123.9	123
2006	294	200	193.3	211
2007	456	290	285.0	281
2008	487	330	252.6	227
2009	437	285	301.2	273
2010	440	291	-	302
2011	508	298	-	-

2. Specifications

2.1 Selection of B_0

As in 2007 the unfished spawning stock biomass, B_0, was determined from the fitted stock-recruitment relationship in order to be consistent with the assumptions underlying the current stock assessment. This in contrast to previous rebuilding analyses for darkblotched rockfish which used a range of estimated historical recruitments to estimate B_0. The current estimate of B_0 is 32,710 mt. Table 2 compares darkblotched summary statistics for 2011 with the 2009 model results.

Table 2. Estimates of unfished spawning stock biomass or output (2011) (B_0) and depletion for the 2009 and 2011 stock assessments.

	2009	**2011**
Unfished 1+ biomass	32,922	32,710
Ending year 1+ biomass	9,065	13,926
Unfished spawning output	28,835	29,168
Ending year spawning output	7,940	8,808
Depletion	27.5%	30.2 %

2.2 Generation of future recruitment

Future recruitments were generated in 2009 using the Beverton-Holt spawner recruit relationship with steepness = 0.6 and σ_r = 0.8 as estimated in the 2007 assessment (Hamel, 2007). Prior to 2007, rebuilding analyses re-sampled from a range of estimated historical recruitments. For the current, 2011 rebuilding analysis, recruitments are generated as in 2007 and 2009, except that the new value of 0.76 is assumed for steepness. This choice is consistent with the assumptions underlying the current stock assessment.

2.3 Mean generation time

The mean generation time is defined as the mean age weighted by net spawning output. The best estimate of the mean generation time is 25 years. This is 3 years longer than in the previous rebuilding analyses (Table 3).

2.3 Methods used

The revised SSC default rebuilding analysis (Punt 2009) was used to find all rebuilding milestones, such as T_{MIN} and the mean generation time, in addition to the results for the various harvest strategies specified below. Darkblotched biological information can be found in the rebuilding analysis input file in Appendix A.

2.4 Harvest strategies

Table 3 summarizes the options considered in the rebuilding analyses. These include:

- No-catch beginning with the first year beyond the current 2011-12 ACLs
- Using the implied SPR in the current analysis from the 2011-12 ACLs (298/296 mt)
- Using the year (2017) associated with 50% probability of rebuilding associated with that SPR. This and the previous case give the upper and lower bounds on the ACLs for achieving rebuilding (P50%) by 2017.
- Using the SPR (0.621) from the 2009 analysis
- Using the SPR (0.607) from the old FMP.
- Using the first quartile-year between Tmin and Tmax.
- The 40-10 rule (applied to the OFL).
- The OFL rule

The reported results from each scenario include the year at which rebuilding is projected with a 50% probability, the 2013 and 2014 ACLs associated with that projection, the associated SPR, and the probabilities, respectively, of rebuilding by 2025 and by 2037 (T_{Target} and T_{Max}).

Table 3. The 8 Scenarios explored in this rebuilding analysis.

Name / Reasoning		$T_{50\%}$	2013 ACL	2014 ACL	SPR	P_{2025} (%)	P_{2037} (%)
F = 0	Beginning in 2013	2016	0	0	1	100	100
SPR = 0.649	Current ACLs based	2017	317	330	0.649	100	100
Yr = 2017		2017	347	360	0.626	100	100
SPR = 0.621	2009 SPR	2018	353	366	0.621	100	100
SPR = 0.607	Old FMP SPR	2018	372	385	0.607	100	100
Yr = 2018	1st quartile year	2018	423	437	0.571	100	100
40-10 rule (applied to OFL)		2024	508	528	>= 0.5	57.3	82.4
OFL Rule		2024	541	553	0.5	53.7	79.5

2.5 Other specifications

The calculations in this document were performed using 3.12b of the rebuilding software developed by Punt (2010) and the results are based on 1,500 Monte Carlo replicates in each case.

The definition of "recovery by year *y*" in this analysis is that the spawning output reaches $0.4B_0$ by year *y* (even if it subsequently drops below this level due to recruitment variability).

Appendix A lists the estimates for the biological and technological parameters and the age-structure of the population at the start of 2000 and 2011. Appendix B lists the MPD time-series of recruitment and spawning output. The input to the rebuilding programs is given as Appendix C. The catch for 2011 and 2012 were set to 298 and 296 mt (the Council-selected *ACLs* for 2011-2012).

3. Results

3.1 Time-to-recovery

The eight harvest scenarios shown in table 3 provide a better-than-50% probability of rebuilding by T_{Target}, 2025.

The year for rebuilding to the target level in the absence of fishing since the year of overfished declaration, T_{min}, is 2016.

T_{max} (T_{min} + one generation time), formerly the maximum permissible time period for rebuilding the stock to its target biomass, is 2037 given the 30.2% depletion level and the age-structure of the population in 2001.

Table 4 shows summary statistics from the 2003, 2005, 2007 and 2009 rebuilding plans and the current analysis. The 2011 and 2009 analyses are in good agreement, and both are a little more optimistic than the 2007 rebuilding plans.

Table 4: Summary Statistics

Value	**2003**	**2005**	**2007**	**2009**	**2011**
T_{min}	2011	2009	2015	2012	2012
Mean generation time	33 years	24 years	25 years	25 years	25 years
T_{max}	2044	2033	2040	2037	2037
$T_{F=0}$ beginning in the year following the ACLs in place			2018 (from 2009)	2016 (from 2011)	2016 (from 2013)
$T_{Rebuild}$(Fishing at SPR_{Target})	2019	2011	2028	2028	2025
SPR_{TARGET}		0.607	0.621	0.621	0.649

3.2 OYs and fishing mortalities

Table 5 gives the 10 year projected Annual Catch (AC) and OFL values based on the SPR for each of the 12 cases explored in this rebuilding analysis. The top number in each cell in the table is the AC, and the bottom number is the OFL (formerly ABC).

Table 5. 10-year projected Annual Catch (top value) and OFL (bottom value).

Scenario	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
F = 0 from 2013	0 540	0 574	0 602	0 627	0 650	0 671	0 691	0 713	0 732	0 754
SPR = 0.649	317 540	329 562	338 577	346 589	351 599	357 608	362 616	367 625	372 634	378 643
Yr = 2017	347 540	359 560	369 575	376 586	381 595	387 603	391 610	396 618	401 625	407 635
SPR = 0.621	353 540	366 560	375 574	382 585	388 594	393 601	397 608	403 616	407 623	413 632
SPR = 0.607	372 540	385 560	394 573	401 583	407 591	412 598	416 604	421 611	425 618	431 626
Yr = 2018	423 540	437 558	445 569	452 577	457 583	461 588	464 593	469 598	473 604	478 611
40-10 rule	508 540	528 554	542 562	552 566	559 569	564 571	567 572	570 574	573 576	577 579
OFL Rule	540 540	553 553	560 560	563 563	565 565	567 567	568 568	570 570	573 573	576 576

Table 6 shows the probability of rebuilding by a range of years from 2012 to 2037, as well as the ACL and OFLs for 2013 and 2014, and the year by which the probability of rebuilding is 50%.

Table 6. Probability of rebuilding.

Scenario	2018	2025	2028	2033	2037	2013 ACL	2013 OFL	2014 ACL	2014 OFL	50% Year
F = 0 from 2013	100	100	100	100	100	0	541	0	574	2016
SPR = 0.649	100	100	100	100	100	317	540	330	562	2017
Yr = 2017	100	100	100	100	100	347	540	360	560	2017
SPR = 0.621	100	100	100	100	100	353	540	366	560	2018
SPR = 0.607	100	100	100	100	100	372	540	385	560	2018
Yr = 2018	50	100	100	100	100	423	540	437	558	2018
40-10 rule	0.3	57.3	66.1	77	82.4	508	540	528	554	2024
ABC Rule	0.2	53.7	63.1	0.74	79.5	541	540	553	553	2024

References

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PFMC. 2004. Darkblotched rockfish (*Sebastes crameri*) rebuilding plan pursuant to the Pacific coast groundfish management plan adopted June 2003 and 2004 addendum to the darkblotched rockfish rebuilding plan *in* Status of the Pacific Coast Groundfish Fishery through 2003 and Recommended Acceptable Biological Catches for 2004. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97201.

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Punt, A.E. 2009. SSC default rebuilding analysis. Technical specifications and user manual. Ver. 3.12.

Rogers, J.B. 2005. Update of Darkbotched (*sic*) Rockfish (*Sebastes crameri*) Rebuilding Analyses. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97201.

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Rogers, J.B., R.D. Methot, T.L. Builder, K. Piner, and M. Wilkins. 2000. Status of the Darkblotched Rockfish (*Sebastes crameri*) Resource in 2000, appendix to Status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, OR 97201.

Wallace, J.W., Hamel, O.S. 2009. Status and future prospects for the darkblotched rockfish resource in waters off Washington, Oregon and California as assessed in 2009. Pacific Fishery Management Council, Portland, OR.

Appendix A: Biological and technological parameters used for the rebuilding analyses based on the MPD estimates. The natural mortality rate (*M*) is 0.07 for all ages, and steepness (h) is 0.76 for the population.

Age	Fecundity	Female Weight	Male Weight	Female Selectivity	Male Selectivity	Numbers F		Numbers M	
						2001	2011	2001	2011
0	0.000	0.013	0.013	0.000	0.000	581	1272	581	1272
1	0.000	0.052	0.052	0.101	0.101	2868	1168	2868	1168
2	0.000	0.129	0.130	0.102	0.102	2424	365	2424	365
3	0.000	0.238	0.239	0.116	0.116	417	2149	417	2149
4	0.001	0.382	0.376	0.228	0.219	749	751	749	751
5	0.011	0.513	0.497	0.498	0.445	450	730	450	730
6	0.077	0.627	0.593	0.772	0.681	1097	894	1103	895
7	0.258	0.729	0.674	0.922	0.838	326	786	331	789
8	0.538	0.825	0.743	0.977	0.919	103	533	106	536
9	0.856	0.916	0.803	0.993	0.958	117	251	122	253
10	1.165	0.998	0.855	0.998	0.976	137	256	144	258
11	1.446	1.071	0.899	0.999	0.985	86	1232	91	1242
12	1.695	1.134	0.935	1.000	0.990	24	1017	26	1026
13	1.913	1.188	0.965	1.000	0.993	234	170	247	172
14	2.101	1.234	0.990	1.000	0.995	176	294	186	298
15	2.264	1.273	1.009	1.000	0.996	51	171	54	173
16	2.403	1.306	1.025	1.000	0.996	39	406	41	413
17	2.522	1.334	1.038	1.000	0.997	35	119	37	122
18	2.623	1.357	1.048	1.000	0.997	23	37	24	39
19	2.708	1.376	1.057	1.000	0.998	26	43	27	45
20	2.781	1.392	1.063	1.000	0.998	72	50	76	53
21	2.841	1.406	1.068	1.000	0.998	72	31	76	33
22	2.892	1.417	1.073	1.000	0.998	62	9	65	9
23	2.934	1.427	1.076	1.000	0.998	19	85	20	90
24	2.970	1.434	1.079	1.000	0.998	10	64	10	68
25	3.000	1.441	1.081	1.000	0.998	20	19	21	20
26	3.024	1.446	1.082	1.000	0.998	23	14	24	15
27	3.045	1.451	1.084	1.000	0.998	18	13	18	13
28	3.062	1.454	1.085	1.000	0.998	16	8	17	9
29	3.076	1.457	1.086	1.000	0.998	15	9	15	10
30	3.088	1.460	1.086	1.000	0.998	13	26	13	28
31	3.098	1.462	1.087	1.000	0.998	12	26	12	28
32	3.106	1.464	1.087	1.000	0.998	11	22	11	24
33	3.112	1.465	1.088	1.000	0.998	10	7	10	7
34	3.118	1.466	1.088	1.000	0.998	9	4	9	4
35	3.123	1.467	1.088	1.000	0.998	8	7	8	8

Age	Fecundity	Female Weight	Male Weight	Female Selectivity	Male Selectivity	Numbers F		Numbers M	
						2001	2011	2001	2011
36	3.126	1.468	1.088	1.000	0.998	7	8	7	9
37	3.130	1.469	1.088	1.000	0.998	6	6	7	7
38	3.132	1.469	1.088	1.000	0.998	6	6	6	6
39	3.134	1.470	1.089	1.000	0.998	5	5	5	5
40	3.136	1.470	1.089	1.000	0.998	4	5	4	5
41	3.138	1.471	1.089	1.000	0.998	3	4	3	4
42	3.139	1.471	1.089	1.000	0.998	3	4	3	4
43	3.140	1.471	1.089	1.000	0.998	3	4	3	4
44	3.141	1.471	1.089	1.000	0.998	2	3	3	3
45 +	3.142	1.471	1.089	1.000	0.998	30	28	31	29

Appendix B: Time-series of recruitment and spawning output since 1940.

Year	Recruitment	Spawning output	Year	Recruitment	Spawning output
1940	3,007	28,989	1976	2,504	14,892
1941	3,007	28,964	1977	1,104	14,823
1942	3,006	28,931	1978	1,845	15,073
1943	3,006	28,892	1979	5,045	15,223
1944	3,005	28,724	1980	5,012	15,106
1945	3,002	28,354	1981	4,144	15,117
1946	2,996	27,719	1982	1,229	14,888
1947	2,993	27,358	1983	875	14,374
1948	2,990	27,073	1984	1,091	13,801
1949	2,989	26,934	1985	991	13,049
1950	2,988	26,839	1986	1,061	12,019
1951	2,987	26,737	1987	2,959	11,602
1952	2,986	26,617	1988	3,221	10,296
1953	2,985	26,496	1989	274	9,493
1954	2,984	26,413	1990	787	8,836
1955	2,983	26,306	1991	1,018	7,695
1956	2,981	26,167	1992	704	6,848
1957	2,979	25,950	1993	496	6,461
1958	2,976	25,688	1994	1,296	5,735
1959	2,974	25,489	1995	3,733	5,345
1960	2,973	25,347	1996	1,361	5,002
1961	2,971	25,155	1997	2,057	4,630
1962	2,969	24,992	1998	1,047	4,138
1963	2,967	24,814	1999	5,624	3,506
1964	2,965	24,624	2000	6,152	3,354
1965	2,964	24,538	2001	1,162	3,262
1966	2,961	24,255	2002	1,034	3,383
1967	2,910	20,449	2003	1,997	3,610
1968	2,863	17,759	2004	2,682	3,947
1969	2,818	15,734	2005	2,792	4,363
1970	2,818	15,711	2006	2,100	5,058
1971	2,817	15,686	2007	2,002	5,911
1972	2,814	15,563	2008	5,330	6,766
1973	2,810	15,413	2009	841	7,568
1974	2,803	15,114	2010	2,505	8,231
1975	3,284	14,908	2011	2,544	8,808

Appendix C. Input file for darkblotched rockfish rebuilding based on selected SPRs.

```
#Title, #runnumber: 17 darkblotched_data.SS darkblotched_control.SS 3877.53
29168.1 8807.95 StartTime: Thu Sep 29 07:19:24 2011
SSv3_default_rebuild.dat
# Number of sexes
2
# Age range to consider (minimum age; maximum age)
0 45
# Number of fleets
1
# First year of projection (Yinit)
2011
# First Year of rebuilding period (Ydecl)
2001
# Number of simulations
1500
# Maximum number of years
500
# Conduct projections with multiple starting values (0=No;else yes)
0
# Number of parameter vectors
1000
# Is the maximum age a plus-group (1=Yes;2=No)
1
# Generate future recruitments using historical recruitments (1)  historical
recruits/spawner (2)  or a stock-recruitment (3)
3
# Constant fishing mortality (1) or constant Catch (2) projections
1
# Fishing mortality based on SPR (1) or actual rate (2)
1
# Pre-specify the year of recovery (or -1) to ignore
-1
# Fecundity-at-age
# 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 #runnumber: 17
darkblotched_data.SS darkblotched_control.SS 3877.53 29168.1 8807.95
 0 0 3.38911e-07 2.41141e-05 0.000740663 0.0109733 0.0770101 0.258095
0.537726 0.85554 1.16501 1.44637 1.69517 1.91251 2.10101 2.26355 2.40295
2.52191 2.62297 2.70847 2.78056 2.84116 2.89197 2.93448 2.96998 2.99958
3.02423 3.04474 3.06178 3.07594 3.08773 3.09751 3.10562 3.11235 3.11792
3.12254 3.12636 3.12953 3.13216 3.13433 3.13613 3.13762 3.13885 3.13987
3.14072 3.14175 #female fecundity; weighted by N in year Y_init across morphs
and areas
# Age specific selectivity and weight adjusted for discard and discard
mortality
 #wt and selex for gender,fleet: 1 1
 0.0126734 0.0517126 0.12861 0.238447 0.382141 0.513489 0.626987 0.72878
0.824981 0.915562 0.99785 1.07052 1.13359 1.18772 1.23385 1.27292 1.30588
1.33358 1.3568 1.37622 1.39243 1.40594 1.41719 1.42654 1.43431 1.44077
1.44612 1.45056 1.45425 1.4573 1.45983 1.46193 1.46367 1.46511 1.4663 1.46729
1.46811 1.46879 1.46935 1.46981 1.47019 1.47051 1.47078 1.47099 1.47117
1.47139
 0 0.101497 0.10176 0.115559 0.228296 0.497915 0.771901 0.921875 0.976634
0.993066 0.997791 0.999215 0.999685 0.999857 0.999927 0.999959 0.999975
```

```
0.999983 0.999988 0.999991 0.999993 0.999994 0.999995 0.999995 0.999996
0.999996 0.999996 0.999996 0.999996 0.999997 0.999997 0.999997 0.999997
0.999997 0.999997 0.999997 0.999997 0.999997 0.999997 0.999997 0.999997
0.999997 0.999997 0.999997 0.999997 0.999997
 #wt and selex for gender,fleet: 2 1
 0.0126734 0.0517126 0.130084 0.239075 0.376489 0.496587 0.593455 0.673903
0.743014 0.80319 0.854988 0.898771 0.935199 0.965153 0.989571 1.00935 1.02531
1.03813 1.04841 1.05664 1.06321 1.06845 1.07263 1.07596 1.07861 1.08071
1.08239 1.08373 1.08479 1.08563 1.0863 1.08683 1.08726 1.08759 1.08786
1.08807 1.08824 1.08837 1.08848 1.08857 1.08863 1.08869 1.08873 1.08876
1.08879 1.08882
 0 0.101497 0.101792 0.11609 0.218898 0.445125 0.681325 0.837681 0.918977
0.95768 0.97615 0.985376 0.990278 0.993053 0.994717 0.995768 0.99646 0.996933
0.997266 0.997506 0.997683 0.997815 0.997914 0.99799 0.998049 0.998094
0.998129 0.998157 0.998179 0.998196 0.998209 0.99822 0.998228 0.998235
0.99824 0.998244 0.998247 0.99825 0.998252 0.998254 0.998255 0.998256
0.998257 0.998258 0.998258 0.998259
# M and current age-structure in year Yinit: 2011
 # gender = 1
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07
 1272.03 1167.94 364.764 2149.18 750.897 729.742 893.667 786.08 533.023
251.088 256.226 1231.93 1016.6 170 294.364 170.692 405.5 119.271 37.4855
42.6727 49.9226 31.3269 8.87939 85.1151 63.9416 18.6537 14.1718 12.6261
8.22207 9.39646 26.0009 26.2139 22.3413 7.01104 3.64992 7.28878 8.48755
6.48496 5.85518 5.30185 4.80265 4.3324 3.89432 3.5459 3.19866 28.1168
 # gender = 2
 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07 0.07
0.07
 1272.03 1167.94 364.764 2149.18 750.886 729.91 895.093 789.126 536.154
252.921 258.311 1242.21 1025.61 171.737 297.986 173.293 413.383 122.307
38.8189 44.6993 52.6414 33.0736 9.37073 89.8746 67.5097 19.6874 14.9898
13.3847 8.7217 9.9794 27.607 27.7464 23.5454 7.35122 3.80728 7.56599 8.76775
6.67072 6.00123 5.41645 4.89692 4.41577 3.97183 3.62061 3.26809 28.7304
# Age-structure at Ydeclare= 2001
 581.004 2867.97 2423.52 417.313 748.685 450.039 1096.67 326.467 103.034
117.438 137.44 86.2551 24.4494 234.368 176.067 51.3641 39.023 34.7669 22.6401
25.8739 71.5954 72.1821 61.5185 19.3054 10.0503 20.0702 23.3711 17.8568
16.1227 14.599 13.2245 11.9296 10.7233 9.76392 8.80775 7.97653 7.12186 6.4004
5.59025 4.70581 3.91046 3.33396 2.95524 2.68569 2.46373 30.2778
 581.004 2867.97 2423.52 417.312 748.649 450.382 1102.56 331.242 105.952
122.464 144.494 90.8731 25.7614 247.161 185.695 54.1607 41.2412 36.8279
23.9988 27.4605 75.9687 76.354 64.7945 20.23 10.4775 20.8214 24.1288 18.3579
16.5155 14.9062 13.4765 12.1523 10.9306 9.96407 8.99392 8.141 7.25773 6.51704
5.71818 4.86642 4.09004 3.49611 3.0754 2.76702 2.51982 30.6187
# Year for Tmin Age-structure (set to Ydecl by SS)
2001
#  recruitment and biomass
# Number of historical assessment years
121
# Historical data
# year recruitment spawner in B0 in R project in R/S project
```

```
1891  1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905
1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920
1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935
1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950
1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980
1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
2011 #years (with first value representing R0)
3008.31  3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31
3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31
3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31
3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31 3008.31
3008.31 3008.31 3008.16 3008.01 3007.85 3007.65 3007.53 3007.42 3007.32
3007.21 3007.15 3007.08 3006.99 3006.85 3006.64 3006.37 3006.04 3004.65
3001.51 2995.95 2992.68 2990.05 2988.74 2987.84 2986.87 2985.73 2984.56
2983.74 2982.69 2981.32 2979.15 2976.48 2974.41 2972.94 2970.9 2969.15
2967.21 2965.12 2964.16 2960.96 2910.34 2863.09 2818.35 2817.76 2817.16
2814.09 2810.3 2802.57 3283.93 2504.06 1104.1 1845.14 5044.87 5012.28 4144.35
1228.91 874.632 1091.33 991.471 1061.42 2958.78 3221.37 274.474 787.043
1018.31 703.758 495.805 1295.56 3732.56 1360.93 2056.99 1047.48 5623.94
6151.83 1162.01 1034.41 1997.24 2682.37 2792.16 2099.71 2002.3 5329.93
841.357 2505.26 2544.05 #recruits; first value is R0 (virgin)
29168.1  29168.1 29168 29167.9 29167.8 29167.8 29167.8 29167.8 29167.8
29167.8 29167.8 29167.8 29167.8 29167.8 29167.8 29167.8 29167.8 29167.8
29167.8 29167.7 29167.7 29167.7 29167.7 29167.7 29167.6 29167.6 29167.6
29167.6 29167.5 29167.5 29167.5 29167.4 29167.4 29167.3 29167.3 29167.3
29167.2 29167.2 29149.7 29131.3 29111.3 29086.8 29072.4 29058.7 29046.6
29033.1 29025.9 29017.2 29006.5 28989.2 28963.9 28930.7 28891.8 28724.3
28353.8 27719.2 27358.2 27073.3 26933.8 26838.6 26736.6 26617.3 26496.4
26412.6 26305.5 26166.9 25950.1 25687.6 25488.5 25347.3 25155.4 24992.2
24813.6 24624 24538.2 24254.6 20448.6 17758.5 15734.3 15710.5 15686.1 15562.6
15412.6 15113.7 14907.8 14892.1 14822.9 15072.5 15222.8 15105.5 15116.8
14887.6 14374.1 13800.5 13048.6 12019 11602 10296.4 9492.7 8836.37 7694.64
6848.3 6460.68 5734.83 5345.23 5002.25 4630.15 4137.72 3506.31 3353.75
3261.53 3383.17 3609.7 3946.65 4362.89 5057.64 5910.63 6766.18 7568.02
8231.42 8807.95 #spbio; first value is SPB_virgin (virgin)
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0  # in Bzero
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1  0 0 0 # in R project
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1  0 0 0 # in R/S project
# Number of years with pre-specified catches
2
# catches for years with pre-specified catches go next
2011 298
2012 296
# Number of future recruitments to override
11
```

```
# Process for overiding (-1 for average otherwise index in data list)
2001 1 2001
2002 1 2002
2003 1 2003
2004 1 2004
2005 1 2005
2006 1 2006
2007 1 2007
2008 1 2008
2009 1 2009
2010 1 2010
2011 1 2011
# Which probability to product detailed results for (1=0.5; 2=0.6; etc.)
3
# Steepness sigma-R Auto-correlation
0.76 0.8 0
# Target SPR rate (FMSY Proxy); manually change to SPR_MSY if not using
SPR_target
0.5
# Discount rate (for cumulative catch)
0.1
# Truncate the series when 0.4B0 is reached (1=Yes)
0
# Set F to FMSY once 0.4B0 is reached (1=Yes)
0
# Maximum possible F for projection (-1 to set to FMSY)
-1
# Defintion of recovery (1=now only;2=now or before)
2
# Projection type
11
# Definition of the 40-10 rule
10 40
# Calculate coefficients of variation (1=Yes)
0
# Number of replicates to use
10
# Random number seed
-99004
# File with multiple parameter vectors
rebuild.SSO
# User-specific projection (1=Yes); Output replaced (1->9)
0  5
# Catches and Fs (Year; 1/2/3 (F or C or SPR); value); Final row is -1
2013 1 1
-1 -1 -1
# Fixed catch project (1=Yes); Output replaced (1->9); Approach (-1=Read in
else 1-9)
0 2 -1
# Split of Fs
2011  1
-1  1
# Yrs to define T_target for projection type 4 (a.k.a. 5 pre-specified
inputs)
0.607 0.649 0.649 0.621 0.5
# Year for probability of recovery
```

```
2014 2018 2022 2025 2028 2031 2034 2037
# Time varying weight-at-age (1=Yes;0=No)
0
# File with time series of weight-at-age data
none
# Use bisection (0) or linear interpolation (1)
1
# Target Depletion
0.4
# CV of implementation error
0
```