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Rebuilding analysis for widow rockfish in 2009

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1. Introduction

In 1998, the PFMC adopted Amendment 11 to the Groundfish Management Plan, which established a minimum stock size threshold of 25% of unfished spawning potential. Based on the stock assessment in 2000 (Williams *et al*. 2000), widow rockfish was formally declared to be overfished in 2001, thereby requiring the development of a rebuilding plan. The 2003 stock assessment (He *et al*. 2003) estimated that the spawning output in 2002 was just below 25% of unfished spawning output. However, in recent stock assessments (He *et al*. 2005, 2007, 2009), the assessment models estimated that the population has never been overfished. This rebuilding analysis is an update based on this year's assessment. It provides information needed to develop harvest specifications for widow rockfish, and is in accord with the SSC Terms of Reference for Groundfish Rebuilding Analyses.

Recent catches and management performance for widow rockfish is presented in Table 1. In general, catches since 2002 have been low and are all below OYs (optimal yields) in recent years. Depletions (current spawning output as a percentage of virgin spawning output) were estimated to be 24.5% in the 2001 assessment, 35.5% in the 2007 assessment, and 38.5% in the current assessment, respectively. The 2007 rebuilding analysis (He *et al*. 2007) forecasted that the population would recover to over 40% of virgin level by 2009. However, the 2009 assessment showed that because the recent recruitments were not as strong as expected from the 2007 assessment, the population was still under the 40% target.

2. Overview of the calculations involved in rebuilding analysis

This rebuilding analysis uses the SSC Default Rebuilding Analysis program as implemented by Punt (2009) (Version 3.12a, September 2009). Historical estimates of spawning output and recruitment are taken from the 2009 assessment (He *et al*. 2009). In the assessment model, growth parameters and selectivity are based on the two-area, two-sex, four-fishery model used in the assessment, and fecundities differ between the southern and northern areas. Since only one vector of fecundity by age can be used in the rebuilding analysis, a spatially-averaged fecundity was used where the weights were the numbers of female fish in each age group in the last year of the assessment period (2009)

3. Estimation of B_0

The analysis used B_0 estimated in the assessment program, which was the virgin spawning output of 40,547 million eggs (in 1915). Mean generation time was estimated to be 17 years, which is the same as in previous rebuilding analysis.

4. Method to generate future recruitments

Future recruitments were generated from the stock-recruitment curve estimated in the 2009 assessment model (He *et al*. 2009), in which the steepness parameter (h) was 0.4061 and σ_R was 0.6. For all simulation runs in the report, the numbers of simulations were set to be 1,000.

5. Determination of minimum and maximum times to recovery

The population would be assessed to be rebuilt by 2010 using default outputs from the assessment base model and setting the catches in 2009 and 2010 at the their OYs because the

2009 assessment indicated that the population was near the target spawning output (depletion = 38.5%). An additional analysis with a lower recruitment potential (h = 0.30) was therefore included in this report. This analysis is similar to the decision analysis used in the 2009 assessment. In this analysis, minimum and maximum times to recovery were computed assuming no catch after 2000 ($T_{\min}$) and mean generation time of 17 years.

6. Harvest during rebuilding

A set of future catches, ranging from 0 mt to 3,000 mt, were evaluated in the analysis (Run 1 to Run 6a, Table 3). A set of harvest rates were also used in the analysis that correspond to a range of SPR rates of 0.80 to 0.975 (Table 4).

7. Evaluating progress towards rebuilding

Estimated ratios of spawning outputs over the target level (40% of B_0) were used to evaluate the population status for all years after 2009.

Table 4 and Figure 1 show the rebuilding results for Runs 1 to Run 6a. In all these runs, which have fixed annual catches of 0 mt to 3,000 mt between 2011 and 2020, the spawning outputs are always above the target level. Table 5 and Figure 2 show the rebuilding results for a set of SPR rates between 0.85 and 0.975 (Runs 7 to 11). Similar to Runs 1 to 6, the spawning outputs after 2010 are above the target level.

8. Decision analysis and model uncertainty

Decision analysis and rebuilding uncertainty were evaluated using a decision table run of h = 0.25 in the 2009 assessment. However, recovery does not occur before $T_{\max}$ with 0.5 probability if h=0.25 irrespective of the future harvest rates (including zero) because this is precluded by the catches that have occurred during the rebuild period.. A separate assessment model was then conducted using h = 0.3. The outputs from this run were then used in the analysis. In this analysis, estimated recruitments between 2001 and 2009 were used.

The results are presented in Table 6 and Figure 3 (Run 12 and Run 13). These runs indicated that spawning output in 2011 is at 0.766 of the target, which corresponds to the depletion level of 30.7% of B_0. The population is projected to recover in 2036 if no catch is taken after 2010. If the SPR_{target} is 0.95, the population is projected to have a probability of 0.62 to recover by 2036 and corresponding annual OYs for 2011 and 2012 will be 256 mt and 243 mt, respectively. Run 12 also projects that the population will recover by 2036 with probability of 0.6 with corresponding OYs for 2011 and 2012 of 297 mt and 282 mt, respectively.

9. Documentation

The rebuilding data file (rebuild.dat) that has a range of SPR rates from 0.80 to 0.975 (Run8) is attached to this report (Appendix A).

10.. Literature cited

He, X., A. Punt, A. D. MacCall, and S. Ralston. 2003. Rebuilding analysis for widow rockfish in 2003. Status of the Pacific coast grounfish fishery through 2003, stock assessment and fishery evaluation, Volume 1. Pacific Fisheries Management Council, August 2003.

He, X., S.V. Ralston, A.D. MacCall, D.E. Pearson, and E.J. Dick. 2006a. Status of the widow rockfish resource in 2005. Status of the Pacific coast groundfish fishery through 2003, stock assessment and fishery evaluation, Volume III. Pacific Fisheries Management Council, April 2006.

He, X., D.E. Person, E.J. Dick, J.C. Field, S.V. Ralston, and A.D. MacCall. 2007. Status of the widow rockfish resource in 2007, An update. Document submitted to the Pacific Fisheries Management Council, July 2007.

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Punt, A. 2009. SSC default rebuilding analysis (Version 3.12a, September 2009). University of Washington, Seattle. (rebuild.exe dated 9-10-2009)

Williams, E. H., A. D. MacCall, S. V. Ralston, and D. E. Pearson. 2000. Status of the widow rockfish resource in Y2K. In: Appendix to Status of the Pacific coast groundfish fishery through 2000 and recommended acceptable biological catches for 2001. Stock assessment and fishery evaluation. Pacific Fishery Management Council. 2130 SW Fifth Avenue, Suite 224, Portland, OR, 97201.

11. Tables

Table 1. Widow rockfish management performance under rebuilding.

Year	ABC (mt)	OY (mt)	Catch (mt)
2001	3,727	2,300	1,989
2002	3,727	856	432
2003	3,871	832	43
2004	3,460	284	101
2005	3,218	285	199
2006	3,059	289	215
2007	5,334	368	258
2008	5,144	368	243
2009	7,728	522	
2010	6,937	509	

Table 2. Summary of widow rockfish rebuilding reference points from the 2007 rebuilding analysis and this year's analysis. Spawning output has unit of millions of eggs.

Parameter	2007 rebuilding	2009 assessment base model (h = 0.406)	2009 assessment assuming h = 0.3
Virgin spawning output	50,746	40,547	42,166
Target spawning output	20,298	15,625	12,539
Current spawning output	17,999	16,218	16,866
T_{min}	2009	2008	2019
Mean generation time	17	17	17
T_{max}	2031		2036*
P_{max}			0.6**
T_{target}	2015	2015	2033*
SPR_{target}	0.95	0.95	0.942*

* Re-estimated

** Assumed

Table 3. Specifications of the rebuilding runs for widow rockfish. The specifications for the "Base" runs (1 to 9) are based on the base model from the 2009 assessment model. The run setups for "h = 0.3" are based on the 2009 alternative state of nature that has h = 0.3. Catches for 2009 and 2010 are set to the OYs selected by the Council in 2007 (522 mt and 509 mt, respectively).

Run number	Run setup	Catch (mt) after 2010 or SPR rate
1	Base	Catch = 0 mt
2	Base	Catch = 200 mt
3	Base	Catch = 400 mt
4	Base	Catch = 600 mt
5	Base	Catch = 800mt
6	Base	Catch = 1,000mt
6a	Base	Catch = 3,000mt
7	Base	SPR = 97.5%
8	Base	SPR = 95.0%
9	Base	SPR = 92.5%
10	Base	SPR = 90.0%
11	Base	SPR = 85.0%
12	h = 0.3	Catch = 0 mt
13	h = 0.3	SPR = 95.0%

Table 4a. Results of rebuilding runs (Run 1 to Run 6) for widow rockfish based on the 2009 assessment base model. Specifications for each run are listed in Table 3. All catches are in metric tons (mt). Catches for 2009 and 2010 are assumed to be the OYs agreed by the Council in 2007 (522 mt and 509 mt, respectively). SP/Target is the ratio of spawning output over the target (40% of B_0).

	Run1		Run2		Run3		Run4		Run5		Run6	
Recovery year	2010		2010		2010		2010		2010		2010	
Probability of recovery by 2010	1.0		1.0		1.0		1.0		1.0		1.0	
2011 ABC (mt)	5,097		5,097		5,097		5,097		5,097		5,097	
2012 ABC (mt)	4,923		4,909		4,895		4,882		4,868		4,854	
SPR_{target} after 2010	1.000		0.971		0.943		0.917		0.891		0.866	
Year	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target
2011	0	1.02	200	1.02	400	1.02	600	1.02	800	1.02	1,000	1.02
2012	0	1.04	200	1.04	400	1.04	600	1.03	800	1.03	1,000	1.03
2013	0	1.05	200	1.04	400	1.04	600	1.03	800	1.03	1,000	1.02
2014	0	1.05	200	1.04	400	1.03	600	1.02	800	1.02	1,000	1.01
2015	0	1.06	200	1.05	400	1.04	600	1.02	800	1.01	1,000	1.00
2016	0	1.07	200	1.06	400	1.05	600	1.03	800	1.02	1,000	1.01
2017	0	1.10	200	1.08	400	1.07	600	1.05	800	1.04	1,000	1.02
2018	0	1.13	200	1.11	400	1.10	600	1.08	800	1.06	1,000	1.04
2019	0	1.16	200	1.14	400	1.12	600	1.10	800	1.09	1,000	1.07
2020	0	1.20	200	1.17	400	1.15	600	1.13	800	1.11	1,000	1.09

Table 4b. Results of rebuilding runs (Run 1 to Run 6) for widow rockfish based on the 2009 assessment base model. Specifications for each run are listed in Table 3. All catches are in metric tons (mt). Catches for 2009 and 2010 are assumed to be the OYs agreed by the Council in 2007 (522 mt and 509 mt, respectively). SP/Target is the ratio of spawning output over the target (40% of B_0).

	Run6a	
Recovery year	2010	
Probability of recovery by 2010	1.0	
2011 ABC (mt)	5,097	
2012 ABC (mt)	4,716	
SPR_{target} after 2010	1.000	
Year	Catch	SP/Target
2011	3,000	1.02
2012	3,000	1.00
2013	3,000	0.97
2014	3,000	0.93
2015	3,000	0.90
2016	3,000	0.88
2017	3,000	0.87
2018	3,000	0.87
2019	3,000	0.88
2020	3,000	0.88

Table 5. Results of rebuilding runs (Run 7 to Run 11) for widow rockfish based on the 2009 assessment base model. Specifications for each run are listed in Table 3. All catches are in metric tons (mt). Catches for 2009 and 2010 are assumed to be the OYs agreed by the Council in 2007 (522 mt and 509 mt, respectively). SP/Target is the ratio of spawning output over the target (40% of B_0).

	Run7		Run8		Run9		Run10		Run11	
Recovery year	2010		2010		2010		2010		2010	
Probability of recovery by 2010	1.0		1.0		1.0		1.0		1.0	
2011 ABC (mt)	5,097		5,097		5,097		5,097		5,097	
2012 ABC (mt)	4,845		4,873		4,886		4,899		4,911	
SPR_{target} after 2010	0.850		0.900		0.925		0.950		0.975	
Year	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target	Catch	SP/Target
2011	1,128	1.02	727	1.02	536	1.02	352	1.02	173	1.02
2012	1,071	1.03	694	1.03	514	1.03	339	1.04	167	1.04
2013	1,012	1.02	659	1.03	489	1.03	323	1.04	159	1.04
2014	986	1.01	645	1.02	479	1.03	317	1.04	157	1.04
2015	1,008	1.00	661	1.02	491	1.03	325	1.04	161	1.05
2016	1,044	1.01	686	1.03	511	1.04	338	1.05	168	1.06
2017	1,088	1.02	716	1.05	533	1.06	354	1.07	175	1.09
2018	1,131	1.04	745	1.07	555	1.09	369	1.10	183	1.12
2019	1,164	1.06	770	1.09	575	1.11	382	1.13	190	1.15
2020	1,191	1.08	789	1.12	590	1.14	393	1.16	195	1.18

Table 6. Results of rebuilding runs (Run 12 to Run 13) for widow rockfish based on the 2009 assessment model with a different state of nature, in which the steepness value (h) is fixed at 0.3. Specifications for each run are listed in Table 3. All catches are in metric tons (mt). Catches for 2009 and 2010 are assumed to be the OYs agreed by the Council in 2007 (522 mt and 509 mt, respectively). SP/Target is the ratio of spawning output over the target (40% of B_0).

	Run12		Run13	
Recovery year	2036		2036	
Probability of recovery by 2036	0.76		0.62	
2011 ABC (mt)	3,685		3,685	
2012 ABC (mt)	3,520		3,503	
SPR_{target} after 2010	1.000		0.950	
Year	Catch	SP/Target	Catch	SP/Target
2011	0	0.74	256	0.74
2012	0	0.76	243	0.76
2013	0	0.76	229	0.76
2014	0	0.77	223	0.76
2015	0	0.76	228	0.75
2016	0	0.76	237	0.75
2017	0	0.77	246	0.75
2018	0	0.79	256	0.77
2019	0	0.80	264	0.78
2020	0	0.82	270	0.79

12. Figures

Figure 1. Projected spawning output versus the target (40% of B_0) for Runs 1 to 6a for widow rockfish rebuilding from 2009 to 2050.

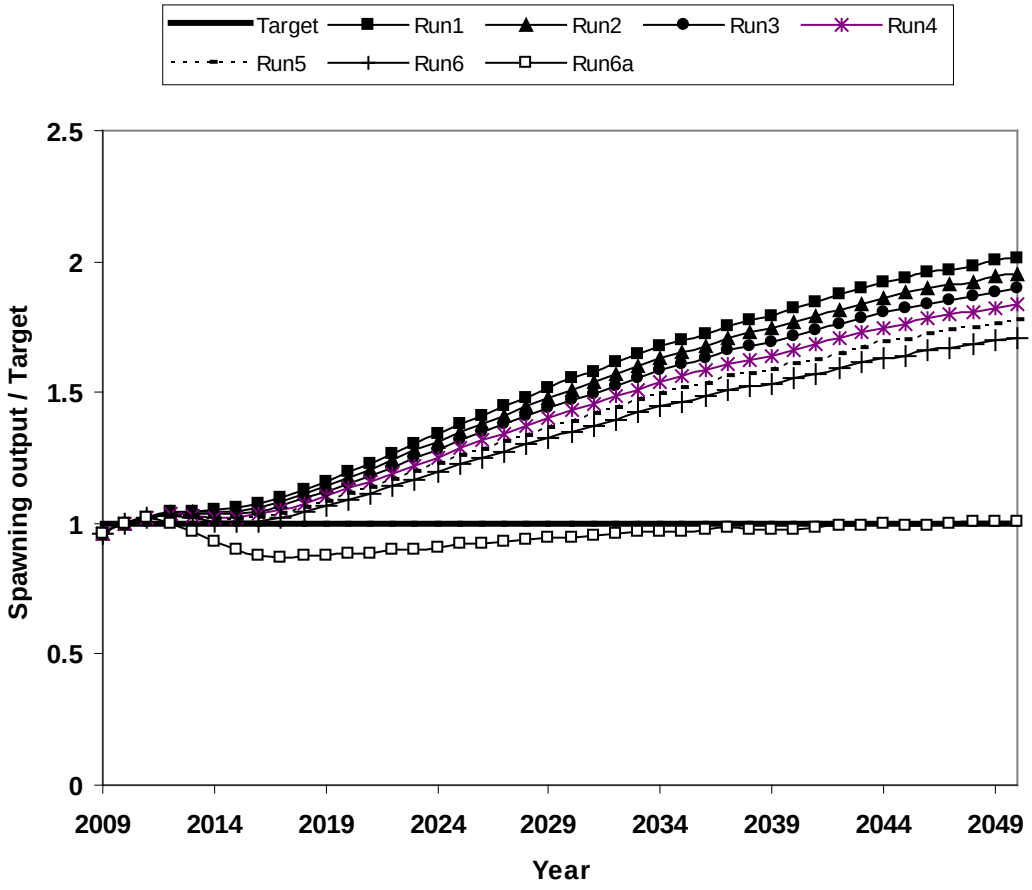


Figure 2. Projected spawning output versus the target (40% of B_0) for Runs 7 to 11 for widow rockfish rebuilding from 2009 to 2050.

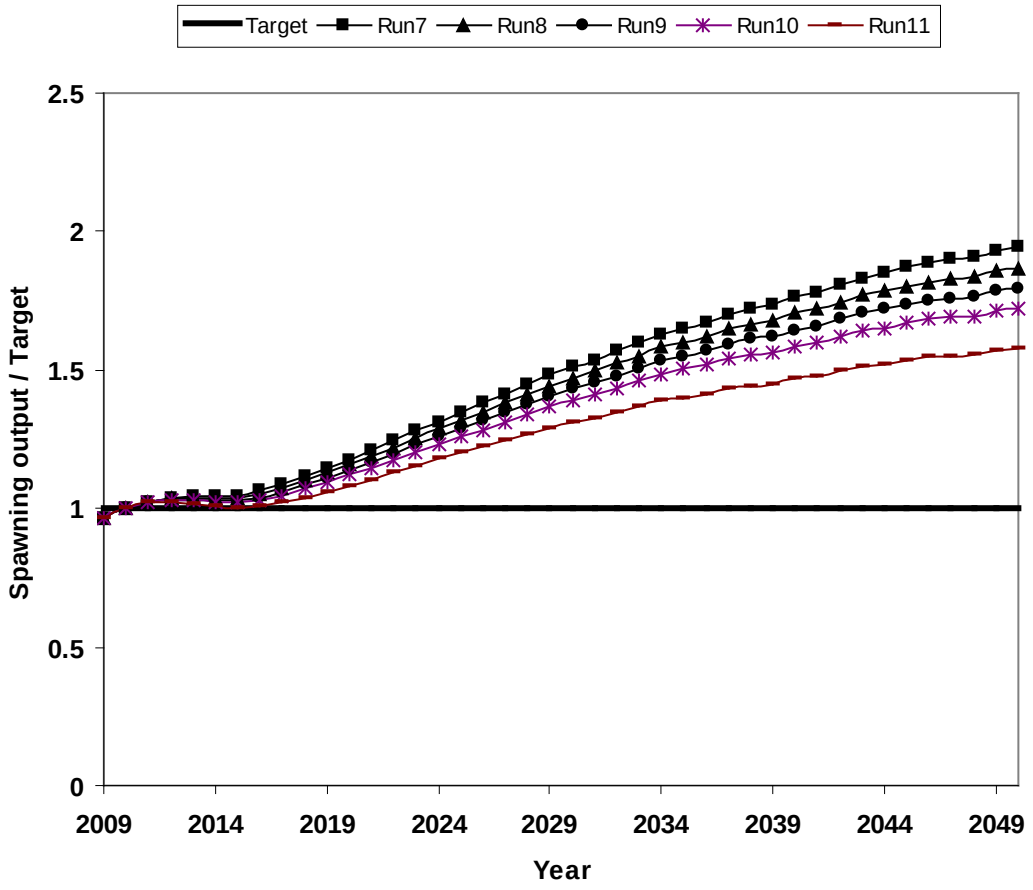
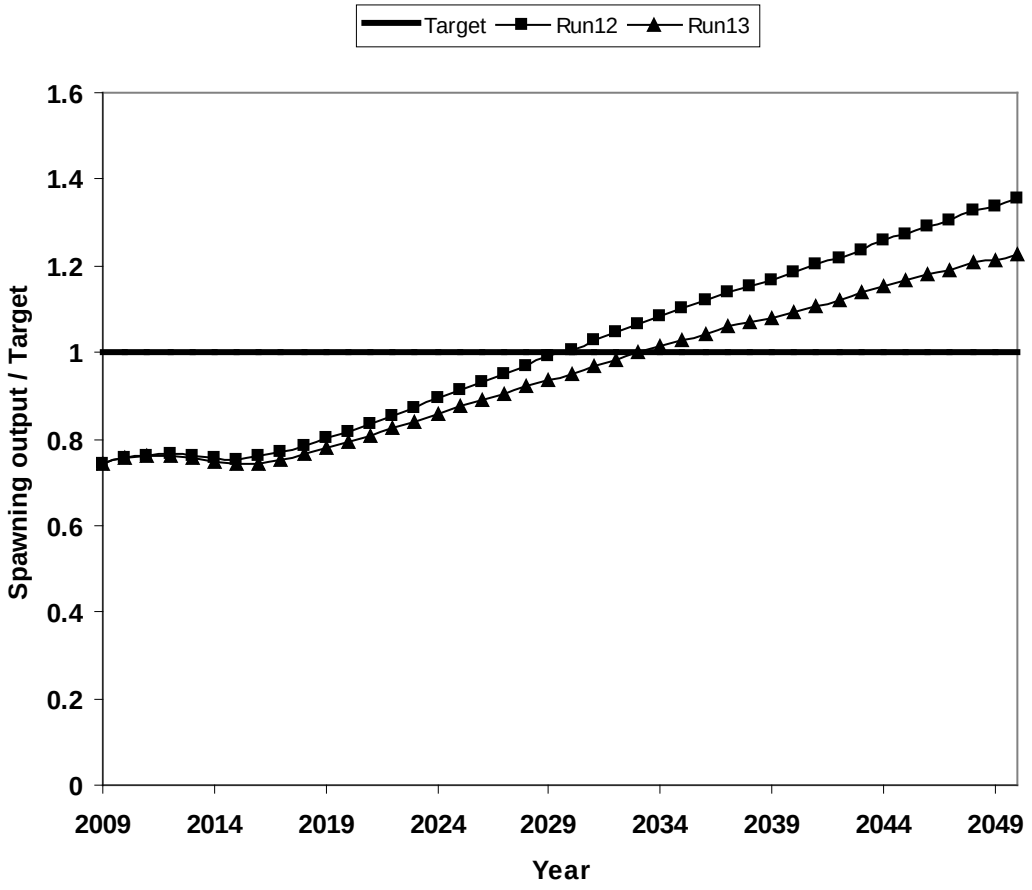


Figure 3. Projected spawning output versus the target (40% of B_0) for Runs 12 and 13 for widow rockfish rebuilding from 2009 to 2050.



Appendix A. Rebuilding data file (rebuild.dat) for Run 8 that has set of SPR rates from 0.80 to 0.975.

#Title, #runnumber: 1324 wdw1.dat wdw1.ctl 650.068 40547.2 15625.1 StartTime: Fri Sep 11 08:42:27 2009
SSv3_default_rebuild.dat
Number of sexes
2
Age range to consider (minimum age; maximum age)
0 30
Number of fleets
4
First year of projection (Yinit)
2009
First Year of rebuilding period (Ydecl)
2000
Number of simulations
1000
Maximum number of years
200
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 #runnumber: 1324 wdw1.dat wdw1.ctl 650.068 40547.2 15625.1
0 0 0 0.000183935 0.000594251 0.0106173 0.0569371 0.158874 0.275523 0.368037 0.44049 0.507873 0.565866 0.617829 0.663986 0.704573 0.739735 0.770859 0.798174 0.821227 0.841005 0.857389 0.870658 0.882936 0.895538 0.907509 0.917071 0.926117 0.936793 0.948787 0.986086 #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
0.0259525 0.088646 0.216807 0.374977 0.505178 0.641461 0.779121 0.914451 1.0447 1.1679 1.28275 1.38836 1.48429 1.57045 1.64707 1.71467 1.77392 1.8256 1.87052 1.90947 1.94318 1.97234 1.99755 2.01933 2.03816 2.05443 2.06851 2.08069 2.09123 2.10035 2.10826
2.534e-008 1.3149e-007 2.3452e-005 0.000428114 0.00772152 0.124234 0.735449 0.971187 0.943255 0.894601 0.844268 0.793917 0.744204 0.695633 0.648598 0.603402 0.56026 0.519311 0.480636 0.444263 0.410178 0.378337 0.348672 0.321099 0.295519 0.27183 0.249923 0.229689 0.211021 0.193813 0.177963
#wt and selex for gender,fleet: 1 2

0.0259525 0.088646 0.216807 0.374977 0.505178 0.641461 0.779121 0.914451 1.0447 1.1679 1.28275
1.38836 1.48429 1.57045 1.64707 1.71467 1.77392 1.8256 1.87052 1.90947 1.94318 1.97234 1.99755
2.01933 2.03816 2.05443 2.06851 2.08069 2.09123 2.10035 2.10826
1.05995e-006 7.74084e-007 2.61073e-005 0.000317188 0.00379405 0.0434832 0.355837 0.829288
0.827874 0.726441 0.627661 0.539504 0.462042 0.394558 0.336154 0.285869 0.242752 0.2059
0.174484 0.147755 0.125051 0.105788 0.0894615 0.0756341 0.0639301 0.0540283 0.0456541
0.0385739 0.0325891 0.0275312 0.0232571
#wt and selex for gender,fleet: 1 3
0.0259525 0.088646 0.216807 0.374977 0.505178 0.641461 0.779121 0.914451 1.0447 1.1679 1.28275
1.38836 1.48429 1.57045 1.64707 1.71467 1.77392 1.8256 1.87052 1.90947 1.94318 1.97234 1.99755
2.01933 2.03816 2.05443 2.06851 2.08069 2.09123 2.10035 2.10826
8.51426e-008 2.08752e-007 1.35537e-005 0.000224858 0.00368041 0.0563383 0.469947 0.86544
0.905004 0.889152 0.860979 0.824736 0.782304 0.735491 0.686031 0.635474 0.585123 0.53601
0.488898 0.44431 0.402572 0.363845 0.328168 0.295492 0.265703 0.238651 0.214157 0.192036
0.172097 0.154153 0.138027
#wt and selex for gender,fleet: 1 4
0.0207554 0.0534052 0.112247 0.215484 0.358227 0.515841 0.67648 0.831598 0.97577 1.10605
1.22125 1.32135 1.40708 1.47965 1.54052 1.59122 1.63323 1.66791 1.69647 1.71994 1.73921 1.75501
1.76797 1.77858 1.78728 1.7944 1.80023 1.805 1.80891 1.81211 1.81473
1e-006 1e-006 5.70293e-005 0.000822524 0.0117425 0.146396 0.71227 0.972779 0.998069 0.999869
0.999993 1 0.999996 0.999988 0.99997 0.999935 0.999862 0.999714 0.999414 0.998802 0.997561
0.995046 0.989966 0.979788 0.959712 0.9213 0.851919 0.738723 0.581505 0.405782 0.251277
#wt and selex for gender,fleet: 2 1
0.0328739 0.107005 0.250798 0.409651 0.515536 0.616992 0.711409 0.797368 0.874321 0.942311
1.00176 1.05329 1.09767 1.13568 1.16807 1.19558 1.21887 1.23854 1.25512 1.26907 1.28079 1.29063
1.29889 1.3058 1.3116 1.31645 1.32051 1.3239 1.32675 1.32912 1.33111
1e-006 1e-006 3.43724e-005 0.000584687 0.00982653 0.147323 0.812674 1 0.905023 0.799822
0.703359 0.616319 0.538339 0.468896 0.407386 0.353159 0.305553 0.263911 0.227604 0.196036
0.168656 0.144958 0.124484 0.106824 0.0916113 0.0785224 0.0672722 0.0576108 0.0493199
0.0422097 0.0361154
#wt and selex for gender,fleet: 2 2
0.0328739 0.107005 0.250798 0.409651 0.515536 0.616992 0.711409 0.797368 0.874321 0.942311
1.00176 1.05329 1.09767 1.13568 1.16807 1.19558 1.21887 1.23854 1.25512 1.26907 1.28079 1.29063
1.29889 1.3058 1.3116 1.31645 1.32051 1.3239 1.32675 1.32912 1.33111
1e-006 1e-006 4.61817e-005 0.000519688 0.00575765 0.0611197 0.463264 1 0.924647 0.751501
0.601411 0.478805 0.379806 0.300407 0.237058 0.186724 0.146863 0.115378 0.0905609 0.0710306
0.0556808 0.0436288 0.0341736 0.0267602 0.0209505 0.0163994 0.0128352 0.0100446 0.00786015
0.00615035 0.00481224
#wt and selex for gender,fleet: 2 3
0.0328739 0.107005 0.250798 0.409651 0.515536 0.616992 0.711409 0.797368 0.874321 0.942311
1.00176 1.05329 1.09767 1.13568 1.16807 1.19558 1.21887 1.23854 1.25512 1.26907 1.28079 1.29063
1.29889 1.3058 1.3116 1.31645 1.32051 1.3239 1.32675 1.32912 1.33111
1e-006 1e-006 2.6482e-005 0.000395525 0.00582822 0.080319 0.603167 1 0.94143 0.8327 0.725904
0.626002 0.534578 0.452468 0.379951 0.316852 0.262652 0.216611 0.177869 0.145527 0.118707
0.0965878 0.078429 0.063577 0.0514667 0.0416166 0.033621 0.0271416 0.0218978 0.0176585
0.0142344
#wt and selex for gender,fleet: 2 4
0.026781 0.0679213 0.13956 0.248329 0.371649 0.492226 0.602587 0.699266 0.781422 0.849735
0.905642 0.95086 0.987109 1.01597 1.03884 1.05689 1.07109 1.08223 1.09096 1.0978 1.10314
1.10731 1.11056 1.1131 1.11509 1.11663 1.11783 1.11877 1.1195 1.12007 1.12052
5.21575e-008 2.40376e-007 6.31769e-005 0.000885398 0.0122823 0.148792 0.703435 0.933519
0.930678 0.905966 0.880432 0.855517 0.831298 0.807761 0.784883 0.762639 0.740999 0.719918
0.69933 0.67912 0.659077 0.638807 0.617556 0.593907 0.565271 0.527287 0.473777 0.399197
0.305343 0.207042 0.12458
M and current age-structure in year Yinit: 2009

gender = 1
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
12567.4 7959.14 4944.43 4036.57 4866.22 5939.04 3849.9 6937.19 2314.32 5415.35 2906.58 3260.31
1425.62 917.286 770.064 931.207 1046.05 588.926 1654.28 938.923 372.988 294.54 405.518 122.542
209.491 227.488 184.428 110.377 270.097 179.603 703.561
gender = 2
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125 0.125
12567.4 7959.14 4944.43 4036.57 4866.22 5938.97 3849.46 6932.99 2311.18 5405.06 2901.09 3256.27
1425.1 915.747 763.69 913.406 1017.88 574.102 1620.24 926.148 373.278 301.411 426.432 133.711
238.566 269.23 225.968 140.575 358.64 248.819 1215.07
Age-structure at Ydeclare= 2000
16913.8 9122.49 10266.2 4496.13 2923.09 2563.51 3360.36 3971.66 2216.56 6114.03 3410.95 1334.84
1040.59 1417.26 424.337 719.283 774.951 624.068 371.17 902.071 595.361 121.653 349.421 205.518
37.5946 56.1952 31.4785 22.6702 26.8851 53.7408 1328.27
16913.8 9122.49 10266.2 4496.12 2923.02 2562.89 3352.42 3919.1 2159.58 5912.91 3293.79 1300.27
1032.61 1441.8 447.183 790.132 884.155 737.067 455.776 1155.66 796.852 170.441 508.104 307.303
56.8498 84.9562 49.6796 39.0998 49.8358 104.415 2413.61
Year for Tmin Age-structure (set to Ydecl by SS)
2000
recruitment and biomass
Number of historical assessment years
95
Historical data
year recruitment spawner in B0 in R project in R/S project
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 #years (with first value representing R0)
39790.5 39790.8 39783.9 39773.2 39761.4 39754.1 39747.3 39742.6 39739.4 39735.9 39735.1 39733.4
39728.8 39725.7 39721.6 39718 39712.1 39707.6 39703.2 39700.4 39697.2 39693.6 39689.1 39685.4
39683.4 39682.5 39680.6 39679.6 39681.8 39675.2 39649.7 39594.9 39551.3 39537.5 39528.2 39526.1
39522.1 39505.2 39490.5 39479.3 39474.6 39468.7 39450.2 39026.4 40694.7 42326.1 41649.1 42985.7
40806.7 49174.4 49584.4 46890.2 56087.9 54512.1 47187.4 125384 37811.4 20009.6 17955.7 24264.2
31291.3 13979.7 55223.6 73166.4 20530.3 81039.9 97131 31452.7 41267.3 39578.6 29014.1 13833.1
36340.1 20421.1 19949.1 38272.7 51694.9 14464.5 20447.7 14368.1 9585.6 9639.21 13083.7 26364.2
20674.3 33827.5 12686.4 33394.7 16308.5 22192 16046.1 11746.4 12697.6 18037.8 25134.8 #recruits;
first value is R0 (virgin)
40547.2 40547.2 40527.8 40498.1 40465.2 40445 40426 40412.9 40404 40394.3 40392.3 40387.5
40374.6 40366 40354.8 40344.7 40328.5 40316 40303.9 40296 40287.2 40277.2 40264.8 40254.6
40249.1 40246.5 40241.3 40238.6 40244.7 40226.3 40156.3 40005.6 39886.4 39848.8 39823.4 39817.7
39806.8 39760.8 39720.8 39690.6 39677.7 39661.8 39611.5 39557.2 39487.4 39445.5 39415 39402.1
39379.8 39342.1 39303.1 39364.5 38546.7 37603.4 37324.7 37598.2 38032.9 38587.7 39327 40102.3
41161.7 42648.2 44431.6 45292.3 45072.9 43609.5 37174.2 29777.9 22991.1 20928.9 19978.1 19617.5
20018.5 20247.6 20287.8 19194.4 18185.2 17627.4 16798.5 15457.7 14507.3 13597.4 13266 13103.7
13149.1 12852.1 12294.4 11999.6 12024.3 12259 12735.3 13402.7 14170.9 14908 15625.1 #spbio; first
value is S0 (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 # 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 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 0 0 0 # in R/S project
Number of years with pre-specified catches
2
catches for years with pre-specified catches go next
2009 522
2010 509
Number of future recruitments to override
0
Process for overiding (-1 for average otherwise index in data list)
Which probability to product detailed results for (1=0.5; 2=0.6; etc.)
4
Steepness sigma-R Auto-correlation
0.406104 0.6 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 2
Catches and Fs (Year; 1/2/3 (F or C or SPR); value); Final row is -1
2011 2 600
2040 2 600
-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
2009 0.00266775 0.00418769 4.73365e-005 0.00213116
-1 0.00266775 0.00418769 4.73365e-005 0.00213116
Yrs to define T_target for projection type 4 (a.k.a. 5 pre-specified inputs)
0.85 0.90 0.925 0.95 0.975
Year for probability of recovery
2009 2010 2011 2012 2013 2014 2015 2016
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
```