Rebuilding Update for Pacific Ocean Perch in 2009

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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 ($0.25B_0$). NMFS determined that a rebuilding plan was required for Pacific ocean perch (*Sebastes alutus*) in March 1999 based on the most recent stock assessment at that time (Ianelli and Zimmerman 1998). The PFMC began developing a rebuilding plan for Pacific ocean perch and submitted this plan to NMFS in February 2000. However, NMFS deferred adoption of the plan until the stock assessment was updated and reviewed, later that year (Ianelli *et al.* 2000).

A full stock assessment for Pacific ocean perch stock was conducted in 2003 (Hamel *et al*., 2003), and subsequently updated every two years (Hamel 2005, 2007, 2009). This assessment, similar to that of Ianelli *et al*. (2000), involves fitting an age-structured population dynamics model to catch, catch-rate, length-frequency, age-composition, and survey data. Ianelli *et al*. (2000), Hamel *et al*. (2003), and Hamel (2005, 2007, 2009) presented results based on maximum likelihood and Bayesian estimation frameworks. Punt (2002) conducted a rebuilding analysis based upon the estimates corresponding to the maximum of the posterior density function (the MPD estimates) from Ianelli et al.'s Model 1c because the STAR panel selected this model variant as the "best assessment" (PFMC 2000). In contrast, the STAR panel that evaluated the 2003 assessment of Pacific ocean perch endorsed both the MPD estimates and the distributions for the model outputs that arose from the application of the MCMC algorithm to sample equally likely parameter vectors from the posterior distribution (PFMC 2003). Punt et al. (2003) conducted a rebuilding analysis with runs based upon both the MPD estimates and the MCMC outputs. The PFMC adopted a rebuilding plan based upon the results of the MCMC analysis. This rebuilding analysis was updated in 2005 and 2007. For this update, rebuilding plan parameters are those specified after the rebuilding analyses in 2005/7.

Management under rebuilding has been effective. While catch exceed the OY in 2001 (by 3 mt) and 2007 (by 6 mt), total catch for 2000-2008 (1376 mt) was only 47% of the combined OYs (2938 mt).

2. Specifications

2.1 Selection of B_0

The unfished spawning stock biomass, B_0, is determined from the fitted stock-recruitment relationship in order to be more consistent with the assumptions underlying the original stock assessment. The MPD estimate of B_0 is 36,983 mt of spawning output while the posterior median and 90% intervals for B_0 are 34,573 mt and (27,620; 44,097). The values for B_0 are slightly lower than those on which the previous rebuilding analyses were based (Table 1). The MPD depletion estimate at the start of 2009 is 0.275 while the posterior median and 90% intervals are 0.311 (0.228; 0.398)

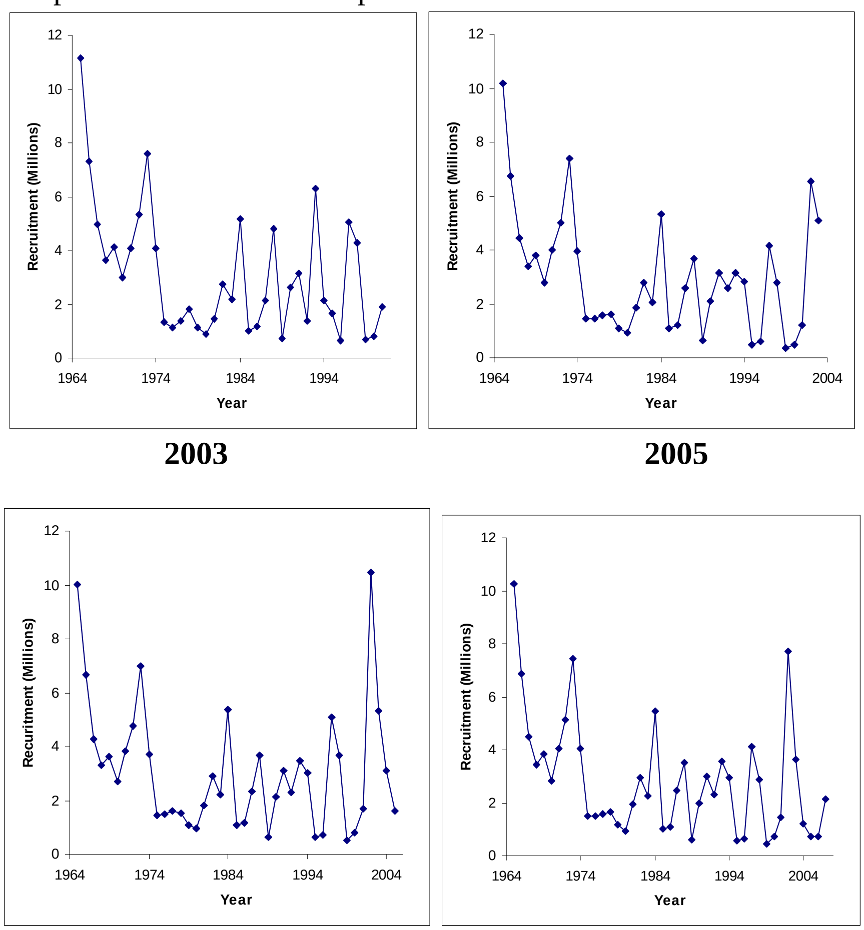
Table 1. MPD and posterior median estimates of unfished spawning stock biomass (B_0) and depletion for the 2003, 2005, 2007 and 2009 stock assessments.

	2003	**2005**	**2007**	**2009**
B_0 MPD (mt)	39,198	37,838	36,983	37,780
B_0 Posterior Median (mt)	37,230	35,371	34,573	35,391
B_0 90% Interval (mt)	29,035 47,393	28,022 44,866	27,620 44,097	27,728 45,189
Depletion MPD	25.4%	23.4%	27.5%	28.6%
Depletion Posterior Median	27.7%	27.6%	31.1%	33.2%
Depletion 90% Intervals	20.1% 38.4%	19.8% 37.1%	22.8% 39.8%	23.8% 45.3%

2.2 Generation of future recruitment

Recruitment in the assessment and projection models for Pacific ocean perch relate to the abundance of 3 year olds. The assessment of Pacific ocean perch by Hamel *et al*. (2003) and its updates (Hamel 2005, 2007, 2009) include the assumption that, *apriori*, recruitment is related to spawning output according to a Beverton-Holt stock-recruitment relationship. The rebuilding analysis conducted by Punt et al. (2003) included three different approaches: 1) basing the projections on resampling historical recruitments or from those for the years 1965-2001, 2) basing the projections on resampling historical recruits per spawner for those same years, and 3) assuming a Beverton-Holt spawner recruit relationship. The first approach was chosen by the Council for the final rebuilding plan.

The rationale for generating future recruitment by sampling historical recruitment for the rebuilding analysis conducted by Punt (2002) was that 1965-1998 was a period of relative stability in recruitment. In contrast to recruitment, recruits/spawning output showed an increasing trend over time. Resampling historical recruitment (3 year olds from the years 1965-2007; year classes 1962-2004) is used exclusively for the analyses in this document in order to remain consistent with the adopted rebuilding plan. Figure 1 plots the MPD estimates of recruitment and recruits / spawning output from the assessments conducted by Hamel *et al*. (2003) and Hamel (2005, 2007, 2009). Hamel (2009) estimated steepness for Pacific ocean perch to be 0.51.



2003 **2005**

2007 **2009**

Figure 1: Recruitment: Pacific ocean perch assessments conducted in 2003, 2005, 2007 and 2009.

2.3 Mean generation time

The mean generation time is defined as the mean age weighted by net spawning output (see Figure 2 for net spawning output *versus* age (MPD estimates)). The best estimate of the mean generation time for the full posterior is 28 years. This is unchanged from the previous rebuilding analyses (Table 3).

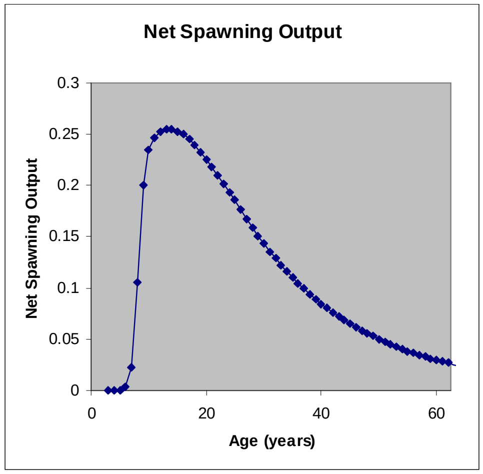


***Figure 2**: Relationship between net spawning output and age for Pacific Ocean perch.*

2.4 The harvest strategies

Table 2 summarizes the options considered in the rebuilding analyses. These include a no catch option (case 1), using the calculated SPR from the last rebuilding analysis (case 2), using the implied SPR in the current analysis from the 2009-10 OYs (189/200 mt; case 3), or using the ABC harvest rule (Case 4). The other 7 cases using values of T_{target} near the calculated $T_{50\%}$ for cases 2 and 3 (cases 5-7), and a spread of cases from T_{min} to T_{max} (cases 8-11). I report the probability of recovering by 2031, choosing the date halfway between T_{min} and T_{max}.

Case	**Name**	$\mathbf{T_{50\%}}$	**2011 OY**	**SPR**	$\mathbf{P_{2031}}$
1	$T_{F=0}$	2018	0	1.000	0.855
2	SPR from 2005/7 rebuilding	2020	180	0.864	0.771
3	SPR from 2009-10 OYs	2021	204	0.848	0.754
4	ABC rule	2065	1026	0.500	0.351
5	T_{target} = 2019	2019	111	0.912	0.807
6	T_{target} = 2020	2020	198	0.852	0.757
7	T_{target} = 2021	2021	265	0.811	0.714
8	T_{target} = 2024	2024	404	0.736	0.633
9	T_{target} = 2031	2031	635	0.636	0.500
10	T_{target} = 2038	2038	751	0.595	0.435
11	T_{target} = 2045 (T_{MAX})	2045	836	0.568	0.402

2.5 Other specifications

The calculations in this document were performed using Version 2.8 and 3.12a of the rebuilding software developed by Punt (2005, 2009) and the results are based on 3,000 Monte Carlo replicates (3 simulations for each of 1,000 samples for the posterior).

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 1 lists the MPD estimates for the biological and technological parameters and the age-structure of the population at the start of 2000 and 2009. Appendix 2 lists the MPD time-series of recruitment and spawning output. The input to the rebuilding programs is given as Appendix 3 and 4. The catch for 2009 and 2010 were set to 189 and 200 mt (the Council-selected *OYs* for 2009-2010).

3. Results

3.1 Time-to-recovery

The median year for rebuilding to the target level in the absence of fishing since the year of overfished declaration, T_{min}, is 2017. Figure 3 shows the distribution for the number of years beyond the year 2000 that it would have taken to recover to $0.4B_0$ had there been no harvest since 2000. $T_{\max}$, the maximum permissible time period for rebuilding the stock to its target biomass, is 2042 when using the new information on the depletion level and the age-structure of the population in 2000. Table 3 gives summary statistics from the 2003, 2005 and 2007 rebuilding plans and the current analysis for full posterior results. The difference between the 2007 and 2009 results are largely due to the relatively low NWFSC trawl survey indices for POP in 2007 and 2008, coupled with a small data error in the 2007 assessment which was corrected in the current assessment. The results for the 2009 rebuilding analysis are relatively close to those from 2005. While the rebuilding timeline has changed substantially from the 2007 version, the resulting catch from a SPR = 0.864 policy has a much smaller change. $T_{F=0}$ (zero catch from 2011 onward) is greater than T_{min} due to a decade of catches in the interim.

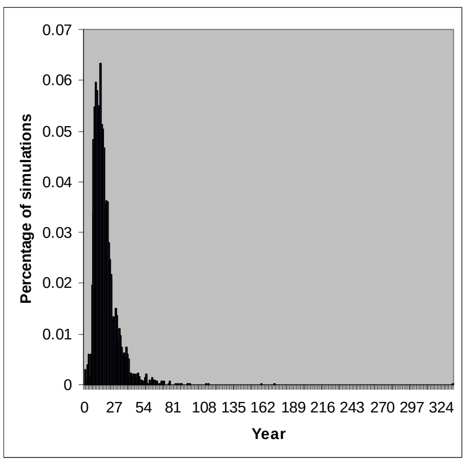


Figure 3: Distribution of time to recovery used to calculate T_{min}, the median year for rebuilding to the target level $0.4B_0$ in the absence of fishing since 2000 for the base-case analysis.

Table 3: Summary statistics

Value	2003	2005	2007	2009
T_{min}	2014	2015	2009	2017
Mean generation time	28 years	28 years	28 years	28 years
T_{max}	2042	2043	2037	2045
$T_{F=0}$ (No fishing mortality beginning in 2004, 2007, 2009, or 2011)	2014	2015	2010	2018
P_{MAX}	70.0	92.9		
T_{TARGET}	2027	2017		
SPR_{TARGET}		86.4%		

3.2 OYs and fishing mortalities

Table 4 gives the probabilities of recovery at 2031 and T_{max} (2045) and 10 year projected OY values based on the SPR for each of the 11 cases explored in this rebuilding analysis.

Table 4: Ten year OY/ABC projections.

Case	**1**		**2**		**3**		**4**	**5**		**6**		**7**		**8**		**9**		**10**		**11**	
RUN	**F=0**		**SPR'07**		**OY'9-10**		**ABC**	**2019**		**2020**		**2021**		**2024**		**2031**		**2038**		**2045**	
SPR	1		0.864		0.848		0.5	0.912		0.852		0.811		0.736		0.636		0.595		0.568	
F	0		0.0079		0.0090		0.0450	0.0048		0.0087		0.0116		0.0177		0.0279		0.0330		0.0368	
T50%	2018		2020		2021		2065	2019		2020		2021		2024		2031		2038		2045	
P2031	85.5		77.1		75.4		35.1	80.7		75.7		71.4		63.3		50.0		43.5		40.2	
P2045	95.8		89.7		88.7		42.7	92.9		88.9		85.6		78.1		62.7		55.0		50.0	
10 Year projected **OYs** and ABCs at SPR rate above:																					
2011	**0**	1026	**180**	1026	**204**	1026	**1026**	**111**	1026	**198**	1026	**265**	1026	**404**	1026	**635**	1026	**751**	1026	**836**	1026
2012	**0**	1057	**183**	1049	**208**	1048	**1007**	**113**	1052	**202**	1048	**269**	1045	**408**	1039	**635**	1028	**747**	1023	**829**	1019
2013	**0**	1073	**185**	1057	**210**	1054	**983**	**115**	1063	**204**	1055	**271**	1049	**408**	1036	**628**	1015	**735**	1004	**812**	996
2014	**0**	1097	**187**	1072	**212**	1069	**964**	**117**	1081	**206**	1070	**273**	1061	**409**	1043	**625**	1012	**729**	998	**803**	987
2015	**0**	1122	**191**	1089	**216**	1085	**946**	**119**	1102	**210**	1086	**278**	1074	**414**	1050	**628**	1010	**729**	992	**801**	978
2016	**0**	1150	**194**	1110	**219**	1104	**933**	**121**	1125	**213**	1105	**281**	1091	**418**	1062	**627**	1013	**726**	990	**795**	973
2017	**0**	1177	**198**	1129	**224**	1123	**927**	**124**	1147	**218**	1124	**287**	1107	**424**	1072	**632**	1018	**729**	991	**797**	971
2018	**0**	1204	**202**	1151	**229**	1144	**926**	**127**	1171	**222**	1146	**292**	1125	**431**	1086	**639**	1025	**734**	995	**800**	973
2019	**0**	1236	**207**	1174	**234**	1167	**926**	**130**	1198	**227**	1168	**299**	1147	**438**	1105	**645**	1036	**739**	1004	**804**	980
2020	**0**	1273	**212**	1203	**239**	1194	**924**	**133**	1231	**232**	1196	**304**	1171	**445**	1120	**650**	1044	**743**	1007	**808**	982

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Punt, A.E. 2005/2009. SSC default rebuilding analysis. Technical specifications and user manual. Ver. 2.8 and Ver. 3.12a

Punt, A.E. 2002. Revised Rebuilding Analysis for Pacific Ocean Perch (July 2002). Pacific Fishery Management Council, 7700 Ambassador Place NE, Suite 200, Portland, OR.

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Appendix 1 : Biological and technological parameters used for the rebuilding analyses based on the MPD estimates.

Age	Fecundity	Weight (kg)	Selectivity	Natural mortality	*N* (2000)	*N* (2009)
3	0.000	0.169	0.001	0.0524	730	1,620
4	0.000	0.241	0.004	0.0524	430	1,540
5	0.000	0.317	0.016	0.0524	2,580	1,930
6	0.004	0.396	0.062	0.0524	3,540	620
7	0.028	0.474	0.197	0.0524	530	580
8	0.137	0.550	0.408	0.0524	440	930
9	0.274	0.622	0.598	0.0524	2,080	2,630
10	0.339	0.690	0.779	0.0524	2,340	5,300
11	0.375	0.752	0.915	0.0524	1,360	940
12	0.404	0.809	0.989	0.0524	1,590	450
13	0.431	0.861	1.000	0.0524	930	260
14	0.454	0.908	0.979	0.0524	250	1,550
15	0.475	0.950	0.979	0.0524	1,270	2,110
16	0.494	0.987	0.979	0.0524	780	310
17	0.510	1.021	0.979	0.0524	300	250
18	0.525	1.050	0.979	0.0524	240	1,200
19	0.538	1.076	0.979	0.0524	1,140	1,340
20	0.550	1.099	0.979	0.0524	410	780
21	0.560	1.119	0.979	0.0524	470	910
22	0.569	1.137	0.979	0.0524	270	530
23	0.576	1.153	0.979	0.0524	120	140
24	0.583	1.166	0.979	0.0524	130	730
25+	0.589	1.178	0.979	0.0524	3,260	4,090

Appendix 2 : MPD historical series of spawning output and recruitment.

Year	Recruitment (age 3)	Spawning output
1956	3,810	33,483
1957	46,540	32,280
1958	4,120	31,161
1959	18,630	30,732
1960	8,860	30,451
1961	4,180	30,606
1962	3,610	32,342
1963	4,870	33,959
1964	14,420	33,573
1965	10,270	33,217
1966	6,870	30,673
1967	4,490	21,904
1968	3,440	16,061
1969	3,850	14,180
1970	2,820	15,863
1971	4,030	16,683
1972	5,120	17,054
1973	7,440	17,215
1974	4,030	16,882
1975	1,490	16,615
1976	1,490	16,675
1977	1,570	16,645
1978	1,660	17,048
1979	1,170	16,913
1980	940	16,394
1981	1,930	15,548
1982	2,930	14,735
1983	2,260	14,140
1984	5,460	13,015
1985	1,020	11,987
1986	1,090	11,126
1987	2,480	10,510
1988	3,520	10,195
1989	600	9,888
1990	1,970	9,499
1991	3,000	9,091
1992	2,290	8,514
1993	3,570	8,252
1994	2,930	7,825
1995	580	7,477
1996	650	7,362
1997	4,140	7,349
1998	2,860	7,500
1999	450	7,669
2000	730	7,711
2001	1,450	7,811
2002	7,710	8,025
2003	3,620	8,448
2004	1,210	8,676
2005	710	8,708
2006	720	8,884
2007	2,150	9,528
2008	1,620	10,342
2009		10,794

Appendix 3: Input File Ver. 2.8 (2005) (for SPR based on 2007-2010 specifications)

```
#Title
POP Re2009
# Number of sexes
1
# Age range to consider (minimum age; maximum age)
3 25
# Number of fleets
1
# First year of projection
2009
# Year declared overfished
2000
# 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)
1
# 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

34

# Fecundity-at-age

# 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

3.84E-06 4.03E-05 0.000392248 0.003560962 0.028260766 0.1374925 0.273954602 0.338584679 0.375081501 0.404469053 0.430553194 0.453991276 0.4749965 0.493739 0.510395 0.52515 0.53818 0.549655 0.559745 0.568595 0.576345 0.58313 0.589055

# Age specific information (Females then males) weight  selectivity

#
0.169105 0.240603 0.317273 0.395966 0.474162 0.54997 0.62206 0.689572 0.752022 0.80921 0.861146 0.907988 0.949993 0.987478 1.02079 1.0503 1.07636 1.09931 1.11949 1.13719 1.15269 1.16626 1.17811


0.001053831	0.004071712	0.016086685	0.062376525	0.197451646	0.407541849	0.597679152
	0.77855632	0.914572718	0.989329767	1	0.97908111	0.97908111	0.97908111
	0.97908111	0.97908111	0.97908111	0.97908111	0.97908111	0.97908111
	0.97908111	0.97908111	0.97908111
# M and current age-structure
#
0.0524459	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459
	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459
	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459	0.0524459
	0.0524459	0.0524459	0.0524459	0.0524459
1621.2	1538.35	1934.49	618.412	576.981	928.787	2627.6	5297.23	942.499	445.726	259.836	1550.73	2105.33
	308.998	254.436	1196.52	1337.2	775.886	909.249	530.029	141.388	729.503	4091.12
# Age-structure at declaration

728.677	427.942	2576.32	3536.44	525.92	438.302	2081.86	2341.98	1360.89	1591.29	925.018	246.453	1271.6
	782.641	298.887	243.973	1141.13	414.899	473.571	271.56	115.097	125.361	3264.12
# Year for Tmin Age-structure

2000

# Number of simulations

3000

#  recruitment and biomass
```

```
# Number of historical assessment years

55

# Historical data

# year recruitment spawner in B0 in R project in R/S project

1955    5.05071 37780    1      0       0
1956    3.81005 33482.7 0       0       0
1957    46.539  32279.7 0       0       0
1958    4.12277 31160.8 0       0       0
1959    18.6279 30731.8 0       0       1
1960    8.86124 30450.6 0       0       1
1961    4.17782 30605.6 0       0       1
1962    3.60617 32342.1 0       0       1
1963    4.87395 33958.9 0       0       1
1964    14.4209 33572.9 0       0       1
1965    10.2657 33217.2 0       1       1
1966    6.86537 30673.1 0       1       1
1967    4.49322 21903.8 0       1       1
1968    3.43633 16060.9 0       1       1
1969    3.85028 14179.7 0       1       1
1970    2.82413 15862.9 0       1       1
1971    4.02554 16682.5 0       1       1
1972    5.11638 17054.4 0       1       1
1973    7.44304 17214.7 0       1       1
1974    4.03033 16881.6 0       1       1
1975    1.48891 16615.4 0       1       1
1976    1.49155 16675.4 0       1       1
1977    1.56796 16645   0       1       1
1978    1.65985 17048   0       1       1
1979    1.17152 16912.9 0       1       1
1980    0.939295 16393.5 0      1       1
1981    1.93024 15547.9 0       1       1
1982    2.93066 14734.7 0       1       1
1983    2.25863 14140.4 0       1       1
1984    5.46058 13015   0       1       1
1985    1.01962 11987.4 0       1       1
1986    1.08802 11126.4 0       1       1
1987    2.47944 10510.4 0       1       1
1988    3.51639 10194.9 0       1       1
1989    0.597451 9888.32 0      1       1
1990    1.97259 9499.19 0       1       1
1991    3.00426 9091.12 0       1       1
1992    2.28769 8513.58 0       1       1
1993    3.57031 8252.42 0       1       1
1994    2.93232 7825.35 0       1       1
1995    0.576252 7476.51 0      1       1
1996    0.650919 7362.1 0       1       1
1997    4.14277 7348.73 0       1       1
1998    2.86189 7499.76 0       1       1
1999    0.451006 7668.72 0      1       1
2000    0.728677 7711.22 0      1       1
2001    1.45313 7811.13 0       1       1
2002    7.71169 8025.19 0       1       1
2003    3.61549 8448.11 0       1       1
2004    1.20941 8675.66 0       1       1
2005    0.712026 8708.42 0      1       1
2006    0.72388 8884.16 0       1       1
2007    2.1485  9528.15 0       1       1
2008    1.6212  10341.6 0       0       0
2009    1.6212  10794.1 0       0       0
# Number of years with pre-specified catches
2
# catches for years with pre-specified catches
2009    189
2010    200
# Number of future recruitments to override
0
# Process for overriding (-1 for average otherwise index in data list)
# Which probability to product detailed results for (1=0.5; 2=0.6; etc.)
3
```

```
# Steepness sigma-R Auto-correlation
0.514   1       0
# Target SPR rate (FMSY Proxy)
0.5
# Target SPR information: Use (1=Yes) and power
0       20
# 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
# Percentage of FMSY which defines Ftarget
0.9
# Maximum possible F for projection (-1 to set to FMSY)
-1
# Conduct MacCall transition policy (1=Yes)
0
# Defintion of recovery (1=now only;2=now or before)
2
# Results for rec probs by Tmax (1) or 0.5 prob for various Ttargets (2)
1
"# Definition of the ""40-10"" rule"
10      40
# Produce the risk-reward plots (1=Yes)
0
# Calculate coefficients of variation (1=Yes)
1
# Number of replicates to use
10
# Random number seed
-99004
# Conduct projections for multiple starting values (0=No;else yes)
1
# File with multiple parameter vectors
mcmcreb.dat
# Number of parameter vectors
1000
# User-specific projection (1=Yes); Output replaced (1->9)
1       5       0       0.1
# Catches and Fs (Year; 1/2/3 (F or C or SPR); value); Final row is -1
2011    3       0.864
-1      -1      -1
# Split of Fs
2009    1
-1      1
# Time varying weight-at-age (1=Yes;0=No)
0
# File with time series of weight-at-age data
HakWght.Csv
```

Appendix 4: Input File Ver. 3.12a (2009)

```
#Title
POP Re2009
# Number of sexes
1
# Age range to consider (minimum age; maximum age)
3 25
# Number of fleets
1
# First year of projection
2009
# First year OY could have been 0
2000
# Number of simulations
3000
# Maximum number of years to simulate
200
# Conduct projections with multiple starting values (0 = no)
1
# 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 BH stock-recruitment (3) or Ricker (4)
1
# 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

# 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

3.84E-06 4.03E-05 0.000392248 0.003560962 0.028260766 0.1374925 0.273954602 0.338584679 0.375081501
0.404469053 0.430553194 0.453991276 0.4749965 0.493739 0.510395 0.52515 0.53818 0.549655 0.559745
0.568595 0.576345 0.58313 0.589055

# Age specific information (Females then males) weight  selectivity

#
0.169105 0.240603 0.317273 0.395966 0.474162 0.54997 0.62206 0.689572 0.752022 0.80921 0.861146
0.907988 0.949993 0.987478 1.02079 1.0503 1.07636 1.09931 1.11949 1.13719 1.15269 1.16626 1.17811


0.001053831    0.004071712    0.016086685    0.062376525    0.197451646    0.407541849    0.597679152
       0.77855632     0.914572718    0.989329767    1       0.97908111     0.97908111     0.97908111
       0.97908111     0.97908111     0.97908111     0.97908111     0.97908111     0.97908111
       0.97908111     0.97908111     0.97908111
# M and current age-structure
#
0.0524459      0.0524459      0.0524459      0.0524459      0.0524459      0.0524459      0.0524459
       0.0524459      0.0524459      0.0524459      0.0524459      0.0524459      0.0524459
       0.0524459      0.0524459      0.0524459      0.0524459      0.0524459      0.0524459
       0.0524459      0.0524459      0.0524459      0.0524459
1621.2  1538.35 1934.49 618.412 576.981 928.787 2627.6  5297.23 942.499 445.726 259.836 1550.73 2105.33
       308.998 254.436 1196.52 1337.2  775.886 909.249 530.029 141.388 729.503 4091.12
# Age-structure at declaration

728.677 427.942 2576.32 3536.44 525.92  438.302 2081.86 2341.98 1360.89 1591.29 925.018 246.453 1271.6
       782.641 298.887 243.973 1141.13 414.899 473.571 271.56  115.097 125.361 3264.12
# Year Yinit^0 (used to compute the stock size at the start of year Ydecl)
2000
#Recruitment and Spawner biomasses
# Number of historical assessment years
55
```

```
# Historical data: Year, Recruitment, Spawner biomass, Used to compute B0, Used to project based
# on R, Used to project based on R/S
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
5050.71 3810.05 46539   4122.77 18627.9 8861.24 4177.82 3606.17 4873.95 14420.9 10265.7 6865.37 4493.22
        3436.33 3850.28 2824.13 4025.54 5116.38 7443.04 4030.33 1488.91 1491.55 1567.96 1659.85 1171.52
        939.295 1930.24 2930.66 2258.63 5460.58 1019.62 1088.02 2479.44 3516.39 597.451 1972.59 3004.26
        2287.69 3570.31 2932.32 576.252 650.919 4142.77 2861.89 451.006 728.677 1453.13 7711.69 3615.49
        1209.41 712.026 723.88  2148.5  1621.2  1621.2
37780   33482.7 32279.7 31160.8 30731.8 30450.6 30605.6 32342.1 33958.9 33572.9 33217.2 30673.1 21903.8
        16060.9 14179.7 15862.9 16682.5 17054.4 17214.7 16881.6 16615.4 16675.4 16645   17048   16912.9
        16393.5 15547.9 14734.7 14140.4 13015   11987.4 11126.4 10510.4 10194.9 9888.32 9499.19 9091.12
        8513.58 8252.42 7825.35 7476.51 7362.1  7348.73 7499.76 7668.72 7711.22 7811.13 8025.19 8448.11
        8675.66 8708.42 8884.16 9528.15 10341.6 10794.1
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       1       1       1       1
        1       1       1       1       1       1       1       1       1       1       1       1       1
        1       1       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       0       0       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
        0       0
# Number of years with pre-specified catches
2
# catches for years with pre-specified catches
2009    189
2010    200
# Number of future recruitments to override
9
# Process for overriding (-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
# Which probability to product detailed results for (1=0.5; 2=0.6; etc.)
3
# Steepness sigma-R Auto-correlation
0.514   1       0
# Target SPR rate (FMSY Proxy)
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
# Definition of recovery (1=now only;2=now or before)
2
#Projection Type
4
# 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
mcmcreb.dat
# User-specific projection (1=Yes); Output replaced (1->9)
0       5       0       0.1
# Catches and Fs (Year; 1/2/3 (F or C or SPR); value); Final row is -1
2011    3       0.864
-1      -1      -1
# Fixed Catch project (1=yes)
0
# Split of Fs
2009    1
-1      1
#prespecified inputs:
2020 2024 2031 2038 2045
# Years for which probability of recovery is needed
2019    2020    2021    2022 2024      2031    2038    2045
# Time-varying weight at age (1=yes,0=no)
0
# File with time series of weight-at-age data
HakWght.Csv
# Use bisection (0) or linear interpolation (1)
0
# Target Depletion
0.4
# CV of implementation error
0
```