

Appendix B: SMBKC Stock Assessment Input Files

The data file:

```
## #=====
## # Gmacs Main Data File Version 1.1: SM15 example
## # GEAR_INDEX DESCRIPTION
## # 1 : Pot fishery retained catch.
## # 1 : Pot fishery with discarded catch.
## # 2 : Trawl bycatch
## # 3 : Fixed bycatch
## # 4 : Trawl survey
## # 5 : Pot survey
##
## # Fisheries: 1 Pot Fishery, 2 Pot Discard, 3 Trawl by-catch, 3 Fixed by-catch
## # Surveys: 4 NMFS Trawl Survey, 5 Pot Survey
## #=====
##
## 1978 # Start year
## 2016 # End year
## 2017 # Projection year
## 5 # Number of seasons
## 5 # Number of distinct data groups (among fishing fleets and surveys)
## 1 # Number of sexes
## 1 # Number of shell condition types
## 1 # Number of maturity types
## 3 # Number of size-classes in the model
## 5 # Season recruitment occurs
## 5 # Season molting and growth occurs
## 4 # Season to calculate SSB
## 1 # Season for N output
## # size_breaks (a vector giving the break points between size intervals with dimension nclass+1)
## 90 105 120 135
## # weight-at-length input method (1 = allometry i.e.  $w_l = a \cdot l^b$ , 2 = vector by sex, 3 = matrix by sex)
## 3
## # weight-at-length allometry  $w_l = a \cdot l^b$ 
## 4.03E-07
## # b (male, female)
## 3.141334
## # Male weight-at-length
## 0.000748427 0.001165731 0.001930510
## 0.000748427 0.001165731 0.001688886
## 0.000748427 0.001165731 0.001922246
## 0.000748427 0.001165731 0.001877957
## 0.000748427 0.001165731 0.001938634
## 0.000748427 0.001165731 0.002076413
## 0.000748427 0.001165731 0.001899330
## 0.000748427 0.001165731 0.002116687
## 0.000748427 0.001165731 0.001938784
## 0.000748427 0.001165731 0.001939764
## 0.000748427 0.001165731 0.001871067
## 0.000748427 0.001165731 0.001998295
## 0.000748427 0.001165731 0.001870418
## 0.000748427 0.001165731 0.001969415
## 0.000748427 0.001165731 0.001926859
## 0.000748427 0.001165731 0.002021492
```

[illegible]

```

## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.1800 0.0000 0.4500 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## 0.0000 0.4400 0.0000 0.1900 0.3700
## # Fishing fleet names (delimited with : no spaces in names)
## Pot_Fishery:Trawl_Bycatch:Fixed_bycatch
## # Survey names (delimited with : no spaces in names)
## NMFS_Trawl:ADFG_Pot
## # Number of catch data frames
## 4
## # Number of rows in each data frame
## 27 15 25 25
## ## CATCH DATA
## ## Type of catch: 1 = retained, 2 = discard
## ## Units of catch: 1 = biomass, 2 = numbers
## ## for SMBKC Units are in number of crab for landed & 1000 kg for discards.
## ## Male Retained
## # year seas fleet sex obs cv type units mult effort discard_mortality
## 1978 2 1 1 436126 0.03 1 2 1 0 0
## 1979 2 1 1 52966 0.03 1 2 1 0 0
## 1980 2 1 1 33162 0.03 1 2 1 0 0
## 1981 2 1 1 1045619 0.03 1 2 1 0 0
## 1982 2 1 1 1935886 0.03 1 2 1 0 0
## 1983 2 1 1 1931990 0.03 1 2 1 0 0
## 1984 2 1 1 841017 0.03 1 2 1 0 0
## 1985 2 1 1 436021 0.03 1 2 1 0 0
## 1986 2 1 1 219548 0.03 1 2 1 0 0
## 1987 2 1 1 227447 0.03 1 2 1 0 0
## 1988 2 1 1 280401 0.03 1 2 1 0 0
## 1989 2 1 1 247641 0.03 1 2 1 0 0
## 1990 2 1 1 391405 0.03 1 2 1 0 0
## 1991 2 1 1 726519 0.03 1 2 1 0 0
## 1992 2 1 1 545222 0.03 1 2 1 0 0
## 1993 2 1 1 630353 0.03 1 2 1 0 0
## 1994 2 1 1 827015 0.03 1 2 1 0 0
## 1995 2 1 1 666905 0.03 1 2 1 0 0
## 1996 2 1 1 660665 0.03 1 2 1 0 0
## 1997 2 1 1 939822 0.03 1 2 1 0 0
## 1998 2 1 1 635370 0.03 1 2 1 0 0
## 2009 2 1 1 103376 0.03 1 2 1 0 0
## 2010 2 1 1 298669 0.03 1 2 1 0 0
## 2011 2 1 1 437862 0.03 1 2 1 0 0

```

## 2012	2	1	1	379386	0.03	1	2	1	0	0
## 2014	2	1	1	69109	0.03	1	2	1	0	0
## 2015	2	1	1	24407	0.03	1	2	1	0	0
## # Male discards Pot fishery										
## 1990	2	1	1	254.9787861	0.6	2	1	1	0	0.2
## 1991	2	1	1	531.4483252	0.6	2	1	1	0	0.2
## 1992	2	1	1	1050.387026	0.6	2	1	1	0	0.2
## 1993	2	1	1	951.4626128	0.6	2	1	1	0	0.2
## 1994	2	1	1	1210.764588	0.6	2	1	1	0	0.2
## 1995	2	1	1	363.112032	0.6	2	1	1	0	0.2
## 1996	2	1	1	528.5244687	0.6	2	1	1	0	0.2
## 1997	2	1	1	1382.825328	0.6	2	1	1	0	0.2
## 1998	2	1	1	781.1032977	0.6	2	1	1	0	0.2
## 2009	2	1	1	123.3712279	0.2	2	1	1	0	0.2
## 2010	2	1	1	304.6562225	0.2	2	1	1	0	0.2
## 2011	2	1	1	481.3572126	0.2	2	1	1	0	0.2
## 2012	2	1	1	437.3360731	0.2	2	1	1	0	0.2
## 2014	2	1	1	45.4839749	0.2	2	1	1	0	0.2
## 2015	2	1	1	21.19378597	0.2	2	1	1	0	0.2
## # Trawl fishery discards										
## 1991	2	2	1	3.538	0.31	2	1	1	0	0.8
## 1992	2	2	1	1.996	0.31	2	1	1	0	0.8
## 1993	2	2	1	1.542	0.31	2	1	1	0	0.8
## 1994	2	2	1	0.318	0.31	2	1	1	0	0.8
## 1995	2	2	1	0.635	0.31	2	1	1	0	0.8
## 1996	2	2	1	0.000	0.31	2	1	1	0	0.8
## 1997	2	2	1	0.000	0.31	2	1	1	0	0.8
## 1998	2	2	1	0.000	0.31	2	1	1	0	0.8
## 1999	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2000	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2001	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2002	2	2	1	0.726	0.31	2	1	1	0	0.8
## 2003	2	2	1	0.998	0.31	2	1	1	0	0.8
## 2004	2	2	1	0.091	0.31	2	1	1	0	0.8
## 2005	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2006	2	2	1	2.812	0.31	2	1	1	0	0.8
## 2007	2	2	1	0.045	0.31	2	1	1	0	0.8
## 2008	2	2	1	0.272	0.31	2	1	1	0	0.8
## 2009	2	2	1	0.635	0.31	2	1	1	0	0.8
## 2010	2	2	1	0.363	0.31	2	1	1	0	0.8
## 2011	2	2	1	0.181	0.31	2	1	1	0	0.8
## 2012	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2013	2	2	1	0.181	0.31	2	1	1	0	0.8
## 2014	2	2	1	0.000	0.31	2	1	1	0	0.8
## 2015	2	2	1	0.000	0.31	2	1	1	0	0.8
## # Fixed fishery discards										
## 1991	2	3	1	0.045	0.31	2	1	1	0	0.5
## 1992	2	3	1	2.268	0.31	2	1	1	0	0.5
## 1993	2	3	1	0.000	0.31	2	1	1	0	0.5
## 1994	2	3	1	0.091	0.31	2	1	1	0	0.5
## 1995	2	3	1	0.136	0.31	2	1	1	0	0.5
## 1996	2	3	1	0.045	0.31	2	1	1	0	0.5
## 1997	2	3	1	0.181	0.31	2	1	1	0	0.5
## 1998	2	3	1	0.907	0.31	2	1	1	0	0.5

## 1999	2	3	1	1.361	0.31	2	1	1	0	0.5
## 2000	2	3	1	0.000	0.31	2	1	1	0	0.5
## 2001	2	3	1	0.862	0.31	2	1	1	0	0.5
## 2002	2	3	1	0.408	0.31	2	1	1	0	0.5
## 2003	2	3	1	1.134	0.31	2	1	1	0	0.5
## 2004	2	3	1	0.635	0.31	2	1	1	0	0.5
## 2005	2	3	1	0.590	0.31	2	1	1	0	0.5
## 2006	2	3	1	1.451	0.31	2	1	1	0	0.5
## 2007	2	3	1	69.717	0.31	2	1	1	0	0.5
## 2008	2	3	1	6.622	0.31	2	1	1	0	0.5
## 2009	2	3	1	7.530	0.31	2	1	1	0	0.5
## 2010	2	3	1	9.571	0.31	2	1	1	0	0.5
## 2011	2	3	1	0.590	0.31	2	1	1	0	0.5
## 2012	2	3	1	0.590	0.31	2	1	1	0	0.5
## 2013	2	3	1	0.272	0.31	2	1	1	0	0.5
## 2014	2	3	1	0.272	0.31	2	1	1	0	0.5
## 2015	2	3	1	0.635	0.31	2	1	1	0	0.5

RELATIVE ABUNDANCE DATA

Units of abundance: 1 = biomass, 2 = numbers

for SMBKC Units are in crabs for Abundance.

Number of relative abundance indices

2

Number of rows in each index

39 9

Survey data (abundance indices, units are mt for trawl survey and crab/potlift for pot survey)

Year, Seas, Fleet, Sex, Abundance, CV units

## 1978	1	4	1	6832.819	0.394	1
## 1979	1	4	1	7989.881	0.463	1
## 1980	1	4	1	9986.830	0.507	1
## 1981	1	4	1	6551.132	0.402	1
## 1982	1	4	1	16221.933	0.344	1
## 1983	1	4	1	9634.250	0.298	1
## 1984	1	4	1	4071.218	0.179	1
## 1985	1	4	1	3110.541	0.210	1
## 1986	1	4	1	1416.849	0.388	1
## 1987	1	4	1	2278.917	0.291	1
## 1988	1	4	1	3158.169	0.252	1
## 1989	1	4	1	6338.622	0.271	1
## 1990	1	4	1	6730.130	0.274	1
## 1991	1	4	1	6948.184	0.248	1
## 1992	1	4	1	7093.272	0.201	1
## 1993	1	4	1	9548.459	0.169	1
## 1994	1	4	1	6539.133	0.176	1
## 1995	1	4	1	5703.591	0.178	1
## 1996	1	4	1	9410.403	0.241	1
## 1997	1	4	1	10924.107	0.337	1
## 1998	1	4	1	7976.839	0.355	1
## 1999	1	4	1	1594.546	0.182	1
## 2000	1	4	1	2096.795	0.310	1
## 2001	1	4	1	2831.440	0.245	1
## 2002	1	4	1	1732.599	0.320	1
## 2003	1	4	1	1566.675	0.336	1
## 2004	1	4	1	1523.869	0.305	1
## 2005	1	4	1	1642.017	0.371	1

```

## 2006 1 4 1 3893.875 0.334 1
## 2007 1 4 1 6470.773 0.385 1
## 2008 1 4 1 4654.473 0.284 1
## 2009 1 4 1 6301.470 0.256 1
## 2010 1 4 1 11130.898 0.466 1
## 2011 1 4 1 10931.232 0.558 1
## 2012 1 4 1 6200.219 0.339 1
## 2013 1 4 1 2287.557 0.217 1
## 2014 1 4 1 6029.220 0.449 1
## 2015 1 4 1 5877.433 0.770 1
## 2016 1 4 1 3485.909 0.393 1
## 1995 1 5 1 12042.000 0.130 2
## 1998 1 5 1 12531.000 0.060 2
## 2001 1 5 1 8477.000 0.080 2
## 2004 1 5 1 1667.000 0.150 2
## 2007 1 5 1 8643.000 0.090 2
## 2010 1 5 1 10209.000 0.130 2
## 2013 1 5 1 5643.000 0.190 2
## 2015 1 5 1 2805.000 0.180 2
## 2016 1 5 1 2378.000 0.186 2
## ## Number of length frequency matrices
## 3
## ## Number of rows in each matrix
## 15 39 9
## ## Number of bins in each matrix (columns of size data)
## 3 3 3
## ## SIZE COMPOSITION DATA FOR ALL FLEETS
## ## SIZE COMP LEGEND
## ## Sex: 1 = male, 2 = female, 0 = both sexes combined
## ## Type of composition: 1 = retained, 2 = discard, 0 = total composition
## ## Maturity state: 1 = immature, 2 = mature, 0 = both states combined
## ## Shell condition: 1 = new shell, 2 = old shell, 0 = both shell types combined
## ##length proportions of pot discarded males
## ##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
## 1990 2 1 1 0 0 0 15 0.1133 0.3933 0.4933
## 1991 2 1 1 0 0 0 25 0.1329 0.1768 0.6902
## 1992 2 1 1 0 0 0 25 0.1905 0.2677 0.5417
## 1993 2 1 1 0 0 0 25 0.2807 0.2097 0.5096
## 1994 2 1 1 0 0 0 25 0.2942 0.2714 0.4344
## 1995 2 1 1 0 0 0 25 0.1478 0.2127 0.6395
## 1996 2 1 1 0 0 0 25 0.1595 0.2229 0.6176
## 1997 2 1 1 0 0 0 25 0.1818 0.2053 0.6128
## 1998 2 1 1 0 0 0 25 0.1927 0.2162 0.5911
## 2009 2 1 1 0 0 0 50 0.1413 0.3235 0.5352
## 2010 2 1 1 0 0 0 50 0.1314 0.3152 0.5534
## 2011 2 1 1 0 0 0 50 0.1314 0.3051 0.5636
## 2012 2 1 1 0 0 0 50 0.1417 0.3178 0.5406
## 2014 2 1 1 0 0 0 50 0.0939 0.2275 0.6786
## 2015 2 1 1 0 0 0 50 0.1148 0.2518 0.6333
## ##length proportions of trawl survey males
## ##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
## 1978 1 4 1 0 0 0 50 0.3865 0.3478 0.2657
## 1979 1 4 1 0 0 0 50 0.4281 0.3190 0.2529
## 1980 1 4 1 0 0 0 50 0.3588 0.3220 0.3192

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## 1981 1 4 1 0 0 0 50 0.1219 0.3065 0.5716
## 1982 1 4 1 0 0 0 50 0.1671 0.2435 0.5893
## 1983 1 4 1 0 0 0 50 0.1752 0.2726 0.5522
## 1984 1 4 1 0 0 0 50 0.1823 0.2085 0.6092
## 1985 1 4 1 0 0 0 46.5 0.2023 0.2010 0.5967
## 1986 1 4 1 0 0 0 23 0.1984 0.4364 0.3652
## 1987 1 4 1 0 0 0 35.5 0.1944 0.3779 0.4277
## 1988 1 4 1 0 0 0 40.5 0.1879 0.3737 0.4384
## 1989 1 4 1 0 0 0 50 0.4246 0.2259 0.3496
## 1990 1 4 1 0 0 0 50 0.2380 0.2332 0.5288
## 1991 1 4 1 0 0 0 50 0.2274 0.3300 0.4426
## 1992 1 4 1 0 0 0 50 0.2263 0.2911 0.4826
## 1993 1 4 1 0 0 0 50 0.2296 0.2759 0.4945
## 1994 1 4 1 0 0 0 50 0.1989 0.2926 0.5085
## 1995 1 4 1 0 0 0 50 0.2593 0.3005 0.4403
## 1996 1 4 1 0 0 0 50 0.1998 0.3054 0.4948
## 1997 1 4 1 0 0 0 50 0.1622 0.3102 0.5275
## 1998 1 4 1 0 0 0 50 0.1276 0.3212 0.5511
## 1999 1 4 1 0 0 0 26 0.2224 0.2214 0.5562
## 2000 1 4 1 0 0 0 30.5 0.2154 0.2180 0.5665
## 2001 1 4 1 0 0 0 45.5 0.2253 0.2699 0.5048
## 2002 1 4 1 0 0 0 19 0.1127 0.2346 0.6527
## 2003 1 4 1 0 0 0 32.5 0.3762 0.2345 0.3893
## 2004 1 4 1 0 0 0 24 0.2488 0.1848 0.5663
## 2005 1 4 1 0 0 0 21 0.2825 0.2744 0.4431
## 2006 1 4 1 0 0 0 50 0.3276 0.2293 0.4431
## 2007 1 4 1 0 0 0 50 0.4394 0.3525 0.2081
## 2008 1 4 1 0 0 0 50 0.3745 0.2219 0.4036
## 2009 1 4 1 0 0 0 50 0.3057 0.4202 0.2741
## 2010 1 4 1 0 0 0 50 0.4081 0.3371 0.2548
## 2011 1 4 1 0 0 0 50 0.2179 0.3940 0.3881
## 2012 1 4 1 0 0 0 50 0.1573 0.4393 0.4034
## 2013 1 4 1 0 0 0 37 0.2100 0.2834 0.5065
## 2014 1 4 1 0 0 0 50 0.1738 0.3912 0.4350
## 2015 1 4 1 0 0 0 50 0.2340 0.2994 0.4666
## 2016 1 4 1 0 0 0 50 0.2255 0.2780 0.4965
## ##length proportions of pot survey
## ##Year, Seas, Fleet, Sex, Type, Shell, Maturity, Nsamp, DataVec
## 1995 1 5 1 0 0 0 100 0.1594 0.2656 0.5751
## 1998 1 5 1 0 0 0 100 0.0769 0.2205 0.7026
## 2001 1 5 1 0 0 0 100 0.1493 0.2049 0.6457
## 2004 1 5 1 0 0 0 100 0.0672 0.2484 0.6845
## 2007 1 5 1 0 0 0 100 0.1257 0.3148 0.5595
## 2010 1 5 1 0 0 0 100 0.1299 0.3209 0.5492
## 2013 1 5 1 0 0 0 100 0.1556 0.2477 0.5967
## 2015 1 5 1 0 0 0 100 0.0706 0.2431 0.6859
## 2016 1 5 1 0 0 0 100 0.0832 0.1917 0.7251
## ## Growth data (increment)
## # nobs_growth
## 3
## # MidPoint Sex Increment CV
## 97.5 1 14.1 0.2197
## 112.5 1 14.1 0.2197
## 127.5 1 14.1 0.2197

```



```

## # 97.5 1 13.8 0.2197
## # 112.5 1 14.1 0.2197
## # 127.5 1 14.4 0.2197
## # Use custom transition matrix (0=no, 1=growth matrix, 2=transition matrix, i.e. growth and molting)
## 2
## # The custom growth matrix (if not using just fill with zeros)
## # Alternative TM (loosely) based on Otto and Cummiskey (1990)
## 0.2 0.7 0.1
## 0.0 0.4 0.6
## 0.0 0.0 1.0
## ## eof
## 9999
##

```

The match model control file:

```

## # Set up to do Stock Reduction Analysis using Catch data and informative priors.
## # Controls for leading parameter vector theta
## # LEGEND FOR PRIOR:
## #
## # 0 -> uniform
## # 1 -> normal
## # 2 -> lognormal
## # 3 -> beta
## # 4 -> gamma
## # ntheta
## 12
## # ival lb ub phz prior p1 p2 # parameter #
## 0.18 0.01 1 -4 2 0.18 0.02 # M
## 14.3 -7.0 30 -2 0 -7 30 # log(R0)
## 10.0 -7.0 20 -1 1 -10.0 20 # log(Rini)
## 10.0 -7.0 20 1 0 -7 20 # log(Rbar)
## 80.0 30.0 310 -2 1 72.5 7.25 # Recruitment size distribution
## 0.25 0.1 7 -4 0 0.1 9.0 # Recruitment size scale (varian
## 0.2 -10.0 0.75 -4 0 -10.0 0.75 # log(sigma_R)
## 0.75 0.20 1.00 -2 3 3.0 2.00 # steepness
## 0.01 0.00 1.00 -3 3 1.01 1.01 # recruitment autocorrelation
## 14.5 5.00 20.00 1 0 5.00 20.00 # logNO vector of initial number
## 14.0 5.00 20.00 1 0 5.00 20.00 # logNO vector of initial number
## 13.5 5.00 20.00 1 0 5.00 20.00 # logNO vector of initial number
## ## GROWTH PARAM CONTROLS ##
## ## Two lines for each parameter if split sex, one line if not ##
## # ival lb ub phz prior p1 p2 # parameter #
## 14.1 10.0 30.0 -3 0 0.0 999.0 # alpha males or combined
## 0.0001 0.0 0.01 -3 0 0.0 999.0 # beta males or combined
## 0.45 0.01 1.0 -3 0 0.0 999.0 # gscale males or combined
## 121.5 65.0 145.0 -4 0 0.0 999.0 # molt_mu males or combined
## 0.060 0.0 1.0 -3 0 0.0 999.0 # molt_cv males or combined
##
## ## ----- ##
## ## SELECTIVITY CONTROLS ##
## ## Each gear must have a selectivity and a retention selectivity. If a uniform ##
## ## prior is selected for a parameter then the lb and ub are used (p1 and p2 are ##
## ## ignored) ##

```

```

## ## LEGEND ##
## ## sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95, ##
## ## 4 = double normal (NIY) ##
## ## gear index: use +ve for selectivity, -ve for retention ##
## ## sex dep: 0 for sex-independent, 1 for sex-dependent ##
## ## ----- ##
## ## ivector for number of year periods or nodes ##
## ## POT TBycatch FBycatch NMFS_S ADFG_pot
## ## Gear-1 Gear-2 Gear-3 Gear-4 Gear-5
## ## 2 1 1 1 1 # Selectivity periods
## ## 0 0 0 0 0 # sex specific selectivity
## ## 0 3 3 0 0 # male selectivity type
## ## Gear-1 Gear-2 Gear-3 Gear-4 Gear-5
## ## 1 1 1 1 1 # Retention periods
## ## 0 0 0 0 0 # sex specific retention
## ## 3 2 2 2 2 # male retention type
## ## 1 0 0 0 0 # male retention flag (0 -> no, 1 -> yes)
## ## gear par sel
## ## index index par sex ival lb ub prior p1 p2 phz start end ##
## ## mirror period period ##
## # Gear-1
## 1 1 1 0 0.490680567427 0.001 2.0 0 0 1 -2 1978 2008
## 1 2 2 0 0.785300542244 0.001 2.0 0 0 1 -2 1978 2008
## 1 3 3 0 1.0 0.001 2.0 0 0 1 -2 1978 2008
## 1 1 1 0 0.402423912257 0.001 2.0 0 0 1 -2 2009 2015
## 1 2 2 0 0.981647895824 0.001 2.0 0 0 1 -2 2009 2015
## 1 3 3 0 1.0 0.001 2.0 0 0 1 -2 2009 2015
## # Gear-2
## 2 7 1 0 40 10.0 200 0 10 200 -3 1978 2015
## 2 8 2 0 60 10.0 200 0 10 200 -3 1978 2015
## # Gear-3
## 3 9 1 0 40 10.0 200 0 10 200 -3 1978 2015
## 3 10 2 0 60 10.0 200 0 10 200 -3 1978 2015
## # Gear-4
## 4 8 1 0 0.793562338771 0.001 2.0 0 0 1 -2 1978 2015
## 4 9 2 0 1.08339465666 0.001 2.0 0 0 1 -2 1978 2015
## 4 10 3 0 1.0 0.001 2.0 0 0 1 -2 1978 2015
## # Gear-5
## 5 11 1 0 0.411256448303 0.001 2.0 0 0 1 -2 1978 2015
## 5 12 2 0 0.861094630732 0.001 2.0 0 0 1 -2 1978 2015
## 5 13 3 0 1.0 0.001 2.0 0 0 1 -2 1978 2015
## ## Retained
## # Gear-1
## -1 14 1 0 120 100 200 0 1 900 -1 1978 2015
## -1 15 2 0 123 110 200 0 1 900 -1 1978 2015
## # Gear-2
## -2 16 1 0 595 1 700 0 1 900 -3 1978 2015
## -2 17 2 0 10 1 700 0 1 900 -3 1978 2015
## # Gear-3
## -3 18 1 0 590 1 700 0 1 900 -3 1978 2015
## -3 19 2 0 10 1 700 0 1 900 -3 1978 2015
## # Gear-4
## -4 20 1 0 580 1 700 0 1 900 -3 1978 2015
## -4 21 2 0 20 1 700 0 1 900 -3 1978 2015
## # Gear-5

```

```

## -5      22      1      0      580      1      700      0      1      900      -3      1978      2015
## -5      23      2      0      20      1      700      0      1      900      -3      1978      2015
##
## ## ----- ##
## ## PRIORS FOR CATCHABILITY
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## ## SURVEYS/INDICES ONLY
## ## ival      lb      ub      phz      prior      p1      p2      Analytic?      LAMBDA
## ## 1.0      0      2      -1      0      0      9.0      0      1      # NMFS trawl
## ## 0.00411135867487 0 5      -1      0      0      9.0      0      1      # ADF&G pot
## ## ----- ##
## ##
## ## ----- ##
## ## ADDITIONAL CV FOR SURVEYS/INDICES
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## ival      lb      ub      phz      prior      p1      p2
## ## 0.0000001      0.00000001      10.0      -4      4      1.0      100      # NMFS
## ## 0.0000001      0.00000001      10.0      -4      4      1.0      100      # ADF&G
## ## ----- ##
## ##
## ## ----- ##
## ## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR
## ## ----- ##
## ## Mean_F      STD_PHZ1      STD_PHZ2      PHZ
## ## 0.3      0.05      50.0      1      # Pot
## ## 0.001      0.05      50.0      1      # Trawl
## ## 0.001      0.05      50.0      1      # Fixed
## ## 0.00      2.00      20.00      -1      # NMFS
## ## 0.00      2.00      20.00      -1      # ADF&G
## ## ----- ##
## ##
## ## ----- ##
## ## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX)
## ## ----- ##
## ## LIKELIHOOD OPTIONS
## ## -1) Multinomial with estimated/fixed sample size
## ## -2) Robust approximation to multinomial
## ## -3) logistic normal (NIY)
## ## -4) multivariate-t (NIY)
## ## -5) Dirichlet
## ## AUTOTAIL COMPRESSION
## ##      pmin is the cumulative proportion used in tail compression.
## ## ----- ##
## ## 1      1      1      # Type of likelihood
## ## 2      2      2      # Type of likelihood

```

```

## # 5 5 5 # Type of likelihood
## 0 0 0 # Auto tail compression (pmin)
## 1 1 1 # Initial value for effective sample size multiplier
## -4 -4 -4 # Phz for estimating effective sample size (if appl.)
## 1 2 3 # Composition aggregator
## 1 1 1 # LAMBDA
## ## ----- ##
##
## ## ----- ##
## ## TIME VARYING NATURAL MORTALITY RATES ##
## ## ----- ##
## ## TYPE:
## ## 0 = constant natural mortality
## ## 1 = Random walk (deviates constrained by variance in M)
## ## 2 = Cubic Spline (deviates constrained by nodes & node-placement)
## ## 3 = Blocked changes (deviates constrained by variance at specific knots)
## ## 4 = Time blocks
## ## ----- ##
## ## Type
## 3
## ## Phase of estimation
## 4
## ## STDEV in m_dev for Random walk
## 10.0
## ## Number of nodes for cubic spline or number of step-changes for option 3
## 2
## ## Year position of the knots (vector must be equal to the number of nodes)
## 1998 1999
## ## ----- ##
##
## ## ----- ##
## ## OTHER CONTROLS
## ## ----- ##
## 3 # Estimated rec_dev phase
## 3 # Estimated rec_ini phase
## 0 # VERBOSE FLAG (0 = off, 1 = on, 2 = objective func)
## 2 # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
## 1978 # First year for average recruitment for Bspr calculation
## 2016 # Last year for average recruitment for Bspr calculation
## 0.35 # Target SPR ratio for Bmsy proxy
## 1 # Gear index for SPR calculations (i.e. directed fishery)
## 1 # Lambda (proportion of mature male biomass for SPR reference points)
## 1 # Use empirical molt increment data (0 = FALSE, 1 = TRUE)
## 0 # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
## ## EOF
## 9999

```

The base model control file:

```
## # Set up to do Stock Reduction Analysis using Catch data and informative priors.
## # Controls for leading parameter vector theta
## # LEGEND FOR PRIOR:
## #
## #         0 -> uniform
## #         1 -> normal
## #         2 -> lognormal
## #         3 -> beta
## #         4 -> gamma
## # ntheta
## 12
## # ival      lb      ub      phz  prior    p1    p2      # parameter      #
## 0.18      0.01      1      -4      2    0.18    0.02    # M
## 14.3      -7.0      30     -2      0     -7      30     # log(R0)
## 10.0      -7.0      20     -1      1    -10.0    20     # log(Rini)
## 10.0      -7.0      20      1      0     -7      20     # log(Rbar)
## 80.0      30.0     310     -2      1     72.5    7.25    # Recruitment size distribution
## 0.25      0.1       7      -4      0     0.1     9.0     # Recruitment size scale (varian
## 0.2      -10.0      0.75    -4      0    -10.0    0.75    # log(sigma_R)
## 0.75      0.20      1.00    -2      3     3.0     2.00    # steepness
## 0.01      0.00      1.00    -3      3     1.01    1.01    # recruitment autocorrelation
## 14.5      5.00      20.00    1      0     5.00    20.00    # logN0 vector of initial numbe
## 14.0      5.00      20.00    1      0     5.00    20.00    # logN0 vector of initial numbe
## 13.5      5.00      20.00    1      0     5.00    20.00    # logN0 vector of initial numbe
## ## GROWTH PARAM CONTROLS
## ## Two lines for each parameter if split sex, one line if not
## # ival      lb      ub      phz  prior    p1    p2      # parameter      #
## 14.1      10.0     30.0     -3      0     0.0     999.0    # alpha males or combined
## 0.0001     0.0      0.01     -3      0     0.0     999.0    # beta males or combined
## 0.45      0.01      1.0      -3      0     0.0     999.0    # gscale males or combined
## 121.5      65.0     145.0    -4      0     0.0     999.0    # molt_mu males or combined
## 0.060      0.0      1.0      -3      0     0.0     999.0    # molt_cv males or combined
##
## ## -----
## ## SELECTIVITY CONTROLS
## ## Each gear must have a selectivity and a retention selectivity. If a uniform
## ## prior is selected for a parameter then the lb and ub are used (p1 and p2 are
## ## ignored)
## ## LEGEND
## ## sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,
## ##            4 = double normal (NIY)
## ## gear index: use +ve for selectivity, -ve for retention
## ## sex dep: 0 for sex-independent, 1 for sex-dependent
## ## -----
## ## ivector for number of year periods or nodes
## ## POT      TBycatch FBycatch  NMFS_S  ADFG_pot
## ## Gear-1    Gear-2    Gear-3    Gear-4    Gear-5
## 2          1          1          1          1      # Selectivity periods
## 0          0          0          0          0      # sex specific selectivity
## 0          3          3          0          0      # male selectivity type
## ## Gear-1    Gear-2    Gear-3    Gear-4    Gear-5
## 1          1          1          1          1      # Retention periods
## 0          0          0          0          0      # sex specific retention
```

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##      3      2      2      2      2      # male retention type
##      1      0      0      0      0      # male retention flag (0 -> no, 1 -> yes)
## ## gear  par  sel
## ## index index par sex ival lb  ub   prior p1    p2    phz  start end
## ## mirror period period
## # Gear-1
##      1      1      1  0    0.4  0.001 1.0    0      0      1      3      1978  2008
##      1      2      2  0    0.7  0.001 1.0    0      0      1      3      1978  2008
##      1      3      3  0    1.0  0.001 2.0    0      0      1     -3      1978  2008
##      1      4      1  0    0.4  0.001 1.0    0      0      1      3      2009  2015
##      1      5      2  0    0.7  0.001 1.0    0      0      1      3      2009  2015
##      1      6      3  0    1.0  0.001 2.0    0      0      1     -3      2009  2015
## # Gear-2
##      2      7      1  0    40   10.0 200    0     10   200   -3      1978  2015
##      2      8      2  0    60   10.0 200    0     10   200   -3      1978  2015
## # Gear-3
##      3      9      1  0    40   10.0 200    0     10   200   -3      1978  2015
##      3     10      2  0    60   10.0 200    0     10   200   -3      1978  2015
## # Gear-4
##      4     11      1  0    0.4  0.001 1.0    0      0      1      4      1978  2015
##      4     12      2  0    0.7  0.001 1.0    0      0      1      4      1978  2015
##      4     13      3  0    1.0  0.001 2.0    0      0      1     -4      1978  2015
## # Gear-5
##      5     14      1  0    0.4  0.001 1.0    0      0      1      4      1978  2015
##      5     15      2  0    0.7  0.001 1.0    0      0      1      4      1978  2015
##      5     16      3  0    1.0  0.001 2.0    0      0      1     -4      1978  2015
## ## Retained
## # Gear-1
##     -1     17      1  0   120   100  200    0      1   900   -1      1978  2015
##     -1     18      2  0   123   110  200    0      1   900   -1      1978  2015
## # Gear-2
##     -2     19      1  0   595      1   700    0      1   900   -3      1978  2015
##     -2     20      2  0     10      1   700    0      1   900   -3      1978  2015
## # Gear-3
##     -3     21      1  0   590      1   700    0      1   900   -3      1978  2015
##     -3     22      2  0     10      1   700    0      1   900   -3      1978  2015
## # Gear-4
##     -4     23      1  0   580      1   700    0      1   900   -3      1978  2015
##     -4     24      2  0     20      1   700    0      1   900   -3      1978  2015
## # Gear-5
##     -5     25      1  0   580      1   700    0      1   900   -3      1978  2015
##     -5     26      2  0     20      1   700    0      1   900   -3      1978  2015
## ## ----- ##
##
## ## ----- ##
## ## PRIORS FOR CATCHABILITY
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## ## SURVEYS/INDICES ONLY
## ##      ival      lb      ub      phz      prior      p1      p2      Analytic?      LAMBDA
## ##      1.0      0      2      -1      0      0      9.0      0      1      # NMFS trawl

```

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##      4e-06      0          5          1          0          0          9.0      0          1          # ADF&G pot
## ## ----- ##
## ## ----- ##
## ## ADDITIONAL CV FOR SURVEYS/INDICES ##
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## ival      lb      ub      phz      prior      p1      p2      # NMFS
##      0.00001      0.000001      10.0      -4      4      1.0      100
##      0.00001      0.000001      10.0      -4      4      1.0      100      # ADF&G
## ## ----- ##
## ## ----- ##
## ## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR ##
## ## ----- ##
## ## Mean_F      STD_PHZ1      STD_PHZ2      PHZ
##      0.3          0.05          50.0          1      # Pot
##      0.001          0.05          50.0          1      # Trawl
##      0.001          0.05          50.0          1      # Fixed
##      0.00          2.00          20.00          -1      # NMFS
##      0.00          2.00          20.00          -1      # ADF&G
## ## ----- ##
## ## ----- ##
## ## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX) ##
## ## ----- ##
## ## LIKELIHOOD OPTIONS
## ##      -1) Multinomial with estimated/fixed sample size
## ##      -2) Robust approximation to multinomial
## ##      -3) logistic normal (NIY)
## ##      -4) multivariate-t (NIY)
## ##      -5) Dirichlet
## ## AUTOTAIL COMPRESSION
## ##      pmin is the cumulative proportion used in tail compression.
## ## ----- ##
## # 1      1      1      # Type of likelihood
## # 2      2      2      # Type of likelihood
## # 5      5      5      # Type of likelihood
## # 0      0      0      # Auto tail compression (pmin)
## # 1      1      1      # Initial value for effective sample size multiplier
## #-4     -4     -4      # Phz for estimating effective sample size (if appl.)
## # 1      2      3      # Composition aggregator
## # 1      1      1      # LAMBDA
## ## ----- ##
## ## ----- ##
## ## TIME VARYING NATURAL MORTALIY RATES ##
## ## ----- ##
## ## TYPE:
## ##      0 = constant natural mortality
## ##      1 = Random walk (deviates constrained by variance in M)

```

```

## ##      2 = Cubic Spline (deviates constrained by nodes & node-placement)
## ##      3 = Blocked changes (deviates constrained by variance at specific knots)
## ##      4 = Time blocks
## ## ----- ##
## ## Type
## 3
## ## Phase of estimation
## 4
## ## STDEV in m_dev for Random walk
## 10.0
## ## Number of nodes for cubic spline or number of step-changes for option 3
## 2
## ## Year position of the knots (vector must be equal to the number of nodes)
## 1998 1999
## ## ----- ##
## ## ----- ##
## ## OTHER CONTROLS
## ## ----- ##
## 3      # Estimated rec_dev phase
## 3      # Estimated rec_ini phase
## 0      # VERBOSE FLAG (0 = off, 1 = on, 2 = objective func)
## 2      # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
## 1978   # First year for average recruitment for Bspr calculation
## 2016   # Last year for average recruitment for Bspr calculation
## 0.35   # Target SPR ratio for Bmsy proxy
## 1      # Gear index for SPR calculations (i.e. directed fishery)
## 1      # Lambda (proportion of mature male biomass for SPR reference points)
## 1      # Use empirical molt increment data (0 = FALSE, 1 = TRUE)
## 0      # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
## ## EOF
## 9999

```


The Francis model control file:

```
## # Set up to do Stock Reduction Analysis using Catch data and informative priors.
## # Controls for leading parameter vector theta
## # LEGEND FOR PRIOR:
## #
## #         0 -> uniform
## #         1 -> normal
## #         2 -> lognormal
## #         3 -> beta
## #         4 -> gamma
## # ntheta
## 12
## # ival      lb      ub      phz      prior      p1      p2      # parameter      #
## 0.18      0.01      1      -4      2      0.18      0.02      # M
## 14.3      -7.0      30      -2      0      -7      30      # log(R0) - unfished recruits
## 10.0      -7.0      20      -1      1      -10.0      20      # log(Rini) - initial recruitment
## 10.0      -7.0      20      1      0      -7      20      # log(Rbar) - average recruits
## 80.0      30.0      310      -2      1      72.5      7.25      # Recruitment size distribution
## 0.25      0.1      7      -4      0      0.1      9.0      # Recruitment size scale (variance)
## 0.2      -10.0      0.75      -4      0      -10.0      0.75      # log(sigma_R)
## 0.75      0.20      1.00      -2      3      3.0      2.00      # steepness
## 0.01      0.00      1.00      -3      3      1.01      1.01      # recruitment autocorrelation
## 14.5      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## 14.0      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## 13.5      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## ## GROWTH PARAM CONTROLS
## ## Two lines for each parameter if split sex, one line if not
## # ival      lb      ub      phz      prior      p1      p2      # parameter      #
## 14.1      10.0      30.0      -3      0      0.0      999.0      # alpha males or combined
## 0.0001      0.0      0.01      -3      0      0.0      999.0      # beta males or combined
## 0.45      0.01      1.0      -3      0      0.0      999.0      # gscale males or combined
## 121.5      65.0      145.0      -4      0      0.0      999.0      # molt_mu males or combined
## 0.060      0.0      1.0      -3      0      0.0      999.0      # molt_cv males or combined
##
## ## -----
## ## SELECTIVITY CONTROLS
## ## Each gear must have a selectivity and a retention selectivity. If a uniform
## ## prior is selected for a parameter then the lb and ub are used (p1 and p2 are
## ## ignored)
## ## LEGEND
## ## sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,
## ##            4 = double normal (NIY)
## ## gear index: use +ve for selectivity, -ve for retention
## ## sex dep: 0 for sex-independent, 1 for sex-dependent
## ## -----
## ## ivector for number of year periods or nodes
## ## POT      TBycatch      FBycatch      NMFS_S      ADFG_pot
## ## Gear-1      Gear-2      Gear-3      Gear-4      Gear-5
## 2      1      1      1      1      # Selectivity periods
## 0      0      0      0      0      # sex specific selectivity
## 0      3      3      0      0      # male selectivity type
## ## Gear-1      Gear-2      Gear-3      Gear-4      Gear-5
## 1      1      1      1      1      # Retention periods
## 0      0      0      0      0      # sex specific retention
```

```

##      3      2      2      2      2      # male retention type
##      1      0      0      0      0      # male retention flag (0 -> no, 1 -> yes)
## ## gear  par  sel
## ## index index par sex ival lb  ub  prior p1  p2  phz  start end
## ## mirror period period
## # Gear-1
##      1      1      1  0  0.4  0.001 1.0  0      0      1      3      1978  2008
##      1      2      2  0  0.7  0.001 1.0  0      0      1      3      1978  2008
##      1      3      3  0  1.0  0.001 2.0  0      0      1     -3      1978  2008
##      1      4      1  0  0.4  0.001 1.0  0      0      1      3      2009  2015
##      1      5      2  0  0.7  0.001 1.0  0      0      1      3      2009  2015
##      1      6      3  0  1.0  0.001 2.0  0      0      1     -3      2009  2015
## # Gear-2
##      2      7      1  0  40   10.0 200  0     10   200  -3      1978  2015
##      2      8      2  0  60   10.0 200  0     10   200  -3      1978  2015
## # Gear-3
##      3      9      1  0  40   10.0 200  0     10   200  -3      1978  2015
##      3     10      2  0  60   10.0 200  0     10   200  -3      1978  2015
## # Gear-4
##      4     11      1  0  0.4  0.001 1.0  0      0      1      4      1978  2015
##      4     12      2  0  0.7  0.001 1.0  0      0      1      4      1978  2015
##      4     13      3  0  1.0  0.001 2.0  0      0      1     -4      1978  2015
## # Gear-5
##      5     14      1  0  0.4  0.001 1.0  0      0      1      4      1978  2015
##      5     15      2  0  0.7  0.001 1.0  0      0      1      4      1978  2015
##      5     16      3  0  1.0  0.001 2.0  0      0      1     -4      1978  2015
## ## Retained
## # Gear-1
##     -1     17      1  0  120   100  200  0      1   900  -1      1978  2015
##     -1     18      2  0  123   110  200  0      1   900  -1      1978  2015
## # Gear-2
##     -2     19      1  0  595      1   700  0      1   900  -3      1978  2015
##     -2     20      2  0    10      1   700  0      1   900  -3      1978  2015
## # Gear-3
##     -3     21      1  0  590      1   700  0      1   900  -3      1978  2015
##     -3     22      2  0    10      1   700  0      1   900  -3      1978  2015
## # Gear-4
##     -4     23      1  0  580      1   700  0      1   900  -3      1978  2015
##     -4     24      2  0    20      1   700  0      1   900  -3      1978  2015
## # Gear-5
##     -5     25      1  0  580      1   700  0      1   900  -3      1978  2015
##     -5     26      2  0    20      1   700  0      1   900  -3      1978  2015
## ## ----- ##
##
## ## ----- ##
## ## PRIORS FOR CATCHABILITY
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## ## SURVEYS/INDICES ONLY
## ## ival  lb  ub  phz  prior  p1  p2  Analytic?  LAMBDA
##      1.0  0   2   -1   0     0   9.0  0          1      # NMFS trawl

```

```

##      4.2e-6  0      5      1      0      0      9.0  0      1      # ADF&G pot
## ## ----- ##
## ## ----- ##
## ## ADDITIONAL CV FOR SURVEYS/INDICES ##
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## ival      lb      ub      phz  prior      p1      p2      ##
##      0.00001    0.000001  10.0    -4    4      1.0    100  # NMFS
##      0.00001    0.000001  10.0    -4    4      1.0    100  # ADF&G
## ## ----- ##
## ## ----- ##
## ## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR ##
## ## ----- ##
## ## Mean_F  STD_PHZ1  STD_PHZ2  PHZ      ##
##      0.3      0.05    50.0      1  # Pot
##      0.001    0.05    50.0      1  # Trawl
##      0.001    0.05    50.0      1  # Fixed
##      0.00     2.00    20.0     -1  # NMFS
##      0.00     2.00    20.0     -1  # ADF&G
## ## ----- ##
## ## ----- ##
## ## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX) ##
## ## ----- ##
## ## LIKELIHOOD OPTIONS ##
## ##      -1) Multinomial with estimated/fixed sample size
## ##      -2) Robust approximation to multinomial
## ##      -3) logistic normal (NIY)
## ##      -4) multivariate-t (NIY)
## ##      -5) Dirichlet
## ## AUTOTAIL COMPRESSION
## ##      pmin is the cumulative proportion used in tail compression.
## ## ----- ##
##      1      1      1  # Type of likelihood
##      2      2      2  # Type of likelihood
##      0      0      0  # Auto tail compression (pmin)
##      1      1      1  # Initial value for effective sample size multiplier
##     -4     -4     -4  # Phz for estimating effective sample size (if appl.)
##      1      2      3  # Composition aggregator
##     1.7239    0.5009    1.7008
## ## ----- ##
## ## ----- ##
## ## TIME VARYING NATURAL MORTALIITY RATES ##
## ## ----- ##
## ## TYPE:
## ##      0 = constant natural mortality
## ##      1 = Random walk (deviates constrained by variance in M)
## ##      2 = Cubic Spline (deviates constrained by nodes & node-placement)

```

```

## ##      3 = Blocked changes (deviates constrained by variance at specific knots)
## ##      4 = Time blocks
## ## ----- ##
## ## Type
## 3
## ## Phase of estimation
## 4
## ## STDEV in m_dev for Random walk
## 10.0
## ## Number of nodes for cubic spline or number of step-changes for option 3
## 2
## ## Year position of the knots (vector must be equal to the number of nodes)
## 1998 1999
## ## ----- ##
## ## ----- ##
## ## OTHER CONTROLS
## ## ----- ##
## 3      # Estimated rec_dev phase
## 3      # Estimated rec_ini phase
## 0      # VERBOSE FLAG (0 = off, 1 = on, 2 = objective func)
## 2      # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
## 1978   # First year for average recruitment for Bspr calculation
## 2016   # Last year for average recruitment for Bspr calculation
## 0.35   # Target SPR ratio for Bmsy proxy
## 1      # Gear index for SPR calculations (i.e. directed fishery)
## 1      # Lambda (proportion of mature male biomass for SPR reference points)
## 1      # Use empirical molt increment data (0 = FALSE, 1 = TRUE)
## 0      # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
## ## EOF
## 9999

```

The no M_{1998} model control file:

```
## # Set up to do Stock Reduction Analysis using Catch data and informative priors.
## # Controls for leading parameter vector theta
## # LEGEND FOR PRIOR:
## #
## #         0 -> uniform
## #         1 -> normal
## #         2 -> lognormal
## #         3 -> beta
## #         4 -> gamma
## # ntheta
## 12
## # ival      lb      ub      phz  prior    p1    p2      # parameter      #
## 0.18      0.01      1      -4      2    0.18    0.02    # M
## 14.3      -7.0     30     -2      0     -7     30    # log(R0)
## 10.0      -7.0     20     -1      1   -10.0    20    # log(Rini)
## 10        -7.0     20      1      0     -7     20    # log(Rbar)
## 80.0      30.0     310     -2      1    72.5    7.25   # Recruitment size distribution
## 0.25      0.1       7      -4      0     0.1     9.0    # Recruitment size scale (varian
## 0.2       -10.0     0.75    -4      0   -10.0    0.75   # log(sigma_R)
## 0.75      0.20     1.00    -2      3     3.0     2.00   # steepness
## 0.01      0.00     1.00    -3      3     1.01    1.01   # recruitment autocorrelation
## 14.5      5.00     20.00     1      0     5.00    20.00  # logN0 vector of initial numbe
## 14.0      5.00     20.00     1      0     5.00    20.00  # logN0 vector of initial numbe
## 13.5      5.00     20.00     1      0     5.00    20.00  # logN0 vector of initial numbe
## ## GROWTH PARAM CONTROLS
## ## Two lines for each parameter if split sex, one line if not
## # ival      lb      ub      phz  prior    p1    p2      # parameter      #
## 14.1      10.0     30.0     -3      0     0.0    999.0   # alpha males or combined
## 0.0001     0.0      0.01    -3      0     0.0    999.0   # beta males or combined
## 0.45      0.01     1.0      -3      0     0.0    999.0   # gscale males or combined
## 121.5      65.0    145.0     -4      0     0.0    999.0   # molt_mu males or combined
## 0.060      0.0      1.0      -3      0     0.0    999.0   # molt_cv males or combined
##
## ## -----
## ## SELECTIVITY CONTROLS
## ## Each gear must have a selectivity and a retention selectivity. If a uniform
## ## prior is selected for a parameter then the lb and ub are used (p1 and p2 are
## ## ignored)
## ## LEGEND
## ## sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,
## ##            4 = double normal (NIY)
## ## gear index: use +ve for selectivity, -ve for retention
## ## sex dep: 0 for sex-independent, 1 for sex-dependent
## ## -----
## ## ivector for number of year periods or nodes
## ## POT      TBycatch FBycatch  NMFS_S  ADFG_pot
## ## Gear-1    Gear-2    Gear-3    Gear-4    Gear-5
## 2          1          1          1          1      # Selectivity periods
## 0          0          0          0          0      # sex specific selectivity
## 0          3          3          0          0      # male selectivity type
## ## Gear-1    Gear-2    Gear-3    Gear-4    Gear-5
## 1          1          1          1          1      # Retention periods
## 0          0          0          0          0      # sex specific retention
```

```

##      3      2      2      2      2      # male retention type
##      1      0      0      0      0      # male retention flag (0 -> no, 1 -> yes)
## ## gear  par  sel
## ## index index par sex ival lb  ub  prior p1  p2  phz  start end
## ## # Gear-1
##      1      1      1  0  0.4  0.001 1.0  0      0      1      3      1978  2008
##      1      2      2  0  0.7  0.001 1.0  0      0      1      3      1978  2008
##      1      3      3  0  1.0  0.001 2.0  0      0      1     -3      1978  2008
##      1      4      1  0  0.4  0.001 1.0  0      0      1      3      2009  2015
##      1      5      2  0  0.7  0.001 1.0  0      0      1      3      2009  2015
##      1      6      3  0  1.0  0.001 2.0  0      0      1     -3      2009  2015
## ## # Gear-2
##      2      7      1  0  40   10.0 200  0     10    200   -3      1978  2015
##      2      8      2  0  60   10.0 200  0     10    200   -3      1978  2015
## ## # Gear-3
##      3      9      1  0  40   10.0 200  0     10    200   -3      1978  2015
##      3     10      2  0  60   10.0 200  0     10    200   -3      1978  2015
## ## # Gear-4
##      4     11      1  0  0.4  0.001 1.0  0      0      1      4      1978  2015
##      4     12      2  0  0.7  0.001 1.0  0      0      1      4      1978  2015
##      4     13      3  0  1.0  0.001 2.0  0      0      1     -4      1978  2015
## ## # Gear-5
##      5     14      1  0  0.4  0.001 1.0  0      0      1      4      1978  2015
##      5     15      2  0  0.7  0.001 1.0  0      0      1      4      1978  2015
##      5     16      3  0  1.0  0.001 2.0  0      0      1     -4      1978  2015
## ## ## Retained
## ## # Gear-1
##     -1     17      1  0  120   100  200  0      1    900   -1      1978  2015
##     -1     18      2  0  123   110  200  0      1    900   -1      1978  2015
## ## # Gear-2
##     -2     19      1  0  595      1   700  0      1    900   -3      1978  2015
##     -2     20      2  0   10      1   700  0      1    900   -3      1978  2015
## ## # Gear-3
##     -3     21      1  0  590      1   700  0      1    900   -3      1978  2015
##     -3     22      2  0   10      1   700  0      1    900   -3      1978  2015
## ## # Gear-4
##     -4     23      1  0  580      1   700  0      1    900   -3      1978  2015
##     -4     24      2  0   20      1   700  0      1    900   -3      1978  2015
## ## # Gear-5
##     -5     25      1  0  580      1   700  0      1    900   -3      1978  2015
##     -5     26      2  0   20      1   700  0      1    900   -3      1978  2015
## ## ## ----- ##
## ## ----- ##
## ## PRIORS FOR CATCHABILITY
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## ## SURVEYS/INDICES ONLY
## ##      ival      lb      ub      phz      prior      p1      p2      Analytic?      LAMBDA
##      1.0      0      2      -1      0      0      9.0      0      1      # NMFS trawl

```

```

##      4e-06      0          5          1          0          0          9.0      0          1          # ADF&G pot
## ## ----- ##
##
## ## ----- ##
## ## ADDITIONAL CV FOR SURVEYS/INDICES ##
## ##      If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##      and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##      prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## ival      lb      ub      phz      prior      p1      p2 ##
##      0.00001      0.000001      10.0      -4      4      1.0      100      # NMFS
##      0.00001      0.000001      10.0      -4      4      1.0      100      # ADF&G
## ## ----- ##
##
## ## ----- ##
## ## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR ##
## ## ----- ##
## ## Mean_F      STD_PHZ1      STD_PHZ2      PHZ ##
##      0.3          0.05          50.0          1      # Pot
##      0.001          0.05          50.0          1      # Trawl
##      0.001          0.05          50.0          1      # Fixed
##      0.00          2.00          20.00          -1      # NMFS
##      0.00          2.00          20.00          -1      # ADF&G
## ## ----- ##
##
## ## ----- ##
## ## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX) ##
## ## ----- ##
## ## LIKELIHOOD OPTIONS
## ##      -1) Multinomial with estimated/fixed sample size
## ##      -2) Robust approximation to multinomial
## ##      -3) logistic normal (NIY)
## ##      -4) multivariate-t (NIY)
## ##      -5) Dirichlet
## ## AUTOTAIL COMPRESSION
## ##      pmin is the cumulative proportion used in tail compression.
## ## ----- ##
##      1      1      1      # Type of likelihood
##      2      2      2      # Type of likelihood
##      0      0      0      # Auto tail compression (pmin)
##      1      1      1      # Initial value for effective sample size multiplier
##      -4      -4      -4      # Phz for estimating effective sample size (if appl.)
##      1      2      3      # Composition aggregator
##      1.6131      0.5125      1.2095
## ## ----- ##
##
## ## ----- ##
## ## TIME VARYING NATURAL MORTALIITY RATES ##
## ## ----- ##
## ## TYPE:
## ##      0 = constant natural mortality
## ##      1 = Random walk (deviates constrained by variance in M)
## ##      2 = Cubic Spline (deviates constrained by nodes & node-placement)

```

```

## ##      3 = Blocked changes (deviates constrained by variance at specific knots)
## ##      4 = Time blocks
## ## ----- ##
## ## Type
## 0
## ## Phase of estimation
## -4
## ## STDEV in m_dev for Random walk
## 10.0
## ## Number of nodes for cubic spline or number of step-changes for option 3
## 2
## ## Year position of the knots (vector must be equal to the number of nodes)
## 1998 1999
## ## ----- ##
## ## ----- ##
## ## OTHER CONTROLS
## ## ----- ##
## 3      # Estimated rec_dev phase
## 3      # Estimated rec_ini phase
## 0      # VERBOSE FLAG (0 = off, 1 = on, 2 = objective func)
## 2      # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
## 1978   # First year for average recruitment for Bspr calculation
## 2016   # Last year for average recruitment for Bspr calculation
## 0.35   # Target SPR ratio for Bmsy proxy
## 1      # Gear index for SPR calculations (i.e. directed fishery)
## 1      # Lambda (proportion of mature male biomass for SPR reference points)
## 1      # Use empirical molt increment data (0 = FALSE, 1 = TRUE)
## 0      # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
## ## EOF
## 9999

```

The force model control file:

```

## # Set up to do Stock Reduction Analysis using Catch data and informative priors.
## # Controls for leading parameter vector theta
## # LEGEND FOR PRIOR:
## #      0 -> uniform
## #      1 -> normal
## #      2 -> lognormal
## #      3 -> beta
## #      4 -> gamma
## # ntheta
## 12
## # ival      lb      ub      phz      prior      p1      p2      # parameter
## 0.18      0.01      1      -4      2      0.18      0.02      # M
## 14.0      -7.0      30      -2      0      -7      30      # log(R0)
## 10.0      -7.0      20      -1      1      -10.0      20      # log(Rini)
## 10.0      -7.0      20      1      0      -7      20      # log(Rbar)
## 80.0      30.0      310      -2      1      72.5      7.25      # Recruitment size distribution
## 0.25      0.1      7      -4      0      0.1      9.0      # Recruitment size scale (varian
## 0.2      -10.0      0.75      -4      0      -10.0      0.75      # log(sigma_R)
## 0.75      0.20      1.00      -2      3      3.0      2.00      # steepness

```



```

## 0.01      0.00      1.00      -3      3      1.01      1.01      # recruitment autocorrelation
## 14.5      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## 14.0      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## 13.5      5.00      20.00      1      0      5.00      20.00      # logN0 vector of initial number
## ## GROWTH PARAM CONTROLS
## ## Two lines for each parameter if split sex, one line if not
## # ival      lb      ub      phz      prior      p1      p2      # parameter      #
## 14.1      10.0      30.0      -3      0      0.0      999.0      # alpha males or combined
## 0.0001      0.0      0.01      -3      0      0.0      999.0      # beta males or combined
## 0.45      0.01      1.0      -3      0      0.0      999.0      # gscale males or combined
## 121.5      65.0      145.0      -4      0      0.0      999.0      # molt_mu males or combined
## 0.060      0.0      1.0      -3      0      0.0      999.0      # molt_cv males or combined
##
## ## -----
## ## SELECTIVITY CONTROLS
## ## Each gear must have a selectivity and a retention selectivity. If a uniform
## ## prior is selected for a parameter then the lb and ub are used (p1 and p2 are
## ## ignored)
## ## LEGEND
## ## sel type: 0 = parametric, 1 = coefficients, 2 = logistic, 3 = logistic95,
## ## 4 = double normal (NIY)
## ## gear index: use +ve for selectivity, -ve for retention
## ## sex dep: 0 for sex-independent, 1 for sex-dependent
## ## -----
## ## ivector for number of year periods or nodes
## ## POT      TBycatch      FBycatch      NMFS_S      ADFG_pot
## ## Gear-1      Gear-2      Gear-3      Gear-4      Gear-5
## 2      1      1      1      1      # Selectivity periods
## 0      0      0      0      0      # sex specific selectivity
## 0      3      3      0      0      # male selectivity type
## ## Gear-1      Gear-2      Gear-3      Gear-4      Gear-5
## 1      1      1      1      1      # Retention periods
## 0      0      0      0      0      # sex specific retention
## 3      2      2      2      2      # male retention type
## 1      0      0      0      0      # male retention flag (0 -> no, 1 -> yes)
## ## gear      par      sel
## ## index      index      par      sex      ival      lb      ub      prior      p1      p2      phz      start      end
## ## # Gear-1
## 1      1      1      0      0.4      0.001      1.0      0      0      1      3      1978      2008
## 1      2      2      0      0.7      0.001      1.0      0      0      1      3      1978      2008
## 1      3      3      0      1.0      0.001      2.0      0      0      1      -3      1978      2008
## 1      4      1      0      0.4      0.001      1.0      0      0      1      3      2009      2015
## 1      5      2      0      0.7      0.001      1.0      0      0      1      3      2009      2015
## 1      6      3      0      1.0      0.001      2.0      0      0      1      -3      2009      2015
## # Gear-2
## 2      7      1      0      40      10.0      200      0      10      200      -3      1978      2015
## 2      8      2      0      60      10.0      200      0      10      200      -3      1978      2015
## # Gear-3
## 3      9      1      0      40      10.0      200      0      10      200      -3      1978      2015
## 3      10      2      0      60      10.0      200      0      10      200      -3      1978      2015
## # Gear-4
## 4      11      1      0      0.4      0.001      1.0      0      0      1      4      1978      2015
## 4      12      2      0      0.7      0.001      1.0      0      0      1      4      1978      2015
## 4      13      3      0      1.0      0.001      2.0      0      0      1      -4      1978      2015

```

```

## # Gear-5
##   5   14   1   0   0.4   0.001 1.0   0   0   1   4   1978   2015
##   5   15   2   0   0.7   0.001 1.0   0   0   1   4   1978   2015
##   5   16   3   0   1.0   0.001 2.0   0   0   1  -4   1978   2015
## ## Retained
## # Gear-1
##  -1   17   1   0  120   100   200   0   1  900  -1   1978   2015
##  -1   18   2   0  123   110   200   0   1  900  -1   1978   2015
## # Gear-2
##  -2   19   1   0  595    1   700   0   1  900  -3   1978   2015
##  -2   20   2   0   10    1   700   0   1  900  -3   1978   2015
## # Gear-3
##  -3   21   1   0  590    1   700   0   1  900  -3   1978   2015
##  -3   22   2   0   10    1   700   0   1  900  -3   1978   2015
## # Gear-4
##  -4   23   1   0  580    1   700   0   1  900  -3   1978   2015
##  -4   24   2   0   20    1   700   0   1  900  -3   1978   2015
## # Gear-5
##  -5   25   1   0  580    1   700   0   1  900  -3   1978   2015
##  -5   26   2   0   20    1   700   0   1  900  -3   1978   2015
## ## ----- ##
##
## ## ----- ##
## ## PRIORS FOR CATCHABILITY
## ##   If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##   and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##   prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## LAMBDA: Arbitrary relative weights for each series, 0 = do not fit.
## ## SURVEYS/INDICES ONLY
## ## ival    lb    ub    phz    prior    p1    p2    Analytic?    LAMBDA
## ## 1.0      0      2    -1     0      0    2.0    0          1.5    # NMFS trawl
## ## 4e-06    0      5     1     0      0    5.0    0          2     # ADF&G pot
## ## ----- ##
##
## ## ----- ##
## ## ADDITIONAL CV FOR SURVEYS/INDICES
## ##   If a uniform prior is selected for a parameter then the lb and ub are used (p1 ##
## ##   and p2 are ignored). ival must be > 0 ##
## ## LEGEND ##
## ##   prior: 0 = uniform, 1 = normal, 2 = lognormal, 3 = beta, 4 = gamma ##
## ## ----- ##
## ## ival      lb      ub      phz    prior    p1    p2
## ## 0.00001    0.000001  10.0   -4     4      1.0   100  # NMFS
## ## 0.00001    0.000001  10.0   -4     4      1.0   100  # ADF&G
## ## ----- ##
##
## ## ----- ##
## ## PENALTIES FOR AVERAGE FISHING MORTALITY RATE FOR EACH GEAR
## ## ----- ##
## ## Mean_F  STD_PHZ1  STD_PHZ2    PHZ
## ## 0.3      0.05     50.0      1  # Pot
## ## 0.001    0.05     50.0      1  # Trawl

```

```

##      0.001      0.05      50.0      1  # Fixed
##      0.00      2.00      20.00     -1  # NMFS
##      0.00      2.00      20.00     -1  # ADF&G
## ## ----- ##
##
## ## ----- ##
## ## OPTIONS FOR SIZE COMPOSTION DATA (COLUMN FOR EACH MATRIX)
## ## ----- ##
## ## LIKELIHOOD OPTIONS
## ##   -1) Multinomial with estimated/fixed sample size
## ##   -2) Robust approximation to multinomial
## ##   -3) logistic normal (NIY)
## ##   -4) multivariate-t (NIY)
## ##   -5) Dirichlet
## ## AUTOTAIL COMPRESSION
## ##   pmin is the cumulative proportion used in tail compression.
## ## ----- ##
##   1   1   1  # Type of likelihood
## #  2   2   2  # Type of likelihood
##   0   0   0  # Auto tail compression (pmin)
##   1   1   1  # Initial value for effective sample size multiplier
##  -4  -4  -4  # Phz for estimating effective sample size (if appl.)
##   1   2   3  # Composition aggregator
##  1.4044  0.2623  0.3814
## ## ----- ##
##
## ## ----- ##
## ## TIME VARYING NATURAL MORTALIIY RATES
## ## ----- ##
## ## TYPE:
## ##   0 = constant natural mortality
## ##   1 = Random walk (deviates constrained by variance in M)
## ##   2 = Cubic Spline (deviates constrained by nodes & node-placement)
## ##   3 = Blocked changes (deviates constrained by variance at specific knots)
## ##   4 = Time blocks
## ## ----- ##
## ## Type
## 0
## ## Phase of estimation
## -4
## ## STDEV in m_dev for Random walk
## 10.0
## ## Number of nodes for cubic spline or number of step-changes for option 3
## 2
## ## Year position of the knots (vector must be equal to the number of nodes)
## 1998 1999
## ## ----- ##
##
## ## ----- ##
## ## OTHER CONTROLS
## ## ----- ##
##   3      # Estimated rec_dev phase
##   3      # Estimated rec_ini phase
##   0      # VERBOSE FLAG (0 = off, 1 = on, 2 = objective func)

```

```

## 2      # Initial conditions (0 = Unfished, 1 = Steady-state fished, 2 = Free parameters)
## 1978    # First year for average recruitment for Bspr calculation
## 2016    # Last year for average recruitment for Bspr calculation
## 0.35    # Target SPR ratio for Bmsy proxy
## 1      # Gear index for SPR calculations (i.e. directed fishery)
## 1      # Lambda (proportion of mature male biomass for SPR reference points)
## 1      # Use empirical molt increment data (0 = FALSE, 1 = TRUE)
## 0      # Stock-Recruit-Relationship (0 = None, 1 = Beverton-Holt)
## ## EOF
## 9999

```