SEDAR-AW-04

STATUS OF THE VERMILION SNAPPER (*RHOMBOPLITES AURORUBENS*) FISHERIES OF THE GULF OF MEXICO

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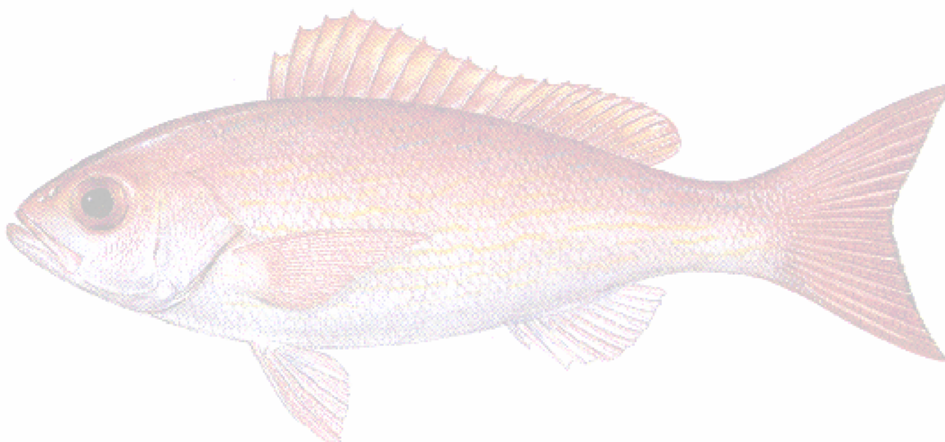

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INTRODUCTION

Two types of models were used to assess the status of vermilion snapper in the U. S. Gulf of Mexico, a state-space implementation of the Pella-Tomlinson (P-T) non-equilibrium production model (Porch, 2001), and a state spaced age-structured production model (Porch, 2003). The P-T production model was used to replicate the previous assessment (Porch and Cass-Calay, 2001), and requires the following assumptions: 1) that there is a single unit stock, 2) that all age classes have the same average fecundity, and 3) that all age classes are equally vulnerable to fishing. These assumptions seem plausible for vermilion snapper of reproductive age (age 1 and older) because the growth curve is relatively flat and the variance in size at age is large. The age-structured production model (SSASPM) assumes a single unit stock, but accommodates fecundity and selectivity functions. In addition, age composition data was used to estimate the selectivity of the directed fleets.

METHODS

Input Data

Available data inputs were used as provided by the SEDAR9 Data Workshop (SEDAR 9: Vermilion Snapper Data Workshop Report) with the exception of the length-weight equation. The length-weight equation was found to differ substantially from the relationship predicted using TIP and NMFS Headboat Survey data. Therefore, the length-weight equation reported by Hood and Johnson (1999) was substituted. The Hood and Johnson (1999) equation was also used during the 2001 vermilion snapper assessment, and was found to be consistent with the available TIP and HB observations.

Continuity Run (P-T Production Model)

The input data and parameter estimates used during the P-T production model runs are summarized in Appendices 1 and 2, respectively.

To replicate the previous assessment of U.S. Gulf of Mexico vermilion snapper, the base case production model used for the 2001 assessment (Porch and Cass-Calay, 2001) was applied to the new catch and CPUE data (summarized in Appendix 1). The 2001 base run and the 2005 continuity run specify three fleets (COMMERCIAL, RECREATIONAL and SHRIMP BYCATCH) and two indices of abundance (COMMERCIAL-HL and HEADBOAT-EAST).

Production models require landings to be entered in weight. Recreational landings in weight were estimated using the available MRFSS, TIP, GULFFIN and HEADBOAT length observations. Average weights were calculated by stratum (YEAR, STATE, FISHING MODE), and these weights were applied to the catch in numbers. Shrimp bycatch (in weight) was provided by Scott Nichols (NOAA Fisheries, Pascagoula). A constant value was provided to be used for all years (9.2 million fish, 0.05 lbs/fish). Due to the extreme annual variability of the estimates, it was not possible to construct a reliable time series of vermilion snapper landed as

bycatch by the shrimp fleet[1]. For the 2001 base model and the current continuity run, no attempt was made to model the dead discards of the recreational and commercial fisheries.
For both P-T production model runs, the catch and effort series were assumed to be lognormally distributed. The shrimp bycatch is poorly known and was assigned a relatively high coefficient of variation (CV) of 1.0, whereas the shrimp effort was assumed to be somewhat better known and assigned a CV of 0.5 The recreational catches were assigned CV's equal to the MRFSS estimates ($CV \cong 0.15$). The commercial catch, which is based on a census, was assumed to have relatively low CV of 0.1.

Estimates of the CVs of the two CPUE series are available from GLM results, but are unrealistically small as they reflect only the uncertainty in measuring CPUE rather than the uncertainty that CPUE reflects abundance. Accordingly, the two indices were assigned equal CVs in each year, and that value was estimated within the production model. In effect, this is equivalent to equally weighting the indices.

The parameters estimated in P-T production model include three catchability coefficients (q_f, one for each fishery, f), three sets of effort parameters (E_{fy}), the initial biomass (B_{1986}), carrying capacity (K), intrinsic rate of increase (R), and production exponent (m). The state variables R, K and q_f were estimated as described in Appendix 2; no interannual variability was allowed. The production exponent was fixed at $m = 2$ (Schaeffer type model). The annual effort parameters were assumed to be lognormally distributed about the overall mean of the series with a relatively large process error ($CV = 0.5$). A penalty was also incorporated that prevented MSY from being greater than the largest catch in the series.

State Spaced Age-Structured Production Model Runs

The State Spaced Age-Structured Production Model (SSASPM) accommodates process errors in the state variables and observation errors in the data variables using a first-order autoregressive model (Porch, 2003). SSASPM runs specified four directed fleets (COMMERCIAL-EAST, COMMERCIAL-WEST, RECREATIONAL and SHRIMP-BYCATCH) and five indices of abundance (COMMERCIAL-HANDLINE-EAST, COMMERCIAL-HANDLINE-WEST, HEADBOAT-EAST, HEADBOAT-WEST, and MRFSS-EAST). Three age composition matrices (number-at-age by year) were used (COMMERCAL-EAST, COMMERCIAL-WEST and RECREATIONAL) to allow estimation of selectivity vectors. Age composition was determined from otolith observations made by the NOAA Fisheries, Panama City Laboratory, and reported in SEDAR9-DW-02.

Catch and CPUE observations were assumed to be unbiased, but imprecise. The annual catches from each fleet were assumed to be equally uncertain with constant coefficient of variation, *CV,* estimated by the model. The annual CPUE values for each fleet were assumed to be less certain than the catches, and were assigned coefficients of variation twice as large as the values estimated for the catch (i.e., $2CV$). The fleet-specific CPUE series were equally weighted. Effort and recruitment process errors were estimated independently. For some runs, recruitment was allowed to vary interannually as an essentially free parameter by allowing a coefficient of

[1] Nichols, S. Personal communication. NOAA Fisheries, Pascagoula Laboratory. Scott.Nichols@noaa.gov

variation equal to 0.4 without autocorrelation. Other runs fixed recruitment at that value predicted by the stock recruitment relationship. The annual effort of the directed fleets (COM-E, COM-W and REC) were allowed to vary with a moderate variance (CV=0.5) and correlation (r = 0.5). The annual effort of the SHRIMP-BYCATCH fleet was allowed to vary with small (CV=0.2) or moderate deviations (CV=0.5) and correlation (r = 0.5). The catchability coefficients, q, were estimated as time-independent constants.

The life history parameters (growth, length-weight, fecundity, natural mortality) were fixed at the values described in the SEDAR9 Data Workshop Report, with the exception of the length-weight parameters which were found to differ substantially from those predicted using TIP and NMFS Headboat Survey data. Therefore, the length-weight equation reported by Hood and Johnson (1999) was substituted: Whole Weight (kg) = 2.51E-08 * Total Length (mm)$^{2.87}$. As suggested by the Data Workshop panel, steepness was estimated using a lognormal prior (mean = 0.6; variance = 0.85) such that there is a <10% chance than steepness exceeds 0.9.

The most recent estimate of shrimp trawl bycatch of vermilion snapper is 9.2 million fish annually[2]. According to Porch and Cass-Calay (2001), the length-distribution obtained from the NMFS observer program is bimodal, and suggests that approximately 25 % of the vermilion snapper landed by the shrimp fleet are age-0 and the remainder are at least age-1 (Figure 1). Because SSASPM does not accommodate age-0, the shrimp bycatch estimate was multiplied by the proportion of fish expected to be at least age-1 (9.2 million * 0.75 = 6.9 million fish). Shrimp bycatch was modeled using a fixed selectivity (100% vulnerability at age-1, 30% at age-2, 3% at age-3 and 0% at ages 4-14+).

SSASPM models were sensitive to the magnitude of the effort deviations allowed for the shrimp bycatch "fleet", assumptions regarding steepness, deviations from the stock-recruitment relationship and the level of shrimp bycatch. To address these sensitivities, two sets of model runs were completed.

Set 1: Effort Deviations of SHRIMP BYCATCH FLEET = 20% CV; other fleets = 50%CV

Run 1)	Shrimp Bycatch = 6.9e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)
Run 2)	Shrimp Bycatch = 6.9e6;	Steepness ESTIMATED;	No Deviation from S-R Relationship
Run 3)	Shrimp Bycatch = 6.9e6;	Steepness FIXED (0.6);	Recruitment Deviations (40%CV)
Run 4)	Shrimp Bycatch = 6.9e6;	Steepness FIXED (0.6);	No Deviation from S-R Relationship
Run 5)	Shrimp Bycatch = 3.45e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)
Run 6)	Shrimp Bycatch = 10.35e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)

Set 2: The same runs except that Effort Deviations of ALL FLEETS= 50% CV

Run 7)	Shrimp Bycatch = 6.9e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)
Run 8)	Shrimp Bycatch = 6.9e6;	Steepness ESTIMATED;	No Deviation from S-R Relationship
Run 9)	Shrimp Bycatch = 6.9e6;	Steepness FIXED (0.6);	Recruitment Deviations (40%CV)
Run 10)	Shrimp Bycatch = 6.9e6;	Steepness FIXED (0.6);	No Deviation from S-R Relationship
Run 11)	Shrimp Bycatch = 3.45e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)
Run 12)	Shrimp Bycatch = 10.35e6;	Steepness ESTIMATED;	Recruitment Deviations (40%CV)

[2] Nichols, S. Personal Communication. NOAA Fisheries, Pascagoula Laboratory. Scott.Nichols@noaa.gov

The input data and parameter estimates used during the SSASPM runs 1-12 are summarized in Appendices 3 and 4, respectively.

In addition, one SSAPSM model was run (***Run 13***) that assumed zero landings of vermilion snapper as shrimp bycatch. The data and parameter files used for this run are described in Appendices 5 and 6. The general description of the model is as follows:

Run 13) Shrimp Bycatch = 0;   Steepness EST; Recruit. Devs. (40%CV); Effort Devs (50%CV all fleets)

Run 13 was used to estimate the average fishing mortality rate of the directed fleets (COM-EAST, COM-WEST and REC), and compare that value to the estimate obtained from simple catch-curve analysis.

No attempt was made to model the dead discards of the recreational or commercial fisheries. Future sensitivity runs may address this omission, however, the recreational and commercial dead discards are unlikely to be important as they compose only a small fraction (typically <2%) of the total landings[3].

RESULTS AND DISCUSSION

Continuity Run (P-T Production Model)

Observed recreational and commercial catches show moderate variations over time (Fig 2). Fits to the catch series are acceptable, with the exception of the shrimp trawl bycatch (Fig. 2). However, as this series was estimated using a constant value and allowing a large variance, the lack of fit is not unexpected. Shrimp trawl effort was modeled using a time series constructed by Scott Nichols (NMFS Pascagoula) for the 2004-2005 red snapper assessment. The fit to the shrimp effort series is also acceptable (Fig. 3).

The model fits to the indices of abundance are adequate (Fig. 4), and suggest an increasing population from 1986-1992, followed by a substantial decline through the 1990s. Recovery since 2000 is indicated by the CM-HL index, although the model estimates do not fit this trend.

Annual trends in biomass and fishing mortality are summarized in Figures 5-8. Management benchmarks are summarized in Table 1. In 1986, F/F_{MSY} was 1.20 (Fig. 5) and B/B_{MSY} was 0.74 (Fig. 6) indicating that this stock was somewhat overfished in 1986. Fishing mortality remained relatively unchanged through 1992 (Fig. 7) while biomass increased (Fig. 8). This allowed the population status to improve through 1992. After 1992, fishing mortality increased substantially, and remained elevated through 1999, causing the population status to decline to B_{1999}/B_{MSY} = 0.46 and F_{1999}/F_{MSY} = 1.62. The population remains overfished as of 2004, B_{2004}/B_{MSY} = 0.40 and F_{2004}/F_{MSY} = 2.70 (Fig. 5-6 and Table 1).

[3] Cass-Calay S.L. Unpublished Manuscript. NOAA Fisheries, Miami Laboratory. Shannon.Calay@noaa.gov

To examine the effects of the revised data inputs and five years of additional data (2000-2004), the 2001 assessment results are overlaid on Figures 5-8, and the management benchmarks are tabulated for comparison in Table 1, and in a control rules (phase) diagram (Fig. 9). The results of the replication run are quite similar to the 2001 base model. In both cases, the current population status is overfished and overfishing is ongoing.

State Spaced Age-Structured Production Model (SSASPM) Runs

Set 1 (Effort Deviations of Shrimp Bycatch Fleet = 20%CV):
Fits the catch series of the directed fleets are shown in Figure 10. Note that the period from 1950-1980 is presumed to be "prehistoric", and is used by the model to tune the results of the historic period 1981-2004. In general, runs that allowed deviations from the stock-recruit relationship fit the catch series most accurately. These included runs 1,3,5 and 6. For runs 2 and 4 (recruitment not allowed to deviate from S-R relationship), the predicted commercial catches were lower than the observed values during 1990-2004.

The fits to the assumed shrimp bycatch levels are shown in Figure 11. Model runs that allowed recruitment to deviate from the S-R relationship (Runs 1,3,5,and 6) predicted lower bycatch than assumed during recent years, 2000-2004. Conversely, model runs 2 and 4 (recruitment not allowed to deviate from S-R relationship) predicted higher bycatch than assumed during the same time period.

Fits to the indices of abundance are summarized in Figure 12. The fits are very similar regardless of the model run. The fits to the CMHL-EAST and HB-WEST indices are similar to the observed trends, but the model fits to the HB-EAST and MRFSS-EAST indices are quite flat compared to the observed values. The recent (2000-2004) increasing trend of the CMHL-WEST index is not fit by the Set 1 SSASPM model runs.

Annual trends in fishing mortality (F), and F relative to MSY and SPR30% levels are summarized in Figure 13. In 1950, F was assumed to be negligible. The linear increase during the "prehistoric" period (1950-1981) is dictated by the model structure (SSASPM-linear). F statistics varied without obvious trend during 1981-2000, but a general increase in F is notable during 2001-2004. Using MSY based management benchmarks, Runs 3 and 4 indicate that overfishing took place in 2004, F_{2004}/F_{MSY} = 1.04 and 1.62, respectively (Table 2, Fig. 13). All other Set 1 SSASPM runs indicated that overfishing was not occurring in 2004. Runs 3 and 4 were also the only Set 1 runs to fix steepness at 0.60, the mean recommended by the SEDAR data workshop. Other runs allowed steepness to be estimated, producing estimates ranging from 0.75 to 0.85. This result suggests that the lower fixed value for steepness used during model runs 3 and 4 resulted in a more pessimistic status. SPR based management benchmarks indicated current overfishing only for model run 4. $F_{2004}/F_{SPR30\%}$ = 1.04 (Table 2, Fig. 13).

Annual trends in spawning stock biomass (SSB) relative to virgin (S_{1950}), MSY and SPR30% levels are summarized in Figure 14. Estimates prior to 1981 are considered "prehistoric", but are useful to tune the model results. For models that allowed recruitment deviations (Runs 1,3,5 and 6), SSB statistics varied without obvious trend during 1981-1990, but generally declined thereafter. In 2004, SSB ranged from 40% to 51% of SSB_{1950}, SSB/SSB_{MSY} estimates ranged from 1.33 to 1.87 and $SSB/SSB_{SPR30\%}$ estimates ranged from 1.52 to 2.68, indicating a population that is not currently overfished (Table 2, Fig. 14). Runs that did not allow recruitment deviations (Runs 2 and 4) were generally less optimistic. They suggest a steady decrease in all SSB measures during the time series (Fig. 14) with SSB_{2004} at 22% to 30% of SSB_{1950}.. Using MSY based benchmarks, Run 4 indicated a population status that was overfished in 2004, $SSB_{2004}/SSB_{MSY} = 0.68$ (Table 2). However, if one considers SPR based benchmarks, no Set 1 run indicated an overfished population, $SSB_{2004}/SSB_{MSY} \geq 1.14$ (Table 2). Management benchmarks pertaining to Set 1 SSASPM runs are also summarized in control rules (phase) diagrams (Fig. 15).

Set 2 (Effort Devs of Shrimp Bycatch Fleet = 50%CV):

Set 2 SSASPM runs allow larger interannual variations in the effort of the shrimp fleet (50% CV). Fits to the catch series of the directed fleets are very similar to the Set 1 runs (Fig. 16). The fits to the assumed shrimp bycatch are shown in Fig. 17. Fits to the indices of abundance were nearly identical to the fits of the Set 1 runs (Figure 11), and are not shown.

Annual trends in fishing mortality (F), and F relative to MSY and SPR30% levels are summarized in Fig.18. In general, the results are more pessimistic than Set 1 runs, particularly during recent years. A substantial increase in F is notable during 2001-2004. Runs 7,9,10 and 12 indicate that overfishing did occur in 2004, F_{2004}/F_{MSY} ranging from 1.09 to 2.05 and $F_{2004}/F_{SPR30\%}$ ranging from 1.12 to 1.38 (Fig. 18, Table 3). Runs 8 and 11 may indicate overfishing in 2004 depending on the management plan criteria, and the level of assumed natural mortality, $F_{2004}/F_{MSY} \geq 0.82$, $F_{2004}/F_{SPR30\%} \geq 0.72$ (Fig. 18, Table 3).

Annual trends in spawning stock biomass (SSB) relative to virgin (S_{1950}), MSY and SPR30% levels are very similar to Set 1 runs, and are summarized in Fig. 19. A substantial decline in each SSB ratio is evident during 2000-2004. In general, the population status is not overfished in 2004 (Fig 19, Table 3). An exception is Run 10, $SSB_{2004}/SSB_{MSY} = 0.64$, if MSY based benchmarks are considered (Table 3). A control rules plot is included to summarize the population status estimates for Set 2 SSASPM model runs (Fig. 20).

Catch Curve Analysis

A catch –curve analysis was conducted to confirm that SSASPM estimates of fishing mortality are comparable those produced by basic data analysis methods. For this comparison, an additional SSASPM run was conducted that assumed zero shrimp bycatch (this was necessary due to the lack of directly measured age composition for the shrimp bycatch). The two procedures used identical assumptions regarding the initial estimates of selectivity and natural mortality, and identical age composition data. As expected, the resulting estimates of average $F_{1994\text{-}2004}$ for the directed fleets were very similar, 0.18 for the SSASPM run and 0.19 catch-curve procedure.

Comparison of Model Results

The conclusions of the Pella-Tomlinson production model are much more pessimistic than those of the State-Spaced Age-Structured Production Model (SSASPM). The 2001 base case and 2005 continuity run of the P-T production model indicate that, as of 2004, vermilion snapper in the Gulf of Mexico stock were overfished, and overfishing was ongoing. Only two of twelve SSASPM model runs indicate that vermilion snapper were overfished in 2004, although some models did indicate that overfishing was occurring.

This disparate result could be due, in part, to a few important differences in model structure. For instance, SSASPM accommodates a fecundity-at-age relationship and observations of age composition while the P-T production model does not. The SSASPM model also allows catches to be input in numbers rather than weight. However, the most important difference is likely to be the starting year of the data series. The P-T production model runs were implemented with data beginning in 1986. Results indicated that the population was already overfished and the overfishing was occurring in 1986. SSASPM model runs used "historical" data series beginning in 1981, but also used additional assumptions to tune the 1981 population status estimates, specifically, the assumed year of near-virgin condition (1950), and the expected shape of the increase in fishing effort from 1950 to 1981 (linear). It is likely that this additional tuning information caused the striking differences in the 2004 population status estimates.

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TABLE 1. Management and biomass status benchmarks for the 2001 base case, and the replication of the previous assessment (P-T Production Model). Biomass benchmarks and carrying capacity are in pounds.

Benchmark	2001 Base Run	2005 Continuity Case
B1986 (LBS)	6.18E+06	7.92E+06
B1999 (LBS)	3.77E+06	4.99E+06
B2004 (LBS)	-	4.32E+06
BMSY (LBS)	1.06E+07	1.08E+07
B1986/BMSY	0.584	0.736
B1999/BMSY	0.356	0.463
B2004/BMSY	-	0.401
F1986	0.443	0.401
F1999	0.632	0.541
F2004	-	0.903
FMSY	0.318	0.334
F1986/FMSY	1.39	1.20
F1999/FMSY	1.99	1.62
F2004/FMSY	-	2.70
R	0.637	0.668
K (LBS)	2.12E+07	2.15E+07
MSY (LBS)	3.37E+06	3.59E+06

*** R is the intrinsic rate of growth; K is the carrying capacity

TABLE 2. Management and biomass status benchmarks for ***Set 1*** SSASPM model runs.

Model Description	**RUN 1**	**RUN 2**	**RUN 3**	**RUN 4**	**RUN 5**	**RUN 6**
Shrimp Bycatch (Millions of Fish)	6.9	6.9	6.9	6.9	3.45	10.35
Steepness Estimated or Fixed?	EST	EST	FIX @ 0.6	FIX @ 0.6	EST	EST
Recruitment Devs?	40%CV	None (0%CV)	40%CV	None (0%CV)	40%CV	40%CV
Benchmark						
SSB_{MSY}	5.26E+07	5.76E+07	7.14E+07	1.02E+08	4.65E+07	5.90E+07
$SSB_{30\%SPR}$	5.40E+07	7.33E+07	3.54E+07	5.07E+07	4.00E+07	6.69E+07
SSB_{1962}/SSB_{MSY}	2.71	2.75	2.01	1.64	2.74	2.63
SSB_{1999}/SSB_{MSY}	2.25	1.75	1.68	0.93	2.33	2.17
SSB_{2004}/SSB_{MSY}	1.80	1.45	1.33	0.68	1.87	1.73
$SSB_{1962}/SSB_{30\%SPR}$	2.64	2.16	4.07	3.30	3.18	2.32
$SSB_{1999}/SSB_{30\%SPR}$	2.20	1.37	3.39	1.86	2.72	1.91
$SSB_{2004}/SSB_{30\%SPR}$	1.75	1.14	2.68	1.37	2.17	1.52
F_{MSY}	0.87	1.08	0.54	0.56	0.66	1.00
$F_{30\%SPR}$	0.85	0.88	0.85	0.88	0.76	0.90
F_{1962}/F_{MSY}	0.43	0.47	0.67	0.93	0.36	0.49
F_{1999}/F_{MSY}	0.60	0.99	0.96	1.91	0.46	0.70
F_{2004}/F_{MSY}	0.65	0.80	1.04	1.62	0.52	0.74
$F_{1962}/F_{30\%SPR}$	0.44	0.57	0.42	0.59	0.31	0.54
$F_{1999}/F_{30\%SPR}$	0.62	1.21	0.60	1.22	0.40	0.77
$F_{2004}/F_{30\%SPR}$	0.67	0.97	0.66	1.04	0.45	0.82
STEEPNESS	0.79	0.85	0.60	0.60	0.75	0.81
MSY (LBS)	5.54E+06	7.52E+06	4.29E+06	6.05E+06	4.25E+06	6.78E+06
F0.1	0.85	0.93	0.85	0.91	0.60	1.00
Virgin Recruitment (R_0)	1.41E+07	1.78E+07	1.44E+07	2.07E+07	1.10E+07	1.69E+07

TABLE 3. Management and biomass status benchmarks for ***Set 2*** SSASPM model runs.

Model Description	**RUN 7**	**RUN 8**	**RUN 9**	**RUN 10**	**RUN 11**	**RUN 12**
Shrimp Bycatch (Millions of Fish)	6.9	6.9	6.9	6.9	3.45	10.35
Steepness Estimated or Fixed?	EST	EST	FIX @ 0.6	FIX @ 0.6	EST	EST
Recruitment Devs?	40%CV	None (0%CV)	40%CV	None (0%CV)	40%CV	40%CV
Benchmark						
SSB_{MSY}	4.94E+07	5.78E+07	6.64E+07	9.74E+07	4.37E+07	5.53E+07
$SSB_{30\%SPR}$	5.10E+07	7.13E+07	3.35E+07	4.93E+07	3.73E+07	6.36E+07
SSB_{1962}/SSB_{MSY}	2.93	2.82	2.22	1.74	2.89	2.88
SSB_{1999}/SSB_{MSY}	2.22	1.78	1.65	0.99	2.28	2.16
SSB_{2004}/SSB_{MSY}	1.44	1.32	1.06	0.64	1.55	1.39
$SSB_{1962}/SSB_{30\%SPR}$	2.84	2.28	4.40	3.44	3.39	2.50
$SSB_{1999}/SSB_{30\%SPR}$	2.14	1.44	3.27	1.96	2.67	1.88
$SSB_{2004}/SSB_{30\%SPR}$	1.40	1.07	2.09	1.27	1.81	1.21
F_{MSY}	0.94	1.08	0.60	0.60	0.72	1.07
$F_{30\%SPR}$	0.91	0.91	0.92	0.92	0.82	0.96
F_{1962}/F_{MSY}	0.35	0.43	0.51	0.80	0.29	0.40
F_{1999}/F_{MSY}	0.82	1.04	1.27	1.88	0.62	0.92
F_{2004}/F_{MSY}	1.09	0.98	1.73	2.05	0.82	1.24
$F_{1962}/F_{30\%SPR}$	0.36	0.51	0.33	0.53	0.26	0.44
$F_{1999}/F_{30\%SPR}$	0.84	1.23	0.83	1.23	0.54	1.02
$F_{2004}/F_{30\%SPR}$	1.12	1.17	1.13	1.34	0.72	1.38
STEEPNESS	0.78	0.84	0.60	0.60	0.74	0.81
MSY (LBS)	5.10E+06	7.21E+06	3.92E+06	5.73E+06	3.89E+06	6.27E+06
F0.1	1.03	1.02	1.04	1.04	0.76	1.17
Virgin Recruitment (R_0)	1.34E+07	1.76E+07	1.37E+07	2.00E+07	1.05E+07	1.62E+07

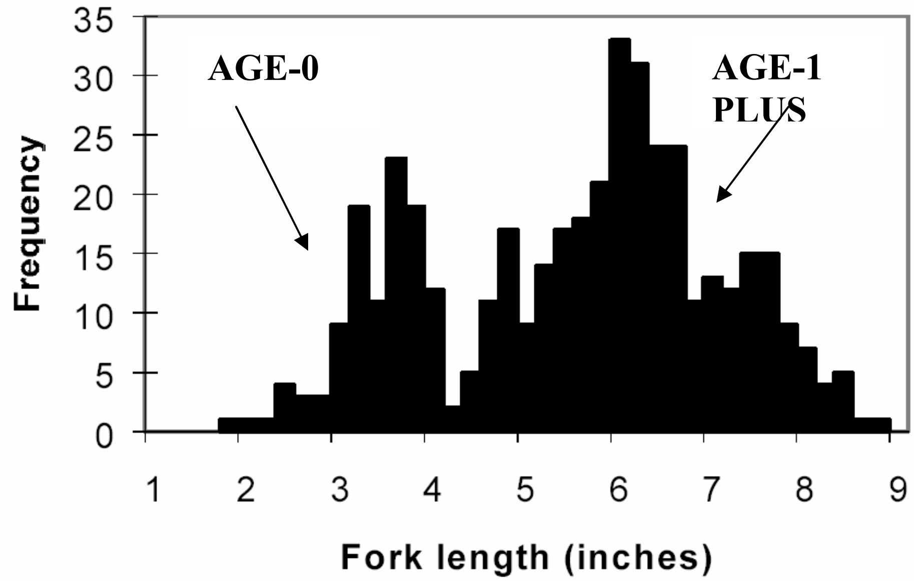


Figure 1. Length frequency distribution of vermilion snapper landed as bycatch by the offshore shrimp fleet (from Porch and Cass-Calay, 2001).

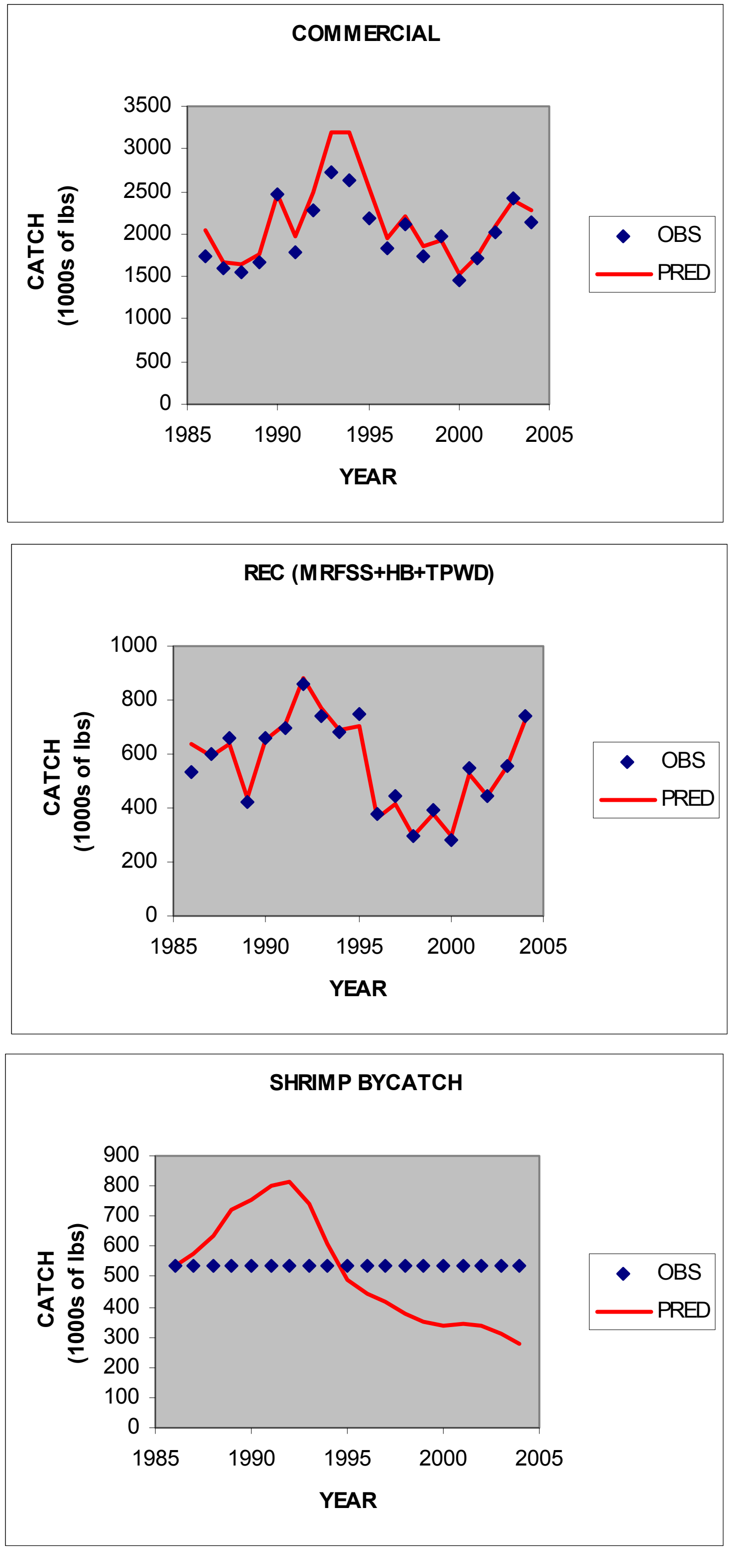


Figure 2. Fits to catch series (***continuity case***).

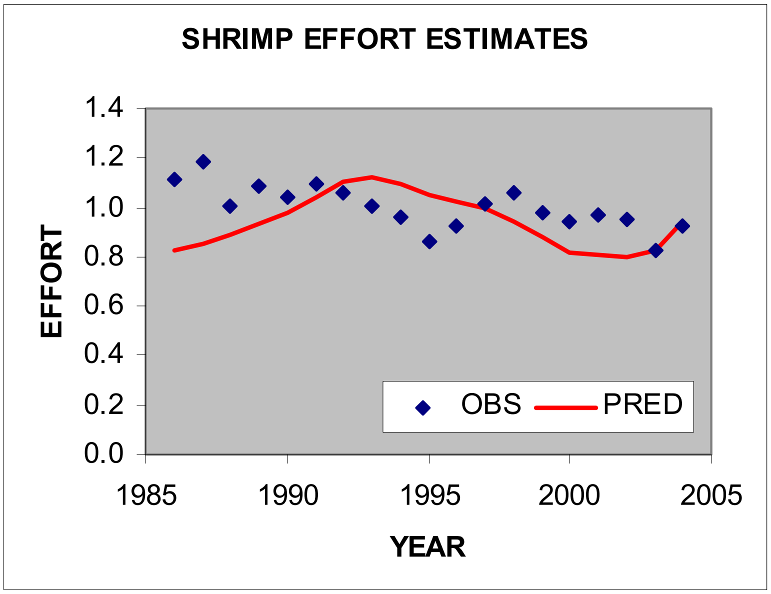
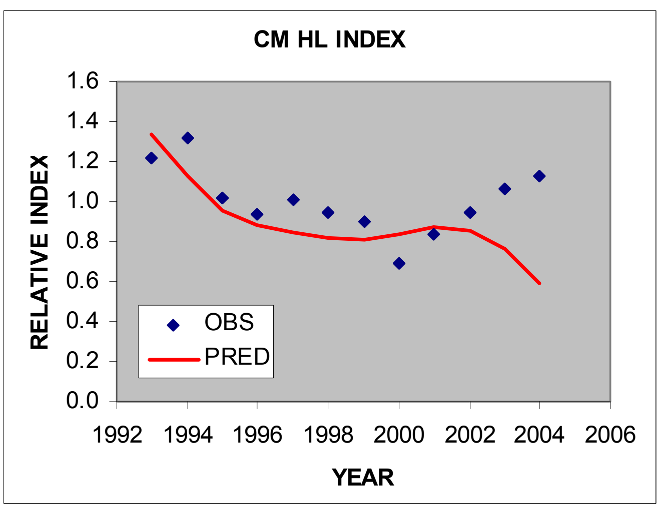


Figure 3. Fit to the shrimp trawl effort series (***continuity case***).



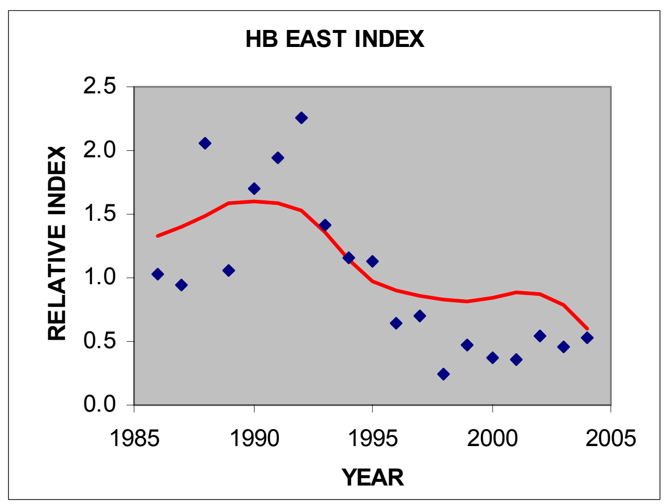


Figure 4. Fit to the indices of abundance (***continuity case***).

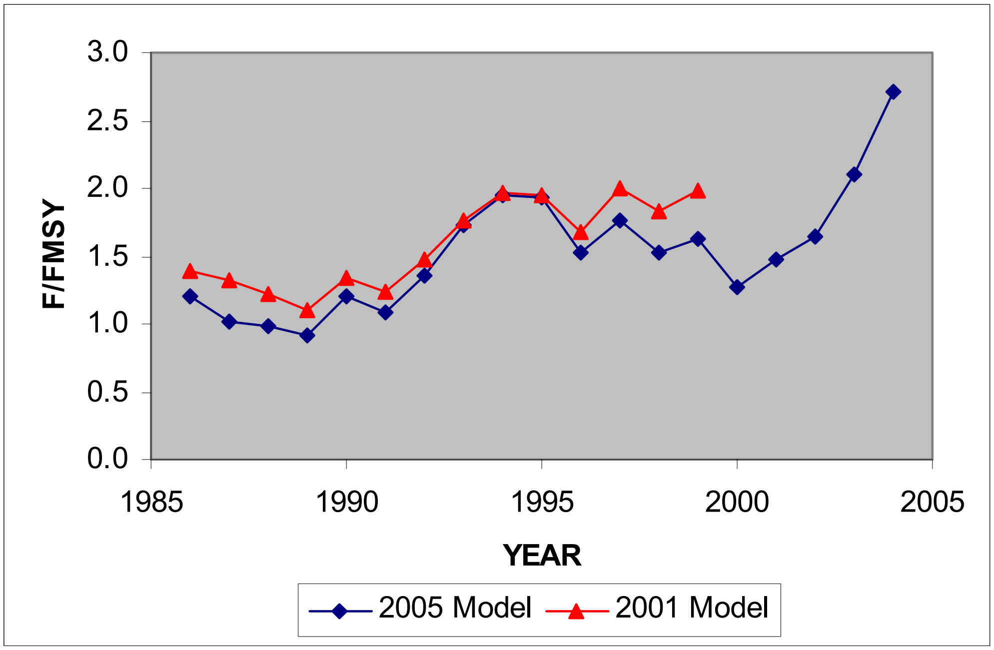


Figure 5. Comparison of the fishing mortality trajectories (as a function of F at MSY) for the continuity case (2005) and the 2001 assessment base run.

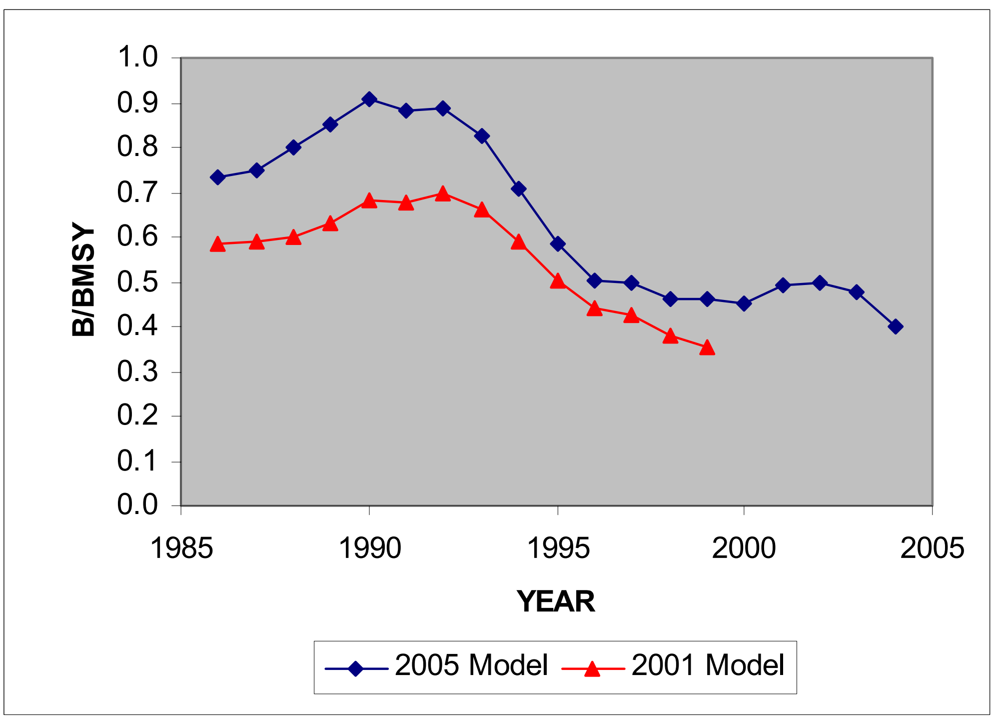


Figure 6. Comparison of the population biomass trajectories (as a proportion of biomass at MSY) for the continuity case (2005) and the 2001 assessment base run.

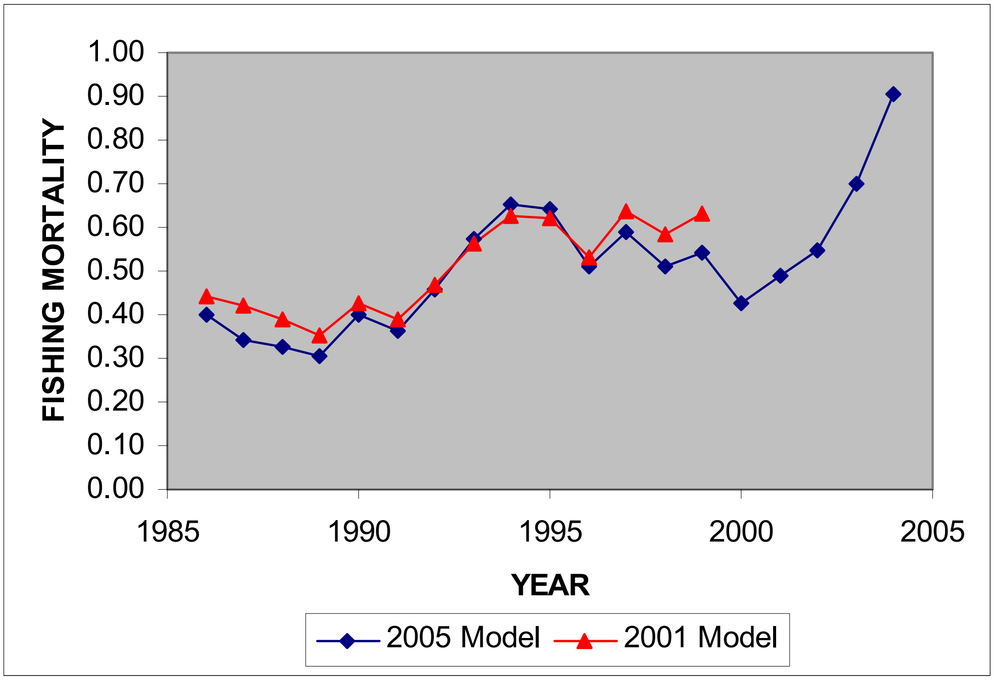


Figure 7. Comparison of the fishing mortality trajectories for the continuity case (2005) and the 2001 assessment base run.

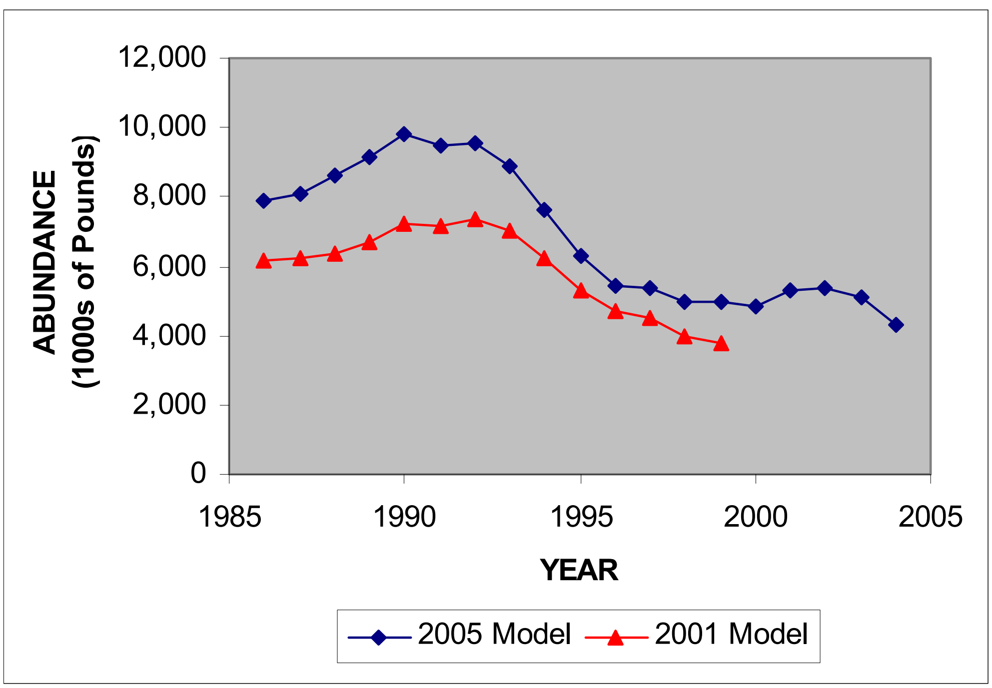


Figure 8. Comparison of the biomass trajectories for the continuity case (2005) and the 2001 assessment base run.

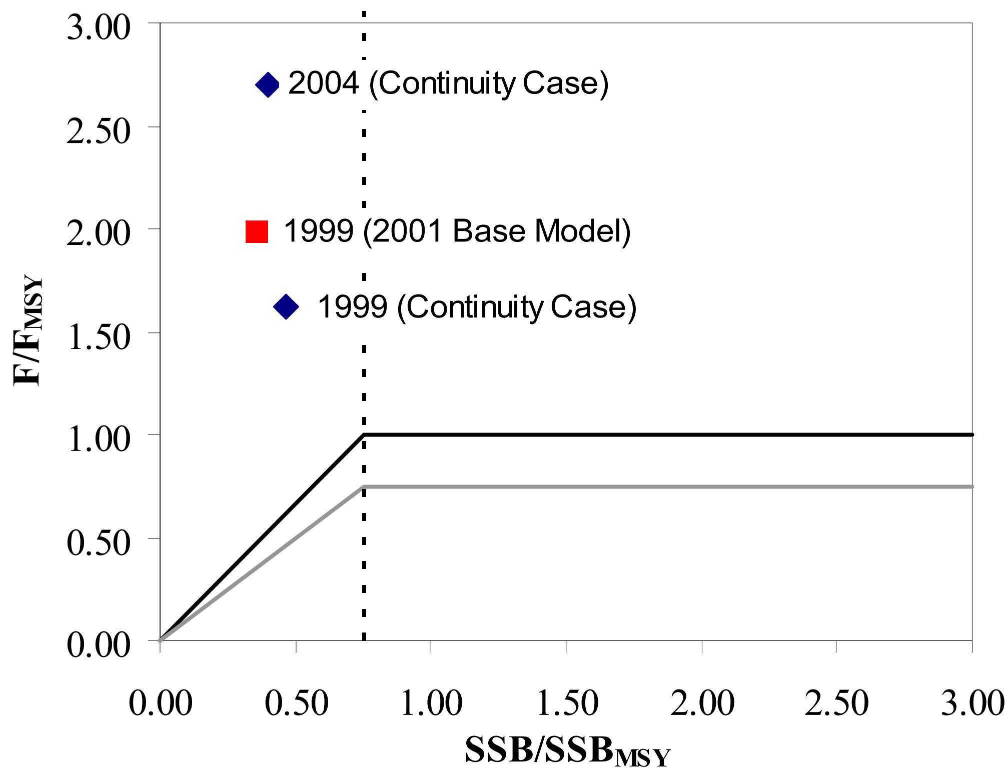


Figure 9. Control rules plot for P-T production model runs.

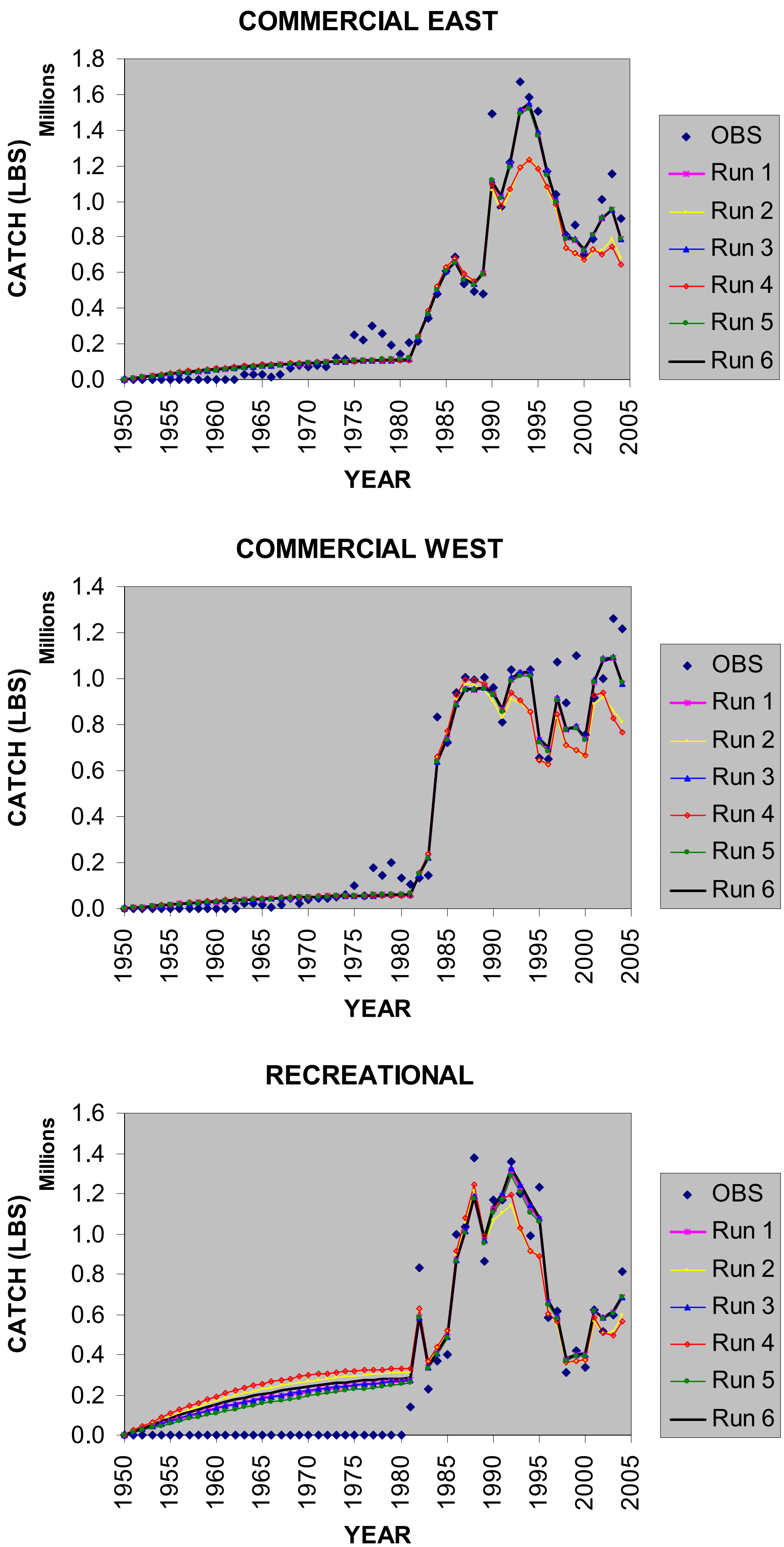


Figure 10. Fits to the commercial and recreational catch series for ***Set 1*** SSASPM models.

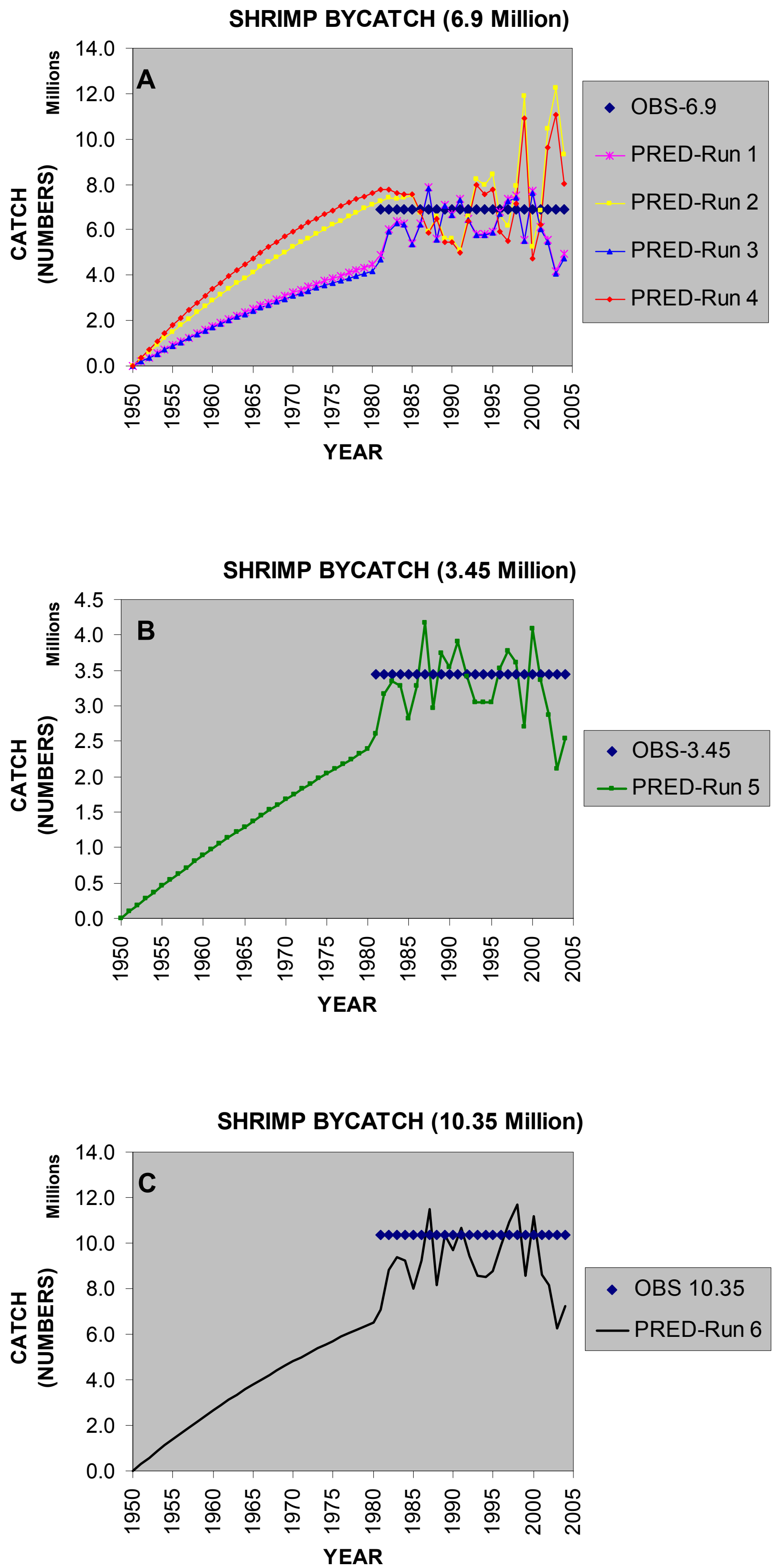


Figure 11. Fits to shrimp bycatch for ***Set 1*** SSASPM model runs assuming various constant levels (Runs 1-4 = 6.9 million, Run 5 = 3.45 million, Run 6 = 10.35 million).

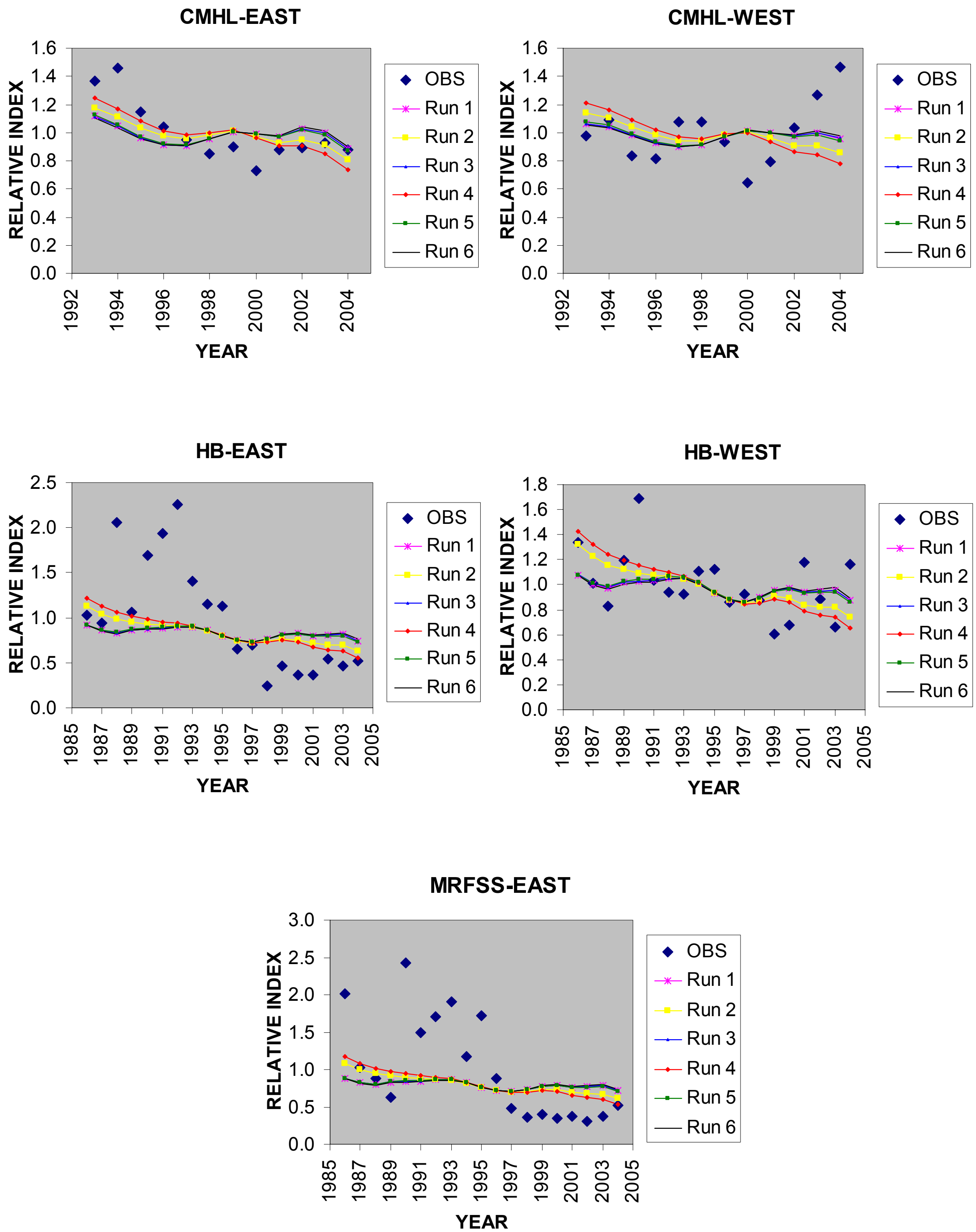


Figure 12. Fits to indices of abundance for ***Set 1*** SSASPM models.

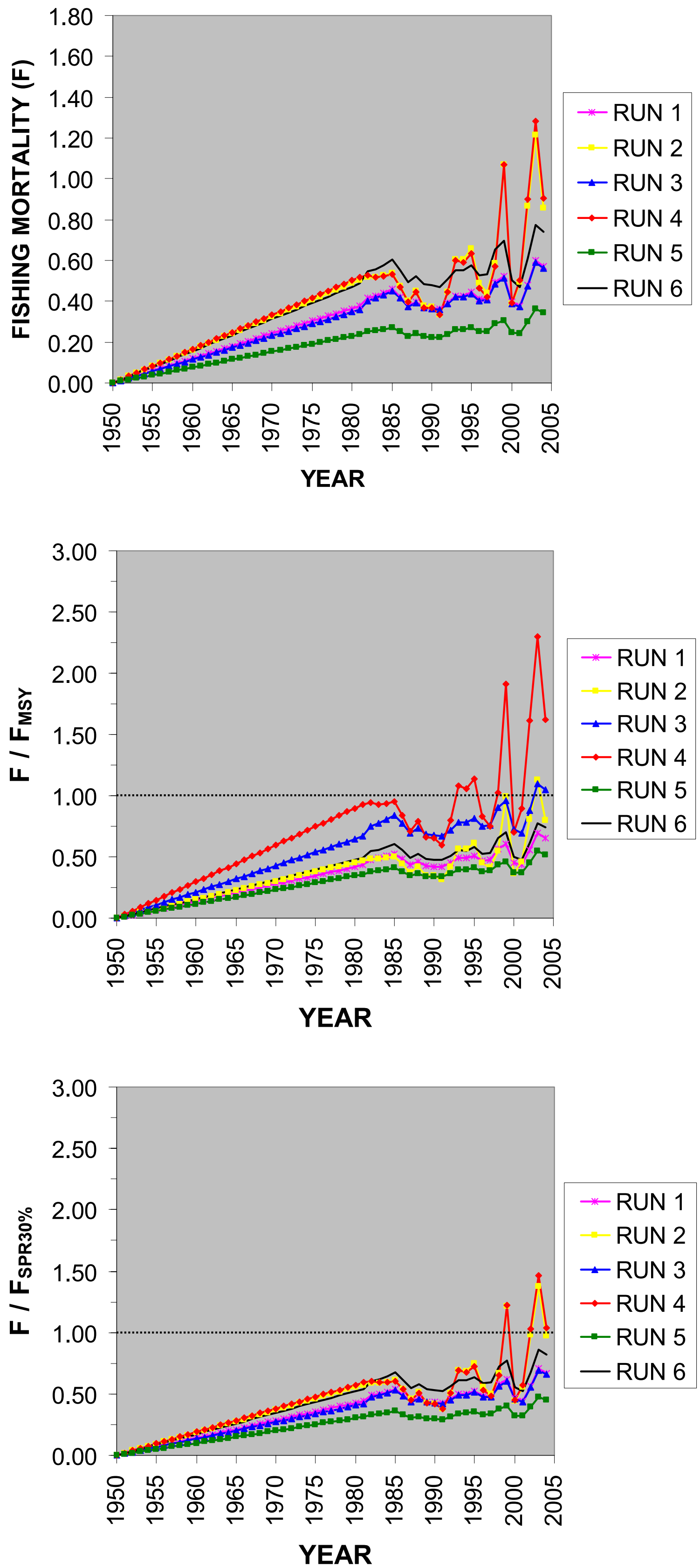


Figure 13. Annual trends in F, F/F_{MSY} and F/$F_{SPR30\%}$ for ***Set 1*** SSASPM models.

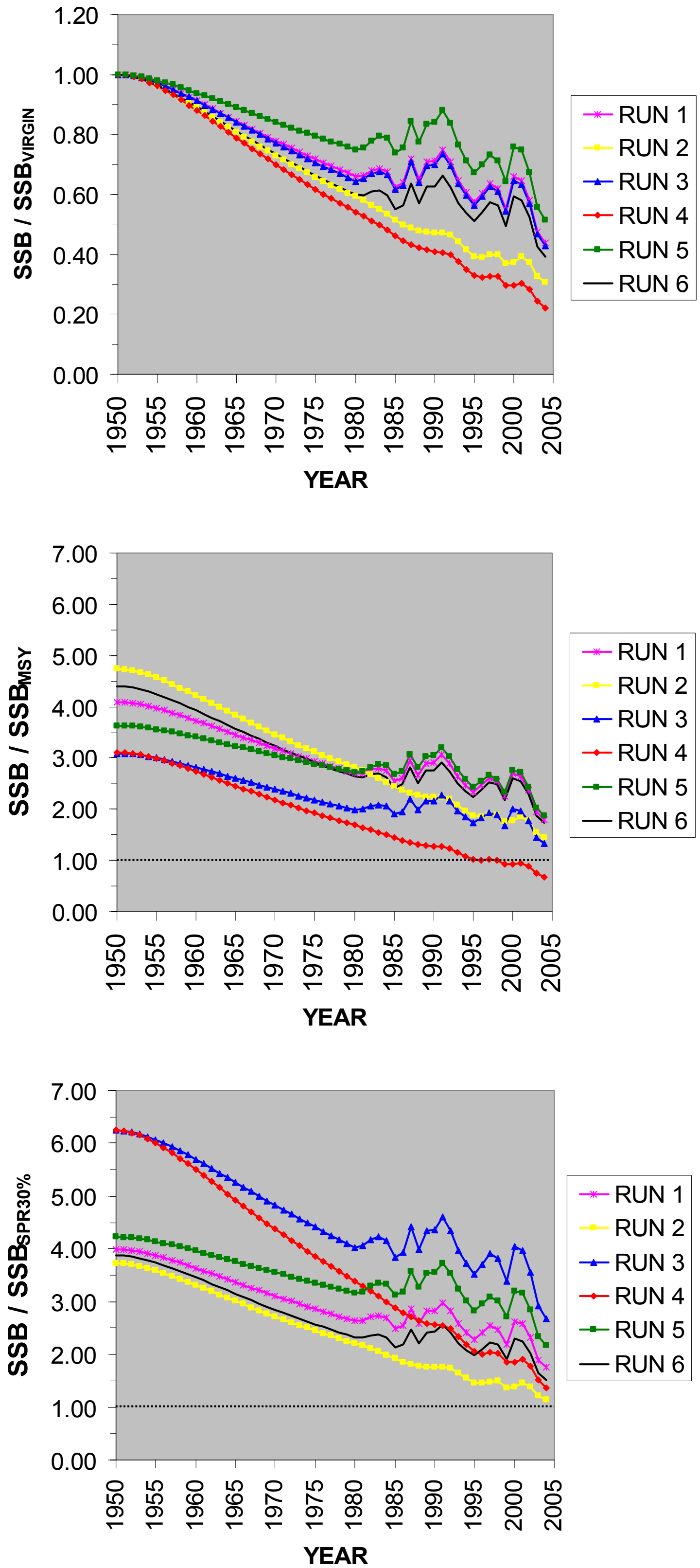


Figure 14. Annual trends in spawning stock biomass (SSB) relative to virgin (S_0), MSY and SPR30% levels for ***Set 1*** SSASPM models.

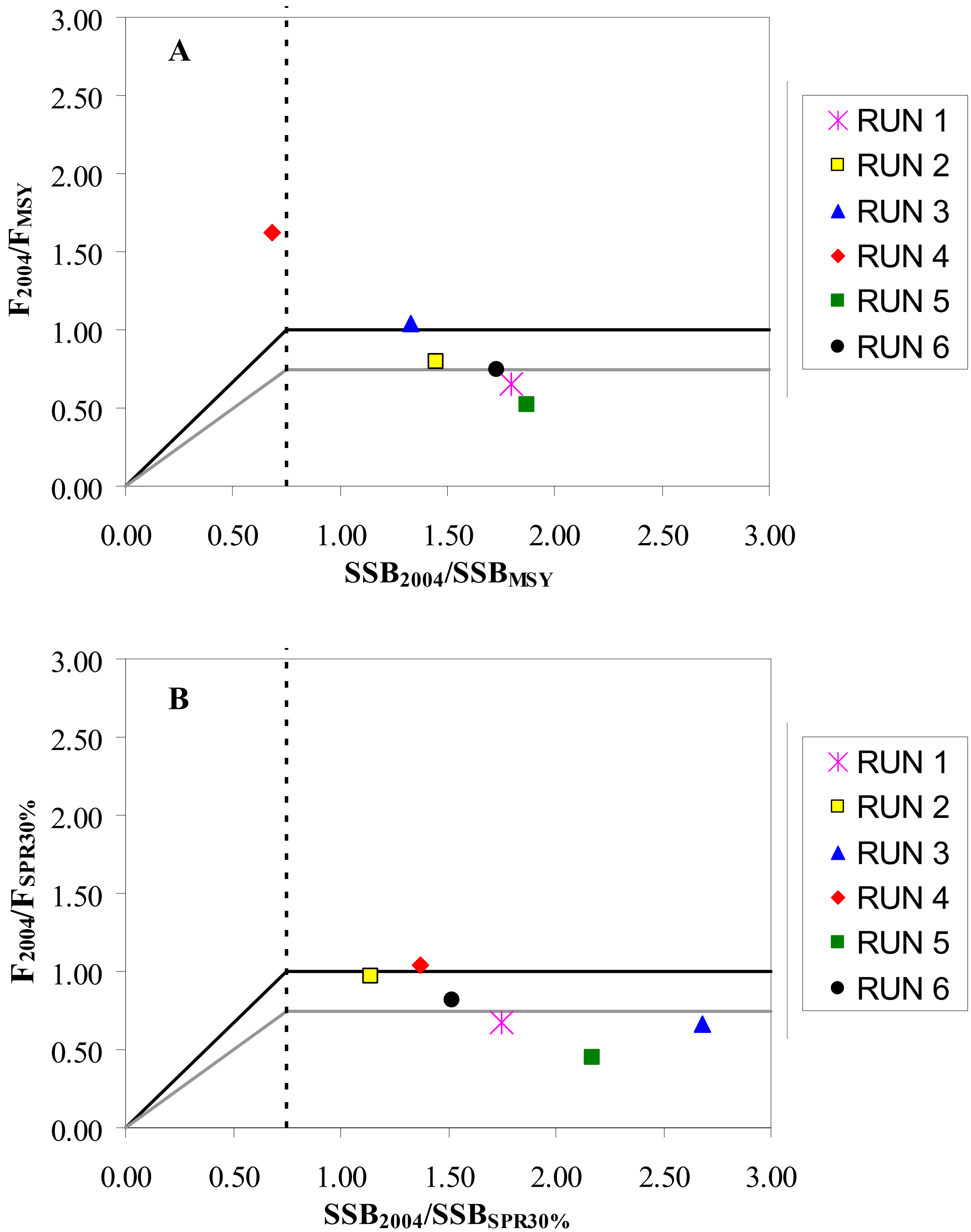


Figure 15. Control rules plot for ***Set 1*** SSASPM Runs. A) MSY and B) SPR30% based management benchmarks.

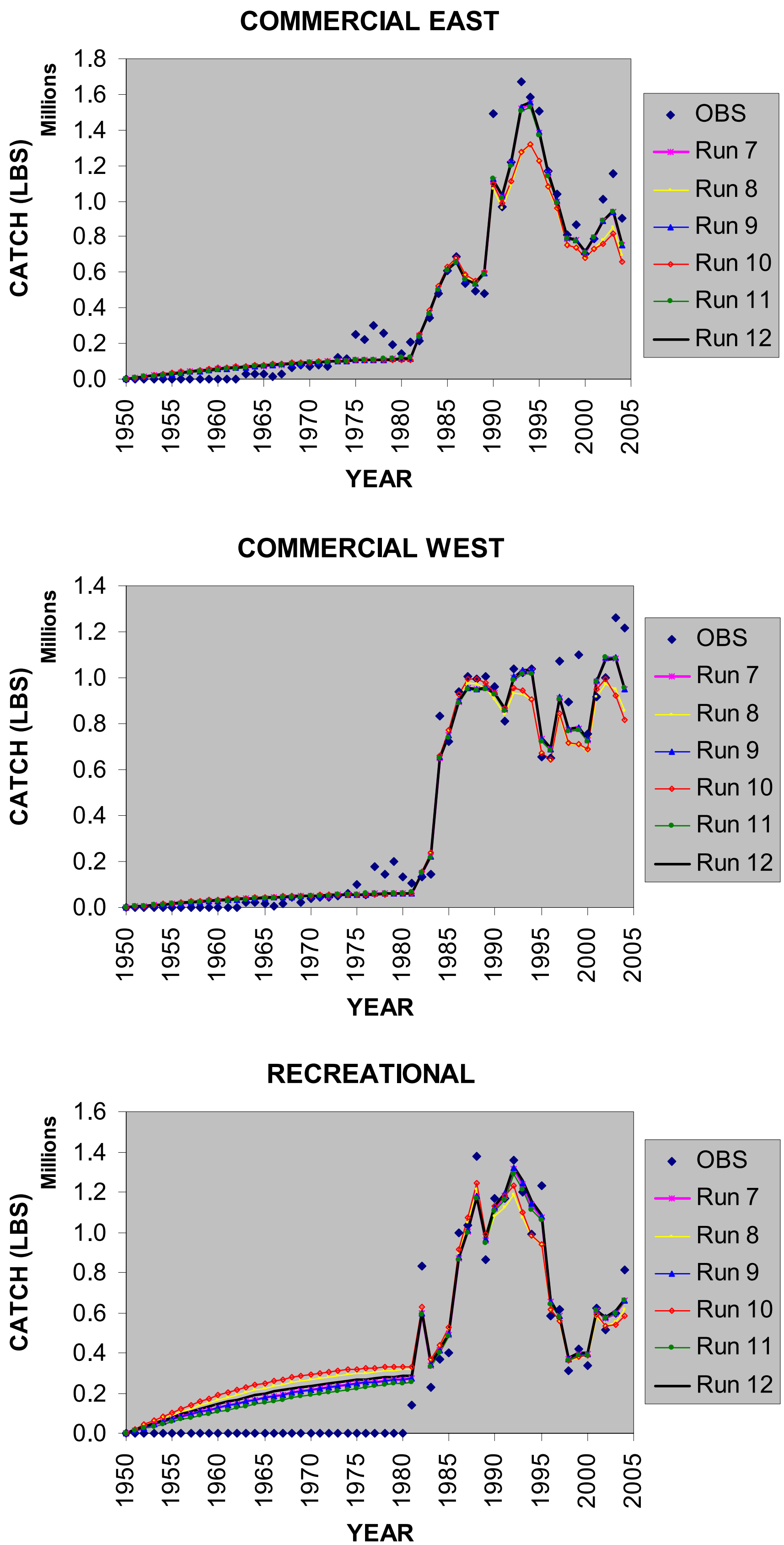


Figure 16. Fits to the commercial and recreational catch series for ***Set 2*** SSASPM models.

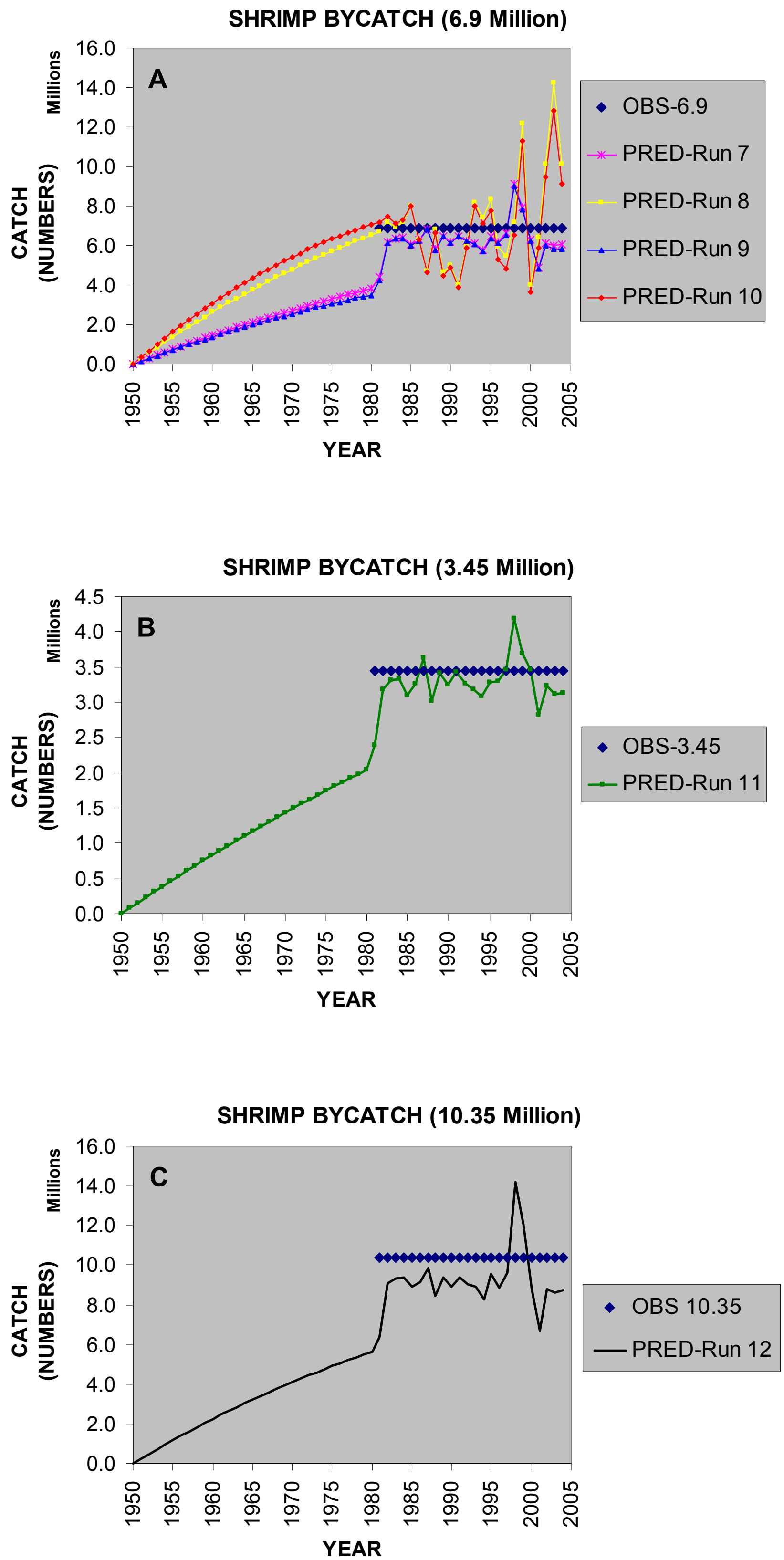


Figure 17. Fits to shrimp bycatch for ***Set 2*** SSASPM model runs assuming various constant levels (Runs 7-10 = 6.9 million, Run 11 = 3.45 million, Run 12 = 10.35 million).

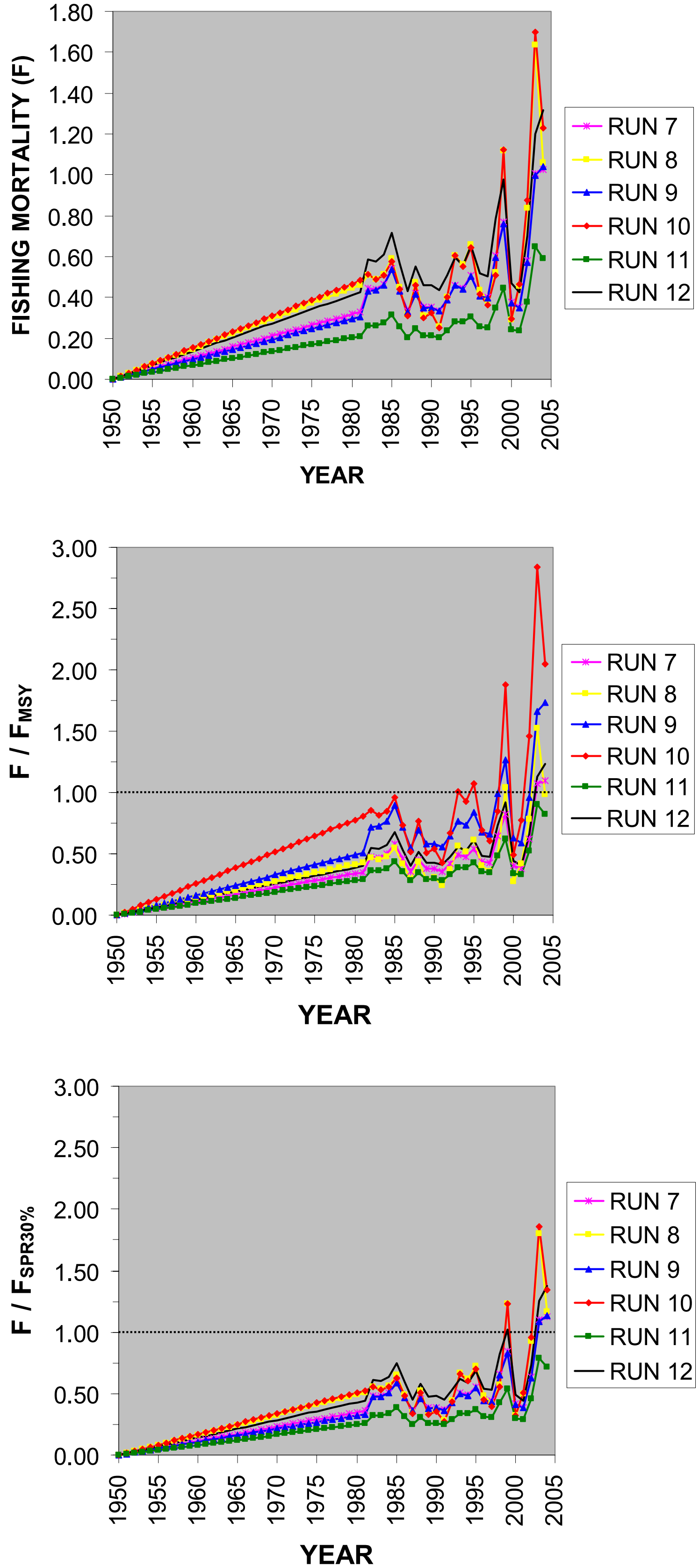


Figure 18. Annual trends in F, F/F_{MSY} and $F/F_{SPR30\%}$ for ***Set 2*** SSASPM models.

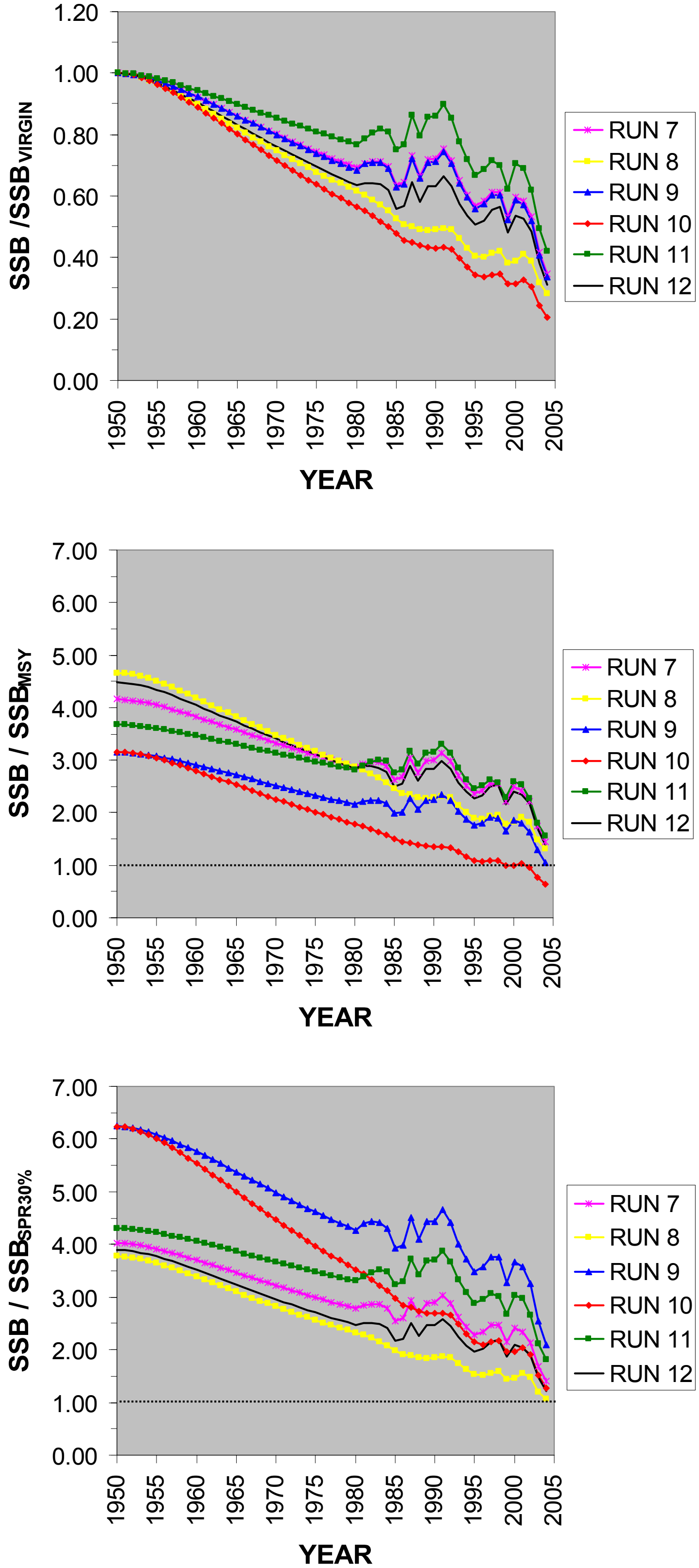


Figure 19. Annual trends in spawning stock biomass (SSB) relative to virgin (S_0), MSY and SPR30% levels for ***Set 2*** SSASPM models.

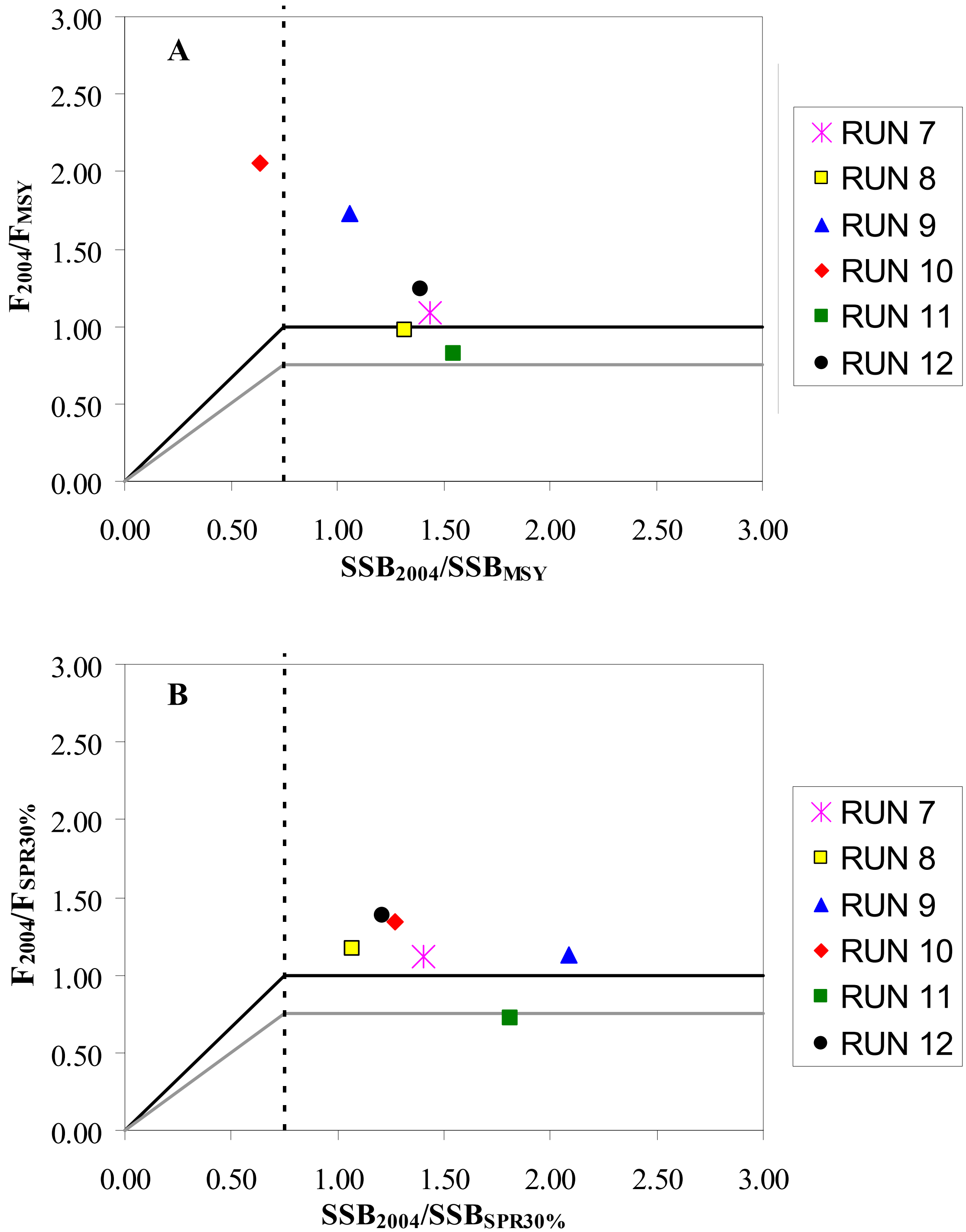


Figure 20. Control rules plot for ***Set 2*** SSASPM Runs. A) MSY and B) SPR30% based management benchmarks.

APPENDIX 1. Input data for P-T production model (**continuity run**).

```
# first and last year of data
 1986  2004
# number of steps per year in numerical integration (best to use binary 2^n))
 16
# type of overall variance parameter (1 = log scale variance, 2 = observation scale variance, 0=force equal weighting)
 1
# pdf of MSY penalty (0 = ignore, 1 = lognormal, 2 = normal)
# |     variance of penalty
# |     |
 1     0.2231
#####################################################
# CATCH INFORMATION If there are no series, there should be no entries between the comment lines.
#####################################################
# number of catch data series
 3
# pdf of observation error for each series (1) lognormal, (2) normal
  1  1  1
# set of variance parameters each series is linked to
  1  1  1
# set of q parameters each series is linked to
  1  2  3
# set of e parameters each series is linked to
  1  2  3
# observed catches by set (no column for year allowed)
# (thousands of lbs)
# COM        REC(HB+MRFSS+TPWD)      SHRIMP BYCATCH
1749.447            535.211              534.152
1605.405            601.701              534.152
1554.542            658.243              534.152
1658.822            423.703              534.152
2454.872            657.975              534.152
1795.025            695.631              534.152
2267.916            860.141              534.152
2719.540            740.495              534.152
2639.233            684.714              534.152
2178.040            750.469              534.152
1827.282            378.737              534.152
2125.814            440.981              534.152
1732.638            293.533              534.152
1982.332            391.784              534.152
1459.944            283.161              534.152
1715.084            551.006              534.152
2008.578            443.242              534.152
2415.748            557.425              534.152
2134.383            741.749              534.152
# annual scaling factors for observation variance
# (use this option to scale up the variance for observations based on very little data)
0.00995             0.02000              0.69315 (Comment: Repeat this row 18 more  times)
#####################################################
# INDICES OF ABUNDANCE (e.g., CPUE) If there are no series, there should be no entries between the comment lines.
#####################################################
# number of index data series
2
# pdf of observation error for each series (1) lognormal, (2) normal
1  1
# option to (1) scale or (0) not to scale index observations
0  0
# set of variance parameters each series is linked to
1  1
# set of q parameters each series is linked to
1  2
```

APPENDIX 1. (continued)

```
# observed indices by series (no column for year allowed)
#    COM-HL                    Headboat (EAST)
-1                             1.03204559
-1                             0.941519134
-1                             2.054584545
-1                             1.062555262
-1                             1.694723765
-1                             1.938460087
-1                             2.260906064
1.218890797                    1.409570685
1.31432212                     1.154854974
1.014353062                    1.129573057
0.937836941                    0.647990601
1.009314675                    0.696907307
0.944932228                    0.247686767
0.898592785                    0.468268173
0.689448207                    0.368769483
0.834727824                    0.363803165
0.942789022                    0.541228501
1.067934164                    0.462856303
1.126858175                    0.523696538
# annual scaling factors for observation variance (use this option to scale up the variance for observations based on very little data)
 1          1   (Comment: Repeat this row 18 more  times)
####################################################
# EFFORT OBSERVATIONS If there are no series, there should be no entries between the comment lines.
####################################################
# number of effort data series
  1
# pdf of observation error for each series (1) lognormal, (2) normal
  1
# option to (1) scale or (0) not to scale effort observations
  1
# set of variance parameters each series is linked to
  1
# set of e parameters each series is linked to
  3
# observed shrimp effort series (no column for year allowed)
 226797.72
 241902.35
 205811.62
 221164.83
 211859.82
 223388.44
 216668.91
 204482.02
 195742.08
 176588.54
 189653.01
 207912.05
 216998.55
 200474.74
 192072.86
 197644.43
 194186.24
 168152.59
 188014.03 # AVG of 2000-2003
# annual scaling factors for observation variance (use this option to scale up the variance for observations based on very little data)
 0.2231     (Comment: Repeat this row 18 more  times)
```

APPENDIX 2. Parameter file for P-T production model (**continuity run**).

```
# INPUT FILE FOR PROGRAM PT-MODEL
# CLASS
#  |       SET (corresponds to pointers in data series.
#  |        |     NATURE specifies deterministic and stochastic parts of parameter class)
#  |        |     |        METHOD OF ESTIMATION (either 'FIXED' or 'ESTIMATED')
#  |        |     |        |                PHASE (immaterial if method = 'FIXED')
#  |        |     |        |                |    BEST ESTIMATE
#  |        |     |        |                |    |             LOWER BOUND
#  |        |     |        |                |    |             |             UPPER BOUND
#  |        |     |        |                |    |             |             |      (-)CV or (+)VARIANCE OF PRIOR
#  |        |     |        |                |    |             |             |             |          PDF OF PRIOR
#  |        |     |        |                |    |             |             |             |            |
 'M'       1    'CONST'  'FIXED'          4    0.2000E+01    0.1000E+00    0.9000E+01    0.2231E+00  'FREQUENTIST'
 'M'       1    'RHO'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
 'M'       1    'VAR'    'FIXED'          3    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
#
 'R'       1    'CONST'  'ESTIMATED'      3    0.6400E+00    0.1000E+00    1.0000E+00    0.5000E+01  'FREQUENTIST'
 'R'       1    'RHO'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
 'R'       1    'VAR'    'FIXED'          3    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
#
 'K'       1    'CONST'  'ESTIMATED'      2    0.5000E+00    0.1000E+00    0.1000E+01    0.5000E+01  'FREQUENTIST'
 'K'       1    'RHO'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
 'K'       1    'VAR'    'FIXED'          3    0.0000E+00    0.0000E+00    0.1000E+13    0.1000E+01  'FREQUENTIST'
#
 'Q'       1    'CONST'  'ESTIMATED'      1    0.1000E+00    0.0000E+00    0.1000E+01    0.5000E+01  'FREQUENTIST'
 'Q'       1    'RHO'    'FIXED'          5    0.0000E+00    0.0000E+00    0.1000E+01    0.1000E+01  'FREQUENTIST'
 'Q'       1    'VAR'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+21    0.1000E+01  'FREQUENTIST'
 'Q'       2    'CONST'  'ESTIMATED'      1    0.1000E+00    0.0000E+00    0.1000E+01    0.5000E+01  'FREQUENTIST'
 'Q'       2    'RHO'    'FIXED'          5    0.0000E+00    0.0000E+00    0.1000E+01    0.1000E+01  'FREQUENTIST'
 'Q'       2    'VAR'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+21    0.1000E+01  'FREQUENTIST'
 'Q'       3    'CONST'  'ESTIMATED'      1    0.1000E+00    0.0000E+00    0.1000E+01    0.5000E+01  'FREQUENTIST'
 'Q'       3    'RHO'    'FIXED'          5    0.0000E+00    0.0000E+00    0.1000E+01    0.1000E+01  'FREQUENTIST'
 'Q'       3    'VAR'    'FIXED'          4    0.0000E+00    0.0000E+00    0.1000E+21    0.1000E+01  'FREQUENTIST'
#
 'E'       1    'CONST'  'ESTIMATED'      1    0.2400E+04    0.1000E+03    0.1000E+07    0.5000E+01  'FREQUENTIST'
 'E'       1    'RHO'    'FIXED'          5    0.5000E+00    0.0000E+00    0.9900E+00    0.1000E+01  'FREQUENTIST'
 'E'       1    'VAR'    'FIXED'          4    0.2231E+00    0.0000E+00    0.1000E+22    0.1000E+01  'FREQUENTIST'
 'E'       1    'DEVS1'  'ESTIMATED'      2    0.0000E+00   -0.5000E+01    0.5000E+01    0.1000E+00  'LOGNORMAL'
 'E'       2    'CONST'  'ESTIMATED'      1    0.5186E+03    0.1000E+02    0.1000E+07    0.5000E+01  'FREQUENTIST'
 'E'       2    'RHO'    'FIXED'          5    0.5000E+00    0.0000E+00    0.9900E+00    0.1000E+01  'FREQUENTIST'
 'E'       2    'VAR'    'FIXED'          4    0.2231E+00    0.0000E+00    0.1000E+22    0.1000E+01  'FREQUENTIST'
 'E'       2    'DEVS1'  'ESTIMATED'      2    0.0000E+00   -0.5000E+01    0.5000E+01    0.1000E+01  'LOGNORMAL'
 'E'       3    'CONST'  'FIXED'          1    0.1000E+01    0.1000E+00    0.1000E+03    0.1000E+01  'FREQUENTIST'
 'E'       3    'RHO'    'FIXED'          5    0.5000E+00    0.0000E+00    0.9900E+00    0.1000E+01  'FREQUENTIST'
 'E'       3    'VAR'    'FIXED'          4    0.2231E+00    0.0000E+00    0.1000E+22    0.1000E+01  'FREQUENTIST'
 'E'       3    'DEVS'   'ESTIMATED'      2    0.0000E+00   -0.5000E+01    0.5000E+01    0.1000E+01  'LOGNORMAL'
#
 'C_D'     1    'VAR'    'FIXED'          4    0.1000E+01    0.1000E+00    0.5000E+01    0.1000E+01  'FREQUENTIST'
#
 'I_D'     1    'VAR'    'FIXED'          5    0.1028E+00    0.1000E-01    0.1000E+01    0.1000E+01  'FREQUENTIST'
#
 'E_D'     1    'VAR'    'FIXED'          4    0.1000E+01    0.1000E-03    0.1000E+01    0.1000E+01  'FREQUENTIST'
#
 'V'       1    'CONST'  'FIXED'          6    0.1000E+01    0.1000E-02    0.1000E+02    0.1000E+01  'FREQUENTIST'
```

APPENDIX 3. Input data for SSASPM model ***Runs 1- 12***.

```
# GENERAL INFORMATION
# first and last year of data
  1950 2004
# number of years of prehistorical period
  31
# Enter 1 to calculate an average historic effort, 2 for a linear trend in historic effort, or 2 for exponential trend in historic
effort
  2
# first and last age of data
  1    14
# number of seasons (months) per year
  12
# type of overall variance parameter (1 = log scale variance, 2 = observation scale variance, 0=force equal weighting)
  1
# spawning season (integer representing season/month of year when spawning occurs)
  6
# maturity schedue (fraction of each age class that is sexually mature
  1 1 1 1 1 1 1 1 1 1 1 1 1 1
# fecundity schedule (index of per capita fecundity of each age class)
# MILLIONS OF EGGS (Batch Fecundity at age * 87) 87=Spawning Frequency
  3.16 3.33 3.51 3.69 3.87 4.05 4.23 4.41 4.59 4.77 4.94 5.12 5.30 5.48

# CATCH INFORMATION
# number of catch data series (if there are no series, there should be no entries after the next line below)
  4
# pdf of observation error for each series (1) lognormal, (2) normal
  1 1 1 1
# units (1=numbers, 2=weight)
  2 2 1 1
# season (month) when fishing begins for each series
  1 1 1 1
# season (month) when fishing ends for each series
  12 12 12 12
# set of catch variance parameters each series is linked to
  1 1 1 1
# set of q parameters each series is linked to
  1 2 3 4
# set of s parameters each series is linked to
  1 2 3 4
# set of e parameters each series is linked to
  1 2 3 4
```

APPENDIX 3. (***Continued***) Input data for SSASPM model ***Runs 1 - 12***.

```
#observed catches by set (column for year required)
#CM-E          CM-W           REC         SHRMP-BYC          YEAR
-1             -1             -1             -1              1950
-1             -1             -1             -1              1951
-1             -1             -1             -1              1952
-1             -1             -1             -1              1953
-1             -1             -1             -1              1954
-1             -1             -1             -1              1955
-1             -1             -1             -1              1956
-1             -1             -1             -1              1957
-1             -1             -1             -1              1958
-1             -1             -1             -1              1959
-1             -1             -1             -1              1960
-1             -1             -1             -1              1961
-1             -1             -1             -1              1962
27700          20300          -1             -1              1963
30300          21200          -1             -1              1964
30100          18700          -1             -1              1965
15700          6000           -1             -1              1966
31800          14200          -1             -1              1967
63200          45300          -1             -1              1968
80500          24400          -1             -1              1969
75100          40000          -1             -1              1970
82000          43300          -1             -1              1971
72400          41900          -1             -1              1972
122100         49500          -1             -1              1973
115900         60200          -1             -1              1974
252200         98500          -1             -1              1975
221600         54500          -1             -1              1976
300337         175789         -1             -1              1977
258155         147082         -1             -1              1978
196791         198599         -1             -1              1979
143836         133743         -1             -1              1980  ####################################################################
208578         104201         141888         6900000         1981  ### NOTE; THIS MODEL ASSUMES SHRIMP BYCATCH OF 6,900,000 ANIMALS ###
215646         131973         833154         6900000         1982  ####################################################################
340912         145961         231710         6900000         1983  ### OTHER RUNS WERE MADE ASSUMING 3.45 and 10.35 MILLION ANIMALS ###
483215         832017         367066         6900000         1984  ###    REPLACE VALUE 6900000 TO CHANGE LEVEL OF SHRIMP BYCATCH    ###
607023         722886         398400         6900000         1985  ####################################################################
689625         939041         998551         6900000         1986
534518         1003433        1035306        6900000         1987
492997         991713         1375143        6900000         1988
481705         1002816        861223         6900000         1989
1489581        962643         1170574        6900000         1990
969399         808348         1165083        6900000         1991
1217900        1036278        1359566        6900000         1992
1667549        1024203        1202661        6900000         1993
```

APPENDIX 3. (***Continued***) Input data for SSASPM model ***Runs 1 - 12***.

```
1582072        1040183        989280         6900000        1994
1506085        654242         1229289        6900000        1995
1166437        651873         586062         6900000        1996
1040331        1072584        617878         6900000        1997
807987         895269         313724         6900000        1998
866821         1098219        421950         6900000        1999
699209         758230         333741         6900000        2000
791599         915733         623512         6900000        2001
1008662        997300         511965         6900000        2002
1153574        1260897        596534         6900000        2003
903434         1218992        815530         6900000        2004
# annual scaling factors for observation variance (use this option to scale up the variance for observations based on very little (or
estimated) data) (column for year required)
#CM-E   CM-W    REC SHRMP-BYC  YEAR
1       1       1       1      1950
#### REPEAT THE SCALING FACTORS FOR EACH YEAR 1951-2004 ###
# INDICES OF ABUNDANCE (e.g., CPUE) If there are no series, there should be no entries between the comment lines.
# number of index data series
  5
# pdf of observation error for each series (1) lognormal, (2) normal
  1 1 1 1 1
# units (1=numbers, 2=weight)
  2 2 1 1 1
# season (month) when index begins for each series
  1 1 1 1 1
# season (month) when index ends for each series
  12 12 12 12 12
# option to (1) scale or (0) not to scale index observations
  0 0 0 0 0
# set of index variance parameters each series is linked to
  1 1 1 1 1
# set of q parameters each series is linked to
  5 6 7 8 9
# set of s parameters each series is linked to
  1 2 3 3 3
# observed indices by series (no column for year allowed)
#CMHL_E        CMHL_W         HB_E           HB_W           MRFSS          YEAR
-1.0000        -1.0000        -1.0000        -1.0000        -1.0000        1950
#### REPEAT PREVIOUS LINE FOR EACH YEAR 1951-1985 ###
-1.0000        -1.0000        1.0320         1.3384         2.0146         1986
-1.0000        -1.0000        0.9415         1.0085         1.0238         1987
-1.0000        -1.0000        2.0546         0.8242         0.8825         1988
-1.0000        -1.0000        1.0626         1.1914         0.6223         1989
-1.0000        -1.0000        1.6947         1.6901         2.4221         1990
-1.0000        -1.0000        1.9385         1.0368         1.4895         1991
-1.0000        -1.0000        2.2609         0.9378         1.7052         1992
1.3672         0.9743         1.4096         0.9196         1.9029         1993
```

APPENDIX 3. (***Continued***) Input data for SSASPM model ***Runs 1 - 12***.

```
1.4585        1.0884        1.1549        1.1050        1.1780        1994
1.1465        0.8371        1.1296        1.1262        1.7258        1995
1.0401        0.8129        0.6480        0.8599        0.8839        1996
0.9461        1.0744        0.6969        0.9198        0.4752        1997
0.8455        1.0737        0.2477        0.8737        0.3558        1998
0.9007        0.9372        0.4683        0.6062        0.4060        1999
0.7258        0.6425        0.3688        0.6771        0.3447        2000
0.8776        0.7942        0.3638        1.1784        0.3744        2001
0.8899        1.0319        0.5412        0.8844        0.3027        2002
0.9232        1.2665        0.4629        0.6573        0.3733        2003
0.8787        1.4669        0.5237        1.1653        0.5176        2004
# annual scaling factors for observation variance (use this option to scale up the variance for obs based on very little data)
#CMHL_E       CMHL_W        HB_E          HB_W          MRFSS
1.0000  1.0000  1.0000  1.0000  1.0000  1950
#### REPEAT THESE SCALING FACTORS FOR EACH YEAR 1951-2004 ###

# EFFORT OBSERVATIONS If there are no series, there should be no entries between the comment lines.
# number of effort data series
   0
# AGE COMPOSITION OBSERVATIONS If there are no series, there should be no entries between the comment lines.
# number of age-composition series (If there are no series, there should be no more entries in this section)
  3
# first year in age-composition series
  1994
# probability densities used for age-comp. series (0 = ignore, 3 = multinomial, 8 = robustified normal)
  3 3 3
# units (only 1=numbers, no other options at this time)
  1 1 1
# season (month) when age collections begin for each series
  1 1 1
# season (month) when age collections end for each series
  12 12 12
# age composition data (MAXIMUM SAMPLE SIZE = 200)
#CM HL EAST
#FLEET  YEAR    SAMPLES AGE1    AGE2    AGE3    AGE4    AGE5    AGE6    AGE7    AGE8    AGE9    AGE10   AGE11   AGE12   AGE13   AGE14+
1       1994    28      0       0       4       9       5       5       1       1       1       0       0       1       1       0
1       1995    6       0       0       0       0       2       2       1       0       1       0       0       0       0       0
1       1996    6       0       0       0       1       1       0       4       0       0       0       0       0       0       0
1       1997    0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
1       1998    138     9       42      67      6       7       4       0       0       0       1       1       1       0       0
1       1999    0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
1       2000    45      0       0       9       10      2       4       4       4       2       3       1       3       2       1
1       2001    200     0       47      165     256     266     177     121     74      40      44      19      17      9       15
1       2002    200     4       211     473     169     130     82      64      45      22      17      21      4       6       10
1       2003    200     1       76      435     800     310     141     188     90      57      13      13      11      6       4
1       2004    200     0       21      144     164     128     53      47      34      20      7       2       3       2       1
```

APPENDIX 3. (***Continued***) Input data for SSASPM model ***Runs 1 - 12***.

#CM HL WEST

#FLEET	YEAR	SAMPLES	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10	AGE11	AGE12	AGE13	AGE14+
2	1994	64	0	0	6	9	20	9	7	4	0	2	2	3	1	1
2	1995	75	0	11	5	14	20	9	8	0	3	3	0	1	0	1
2	1996	71	0	1	21	9	10	11	5	3	3	4	1	1	2	0
2	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2000	81	0	1	7	8	13	10	3	5	6	14	7	0	2	5
2	2001	102	0	1	10	15	14	12	7	6	9	8	4	2	7	7
2	2002	69	0	6	15	7	5	6	8	8	0	2	0	6	1	5
2	2003	200	0	9	51	245	74	44	30	28	19	9	14	10	4	5
2	2004	200	1	8	50	104	144	58	39	22	31	18	5	11	8	12

#REC

#FLEET	YEAR	SAMPLES	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10	AGE11	AGE12	AGE13	AGE14+
3	1994	154	0	0	27	39	30	26	7	12	9	2	1	0	1	0
3	1995	192	2	18	41	40	44	17	13	4	8	3	0	0	1	1
3	1996	200	1	17	44	57	53	54	21	17	6	8	1	1	0	0
3	1997	46	0	8	3	12	6	8	5	2	2	0	0	0	0	0
3	1998	14	0	1	3	2	4	1	2	1	0	0	0	0	0	0
3	1999	200	3	33	74	41	29	19	16	16	8	4	1	1	1	0
3	2000	200	0	6	34	51	53	26	16	19	12	7	1	3	1	1
3	2001	141	0	2	5	19	46	24	22	9	4	3	2	4	1	0
3	2002	200	0	15	45	24	55	36	42	26	5	3	3	2	2	0
3	2003	91	0	9	10	29	10	12	13	3	4	1	0	0	0	0
3	2004	129	0	0	7	41	48	10	16	3	1	2	1	0	0	0

APPENDIX 4. (***Continued***) Parameter inputs for SSASPM model ***Runs 1 – 12.***

```
# Total number of process parameters (must match number of entries in 'Specifications 1' section)
40
# Number of sets of each class of parameters (must be atleast 1)
# q (catchability)
# |     Effort
# |     |     Vulnerability (selectivity)
# |     |     |     catch observation variance scalar
# |     |     |     |     index variance scalar
# |     |     |     |     |     effort variance scalar
# |     |     |     |     |     |
  9     4     4     1     1     1
# Specifications 1: process parameters and observation error parameters
#===========================================================================================
#class (nature) of parameter (1=constant, 2-4 = polynom of degree x, 5=knife edge, 6=logistic, 7=gamma)
#  |        best estimate (or central tendency of prior)
#  |       |                lower bound    upper bound
#  |       |                |                |              phase to estimate (-1 = don't estimate)
#  |       |                |                |              | prior density (1= lognorm, 2=norm, 3=uniform)
#  |       |                |                |              |     |       prior variance
#  |       |                |                |              |     |       |
#------------------------------------------------------------------------------------------
# Natural mortality rate
  1       0.2500E+00       0.1000E-01       0.5000E+00    -1     1       0.2500E+00
# Recruitment (10=Beverton/Holt, 11=Ricker)
  10      0.1000E+07       0.1000E+04       0.1000E+10     1     3       0.1000E+01
# ESTIMATE STEEPNESS WITH MEAN = 0.6 (REMOVE # IF IN USE).
# 10      0.6000E+01       0.1100E+01       1.0000E+02     2     1      -0.8500E+00
# REPLACE PREVIOUS LINE WITH THE FOLLOWING IF YOU INTEND TO FIX STEEPNESS AT 0.60. (REMOVE # IF IN USE).
# 10      0.6000E+01       0.1100E+01       1.0000E+02    -2     1      -0.8500E+00
# Growth (type 8 = von Bertalanfy/Richards, Linf, K, t0, m, a, b (weight=al^b)
  8       0.1699E+02       0.1000E-03       0.1000E+06    -1     0       0.1000E+01
  8       0.2000E+00       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
  8      -0.3900E+01      -0.5000E+01       0.1000E+13    -1     0       0.1000E+01
  8       0.1000E+01       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
  8       0.5957E-03       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
  8       0.2870E+01       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
```

APPENDIX 4. (***Continued***) Parameter inputs for SSASPM model ***Runs 1 – 12.***

```
# catchability
   #Catches (fix at 1 if E assumes Fishing Mortality)
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1      0        0.1000E+01
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1      0        0.1000E+01
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1      0        0.1000E+01
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1      0        0.1000E+01
   #Indices
   1       0.1000E-06       0.1000E-09       0.1000E+00     1      0        0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1      0        0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1      0        0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1      0        0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1      0        0.1000E+01
# effort for 'prehistoric' period when data is sparse
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1      0        0.1000E+01
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1      0        0.1000E+01
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1      0        0.1000E+01
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1      0        0.1000E+01
# effort for period with useful data (Set at assumed F va lues if q =1)
   1       0.01000E+00      0.1000E-02       5.000E+00      1      0        0.1000E+01
   1       0.01000E+00      0.1000E-02       5.000E+00      1      0        0.1000E+01
   1       0.01000E+00      0.1000E-02       5.000E+00      1      0        0.1000E+01
   1       0.01000E+00      0.1000E-02       5.000E+00      1      0        0.1000E+01
# vulnerability (selectivity)
#CM-EAST
   6       0.4046E+00       0.0000E-10       0.2000E+01     1      0        0.1000E+01
   6       2.6600E+00       0.5000E+00       0.4000E+01     3      0        0.6250E-01
#CM-WEST
   6       0.4046E+00       0.0000E-10       0.2000E+01     1      0        0.1000E+01
   6       2.6600E+00       0.5000E+00       0.4000E+01     3      0        0.6250E-01
#REC
   6       0.6329E+00       0.0000E-10       0.2000E+01     1      0        0.1000E+01
   6       3.0000E+00       0.5000E+00       0.4000E+01     3      0        0.6250E-01
#SHRIMP
   15       0.5000E+00       0.1000E-06       0.2000E+01   -4      0        0.1000E+01
   15       0.0100E+00       0.1000E-06       0.2000E+01   -4      0        0.1000E+01
   15       1.5000E+00       0.3000E+00       0.3000E+01   -3      0        0.6250E-01
   15       0.4150E+00       0.1000E-06       0.2000E+01   -4      0        0.1000E+01
   15       0.76938E+00      0.3000E+00       0.3000E+01   -3      0        0.6250E-01
```

APPENDIX 4. (***Continued***) Parameter inputs for SSASPM model ***Runs 1 – 12.***

```
# catch observation error variance scalar
   1       1.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
# index observation error variance scalar
   1       2.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
# effort observation error variance scalar
   1       1.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
#================================================================================
# Specifications 2: process ERROR parameters
#================================================================================
#    best estimate (or central tendency of prior)
#    |                lower bound    upper bound
#    |                |                |              phase to estimate (-1 = don't estimate)
#    |                |                |              |  prior density (1= lognormal, 2=normal, 3=uniform)
#    |                |                |              |     |       prior variance
#    |                |                |              |     |       |
#---------------------------------------------------------------------------------
# overall variance (negative value indicates a CV)
    -0.2000E+00      -0.2000E+01      -0.1000E-01     2     0       0.1000E+01
# recruitment process variation parameters (allows year to year fluctuations)
#    correlation coefficient
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
#    variance scalar (multiplied by overall variance)
# DEVIATION FROM S-R RELATIONSHIP (40%CV) REMOVE # IF IN USE
#     0.14820E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01(
# REPLACE PREVIOUS LINE WITH THE FOLLOWING IF YOU INTEND TO ELIMINATE REC DEVs (0%CV) (REMOVE # IF IN USE)
#    0.0000E+00      -0.1000E-00       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.0000E+00      -0.5000E+01       0.5000E+01     4     1       0.1000E+01
# catchability process variation parameters (allows year to year fluctuations)
#    correlation coefficients
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
```

APPENDIX 4. (***Continued***) Parameter inputs for SSASPM model ***Runs 1 – 12.***

```
#    variance scalars (multiplied by overall variance)
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
# effort process variation parameters (allows year to year fluctuations)
#    correlation coefficients
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
#    variance scalars (multiplied by overall variance)
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
# IF VARIANCE OF SHRIMP FLEET IS 0.04 (20% CV) THEN USE: (REMOVE # FROM LINE IF IN USE)
#     0.040000+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
# IF VARIANCE OF SHRIMP FLEET IS 0.2231 (50% CV) THEN USE: (REMOVE # FROM LINE IF IN USE)
#     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
```

APPENDIX 5. Input data for SSASPM model ***Run 13***.

```
# GENERAL INFORMATION
# first and last year of data
  1950 2004
# number of years of prehistorical period
  31
# Enter 1 to calculate an average historic effort, 2 for a linear trend in historic effort, or 2 for exponential trend in historic
effort
  2
# first and last age of data
  1    14
# number of seasons (months) per year
  12
# type of overall variance parameter (1 = log scale variance, 2 = observation scale variance, 0=force equal weighting)
  1
# spawning season (integer representing season/month of year when spawning occurs)
  6
# maturity schedue (fraction of each age class that is sexually mature
  1 1 1 1 1 1 1 1 1 1 1 1 1 1
# fecundity schedule (index of per capita fecundity of each age class)
# MILLIONS OF EGGS (Batch Fecundity at age * 87) 87=Spawning Frequency
  3.16 3.33 3.51 3.69 3.87 4.05 4.23 4.41 4.59 4.77 4.94 5.12 5.30 5.48

# CATCH INFORMATION
# number of catch data series (if there are no series, there should be no entries after the next line below)
  3
# pdf of observation error for each series (1) lognormal, (2) normal
  1 1 1
# units (1=numbers, 2=weight)
  2 2 1
# season (month) when fishing begins for each series
  1 1 1
# season (month) when fishing ends for each series
  12 12 12
# set of catch variance parameters each series is linked to
  1 1 1
# set of q parameters each series is linked to
  1 2 3
# set of s parameters each series is linked to
  1 2 3
# set of e parameters each series is linked to
  1 2 3
```

APPENDIX 5. (***Continued***) Input data for SSASPM model ***Run 13***.

```
#observed catches by set (column for year required)
#CM-E          CM-W           REC            YEAR
-1             -1             -1             1950
-1             -1             -1             1951
-1             -1             -1             1952
-1             -1             -1             1953
-1             -1             -1             1954
-1             -1             -1             1955
-1             -1             -1             1956
-1             -1             -1             1957
-1             -1             -1             1958
-1             -1             -1             1959
-1             -1             -1             1960
-1             -1             -1             1961
-1             -1             -1             1962
27700          20300          -1             1963
30300          21200          -1             1964
30100          18700          -1             1965
15700          6000           -1             1966
31800          14200          -1             1967
63200          45300          -1             1968
80500          24400          -1             1969
75100          40000          -1             1970
82000          43300          -1             1971
72400          41900          -1             1972
122100         49500          -1             1973
115900         60200          -1             1974
252200         98500          -1             1975
221600         54500          -1             1976
300337         175789         -1             1977
258155         147082         -1             1978
196791         198599         -1             1979
143836         133743         -1             1980
208578         104201         141888         1981
215646         131973         833154         1982
340912         145961         231710         1983
483215         832017         367066         1984
607023         722886         398400         1985
689625         939041         998551         1986
534518         1003433        1035306        1987
492997         991713         1375143        1988
481705         1002816        861223         1989
1489581        962643         1170574        1990
969399         808348         1165083        1991
1217900        1036278        1359566        1992
1667549        1024203        1202661        1993
```

APPENDIX 5. (***Continued***) Input data for SSASPM model ***Run 13***.

```
1582072        1040183        989280         1994
1506085        654242         1229289        1995
1166437        651873         586062         1996
1040331        1072584        617878         1997
807987         895269         313724         1998
866821         1098219        421950         1999
699209         758230         333741         2000
791599         915733         623512         2001
1008662        997300         511965         2002
1153574        1260897        596534         2003
903434         1218992        815530         2004
# annual scaling factors for observation variance (use this option to scale up the variance for observations based on very little (or estimated) data) (column for year required)
#CM-E   CM-W   REC    YEAR
1       1      1      1950
#### REPEAT THE SCALING FACTORS FOR EACH YEAR 1951-2004 ###
# INDICES OF ABUNDANCE (e.g., CPUE) If there are no series, there should be no entries between the comment lines.
# number of index data series
  5
# pdf of observation error for each series (1) lognormal, (2) normal
  1 1 1 1 1
# units (1=numbers, 2=weight)
  2 2 1 1 1
# season (month) when index begins for each series
  1 1 1 1 1
# season (month) when index ends for each series
  12 12 12 12 12
# option to (1) scale or (0) not to scale index observations
  0 0 0 0 0
# set of index variance parameters each series is linked to
  1 1 1 1 1
# set of q parameters each series is linked to
  4 5 6 7 8
# set of s parameters each series is linked to
  1 2 3 3 3
# observed indices by series (no column for year allowed)
#CMHL_E        CMHL_W         HB_E           HB_W           MRFSS
-1.0000        -1.0000 -      1.0000         -1.0000 -      1.0000  1950
#### REPEAT PREVIOUS LINE FOR EACH YEAR 1951-1985 ###
-1.0000        -1.0000        1.0320         1.3384         2.0146         1986
-1.0000        -1.0000        0.9415         1.0085         1.0238         1987
-1.0000        -1.0000        2.0546         0.8242         0.8825         1988
-1.0000        -1.0000        1.0626         1.1914         0.6223         1989
-1.0000        -1.0000        1.6947         1.6901         2.4221         1990
-1.0000        -1.0000        1.9385         1.0368         1.4895         1991
-1.0000        -1.0000        2.2609         0.9378         1.7052         1992
1.3672         0.9743         1.4096         0.9196         1.9029         1993
1.4585         1.0884         1.1549         1.1050         1.1780         1994
1.1465         0.8371         1.1296         1.1262         1.7258         1995
```

APPENDIX 5. (***Continued***) Input data for SSASPM model ***Run 13***.

```
1.0401        0.8129        0.6480        0.8599        0.8839        1996
0.9461        1.0744        0.6969        0.9198        0.4752        1997
0.8455        1.0737        0.2477        0.8737        0.3558        1998
0.9007        0.9372        0.4683        0.6062        0.4060        1999
0.7258        0.6425        0.3688        0.6771        0.3447        2000
0.8776        0.7942        0.3638        1.1784        0.3744        2001
0.8899        1.0319        0.5412        0.8844        0.3027        2002
0.9232        1.2665        0.4629        0.6573        0.3733        2003
0.8787        1.4669        0.5237        1.1653        0.5176        2004
# annual scaling factors for observation variance (use this option to scale up the variance for obs based on very little data)
#CMHL_E       CMHL_W        HB_E          HB_W          MRFSS
1.0000        1.0000        .0000         1.0000        1.0000  1950
```

REPEAT THESE SCALING FACTORS FOR EACH YEAR 1951-2004

```
# EFFORT OBSERVATIONS If there are no series, there should be no entries between the comment lines.
# number of effort data series
   0
# AGE COMPOSITION OBSERVATIONS If there are no series, there should be no entries between the comment lines.
# number of age-composition series (If there are no series, there should be no more entries in this section)
  3
# first year in age-composition series
  1994
# probability densities used for age-comp. series (0 = ignore, 3 = multinomial, 8 = robustified normal)
  3 3 3
# units (only 1=numbers, no other options at this time)
  1 1 1
# season (month) when age collections begin for each series
  1 1 1
# season (month) when age collections end for each series
  12 12 12
```

age composition data (***MAXIMUM SAMPLE SIZE = 200***)

```
#CM HL EAST
#FLEET  YEAR   SAMPLES AGE1   AGE2   AGE3   AGE4   AGE5   AGE6   AGE7   AGE8   AGE9   AGE10  AGE11  AGE12  AGE13  AGE14+
1       1994   28      0      0      4      9      5      5      1      1      1      0      0      1      1      0
1       1995   6       0      0      0      0      2      2      1      0      1      0      0      0      0      0
1       1996   6       0      0      0      1      1      0      4      0      0      0      0      0      0      0
1       1997   0       0      0      0      0      0      0      0      0      0      0      0      0      0      0
1       1998   138     9      42     67     6      7      4      0      0      0      1      1      1      0      0
1       1999   0       0      0      0      0      0      0      0      0      0      0      0      0      0      0
1       2000   45      0      0      9      10     2      4      4      4      2      3      1      3      2      1
1       2001   200     0      47     165    256    266    177    121    74     40     44     19     17     9      15
1       2002   200     4      211    473    169    130    82     64     45     22     17     21     4      6      10
1       2003   200     1      76     435    800    310    141    188    90     57     13     13     11     6      4
1       2004   200     0      21     144    164    128    53     47     34     20     7      2      3      2      1
```

APPENDIX 5. (***Continued***) Input data for SSASPM model ***Run 13***.

#CM HL WEST

#FLEET	YEAR	SAMPLES	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10	AGE11	AGE12	AGE13	AGE14+
2	1994	64	0	0	6	9	20	9	7	4	0	2	2	3	1	1
2	1995	75	0	11	5	14	20	9	8	0	3	3	0	1	0	1
2	1996	71	0	1	21	9	10	11	5	3	3	4	1	1	2	0
2	1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2000	81	0	1	7	8	13	10	3	5	6	14	7	0	2	5
2	2001	102	0	1	10	15	14	12	7	6	9	8	4	2	7	7
2	2002	69	0	6	15	7	5	6	8	8	0	2	0	6	1	5
2	2003	200	0	9	51	245	74	44	30	28	19	9	14	10	4	5
2	2004	200	1	8	50	104	144	58	39	22	31	18	5	11	8	12

#REC

#FLEET	YEAR	SAMPLES	AGE1	AGE2	AGE3	AGE4	AGE5	AGE6	AGE7	AGE8	AGE9	AGE10	AGE11	AGE12	AGE13	AGE14+
3	1994	154	0	0	27	39	30	26	7	12	9	2	1	0	1	0
3	1995	192	2	18	41	40	44	17	13	4	8	3	0	0	1	1
3	1996	200	1	17	44	57	53	54	21	17	6	8	1	1	0	0
3	1997	46	0	8	3	12	6	8	5	2	2	0	0	0	0	0
3	1998	14	0	1	3	2	4	1	2	1	0	0	0	0	0	0
3	1999	200	3	33	74	41	29	19	16	16	8	4	1	1	1	0
3	2000	200	0	6	34	51	53	26	16	19	12	7	1	3	1	1
3	2001	141	0	2	5	19	46	24	22	9	4	3	2	4	1	0
3	2002	200	0	15	45	24	55	36	42	26	5	3	3	2	2	0
3	2003	91	0	9	10	29	10	12	13	3	4	1	0	0	0	0
3	2004	129	0	0	7	41	48	10	16	3	1	2	1	0	0	0

APPENDIX 6. Parameter inputs for SSASPM model ***Run 13***.

```
# Total number of process parameters (must match number of entries in 'Specifications 1' section)
32
# Number of sets of each class of parameters (must be atleast 1)
# q (catchability)
# |     Effort
# |     |     Vulnerability (selectivity)
# |     |     |     catch observation variance scalar
# |     |     |     |     index variance scalar
# |     |     |     |     |     effort variance scalar
# |     |     |     |     |     |
  8     3     3     1     1     1
# Specifications 1: process parameters and observation error parameters
#==========================================================================================
#class (nature) of parameter (1=constant, 2-4 = polynom of degree x, 5=knife edge, 6=logistic, 7=gamma)
#  |       best estimate (or central tendency of prior)
#  |       |                lower bound    upper bound
#  |       |                |                |              phase to estimate (-1 = don't estimate)
#  |       |                |                |              | prior density (1= lognorm, 2=norm, 3=uniform)
#  |       |                |                |              |     |       prior variance
#  |       |                |                |              |     |       |
#------------------------------------------------------------------------------------------
# Natural mortality rate
   1       0.2500E+00       0.1000E-01       0.5000E+00    -1     1       0.2500E+00
# Recruitment (10=Beverton/Holt, 11=Ricker)
  10       0.1000E+07       0.1000E+04       0.1000E+10     1     3       0.1000E+01
```

 # ESTIMATE STEEPNESS WITH MEAN = 0.6 (REMOVE # IF IN USE).

 # 10   0.6000E+01   0.1100E+01   1.0000E+02   2   1   -0.8500E+00

 # REPLACE PREVIOUS LINE WITH THE FOLLOWING IF YOU INTEND TO FIX STEEPNESS AT 0.60. (REMOVE # IF IN USE).

 # 10   0.6000E+01   0.1100E+01   1.0000E+02   -2   1   -0.8500E+00

```
# Growth (type 8 = von Bertalanfy/Richards, Linf, K, t0, m, a, b (weight=al^b)
   8       0.1699E+02       0.1000E-03       0.1000E+06    -1     0       0.1000E+01
   8       0.2000E+00       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
   8      -0.3900E+01      -0.5000E+01       0.1000E+13    -1     0       0.1000E+01
   8       0.1000E+01       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
   8       0.5957E-03       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
   8       0.2870E+01       0.0000E+00       0.1000E+13    -1     0       0.1000E+01
```

APPENDIX 6. (***Continued***) Parameter inputs for SSASPM model ***Run 13***.

```
# catchability
   #Catches (fix at 1 if E assumes Fishing Mortality)
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1     0       0.1000E+01
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1     0       0.1000E+01
   1       1.0000E+00       0.1000E-01       0.1000E+02    -1     0       0.1000E+01
   #Indices
   1       0.1000E-06       0.1000E-09       0.1000E+00     1     0       0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1     0       0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1     0       0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1     0       0.1000E+01
   1       0.1000E-06       0.1000E-09       0.1000E+00     1     0       0.1000E+01
# effort for 'prehistoric' period when data is sparse
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1     0       0.1000E+01
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1     0       0.1000E+01
   1       0.00001E+00     -0.1000E-31       0.1000E+02    -1     0       0.1000E+01
# effort for period with useful data (Set at assumed F va lues if q =1)
   1       0.01000E+00      0.1000E-02       5.000E+00      1     0       0.1000E+01
   1       0.01000E+00      0.1000E-02       5.000E+00      1     0       0.1000E+01
   1       0.01000E+00      0.1000E-02       5.000E+00      1     0       0.1000E+01
# vulnerability (selectivity)
#CM-EAST
   6       0.4046E+00       0.0000E-10       0.2000E+01     1     0       0.1000E+01
   6       2.6600E+00       0.5000E+00       0.4000E+01     3     0       0.6250E-01
#CM-WEST
   6       0.4046E+00       0.0000E-10       0.2000E+01     1     0       0.1000E+01
   6       2.6600E+00       0.5000E+00       0.4000E+01     3     0       0.6250E-01
#REC
   6       0.6329E+00       0.0000E-10       0.2000E+01     1     0       0.1000E+01
   6       3.0000E+00       0.5000E+00       0.4000E+01     3     0       0.6250E-01
```

APPENDIX 6. (***Continued***) Parameter inputs for SSASPM model ***Run 13***.

```
# catch observation error variance scalar
   1       1.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
# index observation error variance scalar
   1       2.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
# effort observation error variance scalar
   1       1.0000E+00       0.1000E+00       0.5000E+01    -1     0       0.1000E+01
#===============================================================================
# Specifications 2: process ERROR parameters
#===============================================================================
#    best estimate (or central tendency of prior)
#    |                lower bound    upper bound
#    |                |                |              phase to estimate (-1 = don't estimate)
#    |                |                |              |  prior density (1= lognormal, 2=normal, 3=uniform)
#    |                |                |              |     |       prior variance
#    |                |                |              |     |       |
#--------------------------------------------------------------------------------
# overall variance (negative value indicates a CV)
    -0.2000E+00      -0.2000E+01      -0.1000E-01     2     0       0.1000E+01
# recruitment process variation parameters (allows year to year fluctuations)
#    correlation coefficient
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
#    variance scalar (multiplied by overall variance)
# DEVIATION FROM S-R RELATIONSHIP (40%CV) REMOVE # IF IN USE
#     0.14820E+00      0.0000E+00       0.1000E+21    -1      0       0.1000E+01(
# REPLACE PREVIOUS LINE WITH THE FOLLOWING IF YOU INTEND TO ELIMINATE REC DEVs (0%CV) (REMOVE # IF IN USE)
#    0.0000E+00      -0.1000E-00       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.0000E+00      -0.5000E+01       0.5000E+01     4     1       0.1000E+01
# catchability process variation parameters (allows year to year fluctuations)
#    correlation coefficients
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.9900E+00    -1     0       0.1000E+01
```

APPENDIX 6. (***Continued***) Parameter inputs for SSASPM model ***Run 13***.

```
#    variance scalars (multiplied by overall variance)
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
     0.0000E+00      -0.1000E-31       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
     0.0000E+00      -0.5000E+01       0.5000E+01    -1     0       0.1000E+01
# effort process variation parameters (allows year to year fluctuations)
#    correlation coefficients
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
     0.5000E+00       0.0000E+00       0.9900E+00    -1     0       0.1000E+01
#    variance scalars (multiplied by overall variance)
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
     0.22300E+00      0.0000E+00       0.1000E+21    -1     0       0.1000E+01
#    annual deviation parameters (last entry is arbitrary for deviations)
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
     0.1000E-03      -0.5000E+01       0.5000E+01     2     1       0.1000E+01
```