APPENDIX 2

2008 PACIFIC MACKEREL STOCK ASSESSMENT, 2007 STOCK ASSESSMENT REVIEW PANEL REPORT, AND JUNE 2008 SCIENTIFIC AND STATISTICAL COMMITTEE REPORT

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Agenda Item G.1.b
Attachment 1
June 2008

PACIFIC MACKEREL (*Scomber japonicus*) STOCK ASSESSMENT FOR U.S. MANAGEMENT IN THE 2008-09 FISHING SEASON

by

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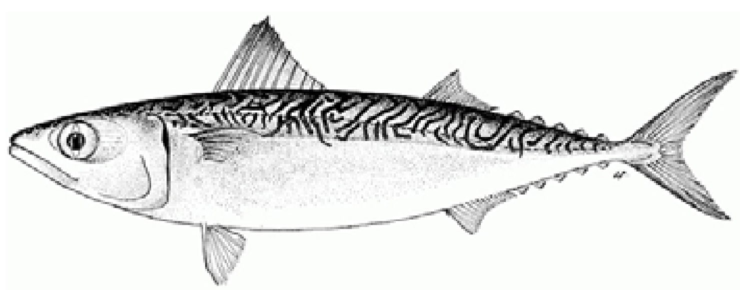

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EXECUTIVE SUMMARY

Stock

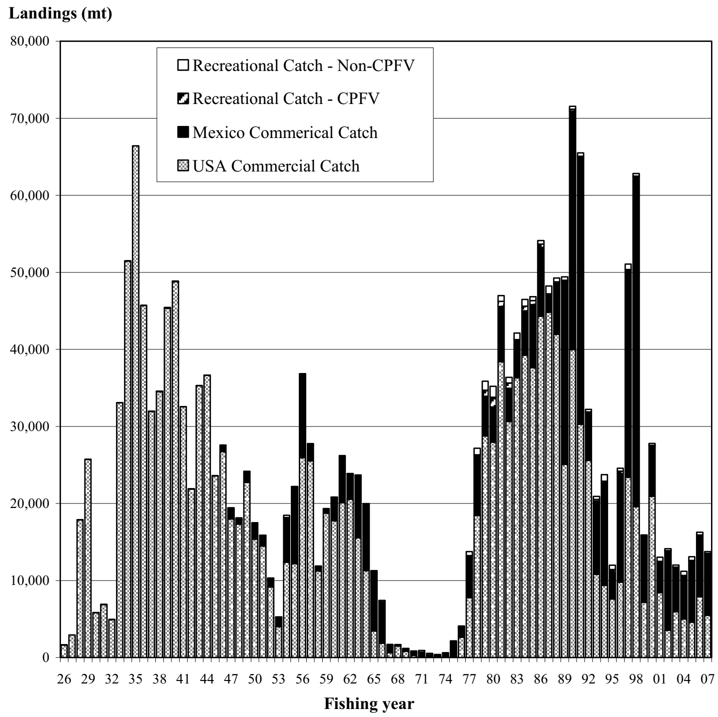
Pacific mackerel (*Scomber japonicus*), in the northeastern Pacific, range from southeastern Alaska to Banderas Bay (Puerto Vallarta), Mexico, including the Gulf of California. They are common from Monterey Bay, California, to Cabo San Lucas, Baja California, but are most abundant south of Point Conception, California. There are possibly three spawning stocks along the Pacific coasts of the U.S. and Mexico: one in the Gulf of California, one in the vicinity of Cabo San Lucas, and one extending along the Pacific coast north of Punta Abreojos, Baja California. The latter "northeastern Pacific" stock is harvested by fishers in the U.S. and Baja California, Mexico, and is considered in this assessment.

Catches

Catches in the assessment were a combination of U.S. and Mexico commercial catches and U.S. recreational catches. The Mexican commercial fishery for Pacific mackerel is primarily based in Ensenada and Magdalena Bay, Baja California. Most of the U.S. commercial catch is landed in southern California (Monterey and San Pedro). The Mexican purse seine fleet has slightly larger vessels, but is similar to southern California's with respect to gear (mesh size) and fishing practice. Demand for Pacific mackerel in Baja California increased in the late 1940s. Mexican landings remained stable for several years, rose to 10,725 mt in 1956-57, then declined to a low of 100 tons in 1973-74. Catches were then negligible until the early 1980s. Pacific mackerel in Ensenada peaked twice, first in 1991-92 at 34,557 mt, and again in 1998-99 at 42,815 mt. The U.S. commercial landings peaked in 1935-36 (66,400 mt) and in 1990-91(39,974 mt), and were the lowest from 1970 to 1976, during the moratorium imposed by the State of California. The Ensenada fishery has been comparable in volume to the southern California fishery since 1990.

Table of catches (1992-2007).

Fishing Season	USA -Commercial Catch (mt)	Mexico-Commercial Catch (mt)	Recreational - CPFV Catch (mt)	Recreational - non-CPFV Catch (mt)	Total Catch (mt)
92	25,584	6,170	135	329	32,217
93	10,787	9,524	196	413	20,920
94	9,372	13,302	226	837	23,737
95	7,615	3,368	439	574	11,996
96	9,788	14,089	320	366	24,563
97	23,413	26,860	104	700	51,076
98	19,578	42,815	108	322	62,823
99	7,170	8,587	55	97	15,910
00	20,936	6,530	78	248	27,792
01	8,436	4,003	51	520	13,010
02	3,541	10,328	22	232	14,123
03	5,972	5,728	28	295	12,023
04	5,012	5,624	23	537	11,195
05	4,572	8,024	20	475	13,091
06	7,870	8,024	16	355	16,265
07	5,483	8,024	18	218	13,743



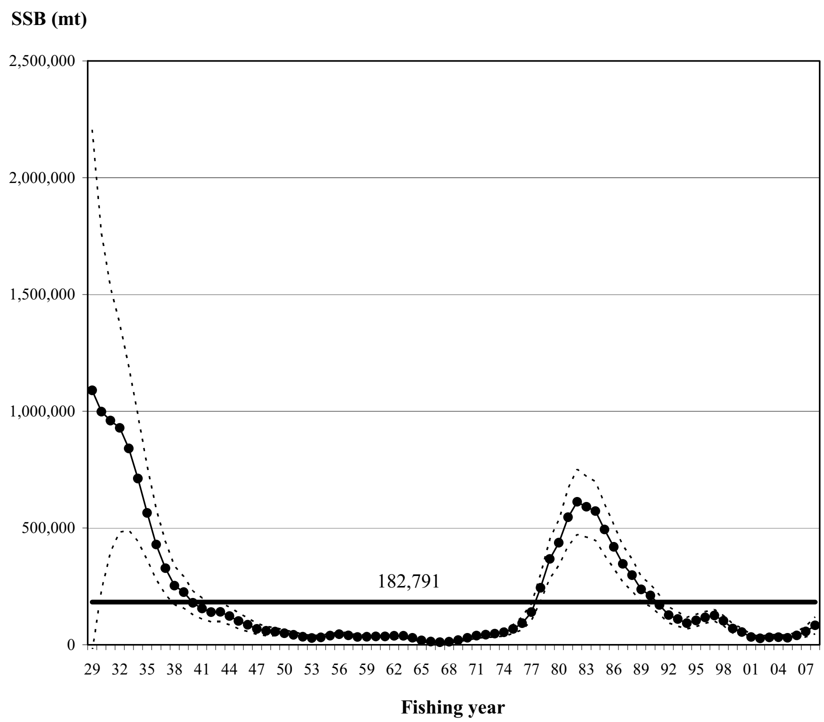
Plot of commercial and recreational landings (mt) of Pacific mackerel in California (USA) and Baja California (Mexico) used in the ASAP-E1 2008 model (1926-08).

Data and assessment:
The last assessment of Pacific mackerel was completed in 2007 for U.S. management in the 2007-08 fishing year. The current assessment is an update based on the Age-Structured-Assessment Program (ASAP)-E1 2007 model recommended by the 2007 Stock Assessment Review (STAR) Panel (La Jolla, May 2007). The assessment includes: catch data (1926-2007); Aerial spotter survey index data (1963-2001); California Passenger Fisheries Vessels (CPFV) recreational CPUE (1935-2007) index data; and California Cooperatives Fisheries Investigations (CalCOFI) larval production at hatching (1951-2006) index data. The final model integrates these data into the ASAP (V.1.3.2), and in this assessment we label this model, "ASAP-E1 2008 model."

Unresolved Problems and Uncertainties:
The assessment suffers from a lack of biological and relative abundance data from Mexico. In particular, there is currently no true fishery-independent index of relative abundance for the whole stock. The 2007 STAR Panels (May and September, La Jolla,) recommended that future stock assessments continue to examine the possibility of using Stock Synthesis2 (SS2) as an alternative to the ASAP platform. Although SS2 and ASAP lead to similar outcomes when configured in a similar manner, SS2 deals better with indices that are not tied to a fishery, can include age-reading error, and allows weight-at-age in the catch to differ from weight-at-age in the population.

Spawning Stock Biomass

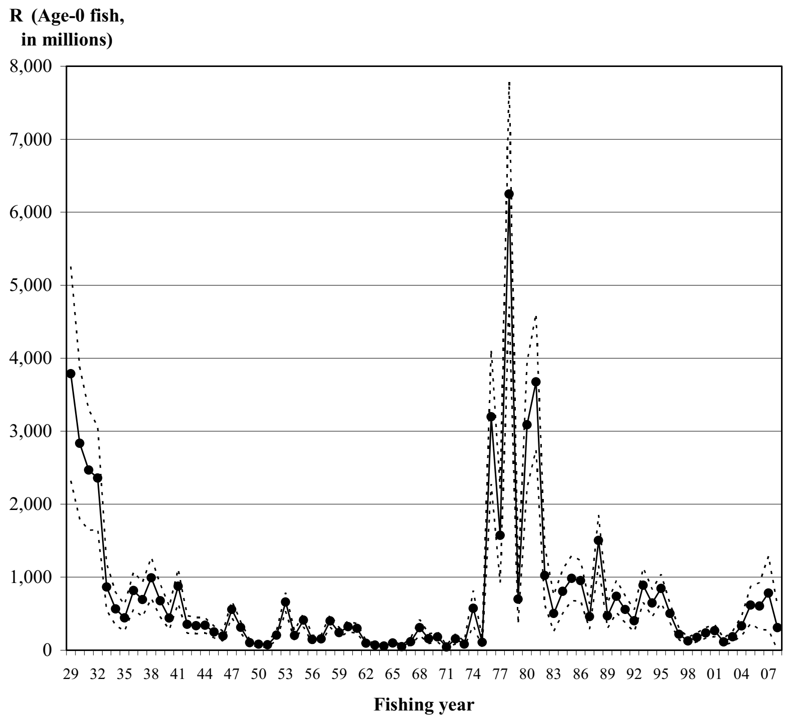
After a period of low abundance (1940-1977) spawning stock biomass (*SSB*) increased in the late 1970s reaching a peak of 611,964 mt in 1982. Since 1982 *SSB* has declined, reaching an estimate of 83,183 mt in 2008. A table of *SSB* estimated in the last 10 years is presented on page 6.



Plot of Pacific mackerel *SSB* (mt) estimated from the ASAP-E1 2008 model (1929-08). The confidence interval (± 2 STD) associated with this time series is also presented. Estimated 'virgin' *SSB* from stock-recruitment relationship is presented as bold horizontal line.

Recruitment

Recruitment was modeled following a standard Beverton & Holt stock-recruit relationship. Steepness was estimated to be 0.32 and Sigma-R (σ_R) was fixed to 0.7. Predicted recruits in the model showed large year classes in 1976, 1978, 1980 and 1981, but low level of recruitment throughout the 1990s and the early 2000s. The number of recruits estimated by the model is presented on page 6.



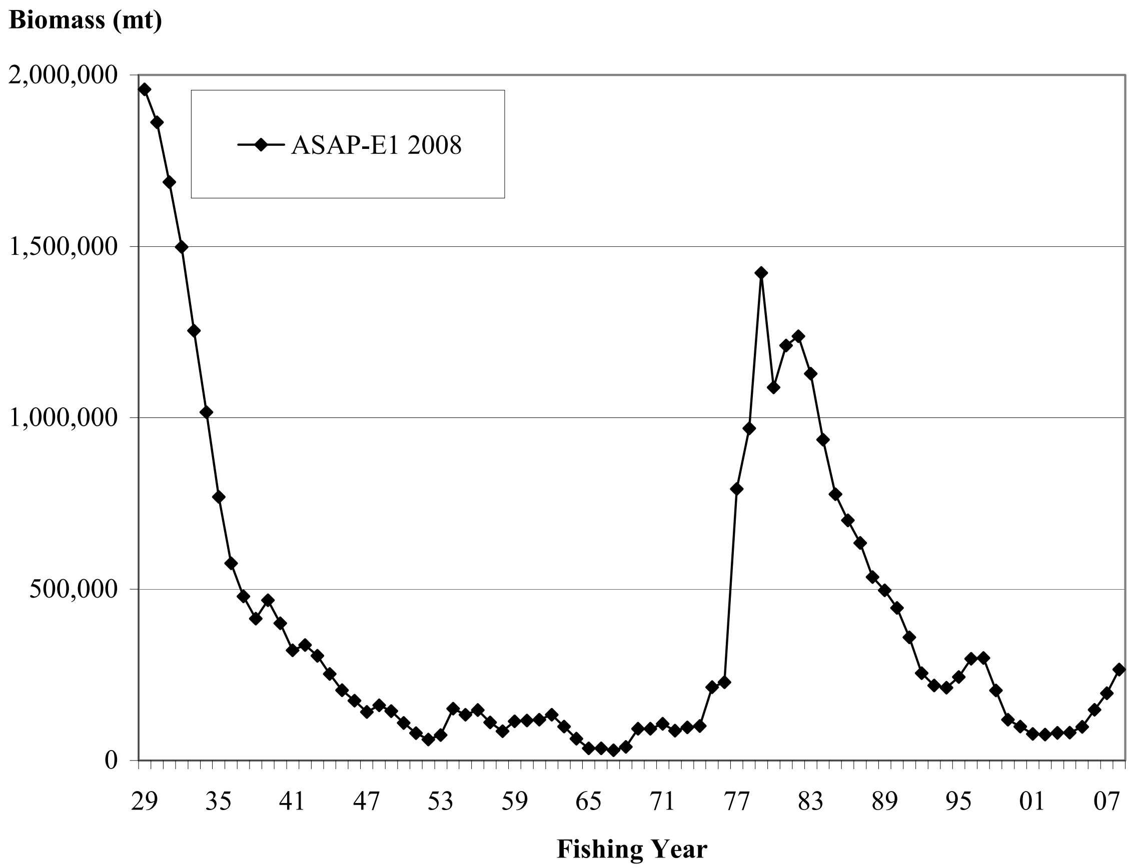
Plot of Pacific mackerel recruitment (age-0 fish in millions, R) estimated from the ASAP-E1 2008 model (1929-08). The confidence interval (± 2 STD) associated with this time series is also presented.

Management performance
Since 2000, Pacific mackerel has been managed based on a Federal Fishery Management Plan (FMP) harvest policy, stipulating that maximum sustainable yield (MSY) control rule for this species should be set to a Harvest Guideline (HG):

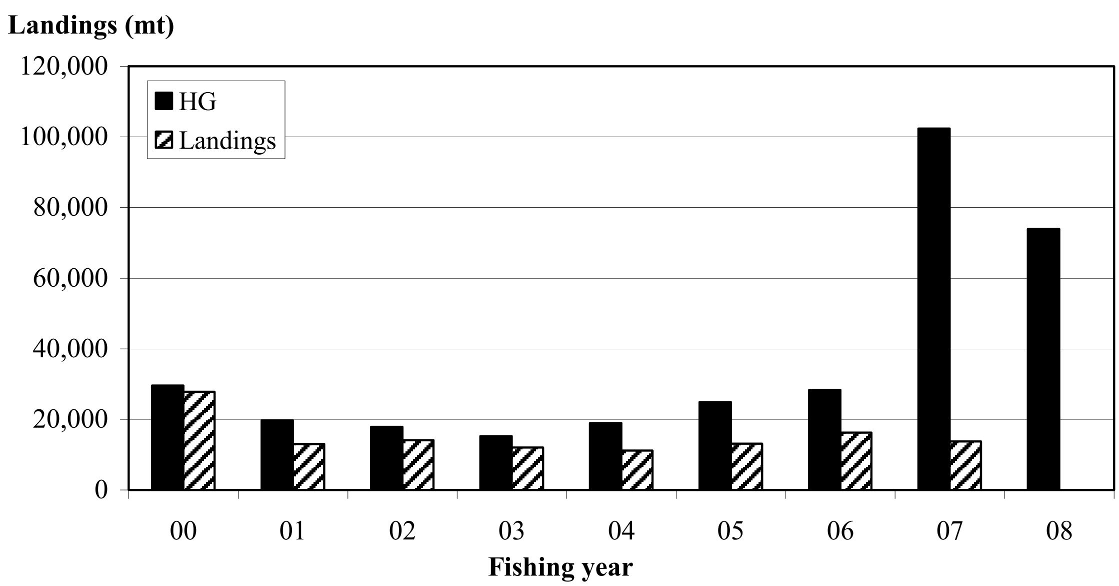
HARVEST = (BIOMASS-CUTOFF) x FRACTION x STOCK DISTRIBUTION,

where HARVEST is the HG, CUTOFF (18,200 mt) is the lowest level of estimated biomass (*B*) at which harvest is allowed, FRACTION (30%) is the fraction of biomass above CUTOFF that can be taken by fisheries, and STOCK DISTRIBUTION (70%) is the average fraction of total BIOMASS (Ages 1+) assumed in U.S. waters (PFMC 1998). Harvest guidelines under the federal FMP are applied to a July-June fishing year.

Age 1+ biomass was low from the late 1940s to the early 1970s, reaching a peak in 1982, and since then generally declined yielding 264,732 mt in 2008. However, landings of Pacific mackerel have been consistently below the HGs since 2001.



Plot of Age-1+ fish *B* (mt) of Pacific mackerel based on population biomass estimated from the ASAP-E1 2008 model (1929-08).



Total landings (mt) and Harvest Guidelines (HG) for Pacific mackerel based on no 'U.S. Distribution' parameter in the harvest control rule (*B*, 2000-08 Fishing years).

Table of estimated recruitment, Age 1+ biomass and spawning stock biomass (1998-2008).

Fishing Year	Recruits (Age-0)	Biomass (Age-1+)	SSB
98	124,650	203,657	102,820
99	175,250	119,155	69,737
00	235,520	98,641	54,266
01	265,960	76,872	32,721
02	113,010	75,701	27,250
03	183,750	79,973	31,670
04	331,430	81,406	32,063
05	615,780	97,727	29,420
06	603,760	147,833	40,167
07	781,550	195,806	56,688
08	307,250	264,732	83,183

Harvest Guideline for the 2008-09 Fishing Season

Biomass (Age-1+)	Cutoff (mt)	Fraction	Distribution	2008-09 Harvest Guideline (mt)
264,732	18,200	30%	70%	51,772

INTRODUCTION

Background

A Pacific mackerel (*Scomber japonicus*) stock assessment is conducted annually in support of the Pacific Fishery Management Council (PFMC) process, which ultimately establishes a harvest guideline (HG) or Optimal Yield (OY) for the Pacific mackerel fishery that operates off the U.S. Pacific coast. The HG for mackerel applies to a fishing year (management season) that begins in July 1st and ends on June 30th of the subsequent year. The main goal of the assessment is to provide an estimate of current abundance (in biomass), which is used in a harvest control rule for calculation of annual-based HGs. For details regarding Pacific mackerel' harvest control rule, see Amendment 8 of the Coastal Pelagic Species (CPS) Fishery Management Plan (FMP), section 4.0 (PFMC 1998).

The last assessment was completed in June 2007, setting an HG of 71,629 mt for the 2007-08 fishing year. However, as a precautionary measure the PFMC concurred with recommendations from the Coastal Pacific Species Management Team (CPSMT), and the Coastal Pacific Species Advisory SubPanel (CPSAS) to set an OY of 40,000 mt for the 2007-08 fishing year. The 2007-08 HG was based on biomass estimated from the ASAP-E1 model that was reviewed and recommended by the May 2007 STAR Panel (La Jolla, CA). This panel also reviewed several Stock Synthesis2 (SS2) model runs, but could not identify an acceptable SS2 model configuration (see STAR Panel report, May 2007). Thus, the STAR Panel recommended that future stock assessments continue to examine the possibility of using SS2 as an alternative to the ASAP platform, and proposed an SS2 methodology review in September 2007. Additional SS2 model runs were examined during the September 2007 STAR Panel in La Jolla, CA; but again the Panel was unable to identify an acceptable base model using SS2. The STAR Panel agreed that SS2 is an appropriate model for the assessment of Pacific mackerel, but further investigations were needed to determine a reliable and stable model configuration (see STAR Panel Report, September 2007).

The 2008-09 stock assessment presented here is an update based on the ASAP-E1 model that was reviewed in May 2007 (STAR Panel, La Jolla) and presented to the PFMC in June 2007 (Dorval et al. 2007). This updated assessment includes updated landings data (1929-06) and an additional year of data (2007) collected from ongoing fishery-dependent sampling programs conducted by the the California Department of Fish and Game (CDFG). Also, prior to adding updated catch and biological data, CDFG made minor updates to the California Commercial Passenger Fishing Vessel (CPFV) time series data, but those changes had no significant effect on the overall trajectory of this index. No new data were added to the aerial spotter index and to the CalCOFI larval production index, thus these input data are similar to the time series used in the 2007 assessment. Model parameterization replicates the ASAP-E1 2007 model, but we also conducted sensitivity analysis showing the performance of the model with and without the updated data stream. In this context we present an updated assessment that follows the "2007 CPS Term of Reference" for off year (i.e., years in which no STAR Panel is conducted). Readers interested in further details regarding the sample data and model parameterization used in this assessment should consult Dorval et al. (2007). Finally, electronic versions of model programs, input data, and displays (Table and Figures) can be obtained from the authors directly.

Distribution and Stock structure

Pacific mackerel, *Scomber japonicus* (a.k.a. 'chub mackerel' or 'blue mackerel') in the northeastern Pacific range from southeastern Alaska to Banderas Bay (Puerto Vallarta), Mexico, including the Gulf of California (Hart 1973). They are common from Monterey Bay, California, to Cabo San Lucas, Baja California, but are most abundant south of Point Conception, California. Pacific mackerel usually occur within 30 km of shore, but have been captured as far as 400 km offshore (Fitch 1969; Frey 1971; Allen et al. 1990; MBC 1987).

There are possibly three spawning stocks along the Pacific coasts of the U.S. and Mexico: one in the Gulf of California, one in the vicinity of Cabo San Lucas, and one extending along the Pacific coast north of Punta Abreojos, Baja California (Collette and Nauen 1983; Allen et al. 1990; MBC 1987). The latter "northeastern Pacific" stock is harvested by fishers in the U.S. and Baja California, Mexico, and is considered in this assessment.

The PFMC manages the northeastern Pacific stock as a single unit, with no area- or sector-specific allocations. The PFMC's harvest control rule does, however, prorate the seasonal HG by a 70% portion assumed to reside in U.S. waters (PFMC 1998).

Fisheries

Pacific mackerel are currently harvested by three fisheries: the California commercial fishery, a sport fishery based primarily in southern California, and the Mexican commercial fishery based in Ensenada and Magdalena Bay, Baja California. In the commercial fisheries, Pacific mackerel are landed by the same boats that catch Pacific sardine, anchovy, jack mackerel, and market squid. There is no directed fishery for mackerel in Oregon or Washington, however, small amounts (100-300 $mt \cdot yr^{-1}$) are taken by whiting trawlers and salmon trollers. Pacific northwest catch peaked at 1,800 mt following the major El Niño event of 1997-98.

ASSESSMENT

Biological Data

Weight-at-age

A year-specific weight-at-age matrix based on fishery samples was developed for use in the ASAP-E1 model. As in the 2007 assessment this matrix was used to calculate spawning stock biomass (*SSB*) and Age 1+ biomass (*B*) from modeled population estimates. Weight-at-age data were updated for the years 2006 and 2007. While it is possible that the population weight-at-age of Pacific mackerel differs from that derived from fishery samples, fishery-independent data do not exist to explore this question. We assumed that fish that occur in the fisheries and in the overall population had similar growth.

Maturity Schedule

As in the 2007 assessment, normalized net fecundity-at-age (fraction mature x spawning frequency x batch fecundity) was used to interpret CalCOFI ichthyoplankton data and calculate *SSB*. Fraction mature was estimated by fitting a logistic regression model to age and fraction mature data in Dickerson et al. (1992). Spawning frequency was estimated by fitting a straight line to age and spawning frequency data from the same study. Following Dickerson et al. (1992), batch fecundity per gram of female body weight was assumed constant.

Natural Mortality

As in the 2007 assessment, natural mortality rate (*M*) was assumed to be constant, 0.5 yr^{-1} for both sexes across all ages (0-8+) and years (1929-08). We refer readers to Dorval et al. (2007) for a review of method applied to derive mortality rate level used in this assessment.

Fishery Data

Landings

The assessment uses commercial and recreational landings in California and commercial landings in Baja California from 1926-27 through 2007-08. Landings were aggregated on a fishing year basis, and the updated time series data are presented in Figure 1. Landings for March-June 2008 were substituted with corresponding months from 2007.

Catch-at-age

As in the 2007 assessment, various sources were used to reconstruct a catch-at-age time series for Pacific mackerel (Dorval et al. 2007). Age compositions were estimated by using the proportions-at-age and average weights-at-age to calculate tonnage per age group. Tons per age was converted to numbers-at-age using average fish weights for each biological year.

Catch-at-age data (in proportion) compiled for the ASAP-E1 2008 model input are displayed in Figure 2. For years where age sampling was carried out (i.e. 1929-30 to

2007-08), an effective sample size (λ) of 45 was used, as in the 2007 assessment. Effective sample size was set to zero for cases with landings but no samples (i.e., 2008-09).

Indices of Relative Abundance

As in the 2007 assessment, survey data of relative abundance used in the ASAP-E1 2008 model include: 1) an aerial sightings by spotter pilots; 2) a larval production at hatching (P_h) from the CalCOFI program; and 3) a standardized, catch-per-unit-effort (CPUE) index developed from the CPFV logbooks (Figure 3).

In this assessment, the spotter index covers the fishing period 1962-63 through 2001-02 and is standardized using a Delta-GLM model as in the 2007 assessment (Dorval et al. 2007). Although data from 2004 through 2006 were available, the 2007 STAR Panel recommended that these data be dropped from the assessment. Therefore, data inputs for the spotter index are similar to inputs used in the 2007 assessment. Further, in 2007 no Pacific mackerel larvae were collected during the CalCOFI survey, consequently the Ph index could not be updated, and this assessment uses the same data inputs as derived in the 2007 assessment (Dorval et al. 2007).

Only the CPFV logbooks data were updated, including minor changes in the 1935-06 time series and new data collected in 2007. The new index was standardized using a Delta-GLM, following the same statistical procedures as in the 2007 assessment (Dorval et al. 2007). Figure 4 compares the 2007 and 2008 CPFV index developed using the Delta-GLM method, and shows that the changes made by CDFG had little effect on the overall trajectory of the index.

As in previous assessments, selectivity for the Spotter, CPFV and CalCOFI indices were fixed outside of the ASAP-E1 2008 model. Figure 5 presents selectivity curves assumed for each index, with time varying selectivity for the CPFV CPUE index.

Survey data for Pacific mackerel vary in quality over space and time, but no single index is proposed to be superior with respect to comprehensiveness or sampling design. Strengths and weaknesses of each survey was thoroughly addressed during the 2007 STAR (May 2007 STAR Panel Report).

ASAP-E1 2008 Model

The ASAP model (Legault and Restrepo 1999) is based on the AD Model Builder (ADMB) software environment, a high-level programming language that utilizes C^{++} libraries for nonlinear optimization (Otter Research 2001). The general estimation approach used in the ASAP is that of a flexible forward-simulation that allows for the efficient and reliable estimation of a large number of parameters. The population dynamics and statistical principles of ASAP are well established and date back to Fournier and Archibald (1982) and Deriso et al. (1985).

The ASAP-E1 2008 model is parameterized similarly to the ASAP-E1 2007 model recommended by the May 2007 STAR Panel. Only the catch, biological, and the CPFV data differ:

- Updated landing time series with additional year (i.e, 2007) of catch, catch-at-age, and weight-at-age data;
- Plus group for age data , 8+ years;
- Effective sample size for age comps iteratively adjusted to 45;
- Fishery selectivity estimated for three time blocks: 1929-69; 1970-77; 1978-08;
- Aerial spotter index, larval production index and updated CPFV index methods were included, with inverse-weighting of observations based on model CVs;
- Survey timings based on fishing year (July 1- June 30);
- Sigma-R for the spawner-recruit model was fixed to 0.7;
- As in the 2007 assessment, ASAP version 1.3.2 (compiled 14 September 2004) was used for all runs presented in this paper.

Results

Catch

The ASAP-E1 2008 model fit to catch data is displayed in Figure 6. The observed and predicted time series essentially overlay each other, indicating precise fit to this data source.

Catch-at-age

Effective sample size for the California catch-at-age data was iteratively adjusted and ultimately set to λ=45 for all years in the input data. Figure 7 presents estimates of Effective sample size from the ASAP-E1 2008 model. Further, Pearson residuals for the catch-at-age fits are displayed in Figure 8. Residual patterns were random, with no obvious trends over age or time. Catch-at-age proportions contributed to 44.8% of the total model likelihood (Table 2).

Fits to Indices

Model fits to the three indices of relative abundance are displayed in Figures 9-11. All three time series have peaks and lows during the same approximate periods of time, however, the magnitude of change for the Aerial Spotter and CalCOFI indices is far greater than that shown for the CPFV index. Index fits contributed to 45.6 % of the total model likelihood (Table 2).

Selectivity Estimates

Fishery selectivities (S_{age}) estimated for the three time blocks are displayed in Figure 12. Selectivities followed a dome-shaped pattern for the two periods of directed fishing (1929-1969 and 1978-2008), with the latter period selecting more fish of the youngest and oldest ages. This difference reflects changes in utilization among the two time periods; fishing primarily for canneries in the early period and a broader range of markets (including pet food) in the latter. During the moratorium (1970-1977), CPS seiners captured Pacific mackerel incidental to other CPS target species (esp. jack mackerel) and tended to be smaller and younger.

Fishing Mortality Rate
The fishing mortality multiplier (Fmult) is displayed in Figure 13, and fishing mortality-at-age is presented in Figure 14. Fmult increased steadily throughout the historic fishery, peaking at close to 0.7 by the mid-1960s. For the recent period, Fmult peaked at 0.62 in 1998 (an El Nino season) when the stock was relatively low but availability was high for the Ensenada fishery.

Spawning Stock Biomass
The time series of *SSB* is presented in Figure 15. *SSB* peaked at 611,964 mt in 1982, declining to 29, 420 mt in 2005 before increasing to the current level of 83,183 mt. B_0 is estimated to be 182,791 mt.

Recruitment
Recruitment time series (age-0 abundance) are displayed in Figure 16. The recruitment trend is closely similar in pattern to that of the 2007 assessment, with large year-classes occurring in 1976, 1978, 1980, and 1981.

Stock-Recruit Relationship
Fit to the stock-recruitment relationship is displayed in Figure 17. In general, estimated recruitment was constrained to a stock-recruitment relationship in the baseline model (Beverton-Holt model; Sigma-R= 0.7). Compensatory productivity ('steepness' parameter) of the population at low adult stock sizes was estimated to be *h*=0.32 – a very low value for small pelagic species, but similar in range to past assessments for this stock.

Biomass of Age 1+ stock for PFMC Management
Stock biomass (Age 1+) peaked at 1.42 million mt in 1979, declined to a low of about 75,701 mt in 2002, increasing again in the recent most years. While the trend in stock biomass was generally similar to past assessments, the magnitude increased due to changes in Sigma-R and higher estimates of recruitment throughout the time series (see 'Recruitment' and 2007 STAR Panel Report). Age 1+ biomass is projected to be 264,732 mt as of July 1, 2008.

Sensitivity Analyses to Last Year's Data
We performed sensitivity tests to investigate potential effects of updated data stream on parameter estimation and population abundance. In this section we present the results of these tests comparing results of four different model runs:

1) *ASAP-E1 2007 model* : similar input data and model parameterization (i.e., no updated data stream in the 2007 fishing year) as in the final ASAP model recommended by the 2007 STAR Panel.
2) *ASAP-E1a*: updated landings for the 2007 fishing year; no 2007 catch-at-age CPFV index estimates; same parameterization as in the ASAP-E1 2007 model.
3) *ASAP-E1b*: updated landing for 2007; updated catch-at-age for 2007; no 2007 CPFV index estimate; same parameterization as in the ASAP-E1 2007 model.

4) *ASAP-E1 2008 model*: all updated data streams were included; and same parameterization as in the 2007 model (see above).

Parameter estimation, spawning stock biomass and recruitment estimates for this model runs are summarized and compared in Table 1 and Figures 18-19.

Sensitivity Analyses to Years with CalCOFI Survey but no Larvae
We also performed a sentivity test to examine the effect of years where the CalCOFI survey was conducted, but no Pacific mackerel larvae were caught. In the ASAP-E1 model these years (i.e., 1964, 1967, 1968, 1975, 1990, 1999, 2000, 2002, 2004, 2007) were dropped from the CalCOFI larval production index. We performed this model run (ASAP-E1c) assuming that Ph for those years was equal to 0.015 (i.e., the lowest estimated value in the time series).

Parameter estimation, spawning stock biomass and recruitment estimates for this model run is also summarized in Table 1 and Figures 18-19.

Comparison of ASAP-E1 2008 Model Results to Previous Assessments

Age 1+ biomass and *SSB* estimated from the 2007 ASAP-E1 model and 2004 Virtual population model (VPA-ADEPT) are compared to 2008 ASAP-E1 2008 estimates in Figures 20 and 21.

HARVEST CONTROL RULE FOR U.S. MANAGEMENT IN 2008-09

In Amendment 8 to the CPS FMP (PFMC 1998), the recommended maximum sustainable yield (MSY) control rule for Pacific mackerel was:

HARVEST = (BIOMASS-CUTOFF) x FRACTION x DISTRIBUTION,

where HARVEST is the U.S. HG, CUTOFF (18,200 mt) is the lowest level of estimated biomass at which harvest is allowed, FRACTION (30%) is the fraction of biomass above CUTOFF that should be taken by all fisheries, and DISTRIBUTION (70%) is the average fraction of total BIOMASS assumed in U.S. waters. CUTOFF and FRACTION values applied in the PFMC's harvest policy for mackerel are based on analyses published by MacCall et al. (1985). BIOMASS (264,732 mt) is the estimated biomass of fish age 1 and older for the whole stock projected for July 1, 2008. Based on this formula, the 2008-09 HG is estimated to be 51,772 mt. Figure 22 presents commercial landings, HGs, and OYs for Pacific mackerel from 1992 to 2007. The recommended HG for the 2008-09 fishing season is 27% lower than the 2007-08' HG, but higher than the OY set by the PFMC for the 2007-08 fishing year and than the maximum yield since 1992-93.

RESEARCH AND DATA NEEDS

CDFG has sampled California's Pacific mackerel fishery for age composition and size-at-age for many decades, and the current stock assessment model incorporates a complete time series of landings and age composition data beginning in 1929. Ensenada landings have rivaled California's for the past decade, but the stock assessment does not include real biological data from the Mexican fishery. Mexican landings are included in the assessment, but must be pooled with the southern California catch. INP (Instituto Nacional de la Pesca)-Ensenada has collected biological samples (size, sex, otoliths) since 1989, but the data have not been available for U.S. stock assessments. There is an urgent need to establish a program of data exchange with Mexican scientists (INP) to fill this information gap. The MexUS-Pacifico (NMFS-INP) meetings are the most appropriate forum for such an exchange.

Weaknesses and strengths of the fishery-independent surveys used in this assessment are highlighted in the 2007 STAR Panel Reports. We summarize below (following bullets excerpted from the report) the most important recommendation of the 2007 Panels.

- Age-reading studies should be conducted to construct an age-reading error matrix for inclusion in future (SS2) assessments.

- The next assessment should continue to examine the possibility of using SS2 as the assessment platform. The analyses presented to the Panels in May and Sepetember suggested that ASAP and SS2 lead to similar outcomes when configured in a similar manner. However, SS2 deals better with indices that are not tied directly to a fishery, can include age-reading error, and allows weight-at-age in the catch to differ from weight-at-age in the population. In principle, it should be easier to represent uncertainty using the MCMC algorithm for assessments based on SS2. Further investigations should be undertaken in an attempt to identify an acceptable SS2 configuration that can form the basis of the 2009-10 harvest guideline

- The construction of the spotter plane index is based on the assumption that blocks are random within region (the data for each region is a “visit” by a spotter plane to a block in that region). The distribution of density-per-block should be plotted or a random effects model fitted in which block is nested within region to evaluate this assumption (e.g. examine whether certain blocks are consistently better or worse than the average).

- The CalCOFI data should be reviewed further to examine the extent to which CalCOFI indices for the Southern California Bight can be used to provide information on the abundance of the coastwide stock.

ACKNOWLEDGEMENTS

This updated stock assessment depends in large part on the diligent efforts of many colleagues and the timely receipt of their data products. Port samples and age data were provided by CDFG Marine Region personnel in Los Alamitos and Monterey, and special thanks go to Leeanne Laughlin, Valerie Taylor, Kelly O'Reilly, Travis Tanaka, Dianna Porzio, Sonia Torres, and Kimberley Pentilla for long dockside and laboratory hours. Wendy Dunlap (CDFG, Los Alamitos) supplied logbook data from California's CPFV logbook program. Ron Dotson, Amy Hays, and Sue Manion (NMFS, La Jolla) provided aerial spotter logbook data. Susan Jacobson (NMFS, La Jolla) extracted CalCOFI larval data. Numerous staff from SIO, NMFS, and CDFG assisted in the ongoing collection and identification of CalCOFI ichthyoplankton samples. We are grateful to Christopher Legault (NMFS, Woods Hole) for providing the ASAP model. Finally we thank André Punt (SSC), Thomas Helser (SSC), and the CPSMT for reviewing an earlier draft of this report.

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Table 1. List of estimated parameters.

Parameters	**Number**
log-sel_year1	9
log_sel_devs_vector:	18
log_Fmult_year1:	1
log_Fmult_devs:	79
log_recruit_devs:	80
log_N_year1_devs:	8
log_q_year1:	3
log_SRR_virgin:	1
SRR_steepness:	1
Total	**200**

Table 2. Comparison of likelihood function components for the ASAP-E1 2008, ASAP-E1a, ASAP-E1b, ASAP-E1c, and ASAP-E1 2007 model runs.

ASAP-E1 2008 Model Run

Component	*n*	*λ*	*RSS*	*L*	% of Total
Catch (weight) - fishery	80	100	0.02	2.36	0.2%
Catch-at-age (proportions) - fishery	720	na	na	530.93	44.8%
Fits - Survey indices					
Spotter	39	1	166.92	119.16	10.1%
CPFV	68	1	16.06	104.85	8.9%
CalCOFI	37	1	76.87	315.54	26.6%
All	144	3	259.85	539.55	45.6%
Recruitment (deviations)	80	1	57.65	57.65	4.9%
Stock-recruit fit	80	1	57.65	53.90	4.6%
F penalty	720	0.001	1.75	0.00	<1%
Number of estimated parameters (Total)	200	na	na	na	
Objective function (Total)	na	na	na	1184.38	100%

ASAP-E1a Model Run

Component	*n*	*λ*	*RSS*	*L*	% of Total
Catch (weight) - fishery	80	100	0.02298	2.298	0.2%
Catch-at-age (proportions) - fishery	720	see_below	na	523.466	44.7%
Fits - Survey indices					
Spotter	39	1	166.557	117.844	10.1%
CPFV	67	1	16.4706	101.298	8.6%
CalCOFI	37	1	76.7361	315.024	26.9%
All	143	3	259.7637	534.166	45.6%
Recruitment (deviations)	80	1	57.483	57.483	4.9%
Stock-recruit fit	80	1	57.483	53.6872	4.6%
F penalty	720	0.001	1.74535	0.001745	<1%
Number of estimated parameters (Total)	200	na	na	na	
Objective function (Total)	na	na	na	1171.1	100.0%

Table 2. cont.

ASAP-E1b Model Run

Component	*n*	*λ*	*RSS*	*L*	% of Total
Catch (weight) - fishery	80	100	0.0230254	2.30254	0.2%
Catch-at-age (proportions) - fishery	720	see_below	na	528.326	44.9%
Fits - Survey indices					
Spotter	39	1	166.509	117.804	10.0%
CPFV	67	1	16.5177	101.799	8.7%
CalCOFI	37	1	76.578	314.643	26.7%
All	143	3	259.604	534.246	45.4%
Recruitment (deviations)	80	1	57.7466	57.7466	4.9%
Stock-recruit fit	80	1	57.7466	54.0177	4.6%
F penalty	720	0.001	1.73547	0.001735	<1%
Number of estimated parameters (Total)	200	na	na	na	
Objective function (Total)	na	na	na	1176.64	100.0%

ASAP-E1c Model Run

Component	*n*	*λ*	*RSS*	*L*	% of Total
Catch (weight) - fishery	80	100	0.0311119	3.11119	0.2%
Catch-at-age (proportions) - fishery	720	see_below	na	532.796	40.3%
Fits - Survey indices					
Spotter	39	1	157.545	112.411	8.5%
CPFV	68	1	17.4904	114.048	8.6%
CalCOFI	47	1	164.818	445.81	33.7%
All	154	3	339.852	672.268	50.8%
Recruitment (deviations)	80	1	59.0798	59.0798	4.5%
Stock-recruit fit	80	1	59.0798	55.6894	4.2%
F penalty	720	0.001	1.3971	0.001397	<1%
Number of estimated parameters (Total)	200	na	na	na	
Objective function (Total)	na	na	na	1322.95	100.0%

Table 2. cont.

ASAP-E1 2007 Model Run					
Component	***n***	***λ***	***RSS***	***L***	**% of Total**
Catch (weight) - fishery	79	100	0.0200987	2.00987	0.2%
Catch-at-age (proportions) - fishery	711	see_below	N/A	524.626	39.7%
Fits - Survey indices					
Spotter	39	1	165.434	119.525	9.0%
CPFV	67	1	15.5464	107.834	8.2%
CalCOFI	37	1	78.0771	318.819	24.1%
All	143	3	259.057	546.179	41.3%
Recruitment (deviations)	79	1	58.803	58.803	4.4%
Stock-recruit fit	79	1	58.803	55.5721	4.2%
F penalty	711	0.001	1.9564	0.001956	<1%
Number of estimated parameters (Total)	198	na	na	na	
Objective function (Total)	na	na	na	1187.19	89.7%

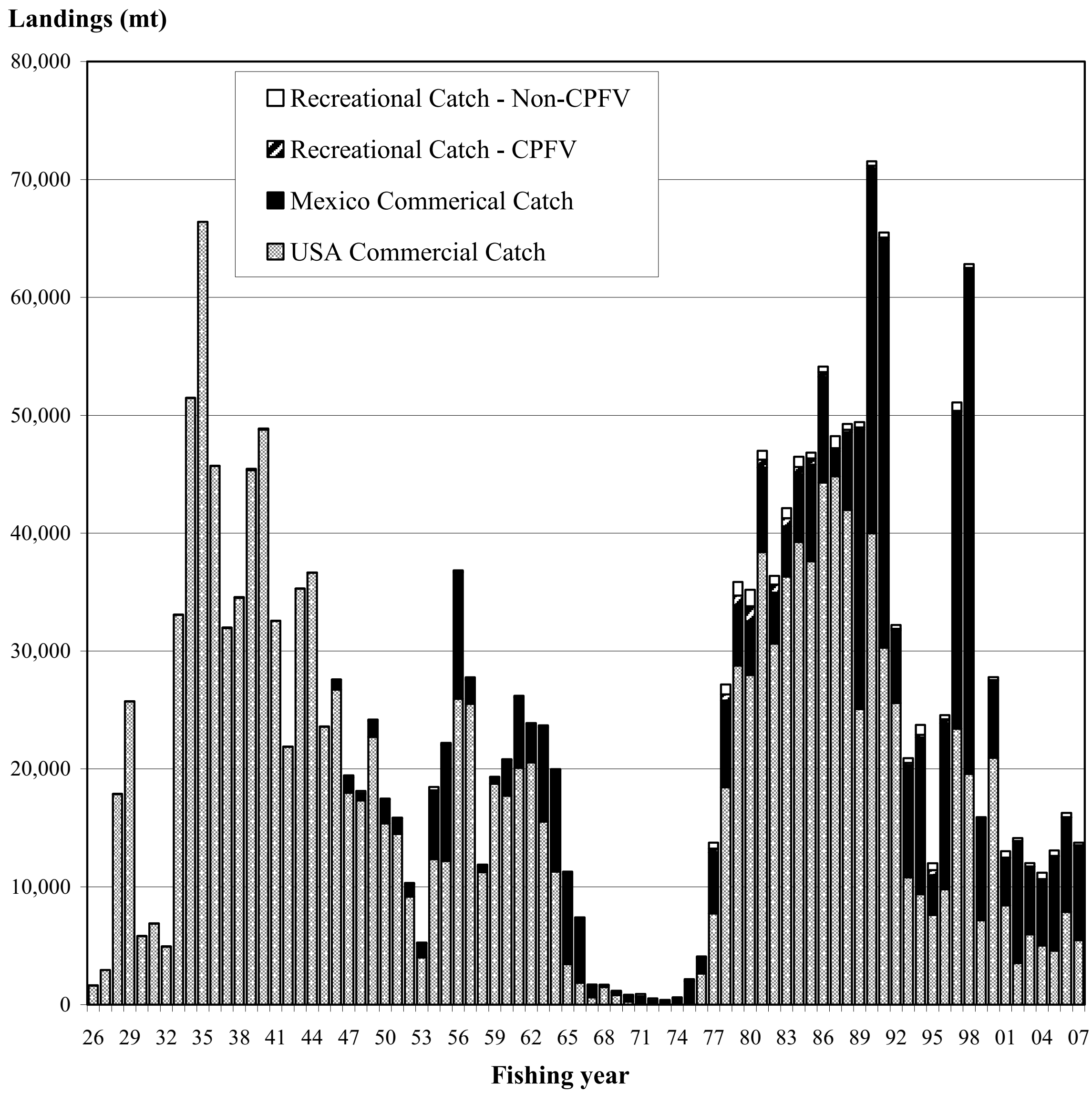

Figure 1. Commercial and recreational landings (mt) of Pacific mackerel in California (CA) and Baja California (MX) used in the ASAP-E1 2008 model (1926-08). See Fishery Data section for descriptions of fishing year.

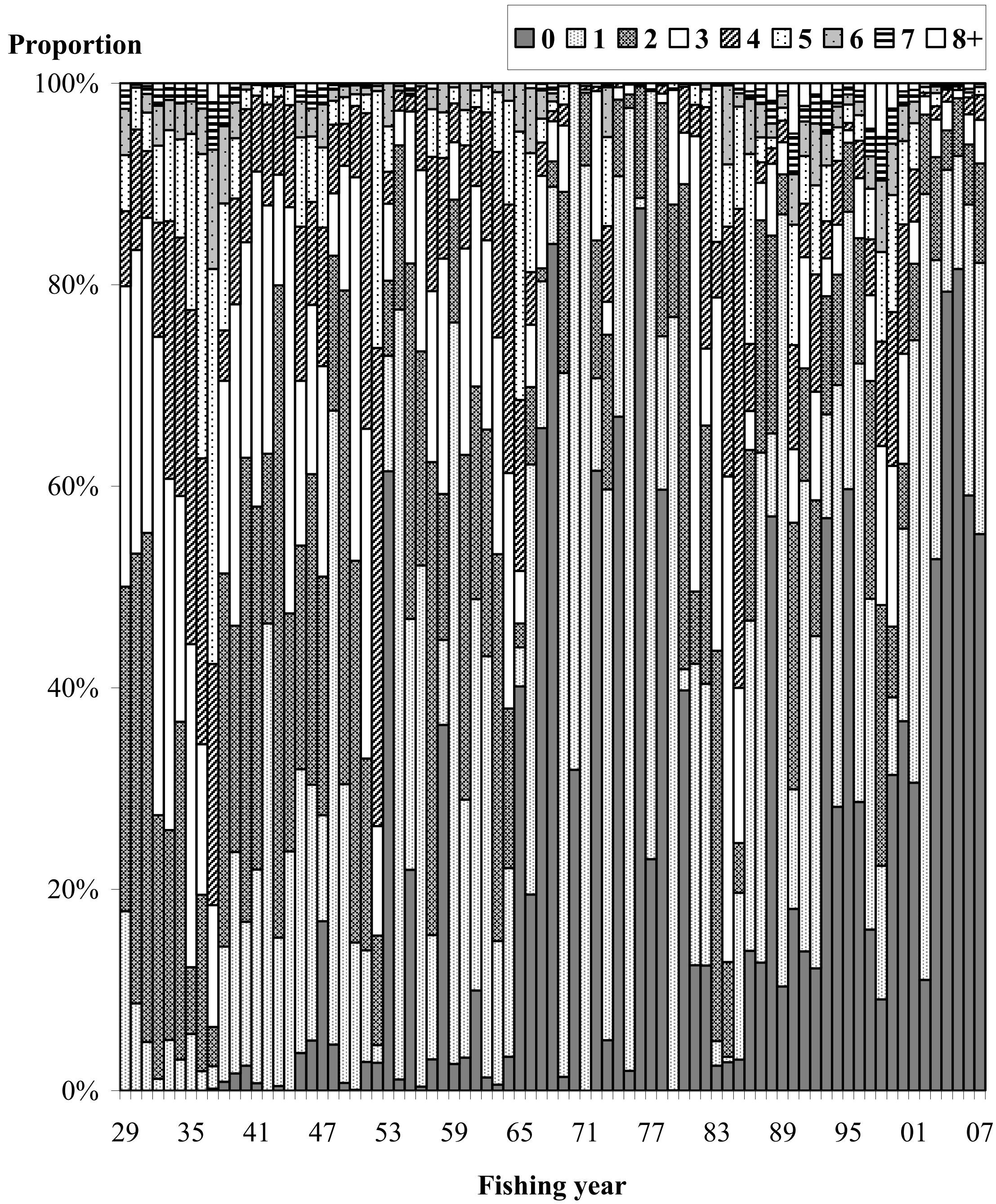

Figure 2. Pacific mackerel catch-at-age (in proportion) estimates used in the ASAP-E1 2008 model (1926-08).

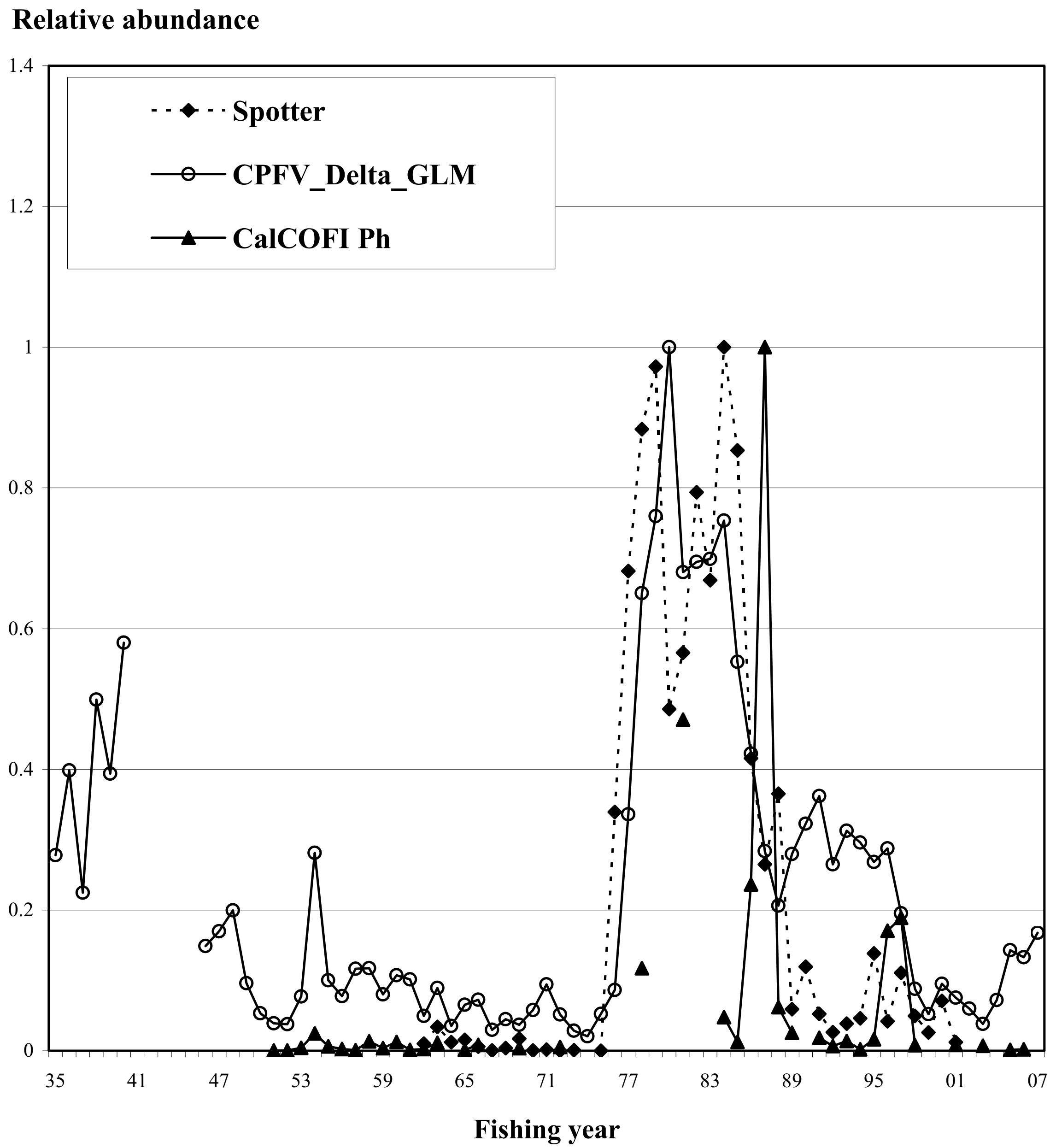

Figure 3. Indices of abundance time series for Pacific mackerel used in the ASAP-E1 2008 model (1926-08). Indices are rescaled (normalized) to a maximum of 1.

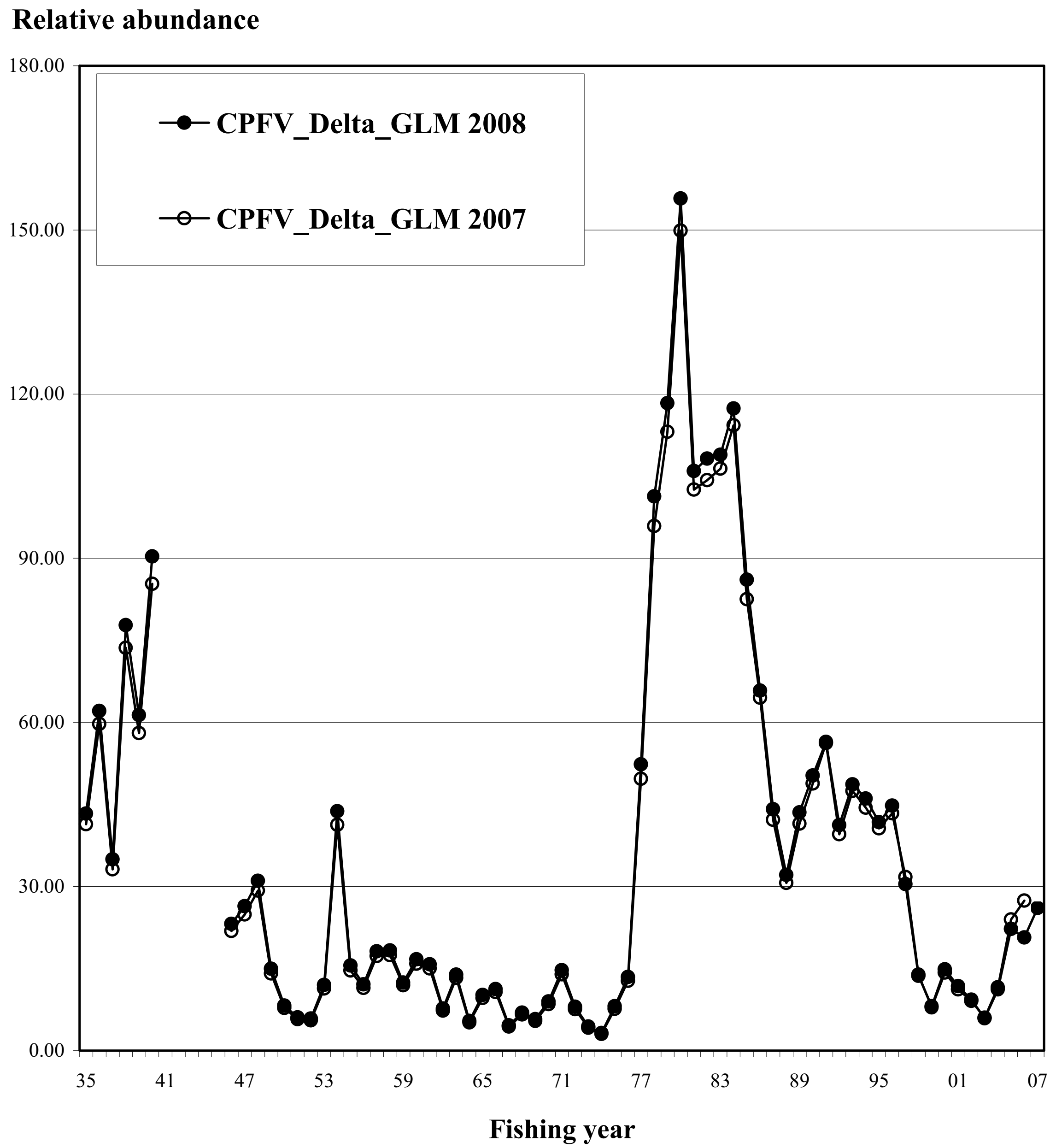

Figure 4. Indices of abundance time series for Pacific mackerel used in the ASAP-E1 and ASAP-E1 2008 models (1926-08) comparing GLM to Delta_GLM.

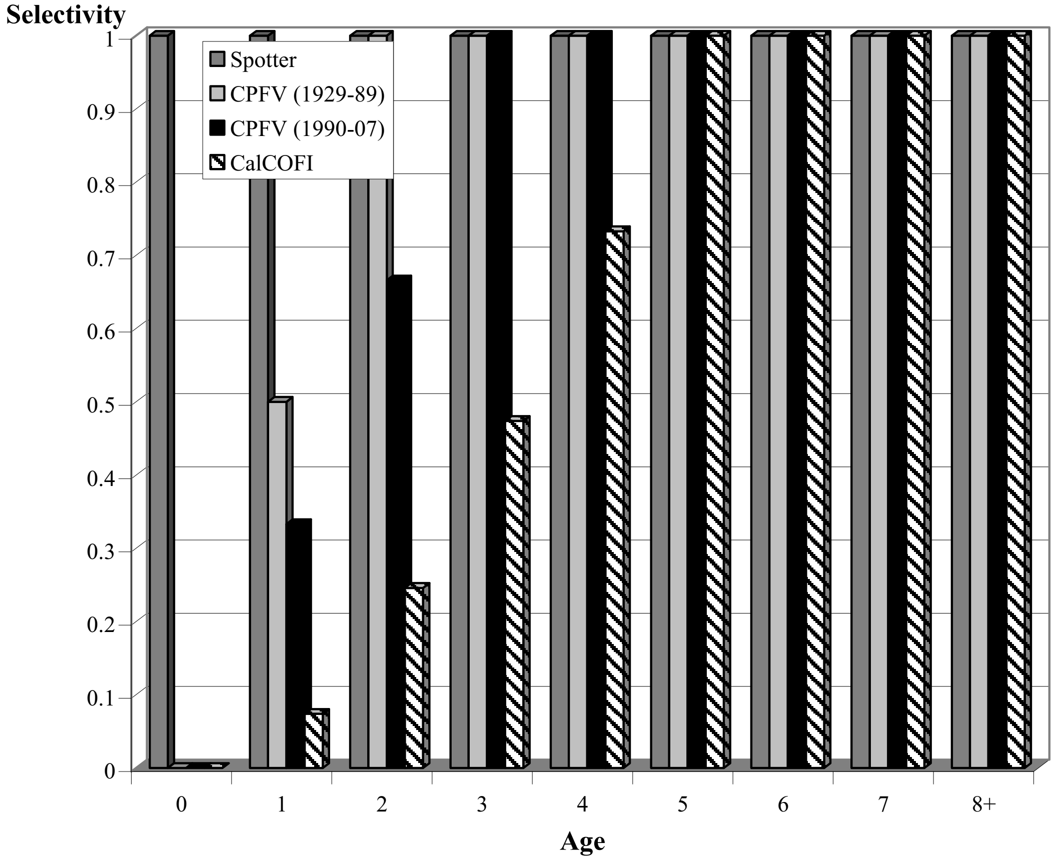

Figure 5. Assumed selectivity ogives for survey-related indices of abundance (Spotter, CPFV, and CalCOFI) from the ASAP-E1 2008 model (1926-08). Note that CPFV ogive represents (1990-07), with ogive for 1929-89 parameterized with slightly different probabilities for ages 1 and 2.

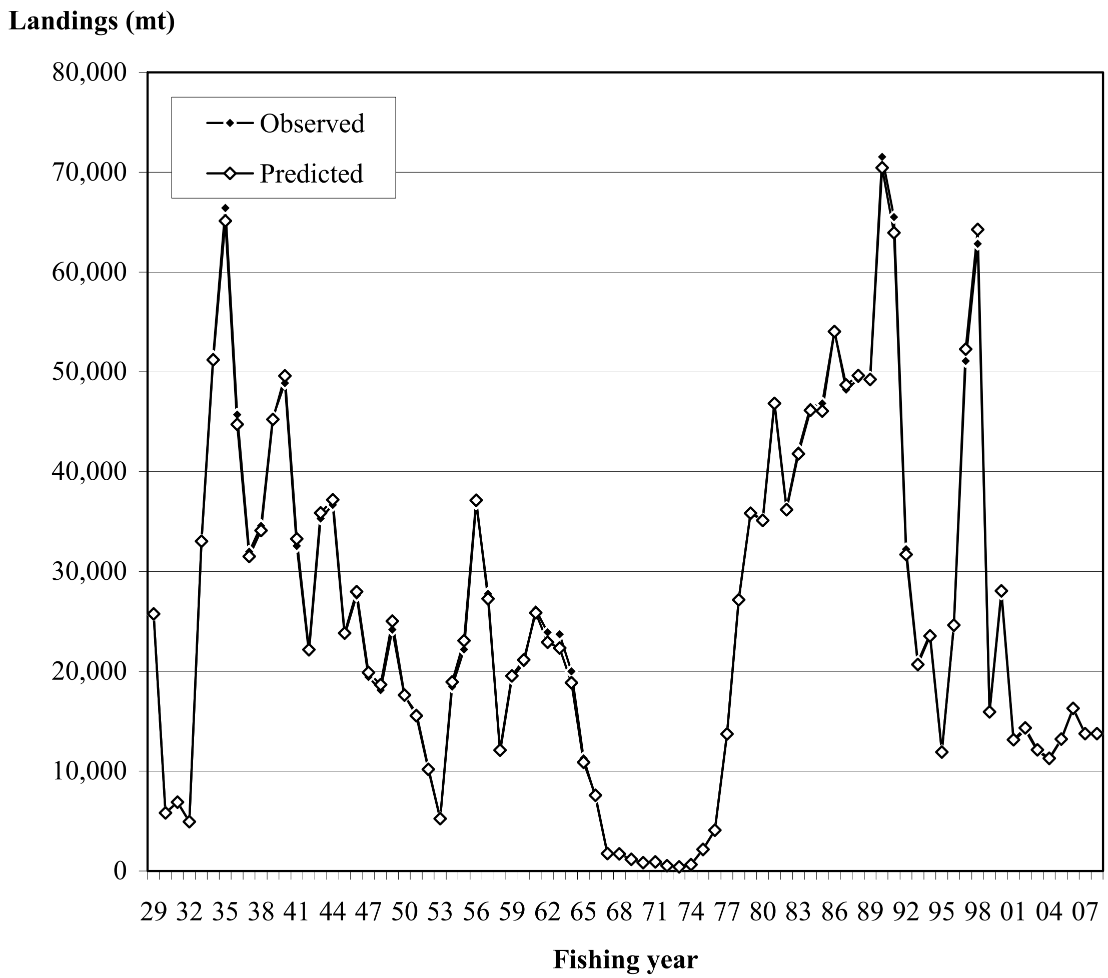

Figure 6. Observed and predicted estimates of total landings (mt) for Pacific mackerel generated from the ASAP-E1 2008 model (1929-08).

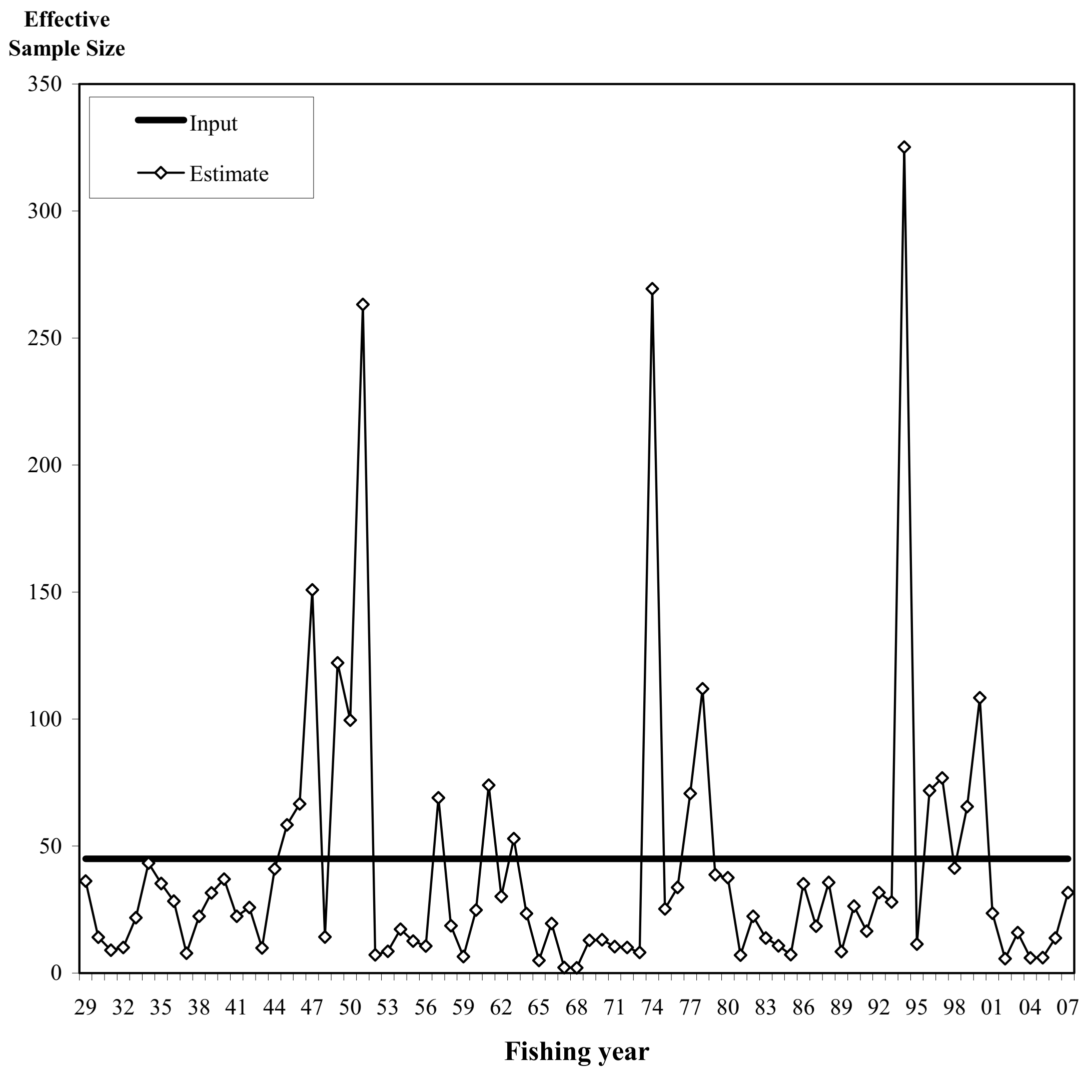

Figure 7. Effective sample sizes estimated for catch-at-age data generated from the ASAP-E1 2008 model (1929-08). Catch-at-age data were given a lamba weighting of '45' for all years.

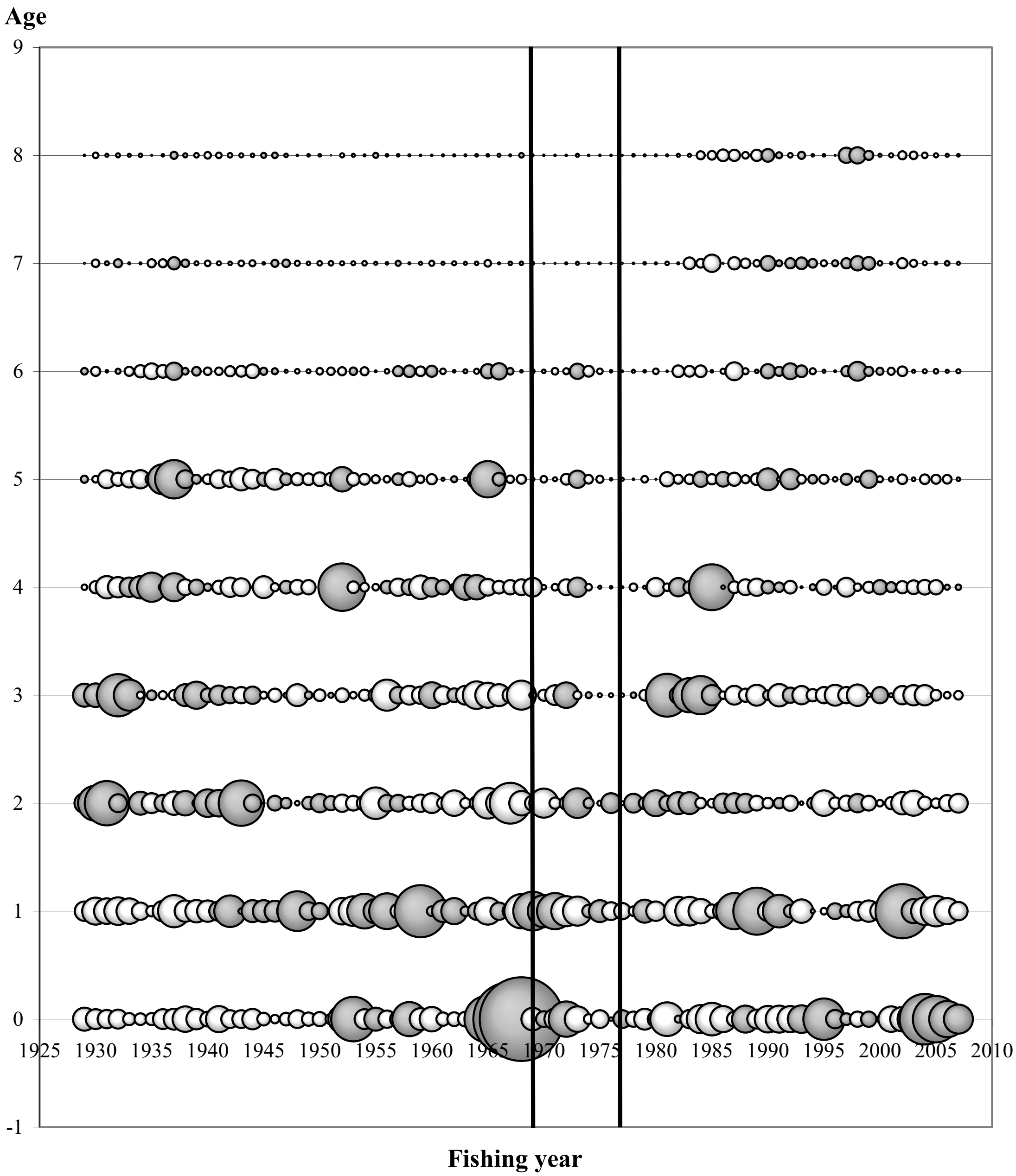

Figure 8. Pearson residual plot for Pacific mackerel catch-at-age fitted to the ASAP-E1 2008 model (1929-08). Dark gray bubbles indicate positive values and white bubbles indicated negative values. Vertical black lines represent periods of major change in fishery selectivity (1929-69, 1970-77, and 1978-07).

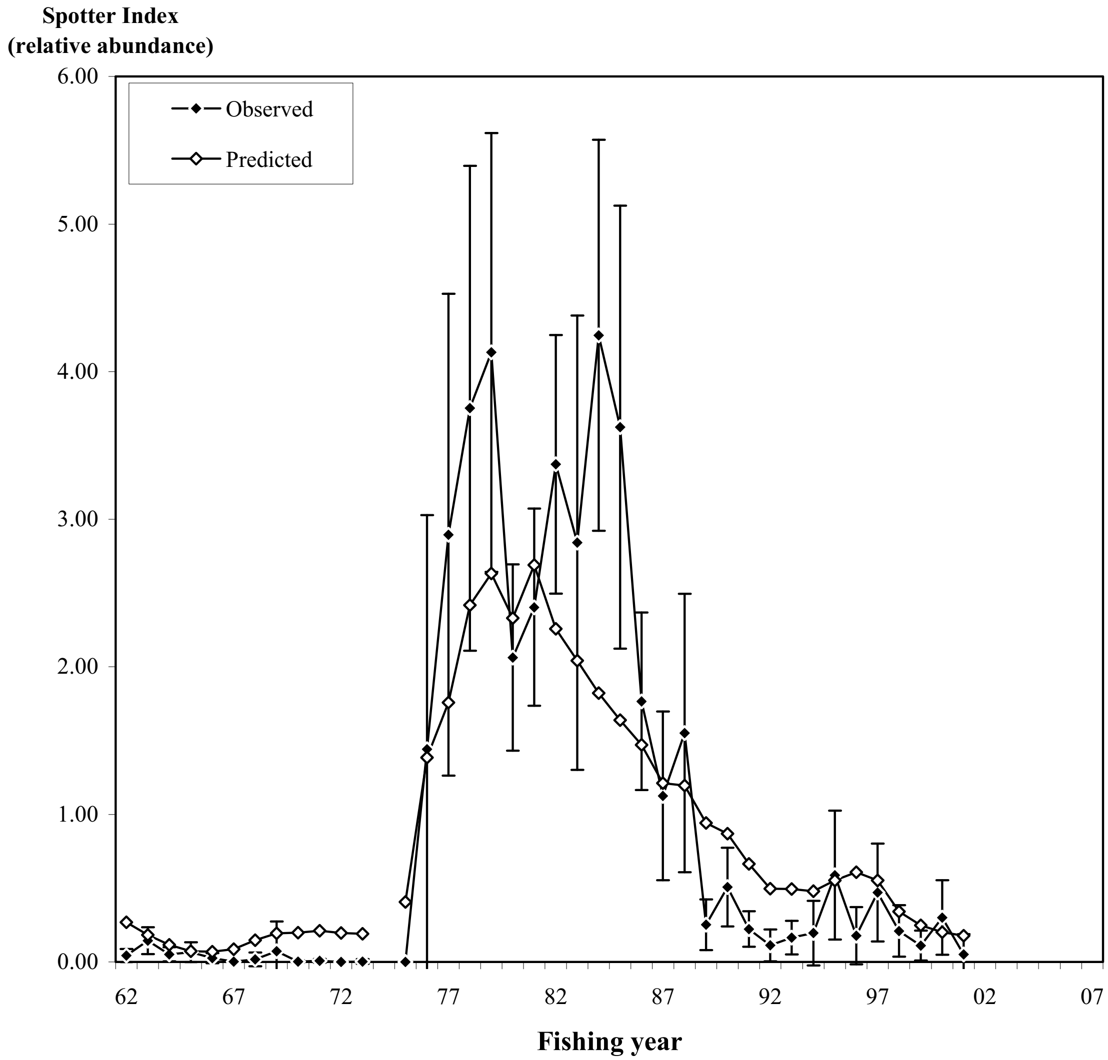

Figure 9. Observed and predicted estimates of the Spotter index of relative abundance for Pacific mackerel generated from the ASAP-E1 2008 model (1962-01). *Note: Observed values were internally re-scaled by ASAP.

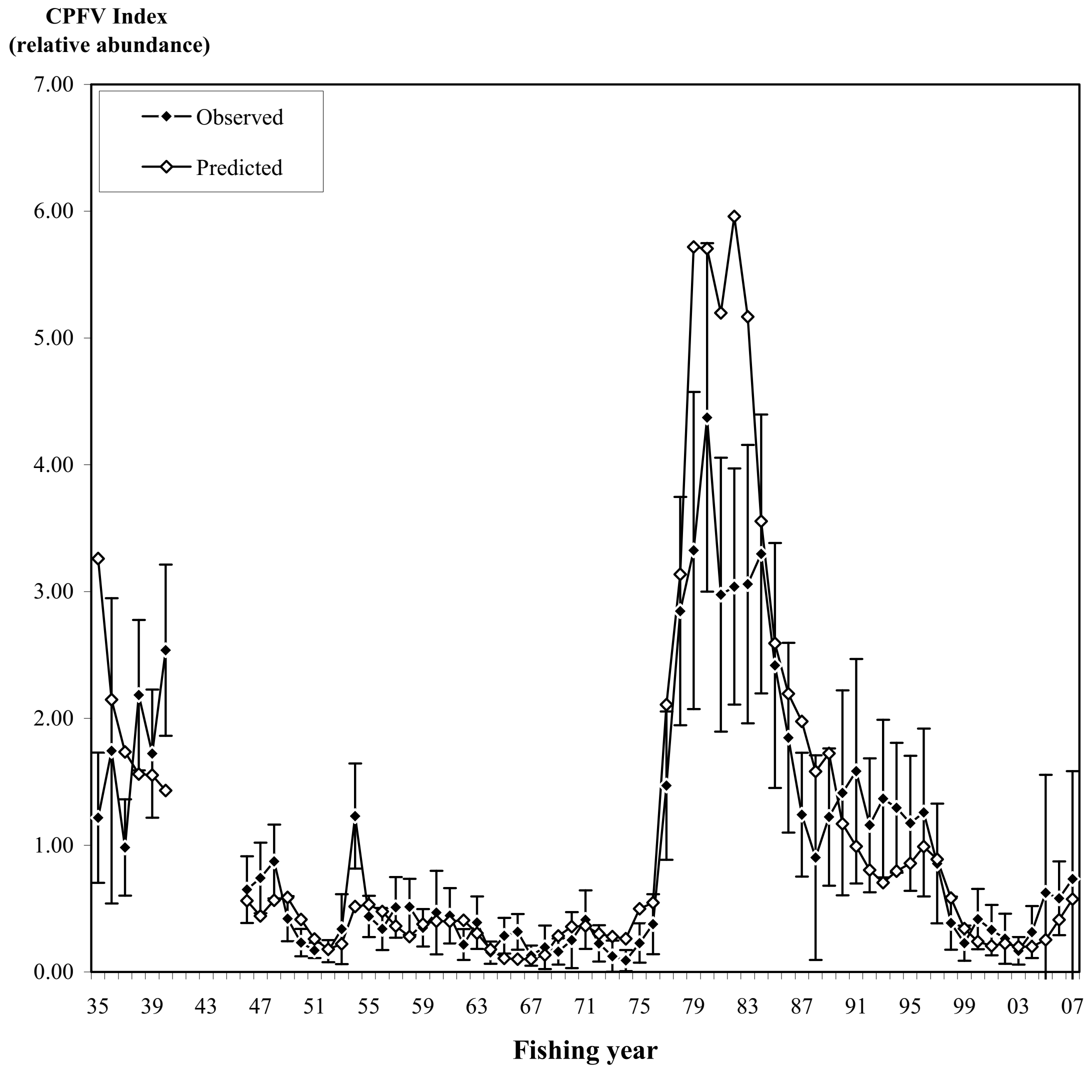

Figure 10. Observed and predicted estimates of the CPFV index of relative abundance for Pacific mackerel generated from the ASAP-E1 2008 model (1935-07). *Note: Observed values were internally re-scaled by ASAP.

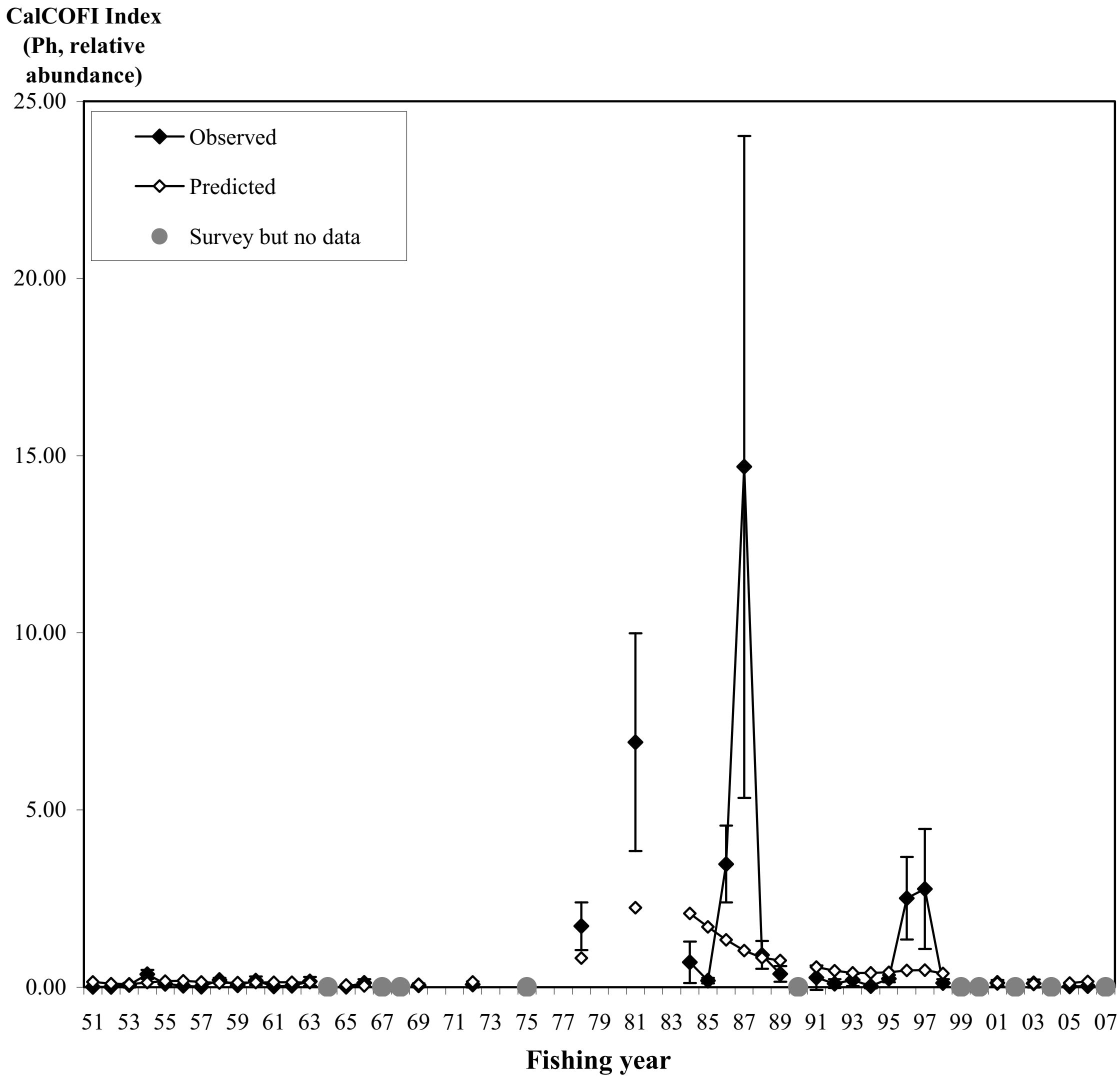

Figure 11. Observed and predicted estimates of the CalCOFI index of relative abundance for Pacific mackerel generated from the ASAP-E1 2008 model (1951-06). *Note: Observed values were internally re-scaled by ASAP.

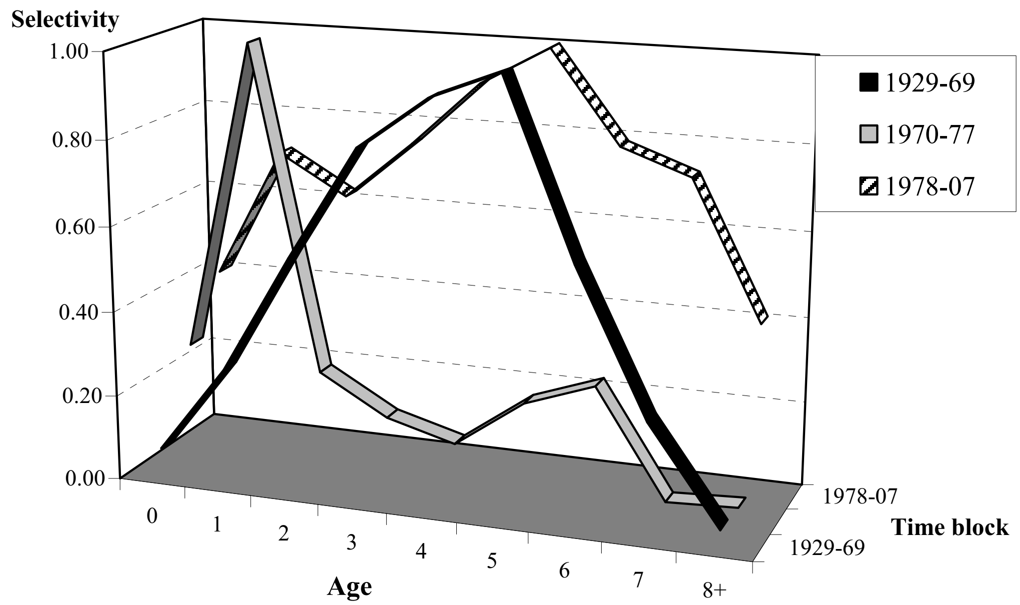

Figure 12. Estimated selectivity schedule for commercial fishery (catch-at-age) data from the ASAP-E1 2008 model (1926-08) based on three time blocks (1929-69, 1970-77, and 1978-07).

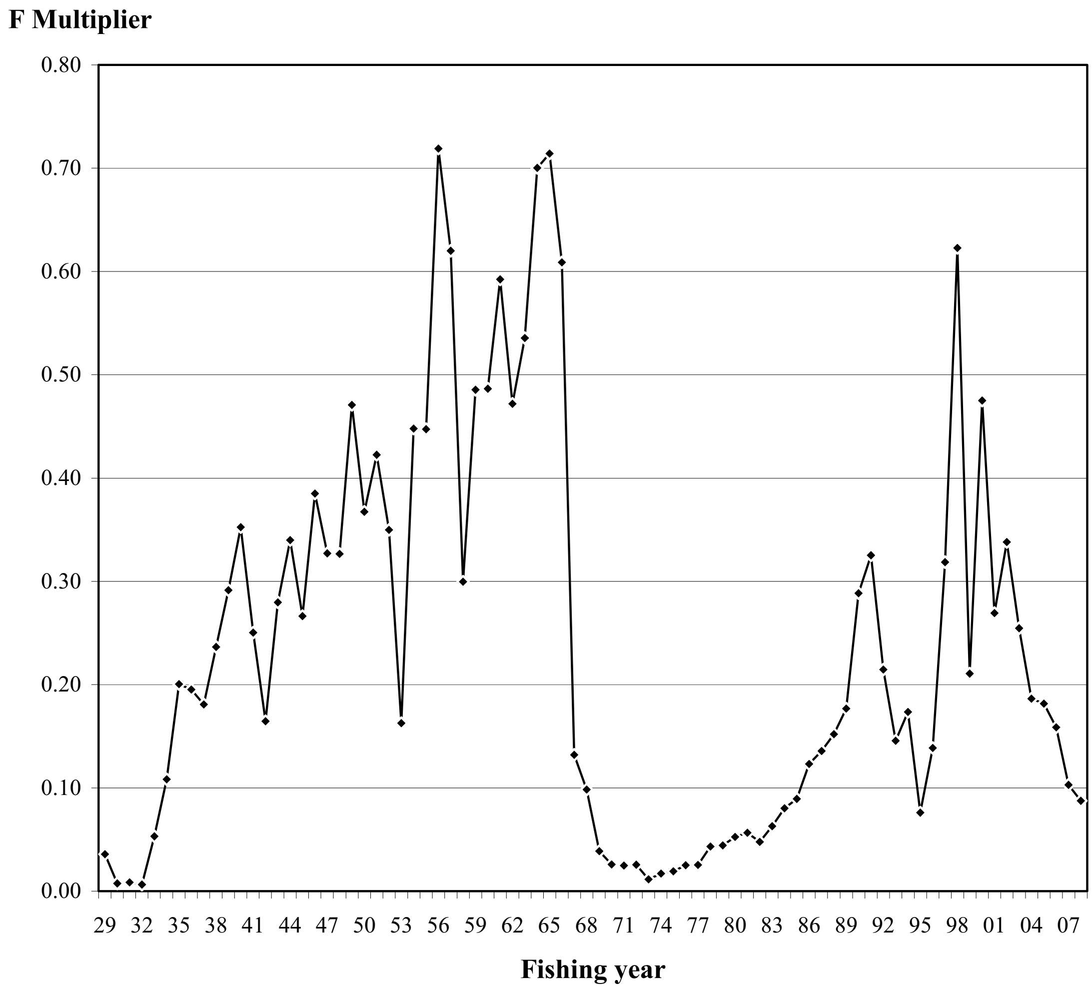

Figure 13. F multiplier for Pacific mackerel generated from the ASAP-E1 08 model (1929-08).

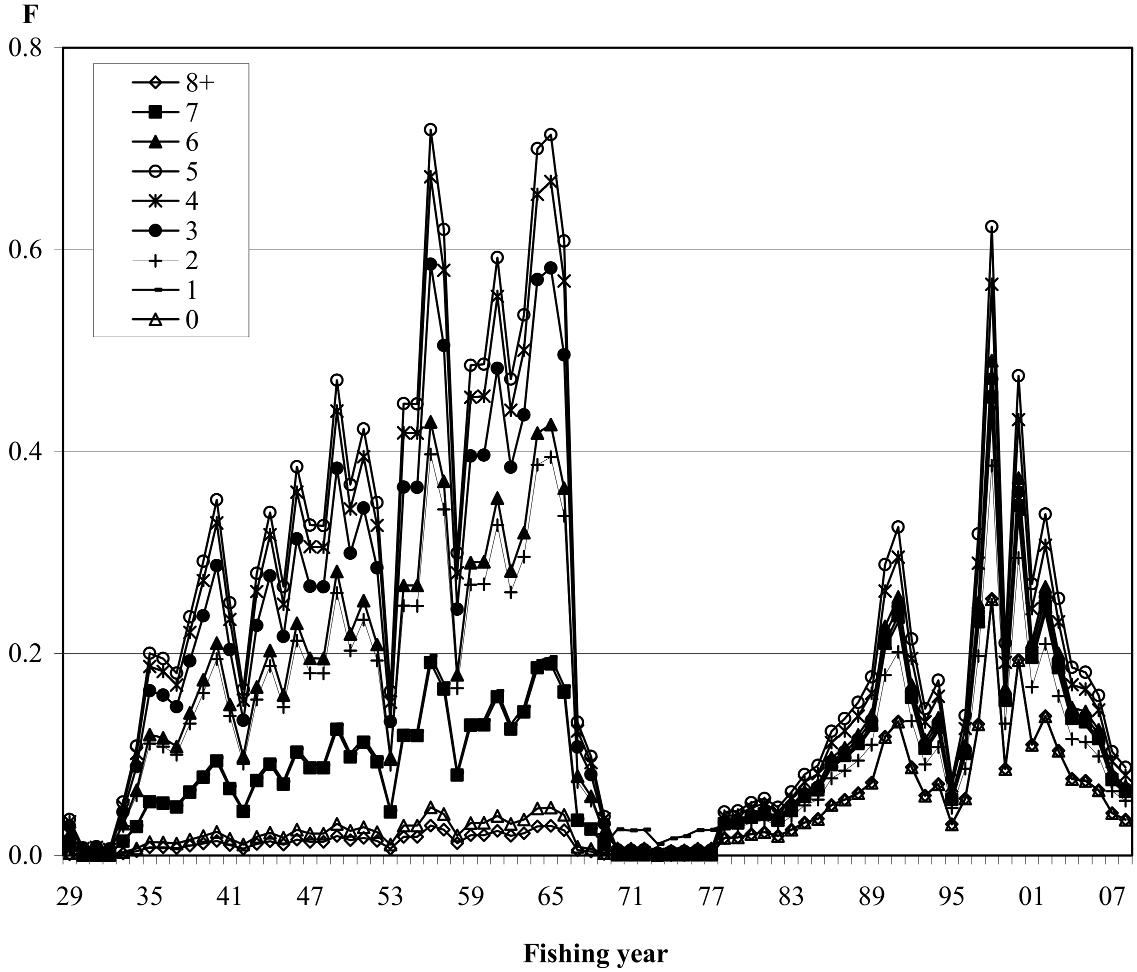

Figure 14. Estimated instantaneous fishing mortality (total) F-at-age for Pacific mackerel generated from the ASAP-E1 2008 model (1929-08).

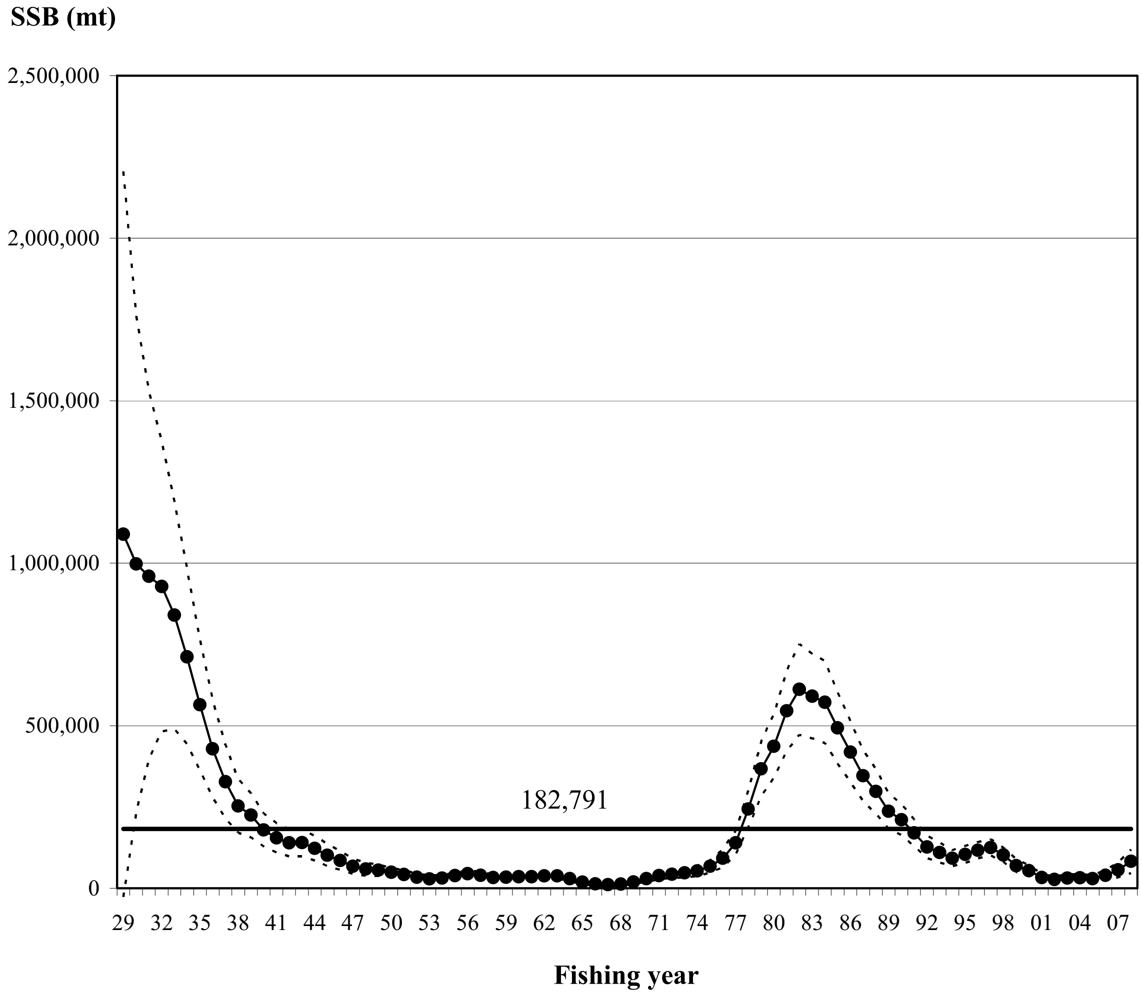

Figure 15. Estimated spawning stock biomass (*SSB*, in mt) of Pacific mackerel generated from the ASAP-E1 2008 model (1929-08). The confidence interval (± 2 STD) associated with this time series is also presented. Estimated 'virgin' *SSB* from stock-recruitment relationship is presented as solid horizontal line.

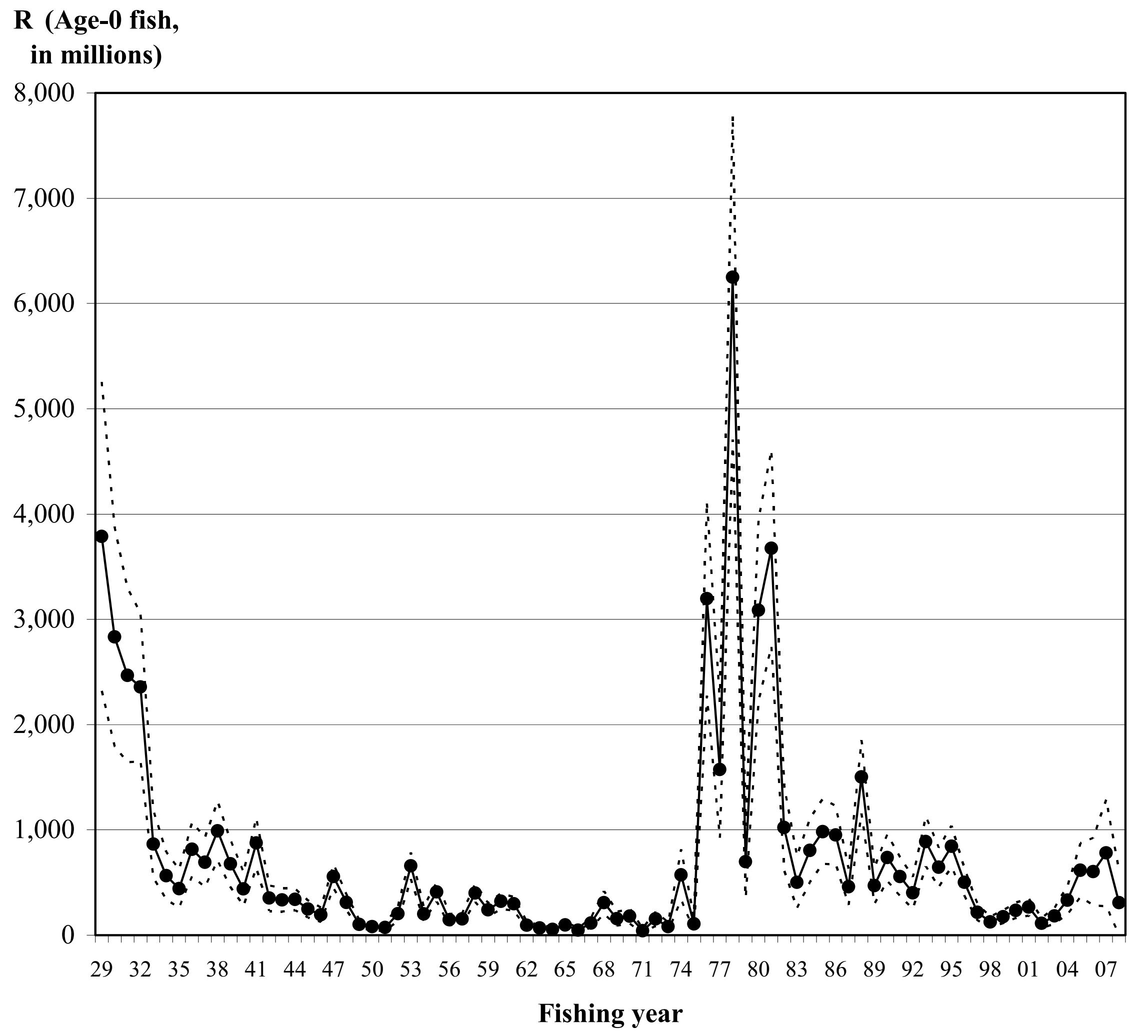

Figure 16. Estimated recruitment (age-0 fish in millions, R) of Pacific mackerel generated from the ASAP-E1 2008 model (1929-08). The confidence interval (± 2 STD) associated with this time series is also presented.

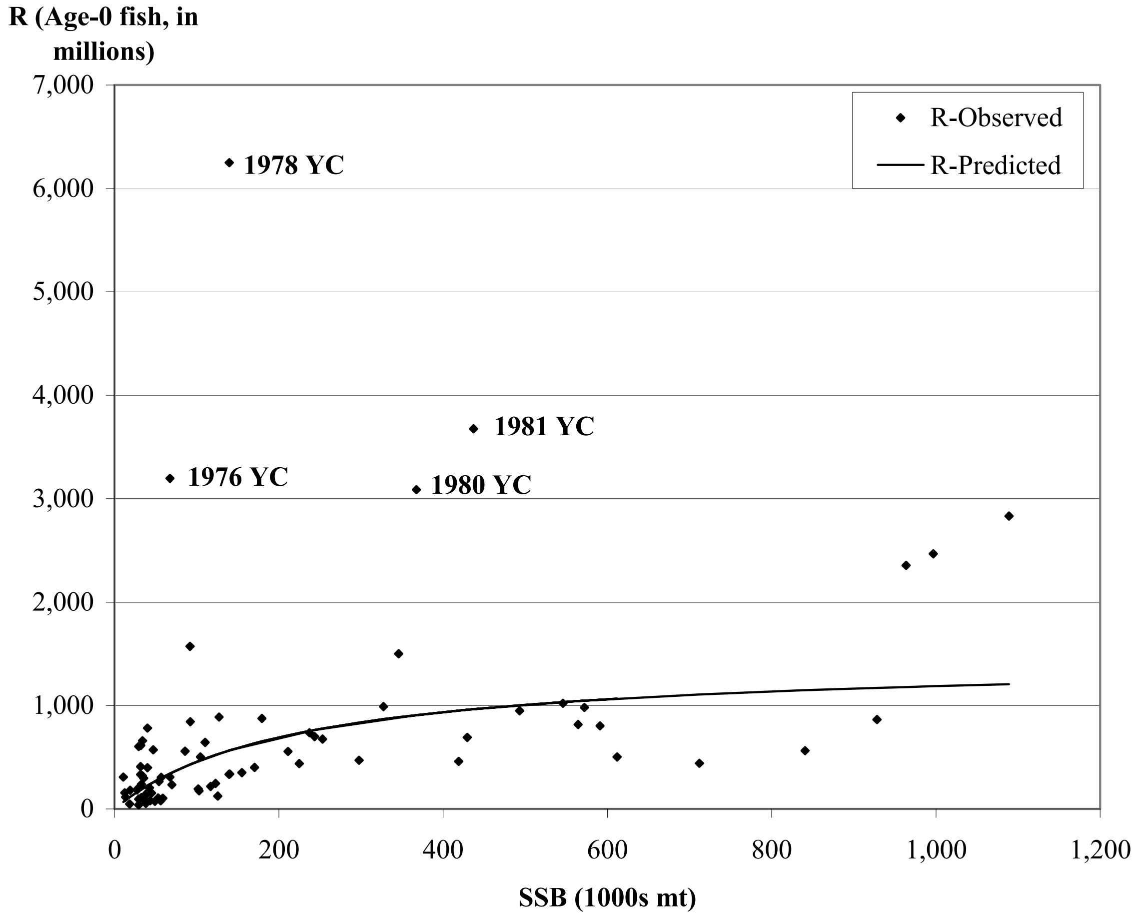

Figure 17. Beverton-Holt stock (*SSB*, in 1000s mt)-recruitment (Age-0 fish (R), in millions) relationship for Pacific mackerel estimated in the ASAP-E1 2008 model (1929-08). Recruitment estimates are presented as (year+1) values. Strong year classes are highlighted. Steepness= 0.32.

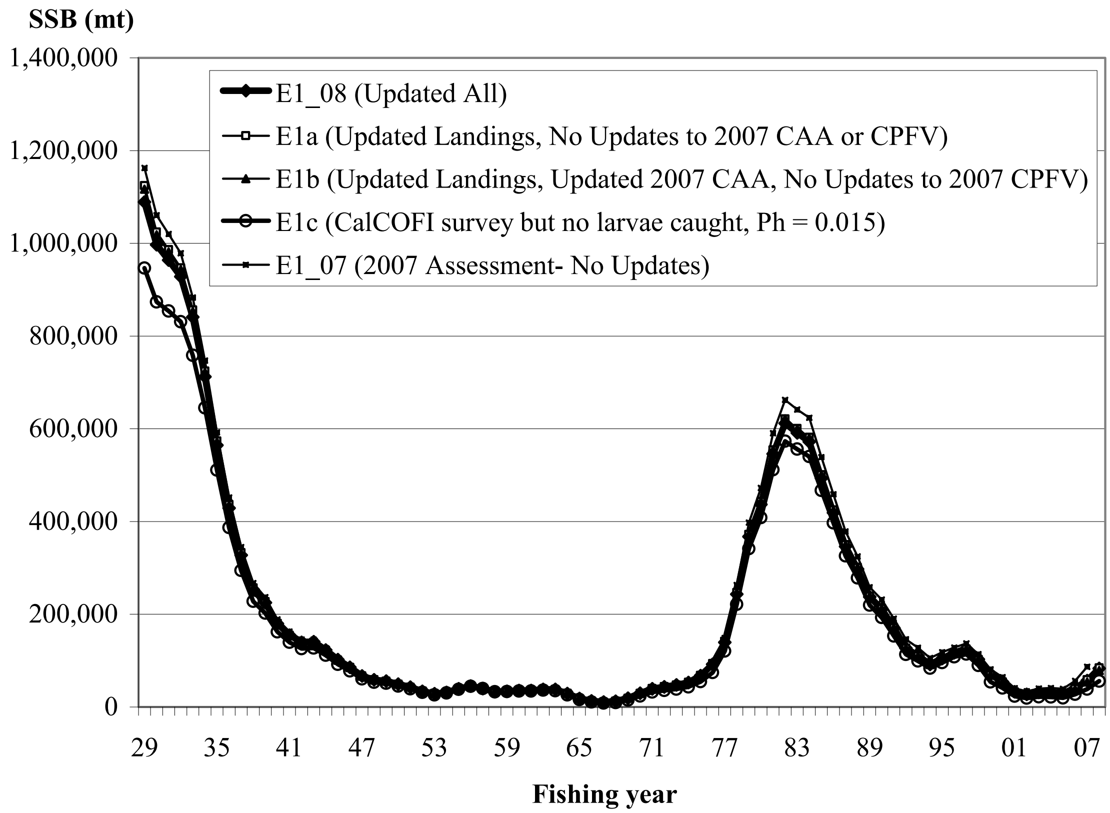

Figure 18. Comparison of spawning stock biomass estimated from sensitivity analyses. See Sensitivity Analysis section for description of each model run.

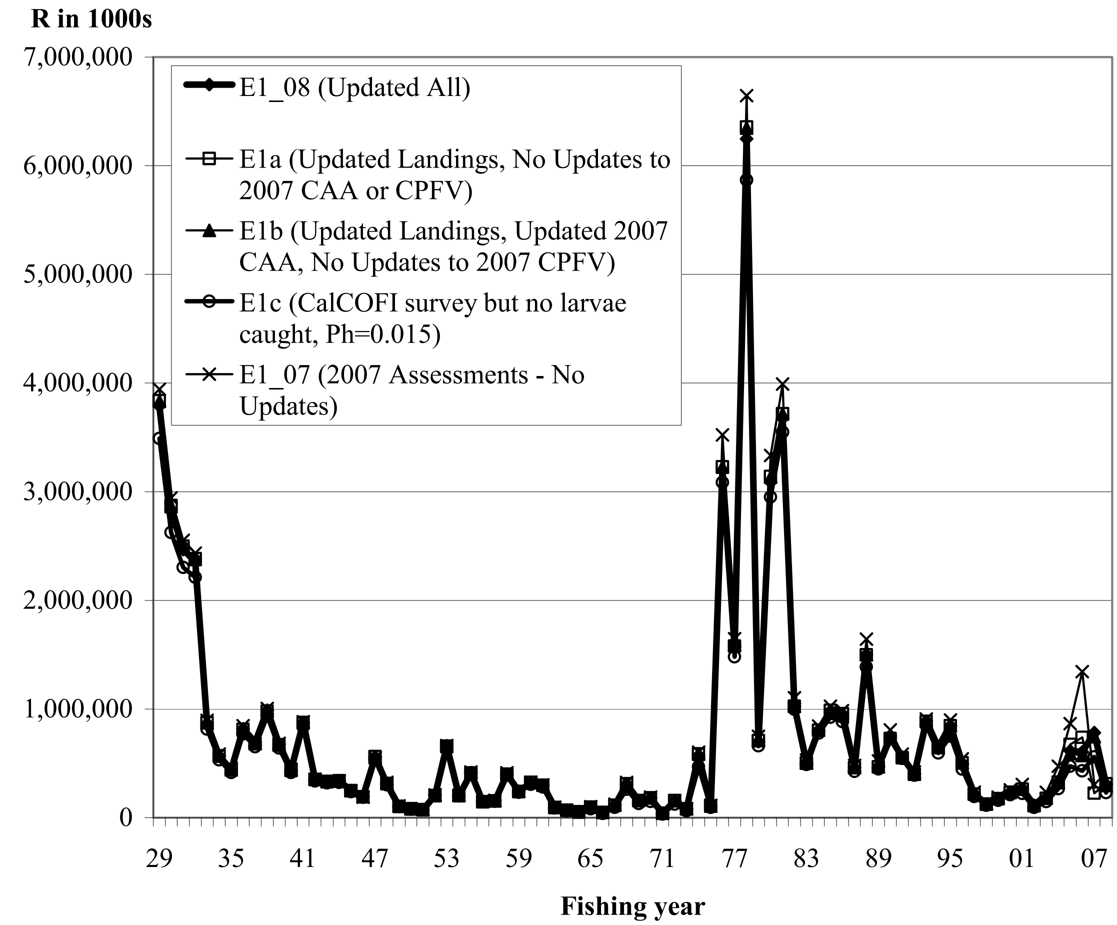

Figure 19. Comparison of recruitment (Age-0 fish) estimated from sensitivity analyses. See Sensitivity Analysis section for description of each model run.

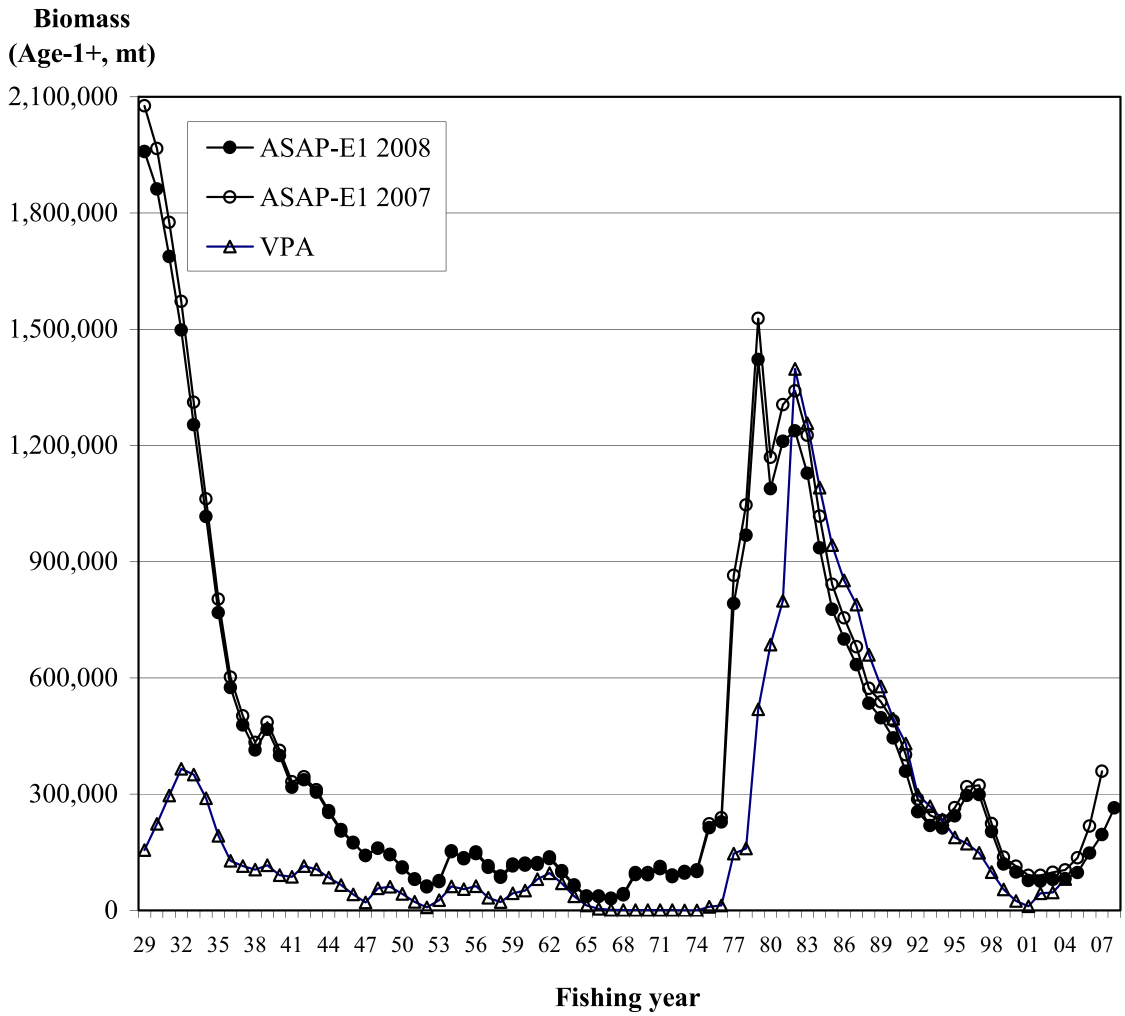

Figure 20. Estimated biomass (Age-1+ fish, in mt) of Pacific mackerel generated from the ASAP-E1 2008, ASAP-E1 2007, and VPA models (1929-08).

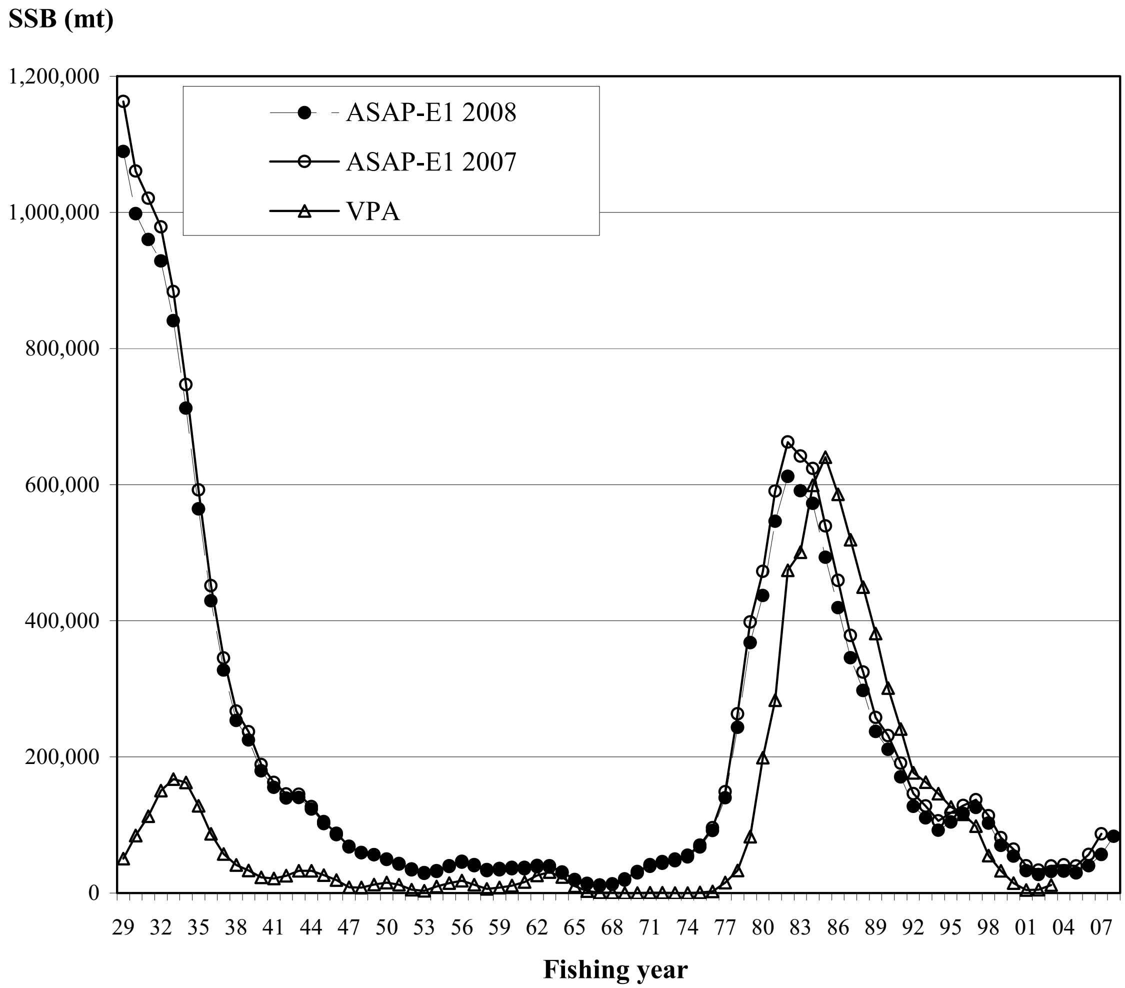

Figure 21. Estimated spawning stock biomass (*SSB*, in mt) of Pacific mackerel generated from the ASAP-E1 2008, ASAP-E1 2007, and VPA models (1929-08).

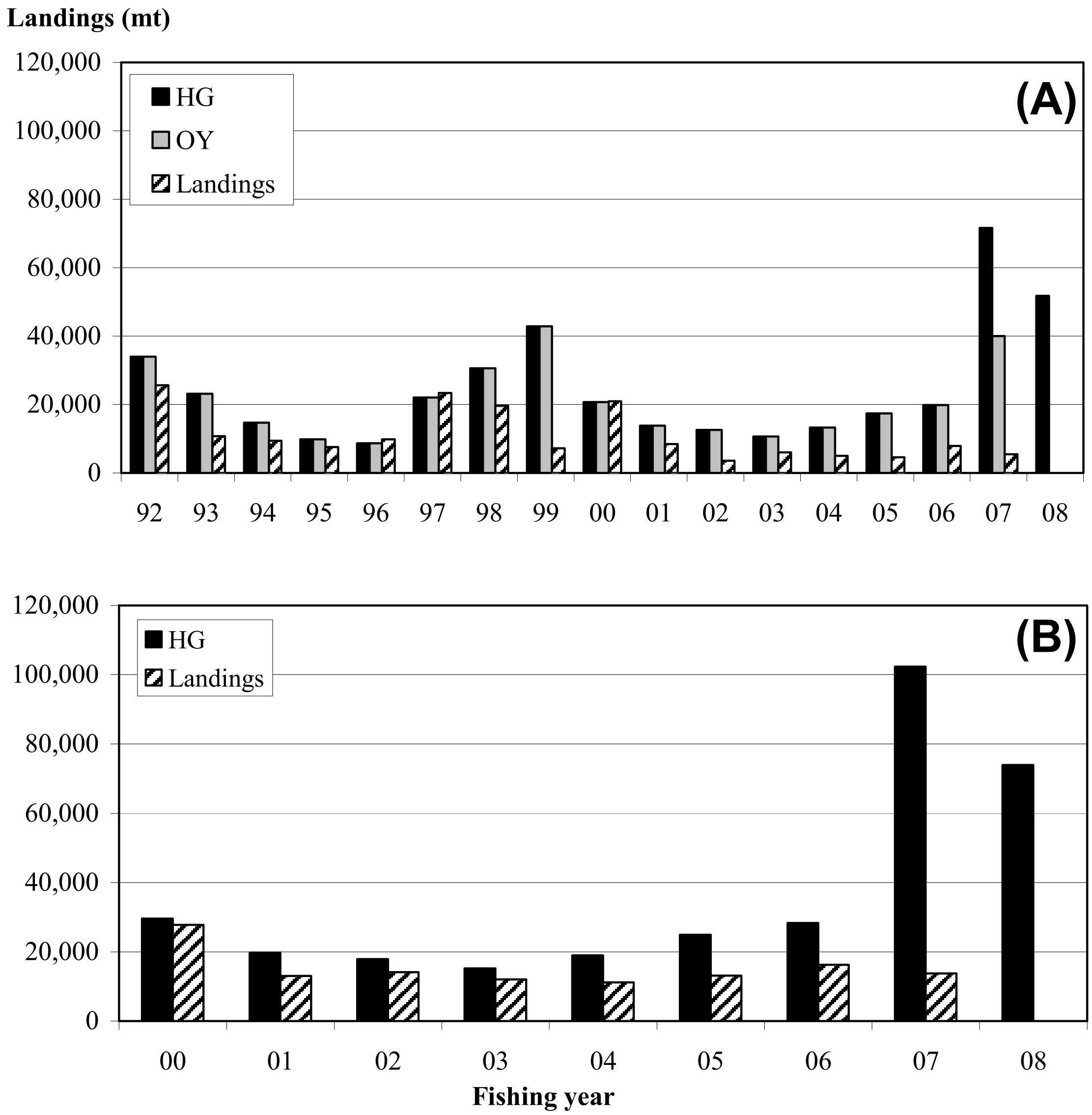

Figure 22. Commercial landings (California directed fishery in mt), Harvest Guidelines (HG in mt), and optimal yield (OY) for Pacific mackerel based on the harvest control rule, display (A, 1992-08 Fishing years). Total landings (mt) and Harvest Guidelines for Pacific mackerel based on no 'U.S. Distribution' parameter in the harvest control rule (B, 2000-08 Fishing years). Note that incidental landings from Pacific Northwest fisheries are not included, but typically range 100 to 300 mt per year.

APPENDIX A

```
# E1: SigR=0.7; M=0.5; update from 07
# Number of Years
  80
# First Year
  1929
# Number of Ages
  9
# Natural Mortality Rate by Age
  0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5
# Fecundity Option
  0
# Maturity Vector
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
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  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
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  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
  0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
```

```
   0.00   0.07   0.25   0.47   0.73   1.00   1.00   1.00   1.00
# Weight at Age Vector
   0.074   0.167   0.297   0.402   0.523   0.615   0.704   0.800   0.830
   0.060   0.139   0.301   0.422   0.511   0.603   0.698   0.800   0.830
   0.077   0.114   0.276   0.399   0.527   0.606   0.701   0.800   0.830
   0.058   0.081   0.277   0.379   0.508   0.604   0.711   0.800   0.830
   0.059   0.083   0.200   0.299   0.493   0.585   0.700   0.800   0.830
   0.065   0.142   0.198   0.233   0.431   0.538   0.683   0.800   0.830
   0.079   0.186   0.217   0.251   0.379   0.472   0.629   0.790   0.830
   0.086   0.193   0.284   0.338   0.393   0.453   0.574   0.750   0.820
   0.119   0.176   0.318   0.429   0.461   0.502   0.575   0.740   0.800
   0.124   0.174   0.310   0.448   0.532   0.582   0.633   0.726   0.790
   0.191   0.246   0.363   0.460   0.583   0.680   0.775   0.795   0.878
   0.180   0.260   0.339   0.442   0.527   0.640   0.729   0.834   0.820
   0.115   0.259   0.343   0.439   0.559   0.650   0.806   0.807   0.850
   0.180   0.236   0.373   0.471   0.546   0.626   0.684   0.909   0.830
   0.165   0.292   0.339   0.474   0.574   0.650   0.629   0.881   1.000
   0.144   0.271   0.379   0.472   0.587   0.660   0.754   0.735   0.948
   0.121   0.234   0.383   0.494   0.611   0.704   0.745   0.819   0.842
   0.125   0.261   0.384   0.487   0.617   0.679   0.736   0.778   0.812
   0.119   0.291   0.400   0.499   0.622   0.709   0.753   0.788   0.818
   0.107   0.227   0.354   0.506   0.616   0.706   0.764   0.895   0.871
   0.109   0.192   0.319   0.456   0.607   0.725   0.799   0.917   0.917
   0.084   0.249   0.323   0.455   0.564   0.664   0.784   0.799   0.871
   0.162   0.255   0.346   0.429   0.569   0.694   0.827   0.835   0.853
   0.173   0.297   0.386   0.471   0.568   0.719   0.832   0.988   0.850
   0.162   0.296   0.411   0.512   0.603   0.763   0.834   0.850   1.100
   0.084   0.257   0.387   0.505   0.585   0.744   0.701   0.879   0.870
   0.140   0.253   0.357   0.484   0.583   0.744   0.762   0.778   0.878
   0.111   0.248   0.373   0.485   0.598   0.752   0.722   0.910   0.870
   0.179   0.310   0.374   0.509   0.602   0.649   0.650   0.700   1.000
   0.176   0.292   0.396   0.488   0.617   0.685   0.775   0.750   0.750
   0.132   0.251   0.398   0.510   0.602   0.702   0.754   0.840   0.850
   0.102   0.276   0.391   0.507   0.611   0.699   0.768   0.820   0.870
   0.144   0.252   0.389   0.495   0.584   0.647   0.817   0.830   0.850
   0.276   0.320   0.420   0.540   0.622   0.712   0.782   0.890   0.860
   0.197   0.298   0.434   0.538   0.627   0.730   0.743   0.840   0.930
   0.181   0.300   0.400   0.503   0.612   0.748   0.812   0.820   0.870
   0.109   0.195   0.384   0.501   0.596   0.723   0.735   0.880   0.850
   0.149   0.273   0.419   0.525   0.658   0.790   0.833   0.850   0.930
   0.166   0.235   0.488   0.510   0.599   0.723   0.869   0.917   0.849
   0.138   0.266   0.391   0.562   0.593   0.709   0.902   0.952   1.070
   0.103   0.322   0.428   0.505   0.662   0.746   0.907   1.000   1.100
   0.099   0.232   0.402   0.584   0.730   0.837   0.850   1.000   1.200
   0.266   0.282   0.457   0.481   0.740   0.955   0.880   0.900   1.200
   0.147   0.266   0.449   0.508   0.552   0.746   1.000   0.900   1.100
   0.119   0.329   0.433   0.609   0.606   0.686   0.758   0.803   0.838
   0.107   0.303   0.604   0.740   0.837   0.800   0.800   0.800   1.000
   0.127   0.361   0.517   0.973   1.053   1.029   1.350   0.900   0.900
   0.170   0.297   0.672   0.864   1.291   1.223   1.531   1.200   1.000
   0.122   0.322   0.600   0.847   1.063   1.100   1.300   1.500   1.300
   0.062   0.334   0.473   0.705   0.908   1.100   1.200   1.400   1.600
   0.082   0.189   0.440   0.598   0.810   0.969   1.200   1.300   1.500
   0.072   0.176   0.270   0.437   0.598   0.874   1.066   1.300   1.400
   0.083   0.190   0.239   0.391   0.597   0.715   0.953   0.929   1.400
   0.032   0.151   0.237   0.345   0.516   0.773   0.916   1.000   1.200
   0.049   0.191   0.302   0.390   0.458   0.511   0.688   0.900   1.100
   0.120   0.235   0.351   0.396   0.505   0.614   0.638   0.871   0.910
   0.157   0.285   0.418   0.461   0.484   0.560   0.612   0.697   0.850
   0.148   0.290   0.408   0.508   0.561   0.595   0.630   0.719   0.784
   0.133   0.272   0.414   0.523   0.600   0.691   0.717   0.766   0.826
   0.101   0.301   0.415   0.576   0.666   0.734   0.806   0.815   0.899
   0.104   0.193   0.381   0.542   0.647   0.749   0.757   0.739   0.827
   0.094   0.267   0.377   0.554   0.649   0.680   0.749   0.775   0.803
   0.071   0.217   0.397   0.514   0.591   0.664   0.724   0.766   0.799
   0.087   0.175   0.330   0.459   0.544   0.661   0.691   0.725   0.805
   0.073   0.228   0.294   0.408   0.583   0.607   0.720   0.756   0.832
   0.100   0.156   0.248   0.361   0.493   0.597   0.644   0.733   0.785
   0.081   0.179   0.275   0.431   0.586   0.689   0.740   0.758   0.920
   0.105   0.182   0.318   0.471   0.589   0.649   0.674   0.705   0.751
   0.149   0.239   0.333   0.446   0.572   0.637   0.719   0.718   0.749
   0.139   0.267   0.325   0.419   0.530   0.615   0.631   0.667   0.689
   0.148   0.228   0.399   0.509   0.575   0.633   0.688   0.754   0.768
   0.114   0.266   0.370   0.550   0.590   0.608   0.646   0.712   0.731
   0.103   0.253   0.347   0.534   0.567   0.619   0.617   0.635   0.627
   0.133   0.218   0.303   0.412   0.552   0.687   0.656   0.728   0.650
   0.125   0.284   0.414   0.603   0.679   0.745   0.809   0.794   0.838
   0.159   0.280   0.407   0.596   0.685   0.821   0.926   0.820   0.902
   0.106   0.267   0.380   0.463   0.556   0.665   0.737   0.797   0.840
   0.126   0.222   0.353   0.522   0.752   0.824   0.848   0.918   0.935
   0.117   0.217   0.359   0.557   0.741   0.878   0.871   0.924   0.935
   0.117   0.217   0.359   0.557   0.741   0.878   0.871   0.924   0.935
# Number of Fleets
   1
#$FLEET-1
# Selectivity Start Age
   1
# Selectivity End Age
   9
# Selectivity Est. Start Age
   1
# Selectivity Est. End Age
   9
# Release Mortality
   0.0
```

```
# Number of Selectivity Changes by Fleet
  2
# Selectivity Change Years
  1970   1978
# Fleet 1 Catch at Age - Last Column is Total Weight
      9.28  12433.52  22466.85  20819.02   5208.01   3874.57   3198.38   1273.12    506.68  25733.54
         0    1392.8   7164.29    4838.4   1916.24    670.23     43.87     17.46      6.95   5825.88
         0     957.2   9990.74   6190.18   1307.12    752.89    371.31     147.8     58.82   6890.14
         0    144.48      3222   5844.95   1393.72    940.26    489.13     194.7     77.49   4938.95
         0   4620.12  19017.01     31887  23363.33      8277   2730.62   1086.93    432.58  33072.19
         0   4894.32  53353.79  35598.25  40807.82  15508.13   5669.25   2256.66    898.11  51483.81
         0  10871.51   12737.4  61704.13  63819.66  33633.06   6205.69   2470.19    983.09  66417.45
         0   2247.75  20403.77   17399.3  33062.36  35158.51   5252.24   2090.67    832.05  45714.21
    128.53    1475.8   2592.22   8035.18  15910.37  26039.26   7865.44   3130.86   1246.02  31987.62
    771.57  11577.22  31967.43  16527.64   4309.46   10883.8   6608.45   2630.51   1046.89  34561.76
   1802.77  23227.99  23713.35  33697.92  11093.97   6309.69   3744.21   1525.42    485.36  45453.99
   3199.27  18452.94  59415.03  27593.71  17024.69   2513.71    685.56    114.26         0  48868.18
    638.04  18396.72  31228.34  28817.98   6522.15    921.61     70.89     70.89         0  32560.77
         0   28454.8  10342.87  15109.17   6148.52   1096.25    142.99     47.66         0   21885.7
    426.03  14144.24  62072.75  10522.97   7412.94   1022.47    170.41     85.21         0   35304.7
         0  20800.04   20684.8  35319.73   8873.15    1613.3    230.47         0     57.62   36657.1
   2034.46  15336.68  12076.33   8920.31   8320.41   4825.32   1930.13     599.9    391.24  23601.43
   3289.73  16672.93  20261.72  11040.52   6704.06   4286.61   1819.32   1096.58    548.29  27582.46
    7426.5   4645.52  10460.31   9227.83   6067.61   3507.84   1896.13    695.25    221.22  19436.99
   2722.71  37272.92   9106.99   3661.57   4037.12    1408.3    657.21    281.66     93.89  18124.69
    565.75  21983.49  36329.33   9173.26   3071.22   1980.13    808.22    121.23     80.82  24188.91
     44.21   6587.64  17065.97   17154.4   3183.29    530.55    397.91     44.21     44.21  17493.02
   1030.94   4004.81   6859.73  11816.18  11300.71    674.08    237.91      79.3      79.3  15857.11
    509.56    324.26   1991.91   1991.91    8708.8   4678.66     92.65     46.32         0  10325.76
  11077.04   2069.34   1338.98   1379.56    568.05     811.5    770.93         0         0   5265.94
    693.87  47799.78  10176.73    2158.7   1233.54         0    308.39    154.19         0  18464.67
  15607.86  17730.53  25097.44  10738.21   1123.77    124.86    249.73    124.86    374.59  22200.87
    419.64  54867.37  22555.42  19093.43   8812.35    314.73         0         0         0  36834.99
   1996.08   7915.49  30078.85  10875.19   8534.96   3028.53   1307.78    344.15         0  27753.42
  11505.37   2665.88   4595.13   7401.32   3156.96   1438.17    912.01         0         0  11874.77
   1689.97   46896.6   7773.85   3633.43   2450.45   1013.98     253.5         0         0  19332.47
   1628.96  12726.27   17002.3  10181.02   5090.51   1730.77   1323.53         0         0  20822.52
   7344.83  28679.83  15564.05  14689.67   5770.94   1224.14    524.63         0         0   26199.2
    738.58  23298.65   12553.8  10472.06   7072.09    1421.2    186.57         0         0  23900.98
    284.46   6843.29  18432.22  10338.63   8843.01    2841.7    424.59         0         0  23702.99
   1389.15   7716.49   6521.08   9629.28  10969.27   4240.06    715.11         0         0  19987.93
  13074.05   1264.81    766.75   1700.61   5524.52   8676.71   1562.99         0         0  11279.44
   3689.34   8093.13   1457.55   1168.16    991.64   2240.26   1219.85     91.12         0   7405.18
   4530.49   1003.32     88.34    631.74    228.46    163.44     191.8     45.48       3.9   1713.31
   7417.78    499.49    221.14    353.17     89.26     85.63     68.09     51.89     37.44   1695.04
     46.32   2354.04    605.77    221.27      70.7     61.36      9.47         0         0   1168.22
   1405.04   3004.08         0         0         0         0         0         0         0    835.49
         0   2852.62    223.99       9.9     11.85       7.9         0         0         0    911.26
   1319.46    197.08    293.14       318      9.27      7.18         0         0         0       532
     50.08    546.98    153.25     32.92     74.92     88.38     49.33      2.06      2.06    400.94
   2154.23    768.64    244.31     39.29      13.1         0         0         0         0    633.81
    129.69   6334.53     89.64     65.67      1.89      3.59       1.8         0         0    2149.3
  13973.68    164.16   1763.31      0.75     22.98         0     26.91         0         0   4091.65
  11070.92  36733.93     77.95    286.78         0         0         0         0         0  13751.25
  73773.14   18836.9  28597.94   1165.54   1006.01    257.27         0         0         0  27172.62
      27.3  102761.6  14944.14  15203.87    222.15    674.58         0         0         0  35858.08
  63977.75    3375.6  77514.48   8220.94   7378.74    407.32    125.57         0         0  35203.07
  19073.13  45821.52  10973.96  69210.11   4792.33   3066.54     75.52    123.26         0  46984.54
  16128.82   36225.3  33231.45   9921.13  31045.14   2318.39    768.07         0         0  36371.39
   2841.49   2812.44  44335.77  40174.47   6319.26  17770.08    251.37         0         0  42117.51
   2874.61    532.91   9588.75  48965.24  25203.82   6271.07   7986.46    197.57         0  46468.33
   3250.53  17477.96   5188.93  16256.13  50114.46  10704.47    1388.6   1046.78         0   46827.8
  18857.41  44528.39  23015.91   5275.98   9001.56  25599.29   7434.51   1023.53   1085.34   54122.6
  18059.02  71919.59  32697.92   5325.97   2861.93   3517.06   4718.34   2063.79     848.6  48222.76
  104976.8   15168.1  36143.18  13133.26   2848.62   1942.85   2573.76   4155.11   3178.37  49264.61
   21820.5  161290.9   8376.37   6715.48   4513.48    2717.9   2542.54    866.91   1677.31  49405.81
  29559.33  19434.09  43284.43  11973.57  16877.91  19587.74   8229.01   6546.39    8186.6  71550.65
  27181.03  91781.73  21911.68  21684.28  10412.43   9327.48   6708.83   3023.18   4448.24  65504.89
   11121.1  30146.79  12343.23   9853.43  10636.66    8100.2   5593.94   2629.49   1025.04  32217.46
  51844.57   9383.17  10677.45   3439.66   3365.54   5042.96   2884.56   2893.11   1650.65   20919.9
  25603.69   38016.3   9946.38   4529.72   5751.48   3022.07   1869.19   1484.89    606.29  23737.04
  46200.33  21302.37   5280.72    982.52    552.27   1417.41    759.08    529.29    336.18  11995.83
  28943.78  43914.05  12553.55   6006.08    3740.6   2567.45   1367.78   1073.12    755.59  24562.68
  24318.16   49846.2  32821.51  12958.96   8403.64   7621.77   4900.96   4165.63   6853.01  51076.32
  13603.22  19878.34  38777.42  23702.43  15523.39  13343.25   10667.9   6471.86   7980.32  62822.66
   11997.3   2949.13   2680.44   6120.22   5834.41    4446.9   1946.44   1330.19    966.05  15909.85
  29466.53  15354.87   5178.47   8768.71  10300.19   6637.51   2844.88   1140.63    630.41   27791.9
  14207.16  20422.43   3517.09   1951.32   2407.56   2133.99    984.14    555.21    298.61  13010.41
   7247.46   51288.5   5175.57   1192.36    228.27     364.9    252.66         0         0  14122.78
  26589.82  14955.19   5147.96   1891.02    662.89    651.84    330.95      95.6     65.05  12022.88
  46349.62   7066.43   2287.65   1657.83    706.03    141.48     94.32     36.78     94.32  11195.41
  71582.68   9838.92   5043.35    729.78     285.3    174.03     89.59     22.52         0  13151.46
  48522.75  23717.95   4882.47   2454.61   1395.46    390.63     309.2    443.38         0  16265.15
  34690.05  16917.34   6182.45   2734.26   1529.06    505.49    191.43     43.64         0  13743.29
         0         0         0         0         0         0         0         0         0  13743.29

# Fleet 1 Discards at Age - Last Column is Total Weight
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         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0
         0         0         0         0         0         0         0         0         0         0
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0	0	0	0	0	0	0	0	0	0
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Fleet 1 Proportion Released at Age

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0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

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# Number of Indices
   3
#$SPOTTER
#$CPFV
#$CALCOFI
# Index Weight Flag
   2
# Index Units
   1   2   2
# Index Month
   4   5   1
# Index Start Age
   1   2   2
# Index End Age
   9   9   9
# Index Fix Age
   -1   -1   -1
# Index Selectivity Choice
   -1   -1   -1
# Index Data - Year, Index, CV, Selectivity
# INDEX - 1
    1929      -999         1         1         1         1         1         1         1         1         1         1
    1930      -999         1         1         1         1         1         1         1         1         1         1
    1931      -999         1         1         1         1         1         1         1         1         1         1
    1932      -999         1         1         1         1         1         1         1         1         1         1
    1933      -999         1         1         1         1         1         1         1         1         1         1
    1934      -999         1         1         1         1         1         1         1         1         1         1
    1935      -999         1         1         1         1         1         1         1         1         1         1
    1936      -999         1         1         1         1         1         1         1         1         1         1
    1937      -999         1         1         1         1         1         1         1         1         1         1
    1938      -999         1         1         1         1         1         1         1         1         1         1
    1939      -999         1         1         1         1         1         1         1         1         1         1
    1940      -999         1         1         1         1         1         1         1         1         1         1
    1941      -999         1         1         1         1         1         1         1         1         1         1
    1942      -999         1         1         1         1         1         1         1         1         1         1
    1943      -999         1         1         1         1         1         1         1         1         1         1
    1944      -999         1         1         1         1         1         1         1         1         1         1
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   1945      -999         1         1         1         1         1         1         1         1         1         1
   1946      -999         1         1         1         1         1         1         1         1         1         1
   1947      -999         1         1         1         1         1         1         1         1         1         1
   1948      -999         1         1         1         1         1         1         1         1         1         1
   1949      -999         1         1         1         1         1         1         1         1         1         1
   1950      -999         1         1         1         1         1         1         1         1         1         1
   1951      -999         1         1         1         1         1         1         1         1         1         1
   1952      -999         1         1         1         1         1         1         1         1         1         1
   1953      -999         1         1         1         1         1         1         1         1         1         1
   1954      -999         1         1         1         1         1         1         1         1         1         1
   1955      -999         1         1         1         1         1         1         1         1         1         1
   1956      -999         1         1         1         1         1         1         1         1         1         1
   1957      -999         1         1         1         1         1         1         1         1         1         1
   1958      -999         1         1         1         1         1         1         1         1         1         1
   1959      -999         1         1         1         1         1         1         1         1         1         1
   1960      -999         1         1         1         1         1         1         1         1         1         1
   1961      -999         1         1         1         1         1         1         1         1         1         1
   1962    461.35     0.518         1         1         1         1         1         1         1         1         1
   1963   1541.53      0.32         1         1         1         1         1         1         1         1         1
   1964    549.34     0.458         1         1         1         1         1         1         1         1         1
   1965    707.89     0.508         1         1         1         1         1         1         1         1         1
   1966    272.08      0.67         1         1         1         1         1         1         1         1         1
   1967     19.88     0.979         1         1         1         1         1         1         1         1         1
   1968    178.55      1.42         1         1         1         1         1         1         1         1         1
   1969    782.89     1.385         1         1         1         1         1         1         1         1         1
   1970     22.03     2.439         1         1         1         1         1         1         1         1         1
   1971      76.7      0.89         1         1         1         1         1         1         1         1         1
   1972      5.46      2.05         1         1         1         1         1         1         1         1         1
   1973     28.95     2.873         1         1         1         1         1         1         1         1         1
   1974      -999         1         1         1         1         1         1         1         1         1         1
   1975      4.31     3.011         1         1         1         1         1         1         1         1         1
   1976  15492.54      0.55         1         1         1         1         1         1         1         1         1
   1977  31112.79     0.282         1         1         1         1         1         1         1         1         1
   1978  40320.84     0.219         1         1         1         1         1         1         1         1         1
   1979  44380.55      0.18         1         1         1         1         1         1         1         1         1
   1980  22164.44     0.153         1         1         1         1         1         1         1         1         1
   1981   25829.5     0.139         1         1         1         1         1         1         1         1         1
   1982  36237.16      0.13         1         1         1         1         1         1         1         1         1
   1983  30524.24     0.271         1         1         1         1         1         1         1         1         1
   1984  45635.38     0.156         1         1         1         1         1         1         1         1         1
   1985  38944.25     0.207         1         1         1         1         1         1         1         1         1
   1986  18979.22      0.17         1         1         1         1         1         1         1         1         1
   1987  12087.23     0.254         1         1         1         1         1         1         1         1         1
   1988  16673.37     0.304         1         1         1         1         1         1         1         1         1
   1989   2700.95     0.341         1         1         1         1         1         1         1         1         1
   1990   5445.68     0.263         1         1         1         1         1         1         1         1         1
   1991   2391.01      0.27         1         1         1         1         1         1         1         1         1
   1992   1207.58      0.48         1         1         1         1         1         1         1         1         1
   1993   1764.32     0.345         1         1         1         1         1         1         1         1         1
   1994    2097.7     0.561         1         1         1         1         1         1         1         1         1
   1995   6317.02     0.372         1         1         1         1         1         1         1         1         1
   1996   1907.85     0.546         1         1         1         1         1         1         1         1         1
   1997   5050.92     0.353         1         1         1         1         1         1         1         1         1
   1998    2248.2     0.417         1         1         1         1         1         1         1         1         1
   1999   1187.88     0.459         1         1         1         1         1         1         1         1         1
   2000   3230.88      0.42         1         1         1         1         1         1         1         1         1
   2001     548.8     1.339         1         1         1         1         1         1         1         1         1
   2002      -999         1         1         1         1         1         1         1         1         1         1
   2003      -999         1         1         1         1         1         1         1         1         1         1
   2004      -999         1         1         1         1         1         1         1         1         1         1
   2005      -999         1         1         1         1         1         1         1         1         1         1
   2006      -999         1         1         1         1         1         1         1         1         1         1
   2007      -999         1         1         1         1         1         1         1         1         1         1
   2008      -999         1         1         1         1         1         1         1         1         1         1
# INDEX - 2
1929      -999      1         0         0.5       1         1         1         1         1         1         1
1930      -999      1         0         0.5       1         1         1         1         1         1         1
1931      -999      1         0         0.5       1         1         1         1         1         1         1
1932      -999      1         0         0.5       1         1         1         1         1         1         1
1933      -999      1         0         0.5       1         1         1         1         1         1         1
1934      -999      1         0         0.5       1         1         1         1         1         1         1
1935      43.31     0.21146   0         0.5       1         1         1         1         1         1         1
1936      62.06     0.34532   0         0.5       1         1         1         1         1         1         1
1937      34.99     0.19303   0         0.5       1         1         1         1         1         1         1
1938      77.75     0.1358    0         0.5       1         1         1         1         1         1         1
1939      61.33     0.14647   0         0.5       1         1         1         1         1         1         1
1940      90.34     0.13289   0         0.5       1         1         1         1         1         1         1
1941      -999      1         0         0.5       1         1         1         1         1         1         1
1942      -999      1         0         0.5       1         1         1         1         1         1         1
1943      -999      1         0         0.5       1         1         1         1         1         1         1
1944      -999      1         0         0.5       1         1         1         1         1         1         1
1945      -999      1         0         0.5       1         1         1         1         1         1         1
1946      23.16     0.20273   0         0.5       1         1         1         1         1         1         1
1947      26.42     0.18721   0         0.5       1         1         1         1         1         1         1
1948      31.04     0.16684   0         0.5       1         1         1         1         1         1         1
1949      14.98     0.21146   0         0.5       1         1         1         1         1         1         1
1950      8.26      0.2328    0         0.5       1         1         1         1         1         1         1
1951      6.09      0.17654   0         0.5       1         1         1         1         1         1         1
1952      5.89      0.2619    0         0.5       1         1         1         1         1         1         1
1953      12.04     0.40643   0         0.5       1         1         1         1         1         1         1
1954      43.78     0.16878   0         0.5       1         1         1         1         1         1         1
1955      15.59     0.18624   0         0.5       1         1         1         1         1         1         1
1956      12.1      0.24347   0         0.5       1         1         1         1         1         1         1
1957      18.17     0.23377   0         0.5       1         1         1         1         1         1         1
1958      18.3      0.21437   0         0.5       1         1         1         1         1         1         1
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1959	12.46	0.21049	0	0.5	1	1	1	1	1	1	1
1960	16.7	0.35114	0	0.5	1	1	1	1	1	1	1
1961	15.8	0.24541	0	0.5	1	1	1	1	1	1	1
1962	7.73	0.27839	0	0.5	1	1	1	1	1	1	1
1963	13.89	0.26578	0	0.5	1	1	1	1	1	1	1
1964	5.47	0.28615	0	0.5	1	1	1	1	1	1	1
1965	10.17	0.24638	0	0.5	1	1	1	1	1	1	1
1966	11.29	0.22213	0	0.5	1	1	1	1	1	1	1
1967	4.62	0.30361	0	0.5	1	1	1	1	1	1	1
1968	6.96	0.44038	0	0.5	1	1	1	1	1	1	1
1969	5.74	0.31913	0	0.5	1	1	1	1	1	1	1
1970	8.98	0.43941	0	0.5	1	1	1	1	1	1	1
1971	14.7	0.28033	0	0.5	1	1	1	1	1	1	1
1972	8.05	0.31719	0	0.5	1	1	1	1	1	1	1
1973	4.43	0.49179	0	0.5	1	1	1	1	1	1	1
1974	3.21	0.45881	0	0.5	1	1	1	1	1	1	1
1975	8.13	0.33853	0	0.5	1	1	1	1	1	1	1
1976	13.46	0.31234	0	0.5	1	1	1	1	1	1	1
1977	52.33	0.19885	0	0.5	1	1	1	1	1	1	1
1978	101.33	0.15811	0	0.5	1	1	1	1	1	1	1
1979	118.36	0.18818	0	0.5	1	1	1	1	1	1	1
1980	155.73	0.15714	0	0.5	1	1	1	1	1	1	1
1981	105.97	0.18139	0	0.5	1	1	1	1	1	1	1
1982	108.23	0.15326	0	0.5	1	1	1	1	1	1	1
1983	108.89	0.17945	0	0.5	1	1	1	1	1	1	1
1984	117.36	0.16684	0	0.5	1	1	1	1	1	1	1
1985	86.09	0.19982	0	0.5	1	1	1	1	1	1	1
1986	65.8	0.20273	0	0.5	1	1	1	1	1	1	1
1987	44.16	0.19691	0	0.5	1	1	1	1	1	1	1
1988	32.12	0.44717	0	0.5	1	1	1	1	1	1	1
1989	43.55	0.22116	0	0.5	1	1	1	1	1	1	1
1990	50.29	0.28615	0	0.333	0.666	1	1	1	1	1	1
1991	56.4	0.27936	0	0.333	0.666	1	1	1	1	1	1
1992	41.23	0.22795	0	0.333	0.666	1	1	1	1	1	1
1993	48.69	0.22698	0	0.333	0.666	1	1	1	1	1	1
1994	46.09	0.19788	0	0.333	0.666	1	1	1	1	1	1
1995	41.76	0.22698	0	0.333	0.666	1	1	1	1	1	1
1996	44.8	0.26287	0	0.333	0.666	1	1	1	1	1	1
1997	30.45	0.27548	0	0.333	0.666	1	1	1	1	1	1
1998	13.71	0.27257	0	0.333	0.666	1	1	1	1	1	1
1999	8.12	0.30555	0	0.333	0.666	1	1	1	1	1	1
2000	14.85	0.28421	0	0.333	0.666	1	1	1	1	1	1
2001	11.78	0.29973	0	0.333	0.666	1	1	1	1	1	1
2002	9.31	0.37733	0	0.333	0.666	1	1	1	1	1	1
2003	5.95	0.32204	0	0.333	0.666	1	1	1	1	1	1
2004	11.23	0.32495	0	0.333	0.666	1	1	1	1	1	1
2005	22.27	0.74399	0	0.333	0.666	1	1	1	1	1	1
2006	20.69	0.25026	0	0.333	0.666	1	1	1	1	1	1
2007	26.09	0.58006	0	0.333	0.666	1	1	1	1	1	1
2008	-999	1	0	0.333	0.666	1	1	1	1	1	1

INDEX - 3

1929	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1930	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1931	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1932	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1933	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1934	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1935	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1936	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1937	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1938	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1939	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1940	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1941	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1942	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1943	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1944	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1945	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1946	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1947	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1948	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1949	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1950	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1951	0.015	0.646	0	0.074	0.246	0.474	0.733	1	1	1	1
1952	0.023	0.54	0	0.074	0.246	0.474	0.733	1	1	1	1
1953	0.187	0.533	0	0.074	0.246	0.474	0.733	1	1	1	1
1954	1.148	0.176	0	0.074	0.246	0.474	0.733	1	1	1	1
1955	0.287	0.309	0	0.074	0.246	0.474	0.733	1	1	1	1
1956	0.113	0.317	0	0.074	0.246	0.474	0.733	1	1	1	1
1957	0.044	0.398	0	0.074	0.246	0.474	0.733	1	1	1	1
1958	0.629	0.162	0	0.074	0.246	0.474	0.733	1	1	1	1
1959	0.184	0.216	0	0.074	0.246	0.474	0.733	1	1	1	1
1960	0.585	0.327	0	0.074	0.246	0.474	0.733	1	1	1	1
1961	0.067	0.329	0	0.074	0.246	0.474	0.733	1	1	1	1
1962	0.125	0.426	0	0.074	0.246	0.474	0.733	1	1	1	1
1963	0.517	0.386	0	0.074	0.246	0.474	0.733	1	1	1	1
1964	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1965	0.057	0.542	0	0.074	0.246	0.474	0.733	1	1	1	1
1966	0.381	0.442	0	0.074	0.246	0.474	0.733	1	1	1	1
1967	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1
1968	-999	1	0	0.074	0.246	0.474	0.733	1	1	1	1

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    1969     0.167     0.493         0     0.074     0.246     0.474     0.733         1         1         1         1
    1970      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1971      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1972     0.246      0.55         0     0.074     0.246     0.474     0.733         1         1         1         1
    1973      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1974      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1975      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1976      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1977      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1978     5.436     0.196         0     0.074     0.246     0.474     0.733         1         1         1         1
    1979      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1980      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1981    21.845     0.222         0     0.074     0.246     0.474     0.733         1         1         1         1
    1982      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1983      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1984     2.222     0.417         0     0.074     0.246     0.474     0.733         1         1         1         1
    1985     0.579     0.213         0     0.074     0.246     0.474     0.733         1         1         1         1
    1986    10.974     0.156         0     0.074     0.246     0.474     0.733         1         1         1         1
    1987    46.389     0.318         0     0.074     0.246     0.474     0.733         1         1         1         1
    1988     2.876     0.215         0     0.074     0.246     0.474     0.733         1         1         1         1
    1989     1.187     0.291         0     0.074     0.246     0.474     0.733         1         1         1         1
    1990      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    1991     0.848     0.645         0     0.074     0.246     0.474     0.733         1         1         1         1
    1992     0.315     0.636         0     0.074     0.246     0.474     0.733         1         1         1         1
    1993     0.643     0.424         0     0.074     0.246     0.474     0.733         1         1         1         1
    1994     0.094     1.029         0     0.074     0.246     0.474     0.733         1         1         1         1
    1995     0.758     0.207         0     0.074     0.246     0.474     0.733         1         1         1         1
    1996     7.922     0.232         0     0.074     0.246     0.474     0.733         1         1         1         1
    1997     8.767     0.305         0     0.074     0.246     0.474     0.733         1         1         1         1
    1998      0.37     0.451         0     0.074     0.246     0.474     0.733         1         1         1         1
    1999      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    2000      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    2001     0.394     0.308         0     0.074     0.246     0.474     0.733         1         1         1         1
    2002      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    2003     0.333     0.549         0     0.074     0.246     0.474     0.733         1         1         1         1
    2004      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    2005     0.068     0.444         0     0.074     0.246     0.474     0.733         1         1         1         1
    2006     0.103     0.554         0     0.074     0.246     0.474     0.733         1         1         1         1
    2007      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
    2008      -999         1         0     0.074     0.246     0.474     0.733         1         1         1         1
# Phase Control Data
# Phase for Selectivity in 1st Year
   1
# Phase for Selectivity Deviations
   4
# Phase for F mult in 1st Year
   1
# Phase for F mult Deviations
   3
# Phase for Recruitment Deviations
   3
# Phase for N in 1st Year
   2
# Phase for Catchability in 1st Year
   1
# Phase for Catchability Deviations
  -5
# Phase for Stock Recruitment Relationship
   1
# Phase for Steepness
   1
# Recruitment CV by Year
   0.7
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#Lambda for Each Index (cv=0.4)
   1   1   1
# Lambda for Total Catch in Weight
   100
# Lambda for Total Discards at Age
   0
# Lambda for Catch at Age by Year & Fleet
        45
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         0
# Lambda for Discards at Age by Year & Fleet
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# Lambda for F mult Deviations by Fleet
   0
# Lambda for N in 1st Year Deviations
   0
# Lambda for Recruitment Deviations
   1
# Lambda for Catchability Deviations by Index
   1   1   1
# Lambda for Selectivity Deviations by Fleet
   0
# Lambda for Selectivity Curvature at Age
   0
# Lambda for Selectivity Curvature Over Time
   0
# Lambda for Deviations from Initial Steepness
   0
# Lambda for Deviation from Initial log of Virgin Stock Size
   0
# NAA for Year 1
  100000  70000  50000  30000  20000  10000  5000  2500  1250
# Log of F mult in 1st year by Fleet
   -3
# log of Catchability in 1st year by index
   -7   -7   -7
# Initial log of Virgin Stock Size
   10
# Initial Steepness
   0.9
# Selectivity at Age in 1st Year by Fleet
     0.009
     0.092
     0.293
     0.703
         1
         1
         1
         1
         1
# Where to do Extras
   2
# Ignore Guesses
   0
# Projection Control Data
# Year for SSB ratio Calculation
   1929
# Fleet Directed Flag
   1
# Final Year of Projections
   2010
# Year Projected Recruits, What Projected, Target, non- directed F mult
      2009         2       0.3         1        -1
      2010         2       0.3         1        -1
# Test Value
   -23456
#####
# ---- FINIS ----
```

APPENDIX B

```
obj_fun        = 1184.38
Component          RSS      nobs  Lambda  Likelihood
  Catch_Fleet_1        0.0236194   80   100   2.36194
Catch_Fleet_Total     0.0236194   80   100   2.36194
  Discard_Fleet_1        0   80   0   0
Discard_Fleet_Total     0   80   0   0
CAA_proportions      N/A            720    see_below      530.926
Discard_proportions      N/A            720    see_below      0
  Index_Fit_1         166.917   39   1   119.157
  Index_Fit_2         16.057   68   1   104.852
  Index_Fit_3         76.8729   37   1   315.538
Index_Fit_Total     259.847   144   3   539.547
  Selectivity_devs_fleet_1   34.3354  2   0  0
Selectivity_devs_Total   34.3354  2   0  0
  Catchability_devs_index_1  0  39  1  0
  Catchability_devs_index_2  0  68  1  0
  Catchability_devs_index_3  0  37  1  0
Catchability_devs_Total  0  144  3  0
  Fmult_fleet_1     28.344   79   0  0
Fmult_fleet_Total   28.344   79   0  0
N_year_1            2.46086   8   0   0
Stock-Recruit_Fit   57.6502  80   1   53.8968
Recruit_devs        57.6502   80   1   57.6502
SRR_steepness       1.09899       1 0   0
SRR_virgin_stock    4.47778      1 0  0
Curvature_over_age  53.0086   14   0   0
Curvature_over_time 68.6708   702   0   0
F_penalty           1.74589    720     0.001     0.00174589
Mean_Sel_year1_pen  0   9      1000  0
Max_Sel_penalty     0.278802        1       100 0
Fmult_Max_penalty   0        ?       100 0

 Input and Estimated effective sample sizes for fleet 1
1929  45  36.2237
1930  45  14.0491
1931  45  9.04635
1932  45  10.0544
1933  45  21.7624
1934  45  43.2674
1935  45  35.2344
1936  45  28.2955
1937  45  7.80704
1938  45  22.3318
1939  45  31.5594
1940  45  37.0004
1941  45  22.3592
1942  45  25.8035
1943  45  9.88299
1944  45  41.0466
1945  45  58.3799
1946  45  66.6043
1947  45  150.869
1948  45  14.1723
1949  45  122.077
1950  45  99.5503
1951  45  263.272
1952  45  7.12822
1953  45  8.56774
1954  45  17.2541
1955  45  12.5785
1956  45  10.6006
1957  45  69.0312
1958  45  18.6191
1959  45  6.51177
1960  45  24.8915
1961  45  73.9718
1962  45  30.1446
1963  45  52.8996
1964  45  23.4466
1965  45  4.99631
1966  45  19.5674
1967  45  2.14204
1968  45  2.07588
1969  45  12.958
1970  45  13.1248
1971  45  10.4233
1972  45  10.0881
1973  45  8.08927
1974  45  269.388
1975  45  25.2922
1976  45  33.6836
1977  45  70.7012
1978  45  111.908
1979  45  38.7142
1980  45  37.5291
1981  45  7.06002
1982  45  22.3468
1983  45  13.7512
1984  45  10.7567
1985  45  7.2822
1986  45  35.1295
```

1987	45	18.4691
1988	45	35.7076
1989	45	8.48506
1990	45	26.341
1991	45	16.5076
1992	45	31.6193
1993	45	28.026
1994	45	325.181
1995	45	11.3491
1996	45	71.7909
1997	45	76.831
1998	45	41.3082
1999	45	65.4619
2000	45	108.359
2001	45	23.5083
2002	45	5.61202
2003	45	15.9449
2004	45	5.96139
2005	45	6.02485
2006	45	13.7905
2007	45	31.6195
2008	0	2.36347
Total	3555	3263.56

Input and Estimated effective Discard sample sizes for fleet 1

1929	0	1e+15
1930	0	1e+15
1931	0	1e+15
1932	0	1e+15
1933	0	1e+15
1934	0	1e+15
1935	0	1e+15
1936	0	1e+15
1937	0	1e+15
1938	0	1e+15
1939	0	1e+15
1940	0	1e+15
1941	0	1e+15
1942	0	1e+15
1943	0	1e+15
1944	0	1e+15
1945	0	1e+15
1946	0	1e+15
1947	0	1e+15
1948	0	1e+15
1949	0	1e+15
1950	0	1e+15
1951	0	1e+15
1952	0	1e+15
1953	0	1e+15
1954	0	1e+15
1955	0	1e+15
1956	0	1e+15
1957	0	1e+15
1958	0	1e+15
1959	0	1e+15
1960	0	1e+15
1961	0	1e+15
1962	0	1e+15
1963	0	1e+15
1964	0	1e+15
1965	0	1e+15
1966	0	1e+15
1967	0	1e+15
1968	0	1e+15
1969	0	1e+15
1970	0	1e+15
1971	0	1e+15
1972	0	1e+15
1973	0	1e+15
1974	0	1e+15
1975	0	1e+15
1976	0	1e+15
1977	0	1e+15
1978	0	1e+15
1979	0	1e+15
1980	0	1e+15
1981	0	1e+15
1982	0	1e+15
1983	0	1e+15
1984	0	1e+15
1985	0	1e+15
1986	0	1e+15
1987	0	1e+15
1988	0	1e+15
1989	0	1e+15
1990	0	1e+15
1991	0	1e+15
1992	0	1e+15
1993	0	1e+15
1994	0	1e+15
1995	0	1e+15
1996	0	1e+15
1997	0	1e+15
1998	0	1e+15

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1999  0  1e+15
2000  0  1e+15
2001  0  1e+15
2002  0  1e+15
2003  0  1e+15
2004  0  1e+15
2005  0  1e+15
2006  0  1e+15
2007  0  1e+15
2008  0  1e+15
 Total  0  8e+16

Observed and predicted total fleet catch by year
 fleet 1 total catches
1929  25733.5  25741.8
1930  5825.88  5826.56
1931  6890.14  6890.57
1932  4938.95  4938.68
1933  33072.2  33026.1
1934  51483.8  51194.2
1935  66417.4  65125.2
1936  45714.2  44728.5
1937  31987.6  31502.6
1938  34561.8  34102
1939  45454  45249.7
1940  48868.2  49589.2
1941  32560.8  33263.3
1942  21885.7  22159.3
1943  35304.7  35855.2
1944  36657.1  37184.6
1945  23601.4  23810.9
1946  27582.5  27969.9
1947  19437  19872
1948  18124.7  18656.5
1949  24188.9  25021.8
1950  17493  17626
1951  15857.1  15540.8
1952  10325.8  10168.5
1953  5265.94  5236.22
1954  18464.7  18934.9
1955  22200.9  23068.4
1956  36835  37140.6
1957  27753.4  27262
1958  11874.8  12102.6
1959  19332.5  19554.3
1960  20822.5  21155.3
1961  26199.2  25858.5
1962  23901  22900
1963  23703  22335
1964  19987.9  18866.1
1965  11279.4  10898.5
1966  7405.18  7581.59
1967  1713.31  1732.8
1968  1695.04  1707.76
1969  1168.22  1171.32
1970  835.49  835.397
1971  911.26  911.794
1972  532  531.976
1973  400.94  401.036
1974  633.81  633.71
1975  2149.3  2148.38
1976  4091.65  4089.82
1977  13751.2  13730.3
1978  27172.6  27154.1
1979  35858.1  35846.7
1980  35203.1  35116.5
1981  46984.5  46846.3
1982  36371.4  36198.9
1983  42117.5  41802.2
1984  46468.3  46153.3
1985  46827.8  46075.7
1986  54122.6  54022.2
1987  48222.8  48682.2
1988  49264.6  49608.1
1989  49405.8  49245.7
1990  71550.6  70424.8
1991  65504.9  63934.7
1992  32217.5  31698.9
1993  20919.9  20683.5
1994  23737  23530.1
1995  11995.8  11919
1996  24562.7  24627.7
1997  51076.3  52266.2
1998  62822.7  64263.4
1999  15909.9  15928.7
2000  27791.9  28050.8
2001  13010.4  13141.7
2002  14122.8  14329.1
2003  12022.9  12128.3
2004  11195.4  11285.7
2005  13151.5  13206.2
2006  16265.1  16296.6
2007  13743.3  13746
2008  13743.3  13743.3
Observed and predicted total fleet Discards by year
```

```
 fleet 1 total Discards
1929  0  0
1930  0  0
1931  0  0
1932  0  0
1933  0  0
1934  0  0
1935  0  0
1936  0  0
1937  0  0
1938  0  0
1939  0  0
1940  0  0
1941  0  0
1942  0  0
1943  0  0
1944  0  0
1945  0  0
1946  0  0
1947  0  0
1948  0  0
1949  0  0
1950  0  0
1951  0  0
1952  0  0
1953  0  0
1954  0  0
1955  0  0
1956  0  0
1957  0  0
1958  0  0
1959  0  0
1960  0  0
1961  0  0
1962  0  0
1963  0  0
1964  0  0
1965  0  0
1966  0  0
1967  0  0
1968  0  0
1969  0  0
1970  0  0
1971  0  0
1972  0  0
1973  0  0
1974  0  0
1975  0  0
1976  0  0
1977  0  0
1978  0  0
1979  0  0
1980  0  0
1981  0  0
1982  0  0
1983  0  0
1984  0  0
1985  0  0
1986  0  0
1987  0  0
1988  0  0
1989  0  0
1990  0  0
1991  0  0
1992  0  0
1993  0  0
1994  0  0
1995  0  0
1996  0  0
1997  0  0
1998  0  0
1999  0  0
2000  0  0
2001  0  0
2002  0  0
2003  0  0
2004  0  0
2005  0  0
2006  0  0
2007  0  0
2008  0  0

Index data
index number 1
units = 1
month = 4
starting and ending ages for selectivity = 1  9
selectivity choice = -1
 year, sigma2, obs index, pred index
1962  0.237696  0.0429284  0.268188
1963  0.0974896  0.143439  0.182984
1964  0.190425  0.0511159  0.1149
1965  0.229574  0.0658689  0.0730904
1966  0.370805  0.0253169  0.0697859
1967  0.672149  0.00184983  0.0860493
```

```
1968  1.10406  0.016614  0.146742
1969  1.07098  0.0728476  0.193622
1970  1.93856  0.00204988  0.197047
1971  0.583388  0.00713691  0.211389
1972  1.64914  0.000508051  0.195614
1973  2.22507  0.00269379  0.189564
1975  2.30918  0.000401044  0.406359
1976  0.264285  1.44157  1.38402
1977  0.0765202  2.89503  1.7583
1978  0.0468464  3.75184  2.41725
1979  0.0318862  4.12959  2.63254
1980  0.0231392  2.06239  2.32948
1981  0.0191367  2.40342  2.68956
1982  0.0167588  3.37185  2.25651
1983  0.0708694  2.84027  2.04102
1984  0.0240446  4.24635  1.82045
1985  0.0419564  3.62375  1.63859
1986  0.0284903  1.76601  1.47004
1987  0.0625202  1.12471  1.21239
1988  0.0883918  1.55145  1.19521
1989  0.110003  0.251322  0.942099
1990  0.0668817  0.506718  0.867667
1991  0.0703653  0.222483  0.664299
1992  0.207339  0.112365  0.495434
1993  0.112458  0.164169  0.493891
1994  0.273624  0.19519  0.478979
1995  0.12961  0.587796  0.551731
1996  0.260914  0.177525  0.60808
1997  0.117435  0.469986  0.552592
1998  0.160322  0.209194  0.341584
1999  0.191183  0.110532  0.248178
2000  0.162459  0.300632  0.202037
2001  1.02709  0.0510656  0.176915
index number 2
units = 2
month = 5
starting and ending ages for selectivity = 2  9
selectivity choice = -1
 year, sigma2, obs index, pred index
1935  0.0437444  1.21646  3.26014
1936  0.112655  1.7431  2.14752
1937  0.0365832  0.982776  1.73522
1938  0.0182737  2.18379  1.56086
1939  0.0212266  1.7226  1.55345
1940  0.0175056  2.53741  1.43095
1946  0.0402773  0.650503  0.562389
1947  0.0344474  0.742067  0.442904
1948  0.0274552  0.871831  0.565511
1949  0.0437444  0.420748  0.58799
1950  0.0527782  0.232001  0.413754
1951  0.0306906  0.171052  0.260908
1952  0.0663415  0.165434  0.18038
1953  0.15288  0.338172  0.221689
1954  0.0280885  1.22966  0.516462
1955  0.0340974  0.437882  0.531292
1956  0.0575872  0.339857  0.477769
1957  0.0532075  0.510347  0.363075
1958  0.0449299  0.513998  0.279651
1959  0.0433526  0.349968  0.378177
1960  0.11627  0.469058  0.401138
1961  0.0584822  0.44378  0.398097
1962  0.0746445  0.217115  0.407661
1963  0.0682557  0.390133  0.305671
1964  0.078702  0.153638  0.178806
1965  0.058932  0.285648  0.108565
1966  0.0481631  0.317106  0.103018
1967  0.0881748  0.129763  0.10114
1968  0.177254  0.195488  0.134086
1969  0.0969851  0.161221  0.285185
1970  0.176539  0.252224  0.358631
1971  0.0756499  0.412884  0.365455
1972  0.0958641  0.226103  0.301137
1973  0.216608  0.124427  0.279559
1974  0.191039  0.0901603  0.263493
1975  0.108498  0.22835  0.499596
1976  0.0930861  0.378056  0.545964
1977  0.0387796  1.46981  2.10855
1978  0.0246914  2.84609  3.13601
1979  0.0347991  3.32442  5.71703
1980  0.024393  4.37404  5.70554
1981  0.0323726  2.97641  5.19734
1982  0.023217  3.03989  5.95925
1983  0.0316947  3.05843  5.16684
1984  0.0274552  3.29633  3.55436
1985  0.0391515  2.41804  2.59132
1986  0.0402773  1.84815  2.1948
1987  0.0380407  1.24034  1.97627
1988  0.182289  0.902165  1.58064
1989  0.0477532  1.2232  1.72395
1990  0.078702  1.41251  1.17016
1991  0.0751464  1.58413  0.991806
1992  0.0506562  1.15804  0.805339
1993  0.0502367  1.36757  0.705475
1994  0.0384093  1.29455  0.795305
1995  0.0502367  1.17293  0.857487
```

```
1996  0.0668178  1.25831  0.988486
1997  0.0731475  0.855259  0.888587
1998  0.0716641  0.385077  0.583458
1999  0.0892563  0.228069  0.343589
2000  0.0776787  0.417097  0.241661
2001  0.0860291  0.330869  0.206449
2002  0.133112  0.261493  0.225535
2003  0.098677  0.16712  0.19989
2004  0.100381  0.315421  0.199123
2005  0.440524  0.625505  0.253329
2006  0.060747  0.581127  0.412353
2007  0.290032  0.732799  0.574302
index number 3
units = 2
month = 1
starting and ending ages for selectivity = 2  9
selectivity choice = -1
 year, sigma2, obs index, pred index
1951  0.348765  0.00474773  0.145789
1952  0.255882  0.00727985  0.1038
1953  0.25005  0.0591884  0.0872772
1954  0.0305059  0.36336  0.134718
1955  0.0911935  0.0908399  0.167498
1956  0.0957546  0.0357662  0.178822
1957  0.147043  0.0139267  0.14683
1958  0.0259055  0.199088  0.117815
1959  0.0456003  0.0582388  0.128421
1960  0.10159  0.185161  0.135326
1961  0.102774  0.0212065  0.140097
1962  0.166765  0.0395644  0.139418
1963  0.138889  0.163638  0.128509
1965  0.257556  0.0180414  0.0590616
1966  0.178451  0.120592  0.0415373
1969  0.217567  0.052858  0.0739768
1972  0.264285  0.0778628  0.14546
1978  0.0376965  1.72058  0.8242
1981  0.048108  6.91428  2.24777
1984  0.160322  0.703297  2.0794
1985  0.0443699  0.183262  1.6993
1986  0.0240446  3.47344  1.33724
1987  0.0963315  14.6828  1.03622
1988  0.0451884  0.910298  0.832714
1989  0.0812859  0.375704  0.756381
1991  0.347854  0.268405  0.568572
1992  0.339679  0.0997023  0.463394
1993  0.165325  0.203519  0.406943
1994  0.722143  0.0297524  0.401192
1995  0.0419564  0.239919  0.418104
1996  0.0524255  2.50743  0.473022
1997  0.0889491  2.77489  0.482144
1998  0.185152  0.117111  0.384828
2001  0.0906302  0.124707  0.118829
2003  0.263441  0.1054  0.102402
2005  0.179932  0.021523  0.115245
2006  0.26767  0.0326011  0.162069

Selectivity by age and year for each fleet rescaled so max=1.0
 fleet 1 selectivity at age
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
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 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
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 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
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 0.0665279 0.275275 0.552692 0.814848 0.934979 1 0.597672 0.265649 0.041441
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
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 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.270373 1 0.238174 0.146137 0.102386 0.218185 0.277213 0.0251064 0.0335359
 0.407434 0.711699 0.620368 0.75767 0.908753 1 0.787272 0.729486 0.40864
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 0.407434 0.711699 0.620368 0.75767 0.908753 1 0.787272 0.729486 0.40864
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 0.407434 0.711699 0.620368 0.75767 0.908753 1 0.787272 0.729486 0.40864
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 0.407434 0.711699 0.620368 0.75767 0.908753 1 0.787272 0.729486 0.40864
```

Fmult by year for each fleet

1929	0.0357653
1930	0.00757934
1931	0.0086251
1932	0.00646769
1933	0.0529301
1934	0.108351
1935	0.20034
1936	0.195105
1937	0.180744
1938	0.236438
1939	0.291464
1940	0.352304
1941	0.250186
1942	0.164527
1943	0.279614
1944	0.33988
1945	0.266283
1946	0.385029
1947	0.327166
1948	0.326627
1949	0.470767
1950	0.367333
1951	0.422506
1952	0.349676
1953	0.16266
1954	0.447751
1955	0.447379
1956	0.718881
1957	0.620093
1958	0.299561
1959	0.485562
1960	0.486616
1961	0.592254
1962	0.471838
1963	0.535444
1964	0.700192
1965	0.714154
1966	0.608781
1967	0.132015
1968	0.0983321
1969	0.0386934
1970	0.025958
1971	0.0248188
1972	0.0257217
1973	0.0115938
1974	0.0169377
1975	0.0191575
1976	0.0250138
1977	0.0252685
1978	0.043068

```
1979   0.0442698
1980   0.0524044
1981   0.0566203
1982   0.0478136
1983   0.0629856
1984   0.0802796
1985   0.0892204
1986   0.123188
1987   0.13567
1988   0.151864
1989   0.176843
1990   0.288319
1991   0.325335
1992   0.214636
1993   0.145579
1994   0.173498
1995   0.0759861
1996   0.138543
1997   0.318584
1998   0.622754
1999   0.210548
2000   0.475146
2001   0.26917
2002   0.338106
2003   0.254637
2004   0.18629
2005   0.181456
2006   0.158491
2007   0.102832
2008   0.0873431

Directed F by age and year for each fleet
 fleet 1 directed F at age
 0.00237939 0.00984531 0.0197672 0.0291433 0.0334398 0.0357653 0.021376 0.00950101 0.00148215
 0.000504237 0.0020864 0.00418904 0.00617601 0.00708652 0.00757934 0.00452996 0.00201344 0.000314096
 0.00057381 0.00237427 0.00476702 0.00702815 0.00806428 0.0086251 0.00515498 0.00229124 0.000357433
 0.000430282 0.0017804 0.00357464 0.00527019 0.00604716 0.00646769 0.00386556 0.00171813 0.000268028
 0.00352133 0.0145703 0.029254 0.04313 0.0494885 0.0529301 0.0316349 0.0140608 0.00219348
 0.00720836 0.0298263 0.0598847 0.0882896 0.101306 0.108351 0.0647584 0.0287833 0.00449017
 0.0133282 0.0551486 0.110726 0.163247 0.187313 0.20034 0.119738 0.05322 0.00830229
 0.0129799 0.0537075 0.107833 0.158981 0.182419 0.195105 0.116609 0.0518293 0.00808534
 0.0120245 0.0497543 0.0998956 0.147279 0.168992 0.180744 0.108026 0.0480143 0.00749021
 0.0157297 0.0650854 0.130677 0.192661 0.221064 0.236438 0.141312 0.0628093 0.00979822
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Population Numbers at the Start of the Year
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 2.46669e+06 1.71715e+06 1.38731e+06 886065 474069 268802 84754.4 46190.6 296824
 2.3567e+06 1.49526e+06 1.03904e+06 837444 533662 285228 161636 51141.8 207920
 866344 1.42879e+06 905310 627959 505266 321731 171884 97659.2 157042
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2003  1.96511e-06
2005  1.96511e-06
2006  1.96511e-06

Proportions of catch at age by fleet
 fleet 1
Year 1 Obs  =  0.000132971 0.178158 0.321923 0.298312 0.0746246 0.055518 0.045829 0.0182423 0.00726013
Year 1 Pred =  0.0906126 0.240943 0.26074 0.219281 0.0795583 0.0462915 0.0380178 0.0178877 0.00666753
Year 2 Obs  =  0 0.0867775 0.446367 0.301453 0.11939 0.0417583 0.00273329 0.00108783 0.000433015
Year 2 Pred =  0.0646768 0.216395 0.277812 0.219375 0.142797 0.0481684 0.0156639 0.00965308 0.00545888
Year 3 Obs  =  0 0.048402 0.505194 0.313014 0.0660961 0.0380708 0.0187757 0.00747368 0.0029743
Year 3 Pred =  0.0564665 0.162514 0.263326 0.247703 0.151994 0.0921516 0.0173935 0.00421883 0.00423296
Year 4 Obs  =  0 0.0117399 0.261808 0.474939 0.113249 0.0764021 0.0397449 0.0158206 0.00629655
Year 4 Pred =  0.0575737 0.151054 0.210574 0.250026 0.182754 0.10445 0.0354189 0.0049859 0.00316428
Year 5 Obs  =  0 0.0505403 0.20803 0.348817 0.255576 0.0905435 0.0298707 0.0118901 0.00473207
Year 5 Pred =  0.0244541 0.166034 0.209811 0.213212 0.196277 0.133463 0.0430305 0.0109543 0.00276292
Year 6 Obs  =  0 0.0307845 0.335587 0.223908 0.256675 0.0975438 0.0356587 0.0141941 0.00564898
Year 6 Pred =  0.0207999 0.0789924 0.255179 0.231904 0.180964 0.154256 0.0596663 0.0147119 0.00352555
Year 7 Obs  =  0 0.0564975 0.0661942 0.320666 0.33166 0.174786 0.03225 0.0128372 0.00510896
Year 7 Pred =  0.0240764 0.075284 0.133642 0.304622 0.209874 0.150698 0.074119 0.0225022 0.00518217
Year 8 Obs  =  0 0.0193028 0.17522 0.149419 0.283927 0.301928 0.0451043 0.0179539 0.00714533
Year 8 Pred =  0.0681446 0.0895891 0.129662 0.160234 0.273257 0.172183 0.0710308 0.0279749 0.00792517
Year 9 Obs  =  0.001935 0.022218 0.0390255 0.120969 0.239529 0.392018 0.118413 0.0471347 0.0187587
Year 9 Pred =  0.0772983 0.221881 0.135338 0.136692 0.126573 0.197566 0.0713566 0.0234936 0.00980242
Year 10 Obs  =  0.00893818 0.134115 0.370324 0.191463 0.0499225 0.126082 0.0765549 0.0304729 0.0121276
Year 10 Pred =  0.124849 0.211736 0.280511 0.11891 0.0899232 0.0761695 0.0688465 0.0199437 0.00911099
Year 11 Obs  =  0.0170716 0.219961 0.224557 0.319107 0.105056 0.0597505 0.0354563 0.0144452 0.00459618
Year 11 Pred =  0.0865955 0.304538 0.235274 0.213442 0.0670021 0.0461046 0.0227803 0.0168611 0.00740191
Year 12 Obs  =  0.0248007 0.143047 0.460585 0.213906 0.131975 0.0194862 0.00531445 0.000885742 0
Year 12 Pred =  0.0605785 0.222418 0.351478 0.183123 0.121648 0.0345582 0.0139842 0.00578146 0.00643085
Year 13 Obs  =  0.007362 0.21227 0.360327 0.332515 0.0752556 0.010634 0.000817962 0.000817962 0
Year 13 Pred =  0.129227 0.154797 0.256772 0.274159 0.104164 0.0625228 0.0102427 0.00346617 0.00464877
Year 14 Obs  =  0 0.463869 0.168609 0.246309 0.100233 0.017871 0.00233102 0.000776952 0
Year 14 Pred =  0.0531001 0.321198 0.177743 0.204392 0.162327 0.0562612 0.0192619 0.00254438 0.00317336
Year 15 Obs  =  0.00444443 0.147556 0.647556 0.109778 0.0773333 0.0106666 0.00177775 0.000888928 0
Year 15 Pred =  0.0559236 0.142486 0.396427 0.152097 0.130981 0.0951509 0.0192499 0.00529986 0.0023853
Year 16 Obs  =  0 0.2375 0.236184 0.403289 0.101316 0.0184211 0.00263156 0 0.000657919
Year 16 Pred =  0.0700839 0.164766 0.189176 0.356096 0.100281 0.0782427 0.0333716 0.00562346 0.00235966
Year 17 Obs  =  0.0373743 0.281744 0.22185 0.163872 0.152851 0.0886441 0.0354577 0.0110205 0.00718732
Year 17 Pred =  0.0638592 0.208358 0.221187 0.17161 0.23582 0.0600318 0.0270983 0.00965993 0.00237713
Year 18 Obs  =  0.0500569 0.253697 0.308305 0.167994 0.10201 0.0652256 0.027683 0.0166857 0.00834285
Year 18 Pred =  0.0612544 0.186876 0.273694 0.196008 0.111599 0.138909 0.0209279 0.00789534 0.00283618
Year 19 Obs  =  0.168217 0.105226 0.236936 0.209019 0.137437 0.079456 0.0429492 0.0157481 0.00501085
Year 19 Pred =  0.194433 0.160077 0.217758 0.212541 0.11002 0.0563518 0.0409274 0.00525523 0.00263673
Year 20 Obs  =  0.0459588 0.62916 0.153724 0.0618066 0.0681458 0.0237718 0.0110936 0.00475437 0.00158485
Year 20 Pred =  0.0991772 0.424994 0.15707 0.143701 0.10228 0.0478261 0.0143243 0.00874555 0.0018812
Year 21 Obs  =  0.00763357 0.296619 0.490185 0.123773 0.0414394 0.0267176 0.0109052 0.00163574 0.00109049
Year 21 Pred =  0.0345807 0.245411 0.464031 0.113559 0.0752425 0.0481992 0.0134941 0.00346777 0.00201535
Year 22 Obs  =  0.000981302 0.146222 0.378803 0.380766 0.0706575 0.0117763 0.00883216 0.000981302 0.000981302
Year 22 Pred =  0.0346458 0.104347 0.325356 0.402676 0.0701528 0.0415131 0.0155679 0.0038139 0.00192761
Year 23 Obs  =  0.0285714 0.110989 0.19011 0.327473 0.313187 0.0186814 0.00659342 0.00219771 0.00219771
Year 23 Pred =  0.0464092 0.117685 0.156563 0.322856 0.288262 0.0451229 0.0158381 0.00511028 0.00215395
Year 24 Obs  =  0.0277779 0.0176766 0.108586 0.108586 0.474747 0.25505 0.00505068 0.00252507 0
Year 24 Pred =  0.164843 0.141642 0.159029 0.139815 0.206972 0.165695 0.0151687 0.00459343 0.00224116
Year 25 Obs  =  0.614865 0.114865 0.0743242 0.0765767 0.0315314 0.0450448 0.0427928 0 0
Year 25 Pred =  0.37005 0.27644 0.108511 0.0831772 0.0535899 0.071868 0.0326819 0.00246845 0.00121312
Year 26 Obs  =  0.0110974 0.764488 0.162762 0.0345253 0.0197287 0 0.00493225 0.00246605 0
Year 26 Pred =  0.0766298 0.598614 0.201607 0.0538811 0.0306855 0.0180069 0.0144945 0.00542789 0.00065349
Year 27 Obs  =  0.219298 0.249123 0.352632 0.150877 0.0157895 0.00175435 0.00350883 0.00175435 0.00526318
Year 27 Pred =  0.139081 0.158883 0.541561 0.118788 0.0225942 0.0114875 0.00400195 0.00283542 0.000769116
Year 28 Obs  =  0.00395652 0.51731 0.212661 0.18002 0.083086 0.00296739 0 0 0
Year 28 Pred =  0.0546912 0.346652 0.167429 0.361414 0.0557328 0.00940273 0.00295962 0.000942265 0.000776345
Year 29 Obs  =  0.0311493 0.123523 0.469388 0.16971 0.13319 0.0472609 0.0204082 0.00537054 0
Year 29 Pred =  0.0750568 0.161901 0.425151 0.125723 0.183539 0.0246558 0.0025092 0.000761687 0.000702505
Year 30 Obs  =  0.363234 0.084164 0.145072 0.233666 0.0996677 0.0454042 0.0287929 0 0
Year 30 Pred =  0.203812 0.184476 0.173237 0.292904 0.060428 0.0780565 0.00603268 0.000551911 0.000502533
Year 31 Obs  =  0.0265252 0.736074 0.122016 0.0570292 0.0384615 0.0159151 0.00397886 0 0
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Year 31 Pred =  0.110379 0.431757 0.172671 0.107656 0.132273 0.0245978 0.0190887 0.00126046 0.000316861
Year 32 Obs  =  0.0327868 0.256148 0.342213 0.204918 0.102459 0.034836 0.0266393 0 0
Year 32 Pred =  0.139608 0.24101 0.407653 0.105101 0.0462767 0.0505713 0.00560976 0.00388857 0.000280807
Year 33 Obs  =  0.099526 0.388626 0.2109 0.199052 0.078199 0.0165877 0.00710899 0 0
Year 33 Pred =  0.126536 0.31476 0.23205 0.250209 0.0453292 0.0177046 0.011733 0.00118013 0.000497582
Year 34 Obs  =  0.0132497 0.417966 0.225209 0.187863 0.12687 0.0254956 0.00334697 0 0
Year 34 Pred =  0.0433132 0.316927 0.337289 0.157832 0.118265 0.018913 0.00437701 0.00265427 0.00042897
Year 35 Obs  =  0.00592527 0.142545 0.383941 0.215353 0.184199 0.0591923 0.00884417 0 0
Year 35 Pred =  0.0399375 0.127109 0.400509 0.273972 0.0905277 0.0603199 0.00580192 0.0012036 0.000619175
Year 36 Obs  =  0.0337332 0.187382 0.158354 0.233831 0.266371 0.102963 0.0173653 0 0
Year 36 Pred =  0.0496149 0.140863 0.188022 0.370649 0.17596 0.0512609 0.0210127 0.00188229 0.000734742
Year 37 Obs  =  0.401408 0.0388331 0.0235413 0.0522133 0.169618 0.266398 0.047988 0 0
Year 37 Pred =  0.135911 0.171766 0.20031 0.16265 0.216606 0.0895126 0.0159664 0.00636334 0.000914247
Year 38 Obs  =  0.194677 0.427054 0.0769113 0.0616409 0.0523264 0.118213 0.0643685 0.00480818 0
Year 38 Pred =  0.0819762 0.379495 0.199074 0.142415 0.0783066 0.090902 0.0226254 0.00388133 0.00132468
Year 39 Obs  =  0.657835 0.145684 0.0128271 0.0917297 0.0331728 0.0237318 0.0278497 0.00660377 0.000566287
Year 39 Pred =  0.186824 0.182798 0.376588 0.129881 0.0655013 0.0320428 0.020798 0.00452744 0.00103967
Year 40 Obs  =  0.840647 0.0566066 0.0250615 0.0400243 0.0101157 0.00970434 0.00771655 0.00588063 0.00424303
Year 40 Pred =  0.309816 0.283399 0.130917 0.191872 0.0502639 0.0233554 0.00646907 0.00326329 0.000643827
Year 41 Obs  =  0.0137492 0.69875 0.179811 0.0656796 0.0209859 0.0182135 0.00281098 0 0
Year 41 Pred =  0.101385 0.499766 0.218294 0.0726195 0.0814997 0.0197498 0.00514655 0.00108972 0.000449556
Year 42 Obs  =  0.318667 0.681333 0 0 0 0 0 0 0
Year 42 Pred =  0.27978 0.535362 0.152615 0.0202754 0.0031893 0.0066216 0.00190221 7.59802e-05 0.000178028
Year 43 Obs  =  0 0.918346 0.0721092 0.00318711 0.00381488 0.00254325 0 0 0
Year 43 Pred =  0.0759693 0.74302 0.0914067 0.0679231 0.0103224 0.00493523 0.00609506 0.000125067 0.000203605
Year 44 Obs  =  0.615382 0.0919161 0.136717 0.148312 0.00432343 0.00334868 0 0 0
Year 44 Pred =  0.447104 0.262351 0.165091 0.0529178 0.0449795 0.0207752 0.0059088 0.000521311 0.000351179
Year 45 Obs  =  0.050081 0.546991 0.153253 0.0329207 0.0749215 0.0883818 0.049331 0.00206004 0.00206004
Year 45 Pred =  0.163443 0.698865 0.0262456 0.0430231 0.0157707 0.0407724 0.0112063 0.000227313 0.000446484
Year 46 Obs  =  0.669105 0.23874 0.0758828 0.0122035 0.00406887 0 0 0 0
Year 46 Pred =  0.683062 0.211584 0.0583367 0.00567501 0.0106322 0.0118469 0.0182394 0.000357915 0.000264923
Year 47 Obs  =  0.0195705 0.955894 0.0135269 0.00990975 0.000285205 0.000541739 0.000271624 0 0
Year 47 Pred =  0.0733956 0.88096 0.0175722 0.012579 0.00139899 0.00796731 0.0052846 0.000580932 0.000261877
Year 48 Obs  =  0.875994 0.010291 0.11054 4.70167e-05 0.00144059 0 0.00168696 0 0
Year 48 Pred =  0.877649 0.0643564 0.0497996 0.00258205 0.00211363 0.000714376 0.00242108 0.000114731 0.000249414
Year 49 Obs  =  0.229832 0.762596 0.00161824 0.00595355 0 0 0 0 0
Year 49 Pred =  0.179712 0.806837 0.00380569 0.00767353 0.0004551 0.00113228 0.000227655 5.5114e-05 0.00010154
Year 50 Obs  =  0.596692 0.152357 0.231306 0.00942713 0.00813682 0.00208085 0 0 0
Year 50 Pred =  0.633317 0.166713 0.174955 0.00426459 0.0167802 0.00156124 0.00143873 0.000211031 0.00075917
Year 51 Obs  =  0.000203985 0.767831 0.111662 0.113603 0.0016599 0.00504044 0 0 0
Year 51 Pred =  0.0742972 0.687368 0.0898171 0.131983 0.00313968 0.0112735 0.000752022 0.000820695 0.000547934
Year 52 Obs  =  0.397376 0.0209664 0.481455 0.0510616 0.0458306 0.00252993 0.000779936 0 0
Year 52 Pred =  0.355795 0.0831943 0.382112 0.0698827 0.100153 0.00217317 0.00559863 0.000442435 0.000648343
Year 53 Obs  =  0.12455 0.29922 0.0716614 0.451951 0.0312945 0.0200249 0.000493155 0.000804903 0
Year 53 Pred =  0.346695 0.299654 0.0347443 0.223385 0.0398087 0.0519958 0.00080949 0.00247317 0.000434377
Year 54 Obs  =  0.124414 0.279434 0.25634 0.0765293 0.239475 0.0178835 0.00592472 0 0
Year 54 Pred =  0.115233 0.426448 0.182577 0.0296559 0.185844 0.0301837 0.0282565 0.000521832 0.00128024
Year 55 Obs  =  0.0248154 0.0245617 0.387195 0.350854 0.0551877 0.155191 0.00219528 0 0
Year 55 Pred =  0.0818168 0.17135 0.314767 0.188525 0.0298361 0.170422 0.019876 0.0220581 0.00134824
Year 56 Obs  =  0.0282877 0.00524412 0.0943585 0.481844 0.248019 0.0617107 0.0785911 0.0019442 0
Year 56 Pred =  0.170747 0.108831 0.112934 0.290131 0.168919 0.0243188 0.099837 0.0138342 0.0104477
Year 57 Obs  =  0.0308318 0.165781 0.0492178 0.154192 0.475344 0.101534 0.0131711 0.00992887 0
Year 57 Pred =  0.234165 0.194207 0.0611788 0.0888127 0.22137 0.117034 0.0121096 0.0591998 0.0119235
Year 58 Obs  =  0.138839 0.327844 0.169457 0.0388448 0.0662747 0.188477 0.0547372 0.00753582 0.0079909
Year 58 Pred =  0.25801 0.267768 0.109746 0.048286 0.0678086 0.153151 0.0583524 0.00720371 0.0296739
Year 59 Obs  =  0.127165 0.506432 0.230247 0.0375036 0.0201527 0.0247659 0.0332249 0.0145325 0.00597554
Year 59 Pred =  0.161614 0.331053 0.16891 0.0967817 0.0410519 0.0520633 0.084697 0.03867 0.0251592
Year 60 Obs  =  0.570154 0.0823816 0.196302 0.0713299 0.0154715 0.0105521 0.0139787 0.0225674 0.0172625
Year 60 Pred =  0.464115 0.139384 0.140164 0.0999424 0.0550956 0.0210695 0.0192633 0.0376235 0.0233432
Year 61 Obs  =  0.10365 0.76615 0.0397887 0.0318993 0.0214395 0.0129103 0.0120773 0.00411792 0.00796741
Year 61 Pred =  0.162549 0.50405 0.0741851 0.104184 0.0712669 0.0353368 0.00975626 0.0107366 0.0279349
Year 62 Obs  =  0.180593 0.118733 0.264447 0.0731527 0.103116 0.119672 0.0502753 0.0399953 0.0500162
Year 62 Pred =  0.305728 0.185388 0.281775 0.0576084 0.0769107 0.0470173 0.0169796 0.00567543 0.0229173
Year 63 Obs  =  0.138341 0.467133 0.111522 0.110364 0.0529952 0.0474732 0.0341453 0.0153868 0.0226398
Year 63 Pred =  0.266308 0.3175 0.0927166 0.196467 0.0377663 0.0445649 0.0197906 0.00877931 0.0161068
Year 64 Obs  =  0.121609 0.329654 0.134973 0.107747 0.116311 0.0885753 0.0611695 0.0287533 0.0112088
Year 64 Pred =  0.24343 0.302993 0.172103 0.0706617 0.141365 0.0240411 0.0203651 0.0111303 0.0139106
Year 65 Obs  =  0.568585 0.102906 0.117101 0.0377232 0.0369103 0.0553067 0.0316353 0.0317291 0.0181029
Year 65 Pred =  0.458158 0.197623 0.119117 0.094975 0.0373052 0.0668501 0.00815757 0.00837436 0.00943972
Year 66 Obs  =  0.281886 0.418543 0.109505 0.0498703 0.0633214 0.0332717 0.020579 0.016348 0.006675
Year 66 Pred =  0.308944 0.415399 0.0878915 0.0739759 0.0566246 0.0200182 0.0258991 0.00380091 0.00744671
Year 67 Obs  =  0.597211 0.275366 0.0682615 0.0127006 0.00713895 0.0183222 0.00981228 0.00684189 0.00434565
Year 67 Pred =  0.378087 0.282233 0.184535 0.0549251 0.0445745 0.0307558 0.00776751 0.0120965 0.0050263
Year 68 Obs  =  0.286794 0.435129 0.124389 0.0595121 0.0370643 0.0254399 0.0135528 0.0106332 0.00748687
Year 68 Pred =  0.233417 0.395107 0.146167 0.133266 0.0383701 0.0282301 0.0140674 0.00423391 0.00714125
Year 69 Obs  =  0.160104 0.328173 0.216088 0.0853181 0.0553272 0.0501796 0.0322665 0.0274253 0.0451183
Year 69 Pred =  0.137557 0.303888 0.25407 0.130081 0.112863 0.0291024 0.0156674 0.00941532 0.0073556
Year 70 Obs  =  0.0907195 0.132568 0.258606 0.158071 0.103525 0.0889858 0.0711439 0.0431607 0.0532205
Year 70 Pred =  0.128678 0.193053 0.206587 0.237219 0.111918 0.0847067 0.0162372 0.0108527 0.010749
Year 71 Obs  =  0.313482 0.077059 0.0700383 0.159918 0.15245 0.116195 0.0508593 0.0347571 0.0252423
Year 71 Pred =  0.275547 0.156542 0.10611 0.162278 0.171753 0.0697766 0.0372712 0.0091375 0.0115864
Year 72 Obs  =  0.366854 0.191166 0.0644712 0.109169 0.128236 0.0826361 0.0354184 0.0142007 0.00784852
Year 72 Pred =  0.373315 0.253577 0.0707096 0.0659878 0.0945942 0.088609 0.0265958 0.0173458 0.00926581
Year 73 Obs  =  0.305678 0.439405 0.0756729 0.0419842 0.0518005 0.0459145 0.0211745 0.0119458 0.00642483
Year 73 Pred =  0.422165 0.314667 0.0993975 0.0391559 0.0339662 0.0424114 0.0284244 0.0107167 0.00909615
Year 74 Obs  =  0.110228 0.780057 0.0787162 0.0181348 0.0034718 0.00554983 0.00384275 0 0
Year 74 Pred =  0.214219 0.45734 0.164787 0.0724443 0.0268513 0.0206122 0.0187363 0.0153931 0.00961547
Year 75 Obs  =  0.527677 0.296787 0.102162 0.0375274 0.0131551 0.0129358 0.00656773 0.00189719 0.00129092
Year 75 Pred =  0.382544 0.209787 0.213244 0.107846 0.0446015 0.0145864 0.00806157 0.0090419 0.0102879
Year 76 Obs  =  0.79319 0.120929 0.039149 0.0283708 0.0120824 0.00242117 0.00161412 0.000629423 0.00161412
Year 76 Pred =  0.499839 0.258007 0.0681617 0.097219 0.0467655 0.0172362 0.0040514 0.00272966 0.00599075
Year 77 Obs  =  0.815607 0.112104 0.0574635 0.00831505 0.00325068 0.00198288 0.00102078 0.000256591 0
Year 77 Pred =  0.555274 0.286291 0.072013 0.0266087 0.0363017 0.0156574 0.0041607 0.00118219 0.0025106
Year 78 Obs  =  0.590902 0.288833 0.0594579 0.0298918 0.0169937 0.00475702 0.00376538 0.00539941 0
Year 78 Pred =  0.416196 0.408692 0.102673 0.0361622 0.012805 0.0156846 0.00486837 0.00156201 0.00135704
```

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Year 79 Obs  =  0.552445 0.269411 0.0984565 0.0435435 0.0243505 0.00805001 0.00304855 0.000694974 0
Year 79 Pred =  0.430467 0.325631 0.15606 0.0550187 0.0186723 0.00596115 0.00523359 0.00195319 0.00100294
Year 80 Obs  =  0 0 0 0 0 0 0 0 0
Year 80 Pred =  0.182935 0.467104 0.173965 0.116782 0.0398823 0.0122685 0.00281127 0.00294679 0.0013061

Proportions of Discards at age by fleet
 fleet 1
Year 1 Obs  =  0 0 0 0 0 0 0 0 0
Year 1 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 2 Obs  =  0 0 0 0 0 0 0 0 0
Year 2 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 3 Obs  =  0 0 0 0 0 0 0 0 0
Year 3 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 4 Obs  =  0 0 0 0 0 0 0 0 0
Year 4 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 5 Obs  =  0 0 0 0 0 0 0 0 0
Year 5 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 6 Obs  =  0 0 0 0 0 0 0 0 0
Year 6 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 7 Obs  =  0 0 0 0 0 0 0 0 0
Year 7 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 8 Obs  =  0 0 0 0 0 0 0 0 0
Year 8 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 9 Obs  =  0 0 0 0 0 0 0 0 0
Year 9 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 10 Obs  =  0 0 0 0 0 0 0 0 0
Year 10 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 11 Obs  =  0 0 0 0 0 0 0 0 0
Year 11 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 12 Obs  =  0 0 0 0 0 0 0 0 0
Year 12 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 13 Obs  =  0 0 0 0 0 0 0 0 0
Year 13 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 14 Obs  =  0 0 0 0 0 0 0 0 0
Year 14 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 15 Obs  =  0 0 0 0 0 0 0 0 0
Year 15 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 16 Obs  =  0 0 0 0 0 0 0 0 0
Year 16 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 17 Obs  =  0 0 0 0 0 0 0 0 0
Year 17 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 18 Obs  =  0 0 0 0 0 0 0 0 0
Year 18 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 19 Obs  =  0 0 0 0 0 0 0 0 0
Year 19 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 20 Obs  =  0 0 0 0 0 0 0 0 0
Year 20 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 21 Obs  =  0 0 0 0 0 0 0 0 0
Year 21 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 22 Obs  =  0 0 0 0 0 0 0 0 0
Year 22 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 23 Obs  =  0 0 0 0 0 0 0 0 0
Year 23 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 24 Obs  =  0 0 0 0 0 0 0 0 0
Year 24 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 25 Obs  =  0 0 0 0 0 0 0 0 0
Year 25 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 26 Obs  =  0 0 0 0 0 0 0 0 0
Year 26 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 27 Obs  =  0 0 0 0 0 0 0 0 0
Year 27 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 28 Obs  =  0 0 0 0 0 0 0 0 0
Year 28 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 29 Obs  =  0 0 0 0 0 0 0 0 0
Year 29 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 30 Obs  =  0 0 0 0 0 0 0 0 0
Year 30 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 31 Obs  =  0 0 0 0 0 0 0 0 0
Year 31 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 32 Obs  =  0 0 0 0 0 0 0 0 0
Year 32 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 33 Obs  =  0 0 0 0 0 0 0 0 0
Year 33 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 34 Obs  =  0 0 0 0 0 0 0 0 0
Year 34 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 35 Obs  =  0 0 0 0 0 0 0 0 0
Year 35 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 36 Obs  =  0 0 0 0 0 0 0 0 0
Year 36 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 37 Obs  =  0 0 0 0 0 0 0 0 0
Year 37 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 38 Obs  =  0 0 0 0 0 0 0 0 0
Year 38 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 39 Obs  =  0 0 0 0 0 0 0 0 0
Year 39 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 40 Obs  =  0 0 0 0 0 0 0 0 0
Year 40 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 41 Obs  =  0 0 0 0 0 0 0 0 0
Year 41 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 42 Obs  =  0 0 0 0 0 0 0 0 0
Year 42 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 43 Obs  =  0 0 0 0 0 0 0 0 0
Year 43 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 44 Obs  =  0 0 0 0 0 0 0 0 0
Year 44 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
```

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Year 45 Obs  =  0 0 0 0 0 0 0 0 0
Year 45 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 46 Obs  =  0 0 0 0 0 0 0 0 0
Year 46 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 47 Obs  =  0 0 0 0 0 0 0 0 0
Year 47 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 48 Obs  =  0 0 0 0 0 0 0 0 0
Year 48 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 49 Obs  =  0 0 0 0 0 0 0 0 0
Year 49 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 50 Obs  =  0 0 0 0 0 0 0 0 0
Year 50 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 51 Obs  =  0 0 0 0 0 0 0 0 0
Year 51 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 52 Obs  =  0 0 0 0 0 0 0 0 0
Year 52 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 53 Obs  =  0 0 0 0 0 0 0 0 0
Year 53 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 54 Obs  =  0 0 0 0 0 0 0 0 0
Year 54 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 55 Obs  =  0 0 0 0 0 0 0 0 0
Year 55 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 56 Obs  =  0 0 0 0 0 0 0 0 0
Year 56 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 57 Obs  =  0 0 0 0 0 0 0 0 0
Year 57 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 58 Obs  =  0 0 0 0 0 0 0 0 0
Year 58 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 59 Obs  =  0 0 0 0 0 0 0 0 0
Year 59 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 60 Obs  =  0 0 0 0 0 0 0 0 0
Year 60 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 61 Obs  =  0 0 0 0 0 0 0 0 0
Year 61 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 62 Obs  =  0 0 0 0 0 0 0 0 0
Year 62 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 63 Obs  =  0 0 0 0 0 0 0 0 0
Year 63 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 64 Obs  =  0 0 0 0 0 0 0 0 0
Year 64 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 65 Obs  =  0 0 0 0 0 0 0 0 0
Year 65 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 66 Obs  =  0 0 0 0 0 0 0 0 0
Year 66 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 67 Obs  =  0 0 0 0 0 0 0 0 0
Year 67 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 68 Obs  =  0 0 0 0 0 0 0 0 0
Year 68 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 69 Obs  =  0 0 0 0 0 0 0 0 0
Year 69 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 70 Obs  =  0 0 0 0 0 0 0 0 0
Year 70 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 71 Obs  =  0 0 0 0 0 0 0 0 0
Year 71 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 72 Obs  =  0 0 0 0 0 0 0 0 0
Year 72 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 73 Obs  =  0 0 0 0 0 0 0 0 0
Year 73 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 74 Obs  =  0 0 0 0 0 0 0 0 0
Year 74 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 75 Obs  =  0 0 0 0 0 0 0 0 0
Year 75 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 76 Obs  =  0 0 0 0 0 0 0 0 0
Year 76 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 77 Obs  =  0 0 0 0 0 0 0 0 0
Year 77 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 78 Obs  =  0 0 0 0 0 0 0 0 0
Year 78 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 79 Obs  =  0 0 0 0 0 0 0 0 0
Year 79 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15
Year 80 Obs  =  0 0 0 0 0 0 0 0 0
Year 80 Pred =  1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15 1e-15

F Reference Points Using Final Year Selectivity Scaled Max=1.0
 refpt           F       slope to plot on SRR
  F0.1     0.546603     11.8214
  Fmax     9.99999     6364.79
  F30%SPR  0.43591     9.24096
  F40%SPR  0.316978     6.93074
  Fmsy     0.138133     4.26029    SSmsy    122357     MSY   23048.2
  Foy      0.1036     xxxxxx    SSoy    158998     OY   21792
  Fcurrent 0.0873431     3.65958

Stock-Recruitment Relationship Parameters
 alpha     = 1.44455e+06
 beta      = 216717
 virgin    = 182787
 steepness = 0.315471
Spawning Stock, Obs Recruits(year+1), Pred Recruits(year+1)
1929  1.08911e+06  2.83254e+06  1.20481e+06
1930  996757  2.46669e+06  1.18656e+06
1931  963593  2.3567e+06  1.17932e+06
1932  928197  866344  1.17112e+06
1933  840657  564630  1.14848e+06
1934  712147  441430  1.10752e+06
```

```
1935  564283  816214  1.04371e+06
1936  429301  692408  959953
1937  327346  989893  869141
1938  253329  676424  778533
1939  224774  438609  735457
1940  179607  876571  654644
1941  155143  352122  602678
1942  139479  334084  565656
1943  140357  338972  567817
1944  123104  248540  523304
1945  101881  193681  461936
1946  85730.5  557898  409466
1947  67354.4  309960  342508
1948  58863.8  102598  308555
1949  55983.5  80024.9  296556
1950  49164.6  74263.5  267114
1951  42537  204026  237014
1952  33991  659370  195852
1953  28592.7  200881  168373
1954  31721.9  410646  184447
1955  38991.7  147555  220272
1956  45090.2  154403  248790
1957  40031.8  399309  225232
1958  32676.7  239901  189272
1959  33843.3  322528  195116
1960  35366  297979  202663
1961  35607.8  93976.6  203853
1962  38256.4  68283.6  216741
1963  38083  54550.1  215906
1964  29331  96708  172203
1965  18498.5  47216.3  113607
1966  13217.8  114845  83039.7
1967  10701.7  309418  67976.6
1968  12437.3  155927  78402.4
1969  19114.7  180759  117084
1970  29403.1  40830.5  172575
1971  39319.3  153731  221838
1972  43519.9  79784.9  241575
1973  47194.4  572756  258324
1974  52977.2  105878  283759
1975  67411.2  3.19561e+06  342729
1976  91854.8  1.57267e+06  430010
1977  139675  6.24907e+06  566140
1978  243480  698876  764279
1979  367600  3.0875e+06  908782
1980  437089  3.67572e+06  965725
1981  546112  1.02151e+06  1.03416e+06
1982  611964  502391  1.06677e+06
1983  591001  804937  1.05697e+06
1984  572172  982993  1.04772e+06
1985  493089  951396  1.0035e+06
1986  419170  459336  952232
1987  345766  1.50165e+06  887985
1988  297606  470734  835869
1989  237230  735979  754913
1990  211149  556558  712876
1991  170401  402952  635859
1992  127154  888898  534153
1993  110197  644569  486934
1994  92115.1  843485  430865
1995  104429  502186  469732
1996  116908  218035  506196
1997  125597  124645  530013
1998  102816  175248  464812
1999  69736.9  235521  351674
2000  54266.5  265956  289282
2001  32720.8  113006  189493
2002  27249.5  183753  161347
2003  31670.1  331431  184185
2004  32062.8  615782  186174
2005  29420.1  603758  172663
2006  40167.2  781553  225874
2007  56688.2  307250  299515
2008  83183.3       xxxx   400675

average F (ages 4 to 8 unweighted) by year
Projection into Future
Projected NAA
 2 179842 259103 111189 60715.2 17163.2 4777.02 1404.64 2873.52
 2 1.14668 98866.2 144248 60738 32481.3 9066.94 2598.85 2417.52
Projected Directed FAA
 0.05628 0.0983092 0.0856933 0.104659 0.125529 0.138133 0.108748 0.100766 0.0564468
 0.05628 0.0983092 0.0856933 0.104659 0.125529 0.138133 0.108748 0.100766 0.0564468
Projected Discard FAA
 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0
Projected Nondirected FAA
 -0 -0 -0 -0 -0 -0 -0 -0 -0
 -0 -0 -0 -0 -0 -0 -0 -0 -0
Projected Catch at Age
 0.0863326 13305.2 16804.6 8732.4 5665.87 1752.55 389.114 106.399 124.397
 0.0863326 0.0848344 6412.14 11328.7 5668 3316.7 738.55 196.858 104.657
Projected Discards at Age (in numbers)
 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0
```

```
Projected Yield at Age
 0.0101009 2887.23 6032.83 4863.95 4198.41 1538.74 338.918 98.3125 116.312
 0.0101009 0.0184091 2301.96 6310.11 4199.99 2912.06 643.277 181.897 97.8539
Year, Total Yield (in weight), Total Discards (in weight), SSB, proj_what, SS/SSmsy
2009  20074.7  0  111152  0  0.908424
2010  16647.2  0  120568  0  0.985386

M =  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
mature =  0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
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 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
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 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
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 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
 0 0.07 0.25 0.47 0.73 1 1 1 1
Weight at age
 0.074 0.167 0.297 0.402 0.523 0.615 0.704 0.8 0.83
 0.06 0.139 0.301 0.422 0.511 0.603 0.698 0.8 0.83
 0.077 0.114 0.276 0.399 0.527 0.606 0.701 0.8 0.83
 0.058 0.081 0.277 0.379 0.508 0.604 0.711 0.8 0.83
 0.059 0.083 0.2 0.299 0.493 0.585 0.7 0.8 0.83
 0.065 0.142 0.198 0.233 0.431 0.538 0.683 0.8 0.83
```

```
 0.079 0.186 0.217 0.251 0.379 0.472 0.629 0.79 0.83
 0.086 0.193 0.284 0.338 0.393 0.453 0.574 0.75 0.82
 0.119 0.176 0.318 0.429 0.461 0.502 0.575 0.74 0.8
 0.124 0.174 0.31 0.448 0.532 0.582 0.633 0.726 0.79
 0.191 0.246 0.363 0.46 0.583 0.68 0.775 0.795 0.878
 0.18 0.26 0.339 0.442 0.527 0.64 0.729 0.834 0.82
 0.115 0.259 0.343 0.439 0.559 0.65 0.806 0.807 0.85
 0.18 0.236 0.373 0.471 0.546 0.626 0.684 0.909 0.83
 0.165 0.292 0.339 0.474 0.574 0.65 0.629 0.881 1
 0.144 0.271 0.379 0.472 0.587 0.66 0.754 0.735 0.948
 0.121 0.234 0.383 0.494 0.611 0.704 0.745 0.819 0.842
 0.125 0.261 0.384 0.487 0.617 0.679 0.736 0.778 0.812
 0.119 0.291 0.4 0.499 0.622 0.709 0.753 0.788 0.818
 0.107 0.227 0.354 0.506 0.616 0.706 0.764 0.895 0.871
 0.109 0.192 0.319 0.456 0.607 0.725 0.799 0.917 0.917
 0.084 0.249 0.323 0.455 0.564 0.664 0.784 0.799 0.871
 0.162 0.255 0.346 0.429 0.569 0.694 0.827 0.835 0.853
 0.173 0.297 0.386 0.471 0.568 0.719 0.832 0.988 0.85
 0.162 0.296 0.411 0.512 0.603 0.763 0.834 0.85 1.1
 0.084 0.257 0.387 0.505 0.585 0.744 0.701 0.879 0.87
 0.14 0.253 0.357 0.484 0.583 0.744 0.762 0.778 0.878
 0.111 0.248 0.373 0.485 0.598 0.752 0.722 0.91 0.87
 0.179 0.31 0.374 0.509 0.602 0.649 0.65 0.7 1
 0.176 0.292 0.396 0.488 0.617 0.685 0.775 0.75 0.75
 0.132 0.251 0.398 0.51 0.602 0.702 0.754 0.84 0.85
 0.102 0.276 0.391 0.507 0.611 0.699 0.768 0.82 0.87
 0.144 0.252 0.389 0.495 0.584 0.647 0.817 0.83 0.85
 0.276 0.32 0.42 0.54 0.622 0.712 0.782 0.89 0.86
 0.197 0.298 0.434 0.538 0.627 0.73 0.743 0.84 0.93
 0.181 0.3 0.4 0.503 0.612 0.748 0.812 0.82 0.87
 0.109 0.195 0.384 0.501 0.596 0.723 0.735 0.88 0.85
 0.149 0.273 0.419 0.525 0.658 0.79 0.833 0.85 0.93
 0.166 0.235 0.488 0.51 0.599 0.723 0.869 0.917 0.849
 0.138 0.266 0.391 0.562 0.593 0.709 0.902 0.952 1.07
 0.103 0.322 0.428 0.505 0.662 0.746 0.907 1 1.1
 0.099 0.232 0.402 0.584 0.73 0.837 0.85 1 1.2
 0.266 0.282 0.457 0.481 0.74 0.955 0.88 0.9 1.2
 0.147 0.266 0.449 0.508 0.552 0.746 1 0.9 1.1
 0.119 0.329 0.433 0.609 0.606 0.686 0.758 0.803 0.838
 0.107 0.303 0.604 0.74 0.837 0.8 0.8 0.8 1
 0.127 0.361 0.517 0.973 1.053 1.029 1.35 0.9 0.9
 0.17 0.297 0.672 0.864 1.291 1.223 1.531 1.2 1
 0.122 0.322 0.6 0.847 1.063 1.1 1.3 1.5 1.3
 0.062 0.334 0.473 0.705 0.908 1.1 1.2 1.4 1.6
 0.082 0.189 0.44 0.598 0.81 0.969 1.2 1.3 1.5
 0.072 0.176 0.27 0.437 0.598 0.874 1.066 1.3 1.4
 0.083 0.19 0.239 0.391 0.597 0.715 0.953 0.929 1.4
 0.032 0.151 0.237 0.345 0.516 0.773 0.916 1 1.2
 0.049 0.191 0.302 0.39 0.458 0.511 0.688 0.9 1.1
 0.12 0.235 0.351 0.396 0.505 0.614 0.638 0.871 0.91
 0.157 0.285 0.418 0.461 0.484 0.56 0.612 0.697 0.85
 0.148 0.29 0.408 0.508 0.561 0.595 0.63 0.719 0.784
 0.133 0.272 0.414 0.523 0.6 0.691 0.717 0.766 0.826
 0.101 0.301 0.415 0.576 0.666 0.734 0.806 0.815 0.899
 0.104 0.193 0.381 0.542 0.647 0.749 0.757 0.739 0.827
 0.094 0.267 0.377 0.554 0.649 0.68 0.749 0.775 0.803
 0.071 0.217 0.397 0.514 0.591 0.664 0.724 0.766 0.799
 0.087 0.175 0.33 0.459 0.544 0.661 0.691 0.725 0.805
 0.073 0.228 0.294 0.408 0.583 0.607 0.72 0.756 0.832
 0.1 0.156 0.248 0.361 0.493 0.597 0.644 0.733 0.785
 0.081 0.179 0.275 0.431 0.586 0.689 0.74 0.758 0.92
 0.105 0.182 0.318 0.471 0.589 0.649 0.674 0.705 0.751
 0.149 0.239 0.333 0.446 0.572 0.637 0.719 0.718 0.749
 0.139 0.267 0.325 0.419 0.53 0.615 0.631 0.667 0.689
 0.148 0.228 0.399 0.509 0.575 0.633 0.688 0.754 0.768
 0.114 0.266 0.37 0.55 0.59 0.608 0.646 0.712 0.731
 0.103 0.253 0.347 0.534 0.567 0.619 0.617 0.635 0.627
 0.133 0.218 0.303 0.412 0.552 0.687 0.656 0.728 0.65
 0.125 0.284 0.414 0.603 0.679 0.745 0.809 0.794 0.838
 0.159 0.28 0.407 0.596 0.685 0.821 0.926 0.82 0.902
 0.106 0.267 0.38 0.463 0.556 0.665 0.737 0.797 0.84
 0.126 0.222 0.353 0.522 0.752 0.824 0.848 0.918 0.935
 0.117 0.217 0.359 0.557 0.741 0.878 0.871 0.924 0.935
 0.117 0.217 0.359 0.557 0.741 0.878 0.871 0.924 0.935
Fecundity
 0 0.01169 0.07425 0.18894 0.38179 0.615 0.704 0.8 0.83
 0 0.00973 0.07525 0.19834 0.37303 0.603 0.698 0.8 0.83
 0 0.00798 0.069 0.18753 0.38471 0.606 0.701 0.8 0.83
 0 0.00567 0.06925 0.17813 0.37084 0.604 0.711 0.8 0.83
 0 0.00581 0.05 0.14053 0.35989 0.585 0.7 0.8 0.83
 0 0.00994 0.0495 0.10951 0.31463 0.538 0.683 0.8 0.83
 0 0.01302 0.05425 0.11797 0.27667 0.472 0.629 0.79 0.83
 0 0.01351 0.071 0.15886 0.28689 0.453 0.574 0.75 0.82
 0 0.01232 0.0795 0.20163 0.33653 0.502 0.575 0.74 0.8
 0 0.01218 0.0775 0.21056 0.38836 0.582 0.633 0.726 0.79
 0 0.01722 0.09075 0.2162 0.42559 0.68 0.775 0.795 0.878
 0 0.0182 0.08475 0.20774 0.38471 0.64 0.729 0.834 0.82
 0 0.01813 0.08575 0.20633 0.40807 0.65 0.806 0.807 0.85
 0 0.01652 0.09325 0.22137 0.39858 0.626 0.684 0.909 0.83
 0 0.02044 0.08475 0.22278 0.41902 0.65 0.629 0.881 1
 0 0.01897 0.09475 0.22184 0.42851 0.66 0.754 0.735 0.948
 0 0.01638 0.09575 0.23218 0.44603 0.704 0.745 0.819 0.842
 0 0.01827 0.096 0.22889 0.45041 0.679 0.736 0.778 0.812
 0 0.02037 0.1 0.23453 0.45406 0.709 0.753 0.788 0.818
 0 0.01589 0.0885 0.23782 0.44968 0.706 0.764 0.895 0.871
```

```
 0 0.01344 0.07975 0.21432 0.44311 0.725 0.799 0.917 0.917
 0 0.01743 0.08075 0.21385 0.41172 0.664 0.784 0.799 0.871
 0 0.01785 0.0865 0.20163 0.41537 0.694 0.827 0.835 0.853
 0 0.02079 0.0965 0.22137 0.41464 0.719 0.832 0.988 0.85
 0 0.02072 0.10275 0.24064 0.44019 0.763 0.834 0.85 1.1
 0 0.01799 0.09675 0.23735 0.42705 0.744 0.701 0.879 0.87
 0 0.01771 0.08925 0.22748 0.42559 0.744 0.762 0.778 0.878
 0 0.01736 0.09325 0.22795 0.43654 0.752 0.722 0.91 0.87
 0 0.0217 0.0935 0.23923 0.43946 0.649 0.65 0.7 1
 0 0.02044 0.099 0.22936 0.45041 0.685 0.775 0.75 0.75
 0 0.01757 0.0995 0.2397 0.43946 0.702 0.754 0.84 0.85
 0 0.01932 0.09775 0.23829 0.44603 0.699 0.768 0.82 0.87
 0 0.01764 0.09725 0.23265 0.42632 0.647 0.817 0.83 0.85
 0 0.0224 0.105 0.2538 0.45406 0.712 0.782 0.89 0.86
 0 0.02086 0.1085 0.25286 0.45771 0.73 0.743 0.84 0.93
 0 0.021 0.1 0.23641 0.44676 0.748 0.812 0.82 0.87
 0 0.01365 0.096 0.23547 0.43508 0.723 0.735 0.88 0.85
 0 0.01911 0.10475 0.24675 0.48034 0.79 0.833 0.85 0.93
 0 0.01645 0.122 0.2397 0.43727 0.723 0.869 0.917 0.849
 0 0.01862 0.09775 0.26414 0.43289 0.709 0.902 0.952 1.07
 0 0.02254 0.107 0.23735 0.48326 0.746 0.907 1 1.1
 0 0.01624 0.1005 0.27448 0.5329 0.837 0.85 1 1.2
 0 0.01974 0.11425 0.22607 0.5402 0.955 0.88 0.9 1.2
 0 0.01862 0.11225 0.23876 0.40296 0.746 1 0.9 1.1
 0 0.02303 0.10825 0.28623 0.44238 0.686 0.758 0.803 0.838
 0 0.02121 0.151 0.3478 0.61101 0.8 0.8 0.8 1
 0 0.02527 0.12925 0.45731 0.76869 1.029 1.35 0.9 0.9
 0 0.02079 0.168 0.40608 0.94243 1.223 1.531 1.2 1
 0 0.02254 0.15 0.39809 0.77599 1.1 1.3 1.5 1.3
 0 0.02338 0.11825 0.33135 0.66284 1.1 1.2 1.4 1.6
 0 0.01323 0.11 0.28106 0.5913 0.969 1.2 1.3 1.5
 0 0.01232 0.0675 0.20539 0.43654 0.874 1.066 1.3 1.4
 0 0.0133 0.05975 0.18377 0.43581 0.715 0.953 0.929 1.4
 0 0.01057 0.05925 0.16215 0.37668 0.773 0.916 1 1.2
 0 0.01337 0.0755 0.1833 0.33434 0.511 0.688 0.9 1.1
 0 0.01645 0.08775 0.18612 0.36865 0.614 0.638 0.871 0.91
 0 0.01995 0.1045 0.21667 0.35332 0.56 0.612 0.697 0.85
 0 0.0203 0.102 0.23876 0.40953 0.595 0.63 0.719 0.784
 0 0.01904 0.1035 0.24581 0.438 0.691 0.717 0.766 0.826
 0 0.02107 0.10375 0.27072 0.48618 0.734 0.806 0.815 0.899
 0 0.01351 0.09525 0.25474 0.47231 0.749 0.757 0.739 0.827
 0 0.01869 0.09425 0.26038 0.47377 0.68 0.749 0.775 0.803
 0 0.01519 0.09925 0.24158 0.43143 0.664 0.724 0.766 0.799
 0 0.01225 0.0825 0.21573 0.39712 0.661 0.691 0.725 0.805
 0 0.01596 0.0735 0.19176 0.42559 0.607 0.72 0.756 0.832
 0 0.01092 0.062 0.16967 0.35989 0.597 0.644 0.733 0.785
 0 0.01253 0.06875 0.20257 0.42778 0.689 0.74 0.758 0.92
 0 0.01274 0.0795 0.22137 0.42997 0.649 0.674 0.705 0.751
 0 0.01673 0.08325 0.20962 0.41756 0.637 0.719 0.718 0.749
 0 0.01869 0.08125 0.19693 0.3869 0.615 0.631 0.667 0.689
 0 0.01596 0.09975 0.23923 0.41975 0.633 0.688 0.754 0.768
 0 0.01862 0.0925 0.2585 0.4307 0.608 0.646 0.712 0.731
 0 0.01771 0.08675 0.25098 0.41391 0.619 0.617 0.635 0.627
 0 0.01526 0.07575 0.19364 0.40296 0.687 0.656 0.728 0.65
 0 0.01988 0.1035 0.28341 0.49567 0.745 0.809 0.794 0.838
 0 0.0196 0.10175 0.28012 0.50005 0.821 0.926 0.82 0.902
 0 0.01869 0.095 0.21761 0.40588 0.665 0.737 0.797 0.84
 0 0.01554 0.08825 0.24534 0.54896 0.824 0.848 0.918 0.935
 0 0.01519 0.08975 0.26179 0.54093 0.878 0.871 0.924 0.935
 0 0.01519 0.08975 0.26179 0.54093 0.878 0.871 0.924 0.935

SSmsy_ratio = 0.983427
Fmsy_ratio =  0.632311
that's all
```

Pacific Mackerel

STAR Panel Meeting Report

NOAA / Southwest Fisheries Science Center
La Jolla, California
May 1-4, 2007

STAR Panel
Tom Jagielo, Washington Department of Fish of Wildlife (Chair)
André Punt, University of Washington (SSC representative)
Malcolm Haddon, University of Tasmania (CIE)

PFMC
Diane Pleschner-Steele (CPSAS)
Dale Sweetnam, SWFSC (CPSMT)

STAT
Emmanis Dorval, NOAA / SWFSC
Kevin Hill, NOAA / SWFSC
Nancy Lo, NOAA / SWFSC
Jennifer McDaniel, NOAA / SWFSC

1) Overview

The Pacific Mackerel STAR Panel (Panel) met at the Southwest Fisheries Science Center, La Jolla, CA Laboratory from May 1-4, 2007 to review a draft assessment by the Stock Assessment Team (STAT) for Pacific Mackerel. The Panel was originally scheduled to conclude on May 3rd, however, additional time was needed and the Panel also met on the morning of May 4th. Introductions were made (see list of attendees, Appendix 1), and the Panel chair (Tom Jagielo) reviewed the Terms of Reference for CPS assessments with respect to how the STAR Panel would be conducted. Draft assessment documents, model input and output files, and extensive background material (previous assessments, previous STAR Panel reports, SSC statements, etc.) were provided to the Panel in advance of the meeting on an FTP site, which served as a timely and convenient means to distribute the material for review. The Panel chair thanked the STAT for providing the draft assessment approximately one week prior to the meeting, which provided sufficient time for review. A file server was provided at the meeting room to provide common access to all presentation material and the additional model runs that were conducted during the course of the Panel meeting.

Emannis Dorval, with assistance from Kevin Hill, led the presentation on assessment methodology. Nancy Lo gave presentations on candidate indices for the stock abundance based on: 1) an aerial spotter program GAM analysis (Appendix I to the draft assessment report), and 2) CalCOFI larval production data (Appendix II to the draft assessment report).

The previous mackerel assessment, used for PFMC management decisions for the period July 1, 2005 to June 30, 2006, used a forward-projection age-structured assessment program (ASAP) model to estimate Pacific mackerel biomass. During the meeting, the Panel reviewed an updated ASAP model, and an alternative model in SS2 provided by the STAT. Initial discussion focused on resolving differences between outputs coming from the two models.

To demonstrate continuity from the previous assessment, the STAT presented revised models in which the ASAP formulation mimicked a comparable SS2 model as closely as possible (see also Section 2 below). The discussion focused on how best to model time changing weight-at-age using SS2, after it was noted that similar estimates of 1+ biomass and recruitment could be obtained from SS2 and ASAP if these two assessment packages were based on the same set of specifications.

Despite the relatively close agreement of many of the outputs from the ASAP and SS2 model runs, detailed scrutiny of the diagnostics and outputs from the SS2 modelling runs revealed that the SS2 model invariably ran up against the harvest rate limit (0.9 and 0.95) in a number of years. Attempts to mitigate this problem were unsuccessful. This was considered to be a critical factor which prevented acceptance of the SS2 implementation. The Panel and the STAT agreed that an updated version of the ASAP model should form the basis for the 2007 assessment.

The Panel commended the STAT for their excellent presentations, well-written and complete documentation, and their willingness to respond to the Panel's requests for additional analyses.

2) Discussion and Requests Made to the STAT during the Meeting

1. The selectivity pattern for the CPFV index is based on fitting the length-frequency data for all recreational modes. The length-frequency data for the CPFV fleet should be compared with the length-frequency data from the other recreational modes to test the assumption that the selectivity pattern for the CPFV fleet is the same as that for the remaining recreational fleets. **Response**. Ultimately, the model chosen as the basecase was framed as an age-structured model obviating the need for this comparison.
2. The CalCOFI indices are based on four methods for estimating the mortality rate and the initial number of larvae (methods "1" – "4"). Methods "3" and "4" are used in cases in which it was impossible to estimate the values for these parameters using weighted non-linear regression. A sensitivity test should be conducted in which the index values based on methods "3 and "4" (which should be the least reliable) are omitted. **Response**: Given the time spent on trying to get the SS2 model to operate successfully, insufficient time remained to attempt this sensitivity analysis.
3. The CalCOFI indices are based on data for the "core" area off southern California, but mackerel spawn from Baja through to northern California. The larval densities for Mexico and the "core" area should be plotted for the years for which data on larval abundance are available for both areas. **Response**. Larval density of mackerel off Mexico is substantially higher than off the "core" area (Fig. 1a). The results of a regression of average larval densities on those for the "core" area (Fig. 1b) indicate that the CALCOFI indices for the "core" area may be able to detect years when larval abundance is high, but the relationship between the larval density for the "core" area and for the region including both Mexico and the "core" area is weak (r^2~0.1) when the two highest larval densities are ignored.
4. The design of the survey used to extend the spotter plane index covers different areas and with different design than the historical (opportunistic) surveys. In addition, estimating the tonnage per block and the proportion positives using models that include a smoothing spline on year leads to temporal correlation among the year-factors. This is inconsistent with the assumptions related to how indices of abundance are included in ASAP and SS2 assessments. Repeat the construction of the spotter plane index using a GLM model in which the survey data (2004 and 2005, years with survey data) and the data for 2003 (low number of trips) are ignored, and in which the smoothing splines on year in the models for the proportion positive and tonnes per block are replaced by a year factor. **Response**. The revised spotter plane index exhibited substantially more inter-annual variability, and the coefficients of variation for the indices were higher. The STAT replaced the original GAM index with the GLM index.
5. Examine the implications of moving from an assessment based on ASAP to one based on SS2. As a first step in this process, apply ASAP and SS2 based on model configurations that are as similar as possible so that the impact of a change in

platform can be examined. This can be achieved using the following specifications for ASAP and SS2:

ASAP configuration:

- Set the weight-at-age in the fishery to the weight-at-age in the population.
- Rescale the catch-at-age data so that the product of catch-at-age and weight-at-age (now based on that for the population) equals the total catch for each year.

SS2 configuration:

- Omit length-based selectivity – assume that selectivity is independent of length.
- Assume age-based selectivity – estimate a selectivity parameter for each age (selectivity option 14).
- Use the catch-at-age data included in the ASAP model (no length data).
- Set weight-at-age to that used in ASAP (not time-varying).
- Have one selectivity pattern only (not time-varying).
- Set selectivity for the spotter and CPFV indices to those used in ASAP.
- Set the recreational catch to 0.0001 for all years.

Response. The STAT conducted the requested analysis, setting the CVs for the ASAP run to the "tuned" values based on the SS2 analyses and setting $\sigma_R = 0.8$. The results from ASAP and SS2 were very similar for the years 1967-2004 but differed slightly for the first years of the assessment period and substantially for the years 2005 onward. The differences between the results for SS2 and ASAP after 2004 were due to the use of the forecast option in SS2, which led to recruitments substantially in excess of those expected under the deterministic stock-recruitment relationship. The Panel agreed that SS2 and ASAP lead to adequately similar results when using the same data, but the SS2 forecast file needs to be corrected for the projections beyond 2004.

6. The recreational catches are included as weights and not numbers in the SS2 assessment. The catches-in-weight are calculated from the catches-in-number under the assumption that each fish weighs 1lb on average. However, SS2 is capable of using catch data entered as catch-in-numbers. Conduct a sensitivity test in which the recreational catches are included in the assessment in the form of catch-in-numbers rather than of catch-in-weight. **Response**. The request became irrelevant once the updated ASAP model was chosen as the assessment platform.
7. The SS2 run presented to the Panel had five time blocks for length-at-age and weight-at-length. Provide the basis for the time-blocking of the growth curves by plotting the annual length-weight relationships for each block. **Response**. The STAT provided the Panel with plots of length versus weight for each year from 1962. There are between-year differences in the length-weight relationship, but it was not possible to identify a preferred time block structure.
8. Run SS2 with pre-specified year-specific growth curves and year-specific length-weight regressions. The CV of length-at-age should be based on the averages over time and the age-specific selectivity pattern for the commercial fishery should be set to three double-normal functions (one for each selectivity epoch). **Response**. The

STAT provided the Panel with several runs in which the CV of length-at-age was set to 0.166 for age 0 animals and 0.05 for age 11 animals (the maximum across years), in which $\sigma_R = 0.8$ (selected by comparing the RMSE for the recruitment residuals and the pre-specified value for σ_R), and in which the CVs assigned to the indices were tuned. The peak abundance is highly sensitive to the value assumed for σ_R. All of the analyses provided to the Panel led to exploitation rates in the 1950s, 1960s, and/or 1990s that exceeded the value permissible value (0.9 and 0.95). After many additional analyses, the Panel and STAT agreed that it would not be possible to base an assessment of Pacific mackerel on SS2 and all additional analyses were based on ASAP.

9. There are concerns with all three potential indices of abundance as they may be in conflict to some extent. Repeat the assessment in which the model is fitted to each index independently. **Response**. The STAT provided results for the ASAP analyses. The different time series are in conflict in some years. For example, the CalCOFI index exhibits an increase in the years 1996 and 1997 whereas the other indices either do not exhibit an increase or show a decline. The stock size exhibits an upturn in the last three or four years of the assessment period. This disappears when the CPFV time series is omitted and only the CalCOFI time series is used (Figure 3).
10. The three indices should be plotted together to provide a visual comparison of where the indices may be in conflict or where each contributes information to the model fit. **Response.** The STAT team produced a graph with an adequate interpretation.
11. Sensitivity runs were requested to examine the impact of varying the natural mortality rate between 0.35 and 0.7yr^{-1}. **Response.** The STAT produced graphs of initial and 1+ biomass which exhibited the expected behaviour; some instability in the model fitting was detected with *M* between 0.55 and 0.6yr^{-1}. In addition, a table of the likelihood components for the range of *M* values was produced to aid in the identification of which factors are most influenced by *M* (Figure 4).

The commercial fleet has failed to take a large proportion of the recommended Harvest Guidelines since 2001. Higher fuel costs that were not matched by comparable increases in price for product were presented as part of the explanation in conjunction with the limited availability of fish close to port. As a result of the increased fuel prices, the area of the fishery has contracted closer to shore, which may have influenced the age composition in recent years by increasing the proportion of 0+ and 1+ fish in the catches. This contraction in area has been exacerbated by spotter plane effort being redirected to higher value fisheries such as tuna.

The results from the 2007 runs based on ASAP are most similar to those from the ADEPT model conducted for assessments prior to 2006 in terms of biomass trends since 1975 (Figure 2). However, there are major differences in biomass trajectories for the years prior to 1950. The results for the 2006 and 2007 ASAP runs differ markedly in terms of biomass in the peak years, in the years prior to 1950 and in recent years. Part of the explanation for this difference is that σ_R has been increased which leads to higher biomass than in the past and because selectivity is estimated for three, rather than one epoch. The increase in biomass in the last three years is a consequence of fitting to the CPFV index; runs without this index lead to markedly less optimistic values.

3) Technical Merits and/or Deficiencies of the Assessment

It was decided to base the 2007 assessment on an ASAP model that includes three selectivity epochs and a higher value for σ_R. Unlike SS2, this model did not lead to diagnostics that were clearly problematical. However, the ASAP is not capable of including more than one fleet so the recreational catches could not be independently modelled. In addition, the ASAP model uses the same weight-at-age for the catch as for the population, which implies that any stock recruitment relationship may be biased. In order to estimate selectivity for a relative abundance index, ASAP requires that the index be associated with a particular fishery. This means there are difficulties estimating the selectivity for the larval abundance and spotter plane indices.

The Panel accepts that the ASAP E1-base model can be used as the basis for management advice and advices that the runs based on all indices included and M=0.35 and M=0.70 be used in order to bracket uncertainty.

4) Areas of Disagreement

There were no major areas of disagreement between the STAT and Panel.

5) Unresolved Problems and Major Uncertainties

Problems unresolved at the end of the meeting form the basis for some of the research recommendations in Section 6. The background to three of the main issues are given here.

1) While the best estimates of the landings off Mexico are included in the assessment, there is a continuing lack of size- and age-composition data from these catches. The 2004 STAR Panel recommended that efforts be made to obtain biological sampling data and especially catch-at-age data from the Mexican fraction of the fishery. The SWFSC began the process of acquiring this information by organizing a US-Mexico workshop in 2007 and obtaining commitments for data provision in time for future assessments. The size and age composition data from the San Pedro fishery are presently assumed to be representative of the whole stock. In addition, two of the indices of relative abundance used in the assessment (the CalCOFI larval survey and the CPFV recreational data) only relate to the Southern Californian Bight. The spawning area is known to extend south to the tip of Baja California. Obtaining data from the Mexican fishery, including the Mexican larval surveys (IMECOCAL) might help remove this important source of uncertainty.
2) There is currently no true fishery-independent index of relative abundance for the whole stock and there are concerns with the three indices used in the present assessment.
   a. The CalCOFI larval surveys are often relatively poor at finding Pacific mackerel larvae. Whether these surveys and the estimates of larval production at hatching constitute representative estimates of the spawning stock size of mackerel is uncertain, especially because the area surveyed is only a fraction of the total spawning region. Obtaining access to the Mexican larval survey data (IMECOCAL) may help solve this problem. In addition, the occurrence of larvae can be limited to one or two size classes in years of relatively low

abundance, which compromises the estimation of the larval production at hatching for those years.

b. The aerial spotter index, up until 2002, provides an opportunistic method for estimating relative abundance. The structure of the index includes an estimate of area based on the number of 10’ x 10’ blocks surveyed, but this number varies from year to year, and includes coastal blocks which are not strictly 10’ x 10’. This acts as a source of uncertainty among years. A further problem with the spotter plane index of abundance is that the design of the sampling changed after 2002. Specifically, a fishery-independent aerial survey was begun in 2004 using a grid search pattern with the added freedom to search for more fish if a school of fish is found. However, the adherence of the pilots to the sampling grid has yet to become stable. The very different sampling strategy used prior to 2003 means that it is questionable whether this new time series can be combined in a meaningful way with the earlier one.

c. The CPFV index is based on the logbook data from the CPFV fleet for California (although limited data do exist for Mexico). Given that it is fishery-dependent data, its use in the assessment as an index of stock abundance is predicated on the assumption that catchability has not changed over time. While this is a concern for all indices of abundance based on fishery-dependent data, the fact that mackerel is not a target species for the CPFV fleet suggests that this assumption may be acceptable in this case.

3) Ageing error rates (see Table 1) indicate substantial imprecision and /or bias, particularly for the younger age-classes (0 and 1), which currently constitute a large fraction of the catch. The impact of this error rate will only become apparent once an ageing error matrix is included in the assessment.

6) Research Recommendations

A. One of the major uncertainties associated with the assessment is that no account is taken of ageing error. SS2 can include an age-reading error matrix. The data from age-reading studies should be used to construct an age-reading error matrix for inclusion in future (SS2) assessments. However, there are currently very few otoliths that have been read multiple times so additional readings need to be made. In the longer-term, an age validation study should be conducted for Pacific mackerel. Such a study should compare age readings based on whole and sectioned otoliths and consider a marginal increment analysis.

B. The next assessment should continue to examine the possibility of using SS2 as the assessment platform. The analyses presented to the Panel suggested that ASAP and SS2 lead to similar outcomes when configured in a similar manner. However, SS2 deals better with indices that are not tied directly to a fishery, can include age-reading error, and allows weight-at-age in the catch to differ from weight-at-age in the population. In principle, it should be easier to represent uncertainty using the MCMC algorithm for assessments based on SS2.

C. The construction of the spotter plane index is based on the assumption that blocks are random within region (the data for each region is a “visit” by a spotter plane to a block in that region). The distribution of density-per-block should be plotted or a random effects model fitted in which block is nested within region to evaluate this assumption (e.g. examine whether certain blocks are consistently better or worse than the average).

D. The data on catches come from several sources. The catch history from 1926-27 to 2006-07 should be documented in a single report.
E. Conduct a study to update the information used to determine maturity-at-length (and maturity-at-age).
F. A large fraction of the catch is taken off Mexico. In particular, catches of mackerel have been as large as those off California in recent years. Efforts should continue to be made to obtain length, age and biological data from the Mexican fisheries for inclusion in stock assessments. Survey data (IMECOCAL program) should be obtained and analyses conducted to determine whether these data could be combined with the CalCOFI data to construct a coastwide index of larval abundance.
G. The SS2 assessment is based on fitting to age-composition data for the commercial fishery. Future SS2 assessments should consider fitting to the length composition and the conditional age-at-length information. This will require estimating time-varying growth curves and may require multiple time-steps within each year.
H. The CalCOFI data should be reviewed further to examine the extent to which CalCOFI indices for the "core" area can be used to provide information on the abundance of the coastwide stock.
I. There are uncertainties regarding the early biological and fishery data. The Panel reiterates the recommendation of the 2004 STAR Panel that consideration should be given to initiating the assessment model in a more recent year (e.g. 1978).
J. The concern of the 2004 STAR Panel that fishery-based weights are used to estimate population parameters has still not been addressed. Future assessments should attempt to estimate a population growth curve in order, for example, to estimate the time-trajectories of 1+ and spawning biomass.

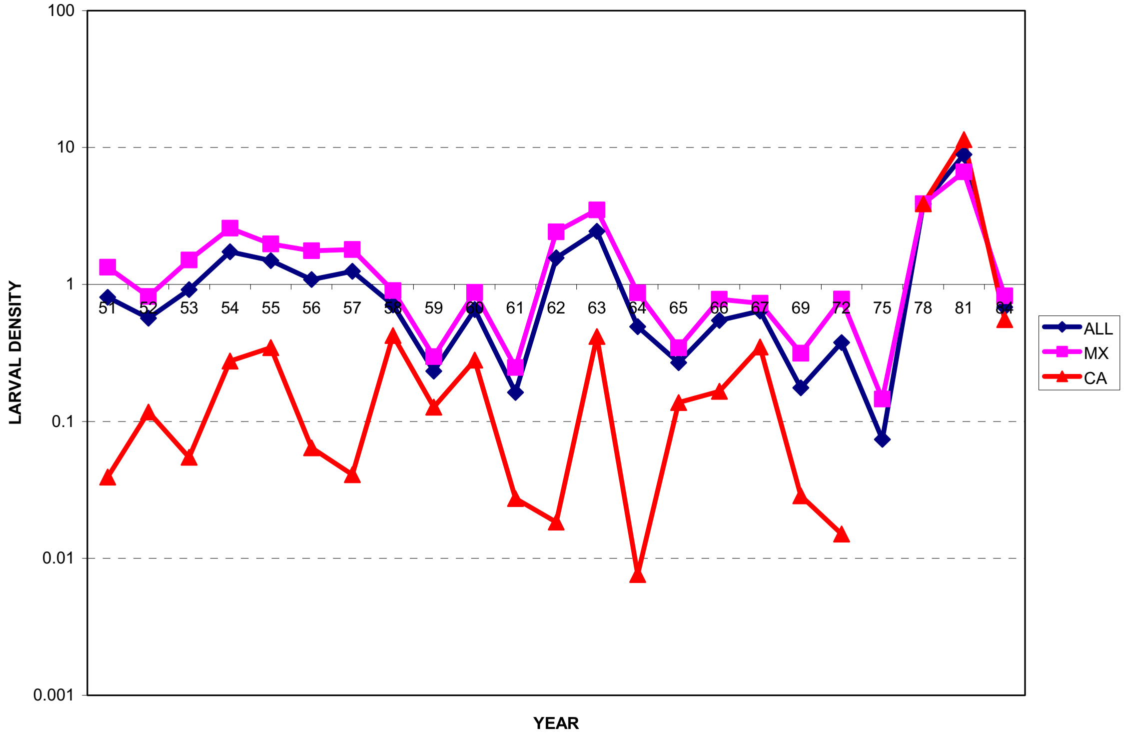


Figure 1a. Coastwide larval densities (diamonds), larval densities off Mexico (squares), and larval densities for the "core" area (results based on CalCOFI surveys that covered Mexico and the "core" area (1951-1984)).

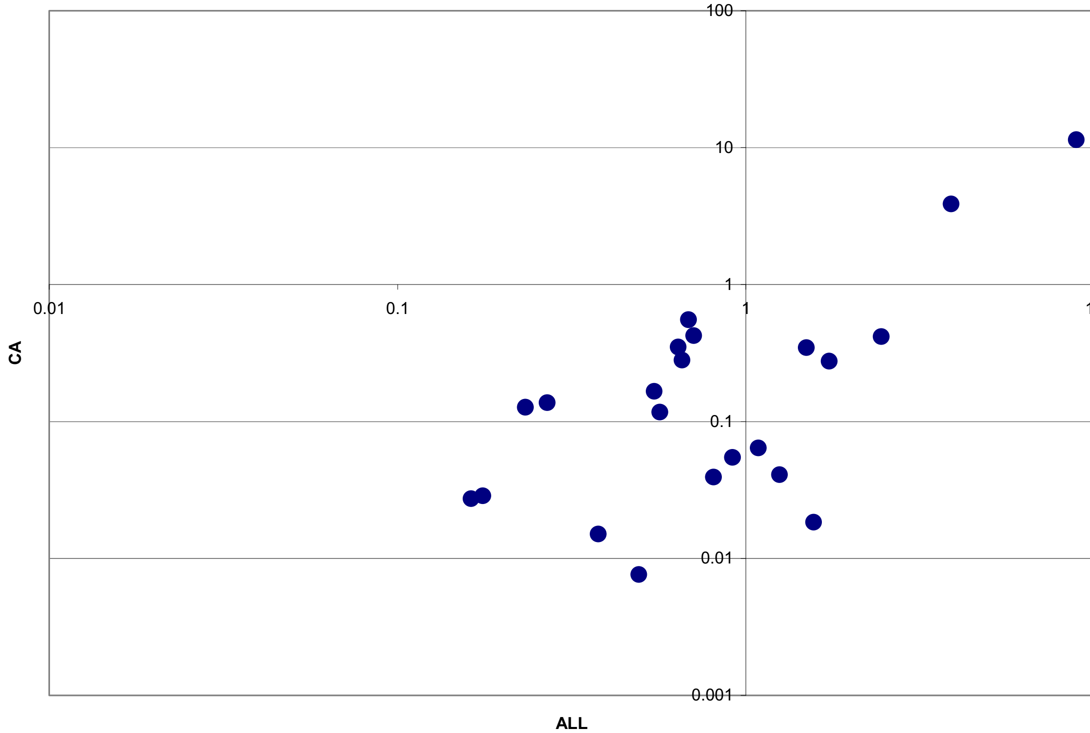


Figure 1b. Average larval densities (Mexico and the "core" area) versus larval densities for the "core" area based on CalCOFI surveys that covered Mexico and the "core" area (1951-1984).

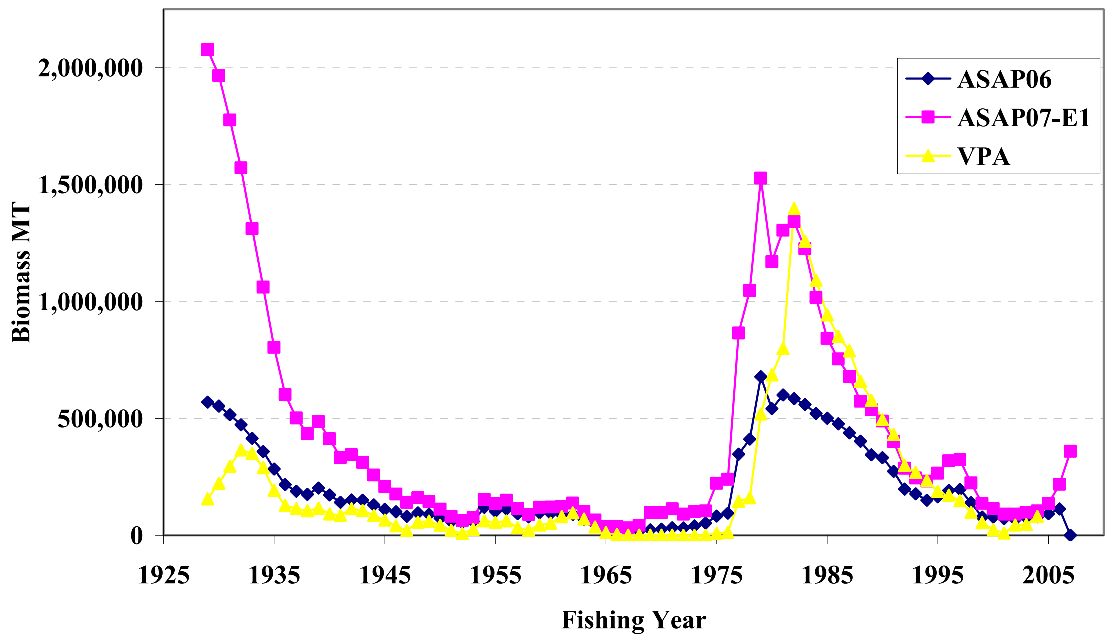


Figure 2. Estimated biomass (age 1+ fish, B in mt) of Pacific mackerel generated from the VPA (2006 assessment), and the ASAP-BaseCase model for the 2007 assessment.

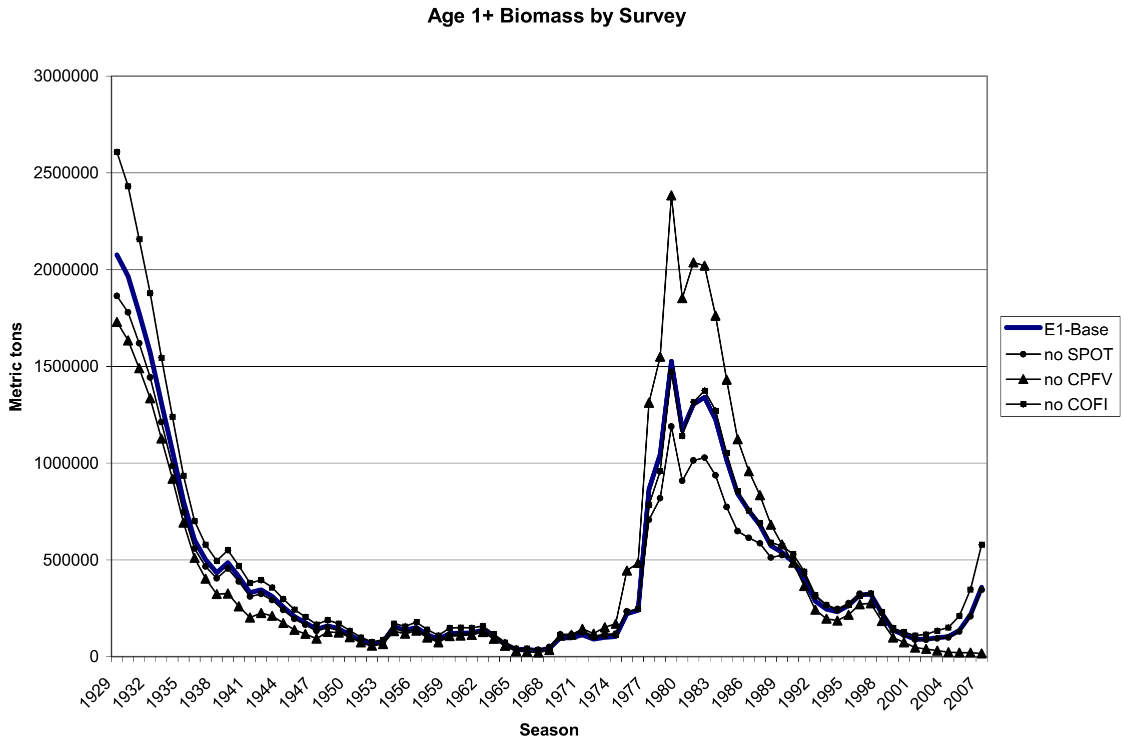


Figure 3. Sensitivity of Base-Case ASAP Model to Indices of Abundance.

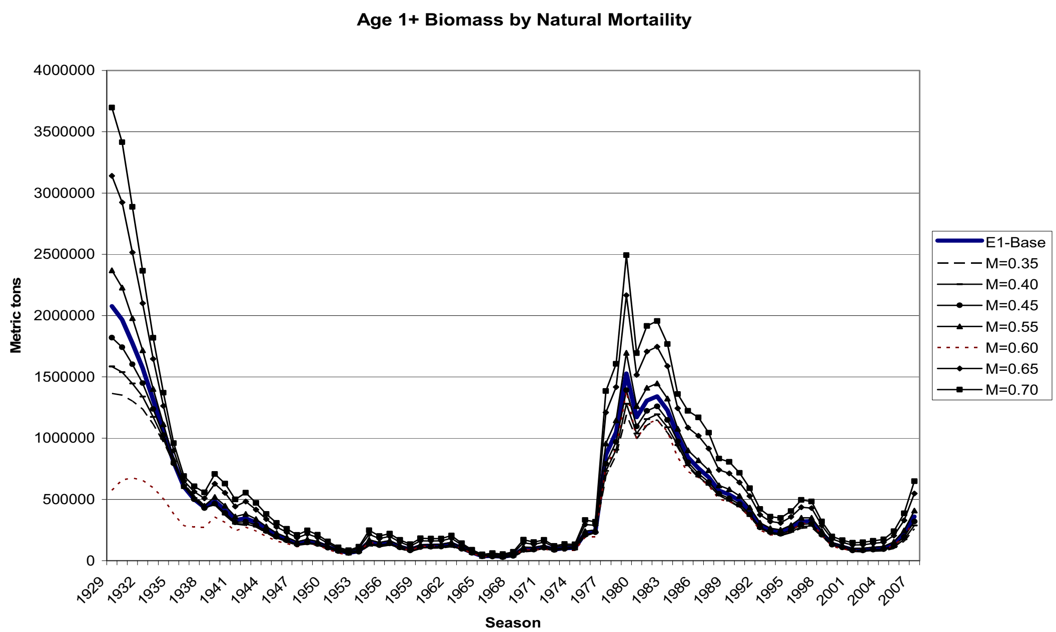


Figure 4. Sensitivity of Base-Case ASAP Model to Natural Mortality.

Table 1
Measures of age-reading error

	Age							
	0	1	2	3	4	5	6	7+
APE	0.298	0.276	0.158	0.150	0.139	0.112	0.111	0.096
CV	0.888	0.758	0.447	0.423	0.408	0.338	0.343	0.286

Appendix 1

STAR Panel Members in Attendance
Mr. Tom Jagielo (Chair), SSC - Washington Department of Fish and Wildlife
Dr. André Punt, SSC - University of Washington
Dr. Malcolm Haddon, CIE - University of Tasmania
Mr. Dale Sweetnam, CPSMT - California Department of Fish and Game
Ms. Diane Pleschner-Steele, CPSAS - California Wetfish Producers Association

STAT Members in Attendance
Dr. Emmanis Dorval, NMFS, Southwest Fisheries Science Center (SWFSC)
Dr Kevin Hill, NMFS, SWFSC
Dr. Nancy Lo, NMFS, SWFSC
Ms. Jennifer McDaniel, NMFS, SWFSC

Others in Attendance
Mr. Mike Burner, Pacific Fishery Management Council
Dr. Ray Conser, NMFS, SWFSC
Dr. Paul Crone, NMFS, SWFSC
Dr. Sam Herrick, NMFS, SWFSC
Mr. Jason Larese, NMFS, SWFSC
Dr. Mark Maunder, Inter-American Tropical Tuna Commission (IATTC)
Dr. Kevin Piner, NMFS, SWFSC
Mr. Alexandre Silva, IATTC

Pacific Mackerel

STAR Panel Meeting Report

NOAA / Southwest Fisheries Science Center
La Jolla, California
September 18-21, 2007

STAR Panel
André Punt, University of Washington (Chair)
Tom Barnes, CDF&G (SSC representative)
John Casey, Cefas (CIE)

PFMC
Diane Pleschner-Steele (CPSAS)
Brian Culver (CPSMT)

STAT
Emmanis Dorval, NOAA / SWFSC
Kevin Hill, NOAA / SWFSC
Jennifer McDaniel, NMFS, SWFSC

1) Overview

The Pacific Mackerel STAR Panel (Panel) met at the Southwest Fisheries Science Center, La Jolla, CA Laboratory from September 18-21, 2007 to review a draft assessment by the Stock Assessment Team (STAT) for Pacific Mackerel. Introductions were made (see list of attendees, Appendix 1), and the Panel chair (André Punt) reviewed the Terms of Reference for CPS assessments with respect to how the STAR Panel would be conducted.

The focus for the review was methodological (to determine whether the 2008 assessment should be conducted using SS2 rather than ASAP) because the harvest guideline for 2007-08 has already been set by the Council based on a 2007 assessment conducted using ASAP. Draft assessment documents, model input and output files, and extensive background material (previous assessments, previous STAR Panel reports, SSC statements, etc.) were provided to the Panel. The draft assessment document was only provided to the Panel on 13 September, well after the two-week deadline for the submission of documents. This did not, however, preclude a thorough review of the material.

The May 2007 Mackerel STAR Panel reviewed an updated ASAP model, and an alternative model in SS2 provided by the STAT. However, despite the relatively close agreement of many of the outputs from the ASAP and SS2 model runs, detailed scrutiny of the diagnostics and outputs from the SS2 modelling runs revealed that the SS2 model invariably ran up against the harvest rate limit (0.9 and 0.95) in a number of years. Attempts to mitigate this problem were unsuccessful and the May 2007 Panel was unable to recommend the use of SS2 for the 2007 assessment. The May 2007 Panel recommended that work continue to examine the possibility of using SS2 as the assessment platform. The analyses presented to the May 2007 Panel suggested that ASAP and SS2 lead to similar results. However, SS2 is to be preferred (at least in principle) because it deals better with indices that are not tied directly to a fishery, can include age-reading error, and allows weight-at-age in the catch to differ from weight-at-age in the population. In principle, it should be easier to represent uncertainty using the MCMC algorithm for assessments based on SS2.

Emannis Dorval (NOAA, SWFSC) gave a presentation on the draft assessment, with assistance from Dr Kevin Hill (NOAA, SWFSC). This assessment addresses several of the recommendations from the May 2007 Panel, namely: (a) the model operates on a quarterly time-step, (b) allowance is made for age-reading error, (c) allowance is made for the weight-at-age in the catch to differ from that in the fisheries, (d) the assessment estimates growth (multiple time blocks) by fitting to catch length-frequency data and conditional age-at-length data, (e) selectivity for the CPFV index is set to that for the recreational fishery, which is now estimated. The draft assessment presented to the May 2007 Panel started in 1935 (the earliest year for which catch-at-age data are available). However, the present assessment started in 1962, the first year for which index data are available.

The Panel focused on differences between the ASAP and SS2 models, in particular, why the initial SS2 base-model estimates much larger 1976 and 1978 cohorts than appears to be plausible. The Panel requested that the STAT examine models with many selectivity and growth time-blocks, in particular because the 1976 cohort was spawned during a period when growth was much faster than is the case at present, meaning that age-selectivity may have been higher for the 1976 than for subsequent cohorts.

The STAT provided several model runs based on SS2 to attempt to identify a base-model which fits the indices adequately, which are consistent with the patterns in the catch-at-age data, and which lead to plausible levels of biomass. However, the SS2 results were very sensitive to changes to model specifications (e.g. time-varying growth, and time-varying selectivity) and to changes to the data (e.g. removing length-composition data for one year changes the relative pattern of recruitment strength as well as recruitment in absolute terms substantially), and none of the model configurations fitted the data adequately. Appendix 2 provides a subset of the results considered during the Panel, illustrating some of the difficulties with the models examined.

The Panel concludes that although considerable progress has been made toward implementing the Pacific mackerel assessment in SS2, it seems likely that much work remains before an acceptable model configuration will be identified. The Panel continues to support further work on an SS2-based mackerel assessment, but recommends that the assessment for mackerel (and hence the basis for management advice) continue to be based on the ASAP platform until a future STAR Panel reviews and approves an SS2-based assessment that is better and more robust than the current ASAP-based assessment.

The Panel believes that the Pacific mackerel assessment will be improved not only by exploring alternative models, but also by: a) refining the indices of abundance (which are all currently subject to considerable uncertainty), b) a more thorough review of the basic age- and length-composition data on which the analyses are based (e.g. to ensure that the length-frequency information is representative of the fishery removals), and c) modifying the SS2 modelling environment (e.g. allowing for cohort-specific growth parameters). The opinion of the Panel is that it could be possible to complete these tasks by 2009. If progress is sufficient, another mackerel Panel could be scheduled for May 2009 (so that the management advice for the 2009-10 harvest guideline could be based on a new assessment platform).

The Panel commended the STAT for their excellent presentations, well-written documentation, and their willingness to respond to the Panel's requests for additional analyses. The number of requests that could be accomplished during the Panel meeting was, however, limited by the focus on Pacific sardine and because the analysts for mackerel were also members of the sardine STAT.

2) Discussion and Requests Made to the STAT during the Meeting

Set #1

A. Reduce the plus group for ages from 14 to 12 yr, reduce the plus group for lengths from 60 to 45 cm and truncate the length data used in the assessment at 11 cm.

Reason: There are no age data for 60 cm fish, and few fish greater than 45 cm are found in the commercial and recreational catches. Also, this will speed up the model runs.

Response: The STAT completed this task as requested.

B. Conduct a sensitivity analysis to examine assumptions regarding selectivity and growth on the sizes of the 1976 and 1978 year classes based on the assumption σ_R = 0.8. Assume that all selectivity patterns are dome-shaped.

   Reason: The Panel was concerned that the sizes of the extremely large 1976 and 1978 cohorts were due to the choice of how selectivity and growth were parameterized.

   Response: The STAT provided results based on time-varying *K*, but pre-specified the initial length of each cohort. The sizes of the 1976 and 1978 year-classes remained unrealistically high.

C. Compare the implied age-structure of the catch for the commercial fleet to the observed catch age-structure for this fleet.

   Reason: This would show how well the model is matching the age data (visual examination of the fits to the conditional age-at-length data is difficult).

   Response: The estimates of recruit strength were very implausibly high so the Panel did not consider these results in detail as the reasons for the unrealistic estimates of recruitment needed to be resolved before detailed examination of model residuals was warranted.

D. Move the fit of the model to the spawning index from quarter 1 to quarter 4.

   Reason: The model needs to be self-consistent concerning the timing of spawning. Since spawning actually occurs in quarter 4, this would also eliminate the need to account for mortality between the two periods.

   Response: The STAT completed this task; there was no major change to the results.

E. Set effective sample size for the length-frequency and conditional age-at-length data to the number of landings sampled, or as the number of fish divided by 25.

   Reason: The STAT intended to define the effective sample sizes as the number of fish divided by 25, but this was not done in the base run supplied to the Panel.

   Response: The effective sample sizes used in the SS2 analyses were updated to reflect the intended effective sample sizes.

Set #2

F. Conduct an age-based run using the re-weighted catch-at-age data pre-specifying length-at-age [e.g. from run G4] (i.e. ignoring the length-frequency data and conditional age-at-length data). Create selectivity blocks for 1962-68, each year for 1969-85, and 1986-2006. Set σ_R=0.8 and A_{min} = 0.25.

Reason: The Panel wished to assess whether the reason for the strong 1976 and 1978 year-classes was related to the length data and misspecification of growth.

Response: The STAT conducted an analysis with three time blocks (1962-68, 1969-85, and 1986-2006). The 1976 and 1978 cohorts remained unrealistically large.

G. Conduct a length-based run using the re-weighted length-frequency data. Estimate a single selectivity pattern and time-varying growth (time blocks as for request #F); treat all three growth parameters as estimable. Set σ_R=0.8 and A_{min} = 0.25.

Reason: The Panel wished to assess whether the reason for the large 1976 and 1978 year-classes was time-varying growth.

Response: The pattern of length-at-age followed the empirical data on length-at-age. The sizes of the 1976 and 1978 were much reduced compared to the initial base model, but still appeared to be unrealistically large. The model still failed to fit the index points for the 1970s.

H. Conduct three model runs based on model G4 (except σ_R=0.8 and A_{min} = 0.25): a) remove the length-frequency data for 1976, b) remove the length-frequency data for 1976-77, and c) remove the length-frequency data for 1976-78.

Reason: The Panel wished to assess whether the reason for the very strong 1976 and 1978 year-classes related to the length-frequency data for particular years.

Response: Leaving out the 1976 length-frequency data led to a qualitative change to the assessment outputs. In particular, the magnitude of the 1976 cohort was reduced substantially from model G4, selectivity for recent years was asymptotic, and the fit to the CPFV and CalCOFI indices was improved. Leaving the 1976 and 1977 data out of the assessment led to asymptotic selectivity for the first selectivity block, and even more reduced abundance of the 1976 cohort. The fit to the CPFV index also improved. Leaving out the 1976-78 length data led to lower estimates of the 1976 cohort, but not the 1978 cohort. Visual examination of the catch-at-age data does not support a very strong 1976 cohort.

The STAT provided an additional model run in which selectivity is age-specific (estimated separately for each age), there is one growth curve, and the model is fitted to conditional age-at-length data. However, this analysis also led to implausibly large estimates of recruitment.

3) Technical Merits and/or Deficiencies of the Assessment

Conducting the assessment using SS2 (potentially) addresses many of the concerns identified by previous STAR Panels with the ASAP model. However, the STAT could not identify a model configuration that was a viable base-model.

4) Areas of Disagreement
There were no areas of disagreement between the STAT and Panel.

5) Unresolved Problems and Major Uncertainties
Despite considerable effort by the STAT, none of model runs presented to the Panel led to adequate fits to the index data or to plausible levels of biomass. In addition, the SS2 results were very sensitive to changes to the specifications of the model (e.g. time-varying growth, and time-varying selectivity) and to changes to the data (e.g. removing length-composition data for one year substantially changed the relative pattern of recruitment strength as well as recruitment in absolute terms).

The Panel wishes to highlight that all three indices of abundance are subject to considerable uncertainty and there are major concerns regarding the suitability of each as an index of relative abundance for mackerel. The May 2007 Panel report provides a detailed discussion of these concerns (see Appendix 3). Another major uncertainty associated with the assessment is the lack of data for the Mexican fishery. In particular, there are no composition data for the Mexican fisheries, and the length and age-compositions of the Mexican landings consequently had to be assumed to be the same as those of the U.S. fishery. The extent to which the length-frequencies (particularly those for the moratorium years) are representative of the fishery landings is also uncertain (and is consequential – leaving the 1976 length-frequency out of the assessment changed the relative strengths of 1976 and 1978 cohorts markedly).

6) Concerns raised by the CPSMT AND CPSAS representatives during the meeting
The CPSMT and CPSAS did not have additional concerns.

7) Research Recommendations
The Panel identified research recommendation, and endorsed the recommendations from the May 2007 Panel that are still outstanding.

Recommendations arising from the current Panel

A. Much of the Panel's time was spent dealing with data-related issues and the Panel recommends that standard data processing procedures be developed for CPS species, similar to those developed for groundfish species.
B. There is a need to review the raw data on which the length-frequency distributions are based to ensure that the data included in the assessment are representative of the catches.
C. The following additional sensitivity tests were identified during the Panel meeting, but were not completed given the other concerns with the draft assessment. The Panel recommends that these sensitivity runs form part of any future analyses:
    1. Re-compute the CPFV Delta GLM using data for those years that are included in the assessment [The Delta GLM currently starts in 1935. The data on which the CPFV index is based therefore includes data for years not included in the assessment. It is possible that the stock may have been behaving differently in the past than in more recent years.]

2. Initialize the model by estimating the initial age structure rather than by specifying an equilibrium catch. [The assumption that the population was in equilibrium given a pre-specified catch in 1962 seems unrealistic, and leads to a very high exploitation rate in the first quarter of the assessment period.]
3. Reduce the additive CVs for each index to zero for each index in turn. [The current base model adds a CV of 1.5 to the CalCOFI and spotter indices, which effectively means that they are little more than noise. Consequently, the CPFV index is the only one being fit (to some extent). This exercise would show how each index would influence the results if it were given more weight.]
4. Start the model in 1970. [1962 is the middle of a period of fairly high catches]

Recommendations arising from the May 2007 Panel

A. There are currently very few otoliths that have been read multiple times so additional readings need to be made. In the longer-term, an age validation study should be conducted for Pacific mackerel. Such a study should compare age readings based on whole and sectioned otoliths and consider a marginal increment analysis.
B. The construction of the spotter plane index is based on the assumption that blocks are random within region (the data for each region is a "visit" by a spotter plane to a block in that region). The distribution of density-per-block should be plotted or a random effects model fitted in which block is nested within region to evaluate this assumption (e.g. examine whether certain blocks are consistently better or worse than the average).
C. The data on catches come from several sources. The catch history from 1926-27 to 2006-07 should be documented in a single report.
D. Conduct a study to update the information used to determine maturity-at-length (and maturity-at-age).
E. A large fraction of the catch is taken off Mexico. In particular, catches of mackerel have been as large as those off California in recent years. Efforts should continue to be made to obtain length, age and biological data from the Mexican fisheries for inclusion in stock assessments. Survey data (IMECOCAL program) should be obtained and analyses conducted to determine whether these data could be combined with the CalCOFI data to construct a coastwide index of larval abundance.
F. The CalCOFI data should be reviewed further to examine the extent to which CalCOFI indices for the "core" area can be used to provide information on the abundance of the coastwide stock.

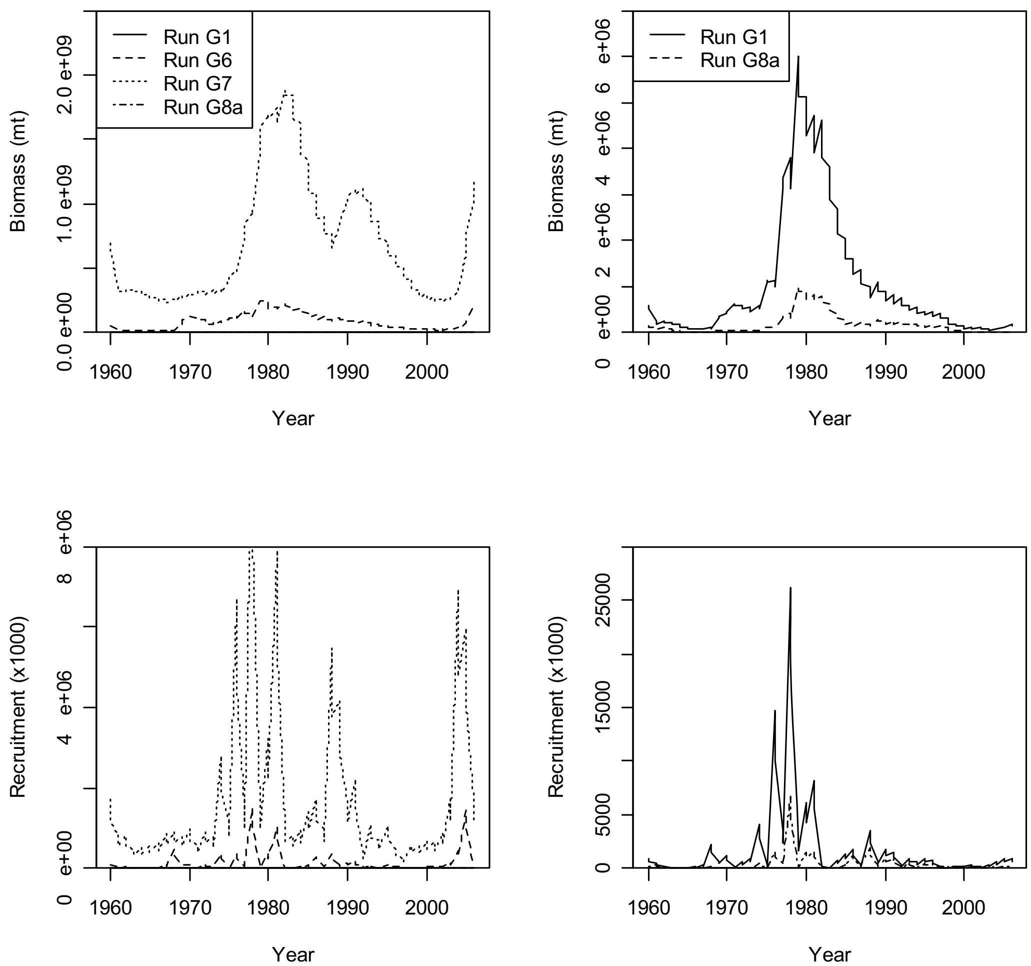
Appendix 1

STAR Panel Members in Attendance
Dr. André Punt, (Chair), SSC - University of Washington
Mr Tom Barnes, SSC – CDF&G
Dr John Casey, CIE – CEFAS (UK)
Mr Brian Culver, CPSMT - WDFW
Ms. Diane Pleschner-Steele, CPSAS - California Wetfish Producers Association

STAT Members in Attendance
Dr Kevin Hill, NMFS, SWFSC
Dr. Emmanis Dorval, NMFS, SWFSC
Dr. Nancy Lo, NMFS, SWFSC
Ms. Jennifer McDaniel, NMFS, SWFSC

Others in Attendance
Mr. Dale Sweetnam, CDF&G
Mr Richard Carroll, Ocean Gold Seafoods
Mr Bev Macewicz, NMFS, SWFSC
Dr. Ray Conser, NMFS, SWFSC
Dr. Paul Crone, NMFS, SWFSC
Dr. Sam Herrick, NMFS, SWFSC

Appendix 2
Example results from four of the model configurations presented to the Panel



Model G1: time-varying length-based selectivity (blocks 1962-69; 1970-77; 1978-06); time-varying growth (1962-69; 1970-77; 1978-06); length compositions based on 57 bins (4-60+cm); age-at-length compositions based on ages 0-11+; spawning biomass is in season 4. This was the initial base-model.

Model G4: as for model G1, except that growth for 1962-68 and 1986-06 is pre-specified and growth for 1969-85 is estimated separately for each year, the length compositions are based on 35 bins (11-45+ cm), the age-at-length compositions are based on ages 0-11+, A_{min} =0.5, and the spawning biomass is in season 1;

Model G7: as for model G4, except that selectivity is age-specific, there is a single growth curve with pre-specified parameters, and model is fitted to length composition data for CPFV fleet and the age-composition data for commercial fleets (ages 0-11+).

Model G8a: as for model G4, expect that growth is estimated for all three time-blocks, and the length-frequency data for 1976 are ignored.

Appendix 3

Except from the May 2007 Pacific Mackerel STAR Panel Report

There is currently no true fishery-independent index of relative abundance for the whole stock and there are concerns with the three indices used in the present assessment.

1. The CalCOFI larval surveys are often relatively poor at finding Pacific mackerel larvae. Whether these surveys and the estimates of larval production at hatching constitute representative estimates of the spawning stock size of mackerel is uncertain, especially because the area surveyed is only a fraction of the total spawning region. Obtaining access to the Mexican larval survey data (IMECOCAL) may help solve this problem. In addition, the occurrence of larvae can be limited to one or two size classes in years of relatively low abundance, which compromises the estimation of the larval production at hatching for those years.

2. The aerial spotter index, up until 2002, provides an opportunistic method for estimating relative abundance. The structure of the index includes an estimate of area based on the number of 10' x 10' blocks surveyed, but this number varies from year to year, and includes coastal blocks which are not strictly 10' x 10'. This acts as a source of uncertainty among years. A further problem with the spotter plane index of abundance is that the design of the sampling changed after 2002. Specifically, a fishery-independent aerial survey was begun in 2004 using a grid search pattern with the added freedom to search for more fish if a school of fish is found. However, the adherence of the pilots to the sampling grid has yet to become stable. The very different sampling strategy used prior to 2003 means that it is questionable whether this new time series can be combined in a meaningful way with the earlier one.

3. The CPFV index is based on the logbook data from the CPFV fleet for California (although limited data do exist for Mexico). Given that it is fishery-dependent data, its use in the assessment as an index of stock abundance is predicated on the assumption that catchability has not changed over time. While this is a concern for all indices of abundance based on fishery-dependent data, the fact that mackerel is not a target species for the CPFV fleet suggests that this assumption may be acceptable in this case.

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON PACIFIC SARDINE AND PACIFIC MACKEREL MANAGEMENT

Pacific Sardine

The Scientific and Statistical Committee (SSC) reviewed the Pacific sardine stock assessment and Stock Assessment Review (STAR) Panel report. An overview of the stock assessment was provided to the SSC by Dr. Kevin Hill. Recent assessments of sardine were based on the forward projection age-structured assessment program (ASAP) and the September 2007 STAR Panel review focused on new assessment results based on the Stock Synthesis 2 (SS2) model platform. The STAR Panel concluded that the ASAP model had a number of difficulties that SS2 was able to overcome, including: 1) allowance for some sardine to spawn at age-0, 2) differences in timing of the fisheries throughout the range, 3) estimation of initial conditions, 4) variability in weight-at-age among fisheries and between the fishery and population, and 5) log-normal bias correction for the stock-recruitment relationship. Residual patterns in the fit to the length frequency data were also removed using SS2 and model fits to the survey index data were improved. Based on these improvements in the sardine model, the SSC concurs with the STAR and Stock Assessment Team (STAT) that results from SS2 providing a better basis for modeling sardine population dynamics.

Conversion of the Pacific sardine assessment into the SS2 modeling framework produced assessment results that are less optimistic about current stock status than that based on the 2006 ASAP assessment. In particular, age 1+ Pacific sardine biomasses are at lower levels and have declined more precipitously in recent years. This trend in biomass is largely driven by SS2 estimates of recruitment which show strong 1997 and 1998 cohorts and a weaker 2003 cohort. Recent cohorts estimated by SS2 appear to be weaker compared to the ASAP model estimates. Differences in 2007 SS2 and 2006 ASAP assessment results were identified to be largely driven by new data (a sharp decline in the daily egg production method [DEPM] index of abundance from 2006 to 2007). Treatment of the data (quarterly partition of the length and conditional age compositions) in SS2 as well as other factors including model structure, weighting, and a revised survey index also contributed to differences from the last assessment.

Major uncertainties in the assessment were identified. The assessment assumes that indices of spawning biomass for the “standard” survey area are linearly proportional to total spawning biomass, which has yet to be verified. The assessment lacks fishery independent data from the Pacific Northwest. A routine, coastwide survey would greatly improve the assessment of the sardine population. Historic information on sardine is extensive and efforts should be directed at evaluating and, if deemed reliable, incorporating it into future assessments.

Lack of catch data from Mexico makes total removals for recent years uncertain. Stock structure for sardine continues to be a major source of uncertainty, and southern sub-population catches may have contributed to the unusually high 1985 catches. Finally, the value of natural mortality is uncertain. Uncertainty in the assessment was captured by a lower and upper value for natural mortality, M=0.3 and M=0.5.

The SSC acknowledges the improvement of the sardine assessment with the use of SS2 and commends the STAT on their work. The SSC endorses the sardine stock assessment as the best available science and its use for management. The STAR Panel recommended that consideration should be given to holding the next STAR Panel for sardine in 2009 rather than 2010. The SSC concurs with this.

Pacific Mackerel

The SSC reviewed the STAR Panel report for Pacific mackerel. The STAR Panel review held in September 2007 focused only on assessment methodology, specifically on whether future mackerel assessments should be conducted using the SS2 platform. The STAR Panel concluded that the use of SS2 would be preferred (in principle), but that model results produced unrealistically high exploitation rates. The SSC recommends that continued effort be directed at developing an acceptable SS2 model configuration. If sufficient progress is made, a new mackerel stock assessment could be scheduled for May 2009 to establish harvest guidelines for the 2009-2010 fishery season. The SSC agrees with the recommendations of the STAR Panel and notes that 2008 harvest guidelines have already been set by the Council based on the 2007 assessment conducted using ASAP.

PFMC
11/07/07

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON PACIFIC MACKEREL MANAGEMENT FOR 2008-2009

The Scientific and Statistical Committee (SSC) received a presentation on the 2008 Pacific mackerel stock assessment by Dr. Emmanis Dorval. In addition, Dr. Tom Helser briefed the SSC on the results of an assessment review that was sponsored by the Council on May 13, 2008, in Long Beach, CA. The review was conducted by two members of the Coastal Pelagic Species (CPS) sub-committee of the SSC, and several members of the CPS Management Team.

The last full assessment of Pacific Mackerel occurred during May 2007 and the current assessment was prepared as an update assessment. The SSC considers that the assessment has satisfied the Terms of Reference for a CPS Stock Assessment update because (a) the base model that was selected and approved at the 2007 Stock Assessment Review (STAR) Panel formed the basis for the update assessment, (b) this assessment used the same model structure and estimation framework (ASAP) as the last full assessment, and (c) only updates to the data used during the 2007 full assessment were included in the updated assessment. The updated assessment included revised catch landings, catch-at-age and weight-at-age data for 2006-07, and new 2007-08 data. The assessment was based on three indices of abundance (California Cooperative Oceanic Fisheries Investigations [CalCOFI], commercial passenger fishing vessel [CPFV] and spotter). Only one of the indices of abundance (CPFV) was updated to include data for 2007-08. The CPFV index is now the primary index of abundance for Pacific mackerel, but is based on fishery-dependent sampling and is therefore subject to the concerns associated with such data. In addition, the CPFV index may not reflect trends in abundance for the southern portion of the range.

Dr. Dorval indicated that the stock assessment team (STAT) intends to continue to investigate an SS2-based Pacific mackerel assessment. If completed, an SS2-based assessment should be reviewed at a May 2009 STAR Panel. The SSC also notes that the ASAP model has been updated and that some of its new features may be useful for the Pacific mackerel assessment. Should the work on SS2 modelling for Pacific mackerel prove problematic, the updated ASAP model should be considered as a possible alternative modelling platform.

The SSC endorses the update assessment as the best available science and its use in Council management decisions. Based on the Council's harvest control rule, the acceptable biological catch (ABC) and maximum allowable harvest guideline for Pacific mackerel from the update assessment is 51,772 mt.

PFMC
6/9/08

COASTAL PELAGIC SPECIES MANAGEMENT TEAM STATEMENT ON PACIFIC SARDINE AND PACIFIC MACKEREL MANAGEMENT

Pacific Sardine

The Coastal Pelagic Species Management Team (CPSMT), along with the Coastal Pelagic Species Advisory Subpanel, received an overview of the assessment for Pacific sardine from Dr. Kevin Hill. The CPSMT agrees that the base model forwarded by the Stock Assessment Review Panel and endorsed by the Scientific and Statistical Committee represents the best available science to inform management of the West Coast sardine fishery. Based upon the 832,706 mt age 1+ biomass from the assessment, the Council's harvest control rule produces an acceptable biological catch (ABC) for the 2008 fishery of 89,093 mt. This ABC is 42% less than the 2007 ABC/harvest guideline (HG) adopted by the Council.

The CPSMT recognizes that there are substantial differences in the presentation of uncertainty in the Coastal Pelagic Species (CPS) models as compared to groundfish decision tables the Council receives to select appropriate harvest values. Due to the dynamic annual fluctuations in CPS like sardines, forward projections to evaluate impacts of different catches are not practicable, so the CPSMT cannot characterize the biological risk associated with adopting harvest levels different than the base model. The CPSMT notes that the uncertainty associated with forward projections is precisely the reason sardine assessments are conducted annually.

The base model uses alternative values of natural mortality (M) as one axis to bracket the uncertainty around the point estimate of biomass. The CPSMT deliberated whether the range of biomass values resulting from the profile across different values of M represent alternate states of nature to be incorporated in the Council's selection of a sardine ABC, or rather a within-model evaluation of uncertainty. The CPSMT recognizes that, as with all models, other areas of uncertainty exist (e.g., stock structure, changes in geographic spawning area), but that such uncertainties are largely qualitative and difficult to quantify.

In view of the distinct possibility that each seasonal allocation of the annual HG could be reached prematurely, the CPSMT recommends that incidental catch set asides be established for each allocation period (as set forth in Table 1), and an incidental catch allowance be established for sardines caught in other fisheries once the seasonal allocation is reached. Without the incidental catch set aside, a greater potential exists for shutting down other fisheries that catch sardines incidentally. The CPSMT recommends an incidental catch structure based on a California Department of Fish and Game (CDFG) analysis of 2001-2006 incidental sardine catches off California (Agenda Item G.1.c, Supplemental CDFG Report) is presented in Table 1 for the 2008 HG of 89,093 mt. Incidental sardine catches from the Pacific Northwest (PNW) are minimal (< 5mt) and not included in Table 1. If the incidental set aside is not fully attained or is exceeded in a given allocation period, the CPSMT recommends that NMFS adjust the directed harvest allocation to account for the discrepancy in the following allocation period as an automatic action.

TABLE 1. Seasonal set asides based on a 10% annual incidental harvest of the Pacific sardine HG.

	Jan 1- June 30	July 1- Sept 14	Sept 15 – Dec 31	Total
Seasonal Allocation (mt)	31,183	35,637	22,273	89,093
Set Aside %	5.2%	1.2%	3.6%	10%
Set Aside (mt)	4,632	1,070	3,208	8,910
Adjusted Allocation (mt)	26,550	34,568	19,065	80,083

If the directed commercial sardine harvest is attained and other CPS fisheries achieve their incidental set aside, the CPSMT expectation is that retention of sardines would be prohibited. However, some level of incidental discard mortality would continue to occur. If the combined directed and incidental sardine HG is set at the ABC, this continuing discard mortality, as well as mortality occurring in the directed fisheries, would represent overfishing. This risk of overfishing could also be mitigated by setting an HG at some level below the ABC. The CPSMT also notes that sardine catches in the live bait fishery will be counted toward the ABC.

The CPSMT recommends additional research to fully evaluate stock structure, differential growth and migration rates of subpopulations, and the contribution of PNW sardine to the spawning biomass as a whole. The CPSMT recommends the Council encourage NMFS to continue to fund comprehensive coastwide annual CPS research, including the survey off the PNW, and encourage similar cooperative surveys in Canada and Mexico. The CPSMT also recommends that NMFS continues to fund the observer program. The CPSMT continues to believe strongly that coordinated international management of CPS fisheries is essential to avoid the potential for coastwide overfishing. Moreover, the CPSMT also agrees that inclusion of complete Mexican catch statistics is vital to the CPS assessment process. The CPSMT encourages the Council and NMFS and the State Department to continue working to achieve timely receipt of research data from Mexico.

Pacific Mackerel

On November 7, 2007 the CPSMT reviewed the Pacific Mackerel Stock Assessment Review (STAR) Panel Meeting Report (Agenda Item G.1.b, Attachment 3, November 2007), a summary by Tom Barnes, and the Scientific and Statistical Committee's (SSC) report on Pacific Mackerel Management (Agenda Item G.1, Situation Summary, November 2007). The CPSMT agrees with the recommendations of the STAR Panel and also notes that the 2008 HG has already been set by the Council for 2007/2008 management cycle using the Age Structured Assessment Program (ASAP) model. An assessment update using the ASAP model will be conducted in May 2008. The CPSMT concurs with the STAR Panel and the SSC that the use of the Stock Synthesis 2 (SS2) model would be preferred for the next new assessment set for May 2009 (establishing HGs for the 2009/2010 fishery season) but further refinement and review of the model is needed prior to its use.

PFMC
11/08/07

COASTAL PELAGIC SPECIES MANAGEMENT TEAM REPORT ON PACIFIC MACKEREL MANAGEMENT FOR 2008-2009

In 2008, an updated assessment for Pacific mackerel was completed by Southwest Fisheries Science Center of the National Marine Fisheries Service. The Coastal Pelagic Species Management Team (CPSMT) and the Scientific and Statistical Committee's Coastal Pelagic Species (CPS) Subcommittee met May 13, 2008 in Long Beach, California to review the latest stock assessment of Pacific mackerel. The CPSMT heard a presentation by Dr. Emmanis Dorval of the Stock Assessment Team. The CPSMT supported conclusions from the most recent Pacific mackerel stock assessment update and recommends the Pacific Fishery Management Council (Council) adopt the resulting acceptable biological catch (ABC) associated with the harvest control rule stipulated in this species' fishery management plan for the 2008-2009 management season (i.e., July 1, 2008 through June 30, 2009). Based on a total stock biomass estimate of 264,732 mt, the ABC for U.S. fisheries is 51,772 mt.

Due to uncertainty associated with changes to modeling parameters recommended by the 2007 Stock Assessment Review Panel and the fact that the U.S. fishery is assumed to be market limited to roughly 40,000 mt, the CPSMT recommends setting the 2008-2009 harvest guideline (HG) no higher than 40,000 mt. This HG recommendation is the same as the HG adopted by the Council for the 2007-2008 fishery.

Recent U.S. annual landings have been well below the established HGs for the directed fishery. However, uncertainty still exists concerning the magnitude of fisheries in Mexico that harvest Pacific mackerel and thus, caution is recommended when evaluating fishery impacts on transboundary Pacific mackerel stocks.

PFMC
05/19/08

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON PACIFIC SARDINE AND PACIFIC MACKEREL MANAGEMENT

The Coastal Pelagic Species Advisory Subpanel (CPSAS) heard a presentation by Dr. Kevin Hill regarding the 2007 Pacific sardine stock assessment and projected harvest guideline for the 2008 fishery. The CPSAS voices the strongest concern possible that the new Stock Synthesis 2 (SS2) model results grossly underestimated the volume of sardine observed in the water in 2007.

The CPSAS believes the model did not accurately predict the biomass observed in the field, based on reliable observations from fishermen and spotter pilots. The difference is in millions of tons. The CPSAS agrees unanimously that additional research and different research approach is essential to capture the full extent of the resource, particularly the volume of fish observed in the Pacific Northwest. Specifically, the CPSAS agrees a spotter pilot index of abundance is required for the 2008 assessment and should be continued into the future. A qualified spotter pilot survey can be easily started and maintained to provide reliable and cost effective results. It has been used in the past and is now available with new technology. This survey should be conducted in both the Pacific Northwest and California both to validate egg production, a highly variable index, and for use as a second independent index of stock abundance.

If the landings and market demand continue in 2008 as they progressed in 2007, all seasons will be prematurely closed. The harvest guideline resulting from the stock assessment approved by the Scientific and Statistical Committee (SSC) will cause extreme hardship to all coastal pelagic species (CPS) fishery sectors in 2008. This includes market squid as well as the other CPS. We estimate, for Pacific sardine alone, the economic impact will be a 5 to 6.5 million dollar loss in exvessel value and a 15.5 to 25 million dollar loss to the processing sector coastwide.

The CPSAS supports a joint Council/industry effort, including in-person meetings with national NOAA officials, to emphasize the need for substantial additional research funding for sardine in the fiscal year 2009 budget cycle.

The CPSAS voiced strong concern that the current process does not provide flexibility to test model results with observations in the field or other existing models including Age-structured Assessment Program (ASAP). To that end, the majority of the CPSAS recommends the Stock Assessment Team (STAT) run and review in parallel the ASAP and the SS2 models for possible discrepancies in outcomes for several years.

We recommend that the Council approve a data modeling workshop, including fishermen, spotter pilots, and other industry representatives be convened in conjunction with the next Stock Assessment Review (STAR) Panel, and that review be held as soon as possible, no later than 2009.

We recommend the STAT reevaluate the assumption that the fishery harvests a single stock. For example, test the possibility that the fishery harvests multiple stocks. We further recommend including a representative from the Pacific Northwest on the next STAT meeting.

In the event the Council adopts the harvest guideline recommendations of the SSC and the CPSMT, the CPSAS concurs with the CPSMT proposal that 10 percent of the harvest guideline for incidental take in fisheries other than Pacific sardine. This incidental harvest set aside will be allocated across the three allocation time blocks adopted under Amendment 11. Any unused incidental landing set aside from one allocation period shall be rolled into the directed harvest guideline of the next allocation period. In addition, the CPSAS recommends a maximum incidental landing allowance of 20 percent by weight.

PFMC
11/08/07

COASTAL PELAGIC SPECIES ADVISORY SUBPANEL REPORT ON PACIFIC MACKEREL MANAGEMENT FOR 2008-2009

The Coastal Pelagic Species Advisory Subpanel (CPSAS) heard a report from Dr. Emmanis Dorval and Dr. Kevin Hill of the Pacific Mackerel Stock Assessment Team regarding the Pacific mackerel stock assessment and proposed harvest guideline for the 2008-2009 season.

Based on the current assessment update and the harvest control rule for Pacific mackerel, the acceptable biological catch (ABC) for the 2008-2009 is estimated to be 51,772 metric tons (mt). The CPSAS again concurs with the Coastal Pelagic Species Management Team (CPSMT) recommendation to establish a harvest guideline for the directed fishery at 40,000 mt, providing an 11,772 mt set-aside for incidental landings in other fisheries. The CPSAS recommends that the Council provide guidance to the National Marine Fisheries Service (NMFS) that, in the event the directed fishery reaches 40,000 mt, NMFS close the directed fishery and revert to an incidental-catch-only fishery with a 45 percent incidental landing allowance when Pacific mackerel are landed with other coastal pelagic species (CPS), except that up to 1 mt of Pacific mackerel could be landed without landing any other CPS.

The CPSAS recommends an in-season review of the 2008-2009 Pacific mackerel fishery at the nearest feasible Council meeting, if needed, with the possibility of either releasing a portion of the incidental set-aside to the directed fishery or further constraining incidental landings to ensure total harvest remains below the ABC.

PFMC
05/21/08