

Pacific Mackerel

STAR Panel Meeting Report

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

STAR Panel

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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 ($r^2 \sim 0.1$) 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 advises 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.

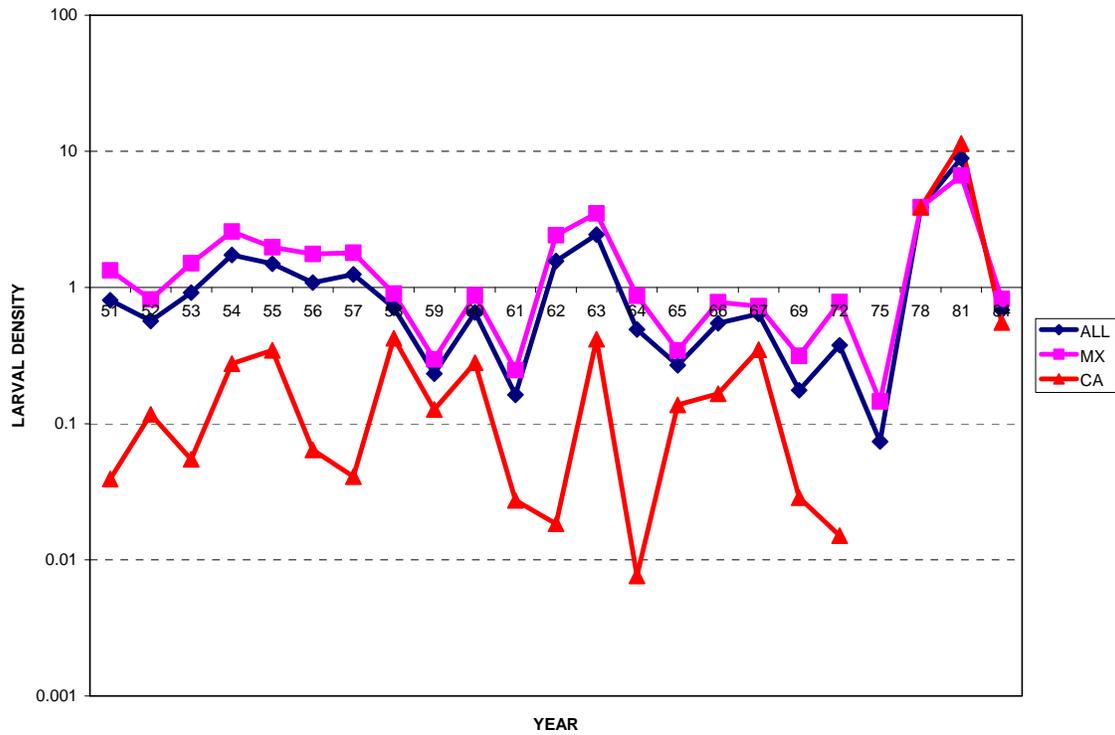


Figure 1a. Coastwide larval densities (diamonds), larval densities off Mexico (squares), and larval densities for the “core” area (results based on CalCOFI surveys that covered Mexico and the “core” area (1951-1984)).

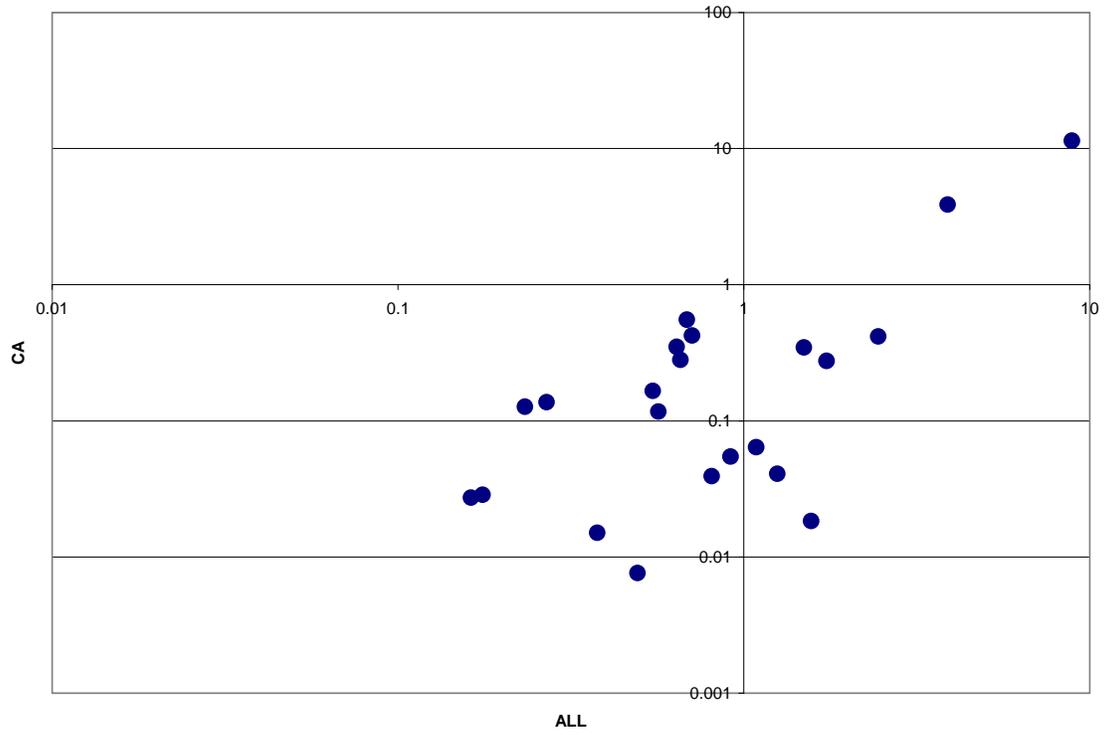


Figure 1b. Average larval densities (Mexico and the “core” area) versus larval densities for the “core” area based on CalCOFI surveys that covered Mexico and the “core” area (1951-1984).

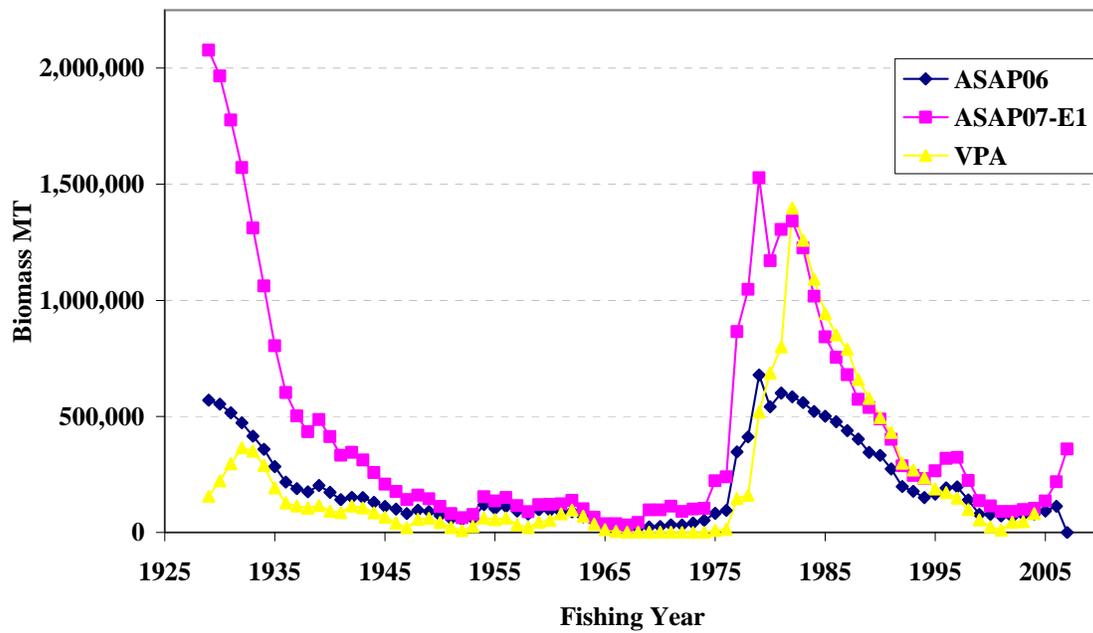


Figure 2. Estimated biomass (age 1+ fish, B in mt) of Pacific mackerel generated from the VPA (2006 assessment), and the ASAP-BaseCase model for the 2007 assessment.

Age 1+ Biomass by Survey

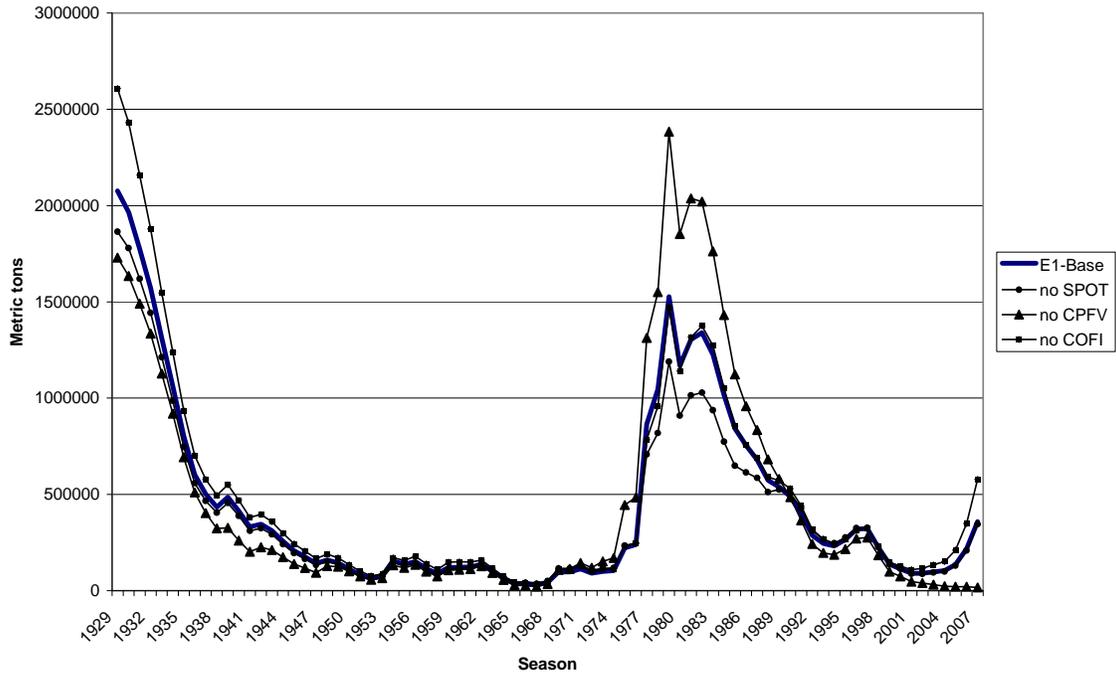


Figure 3. Sensitivity of Base-Case ASAP Model to Indices of Abundance.

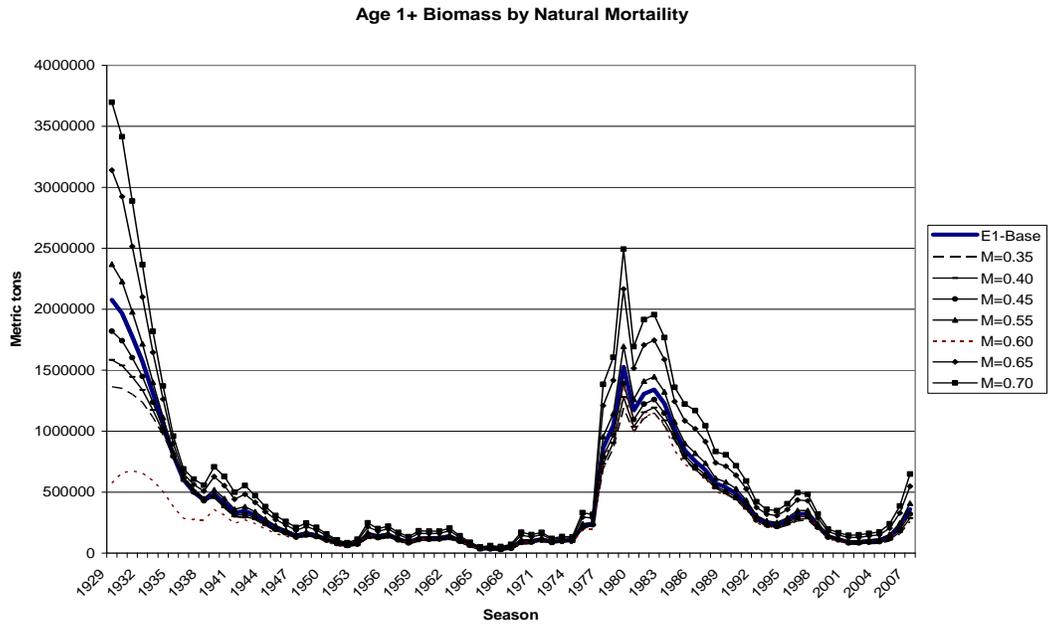


Figure 4. Sensitivity of Base-Case ASAP Model to Natural Mortality.

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