

Pacific Fisheries Management Council (PFMC)
Coastal Pelagic Species (CPS)
Stock Assessment Review (STAR)

National Marine Fisheries Service
Southwest Fisheries Science Center
La Jolla, California
June 21 - 24, 2004

Report Prepared

for

University of Miami Independent System for Peer Review

by

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Executive Summary

- A Stock Assessment Review (STAR) Panel meeting was held at the Southwest Fisheries Science Center in La Jolla, California from June 21 to 24, 2004. This was the first formal Pacific Fisheries Management Council (PFMC) stock assessment review for Coastal Pelagic Species (CPS).
- The STAR Panel was asked to review Pacific Sardine and Pacific Mackerel stock assessment documents and any other pertinent information (e.g.: previous assessments), to work with Stock Assessment Teams (STAT) to ensure that the assessments were reviewed as needed, and to document the meeting discussions.
- One of the terms of reference for STAR Panels was not addressed. Normally, summaries of stock status, prepared by the STAT, are reviewed for inclusion in a stock assessment and fishery evaluation (SAFE) report. However, a June 2004 PFMC Scientific and Statistical Committee report (Supplemental SSC Report F.2.b.) recommended that a separate STAR Panel be formed to deal with issues of yield and harvest formula for CPS species. Therefore, summaries of stock status and harvest guidelines were not reviewed by this STAR Panel as the focus of the meeting was to review assessment methodologies and not results.
- This report provides a summary of the technical discussions and recommendations from the STAR Panel meeting. Detailed information is available in the Pacific Sardine and Pacific Mackerel reports, generated as output from the meeting. Perceptions of the review process, which are the opinions of the author, are also provided.
- For Pacific Sardine, the STAT provided results for two assessment frameworks: 1) a two area catch-at-age model (CAMSAR-TAM) and 2) an age-structured assessment program (ASAP). The CAMSAR-TAM has provided the basis for the Pacific Sardine assessment in recent years. It allows for the one-way migration of sardines from southern California to the Pacific Northwest while relying upon abundance indices from southern California to infer the status of the total population size. However, migration parameters are largely arbitrary and the treatment of fisheries in the Pacific Northwest is ad hoc. In contrast, the ASAP is a multi-fleet model that can include the Pacific Northwest population component, both in its contribution to the catch and spawning biomass. The STAR Panel concluded that the ASAP model provided a more defensible basis for conducting future assessments of Pacific Sardine.
- Recent Pacific Mackerel assessments have used a modified virtual population analysis model (ADEPT) to estimate stock biomass. During the meeting, the STAR Panel briefly reviewed the method and results from the ADEPT model. However, most discussion focused on a forward-projection age-structured assessment program (ASAP) model which the STAT proposed for future assessments of Pacific Mackerel. The ASAP model is intended as an alternative statistical model to evaluate more fully the relationship between the species' population dynamics and associated fishery operations than is possible using ADEPT. The STAR Panel concluded that the ASAP model should form the basis for the 2005 assessment, but for continuity purposes,

future assessments should include an ADEPT analysis as a sensitivity test.

- There were some common sources of uncertainty for both assessments and hence some common recommendations. Stock structure and migration are not well understood. The Panel recommended a concerted approach to develop a coast wide synoptic survey, ideally on an annual basis, to estimate stock structure and migration. Both species are distributed from Mexico in the south to at least British Columbia in the north. However, abundance indices, used in the assessments, are all derived from southern California, in a relatively small area compared to distributional ranges. The Panel recommended that the synoptic survey, as proposed above, also be used to estimate indices of stock biomass. Biological data for the Mexican and Pacific Northwest fisheries are limited. The Panel recommended that fishery and survey data, where available, be acquired and incorporated in future assessments.
- As this was the first formal PFMC stock assessment review for these species, there were no previous STAR Panel recommendations to review.

Background

The terms of reference for a CPS STAR, as defined by the PFMC, include the following goals and objectives: 1) to ensure that CPS stock assessments provide the kinds and quality of information required by all members of the Council family, 2) to satisfy the Magnuson-Stevens Act and other legal requirements, 3) to provide a well-defined, Council oriented process that helps make CPS stock assessments the best available scientific information, and facilitates use of the information by the Council, 4) to emphasize external, independent review of CPS stock assessments, 5) to increase the understanding and acceptance of CPS stock assessment and review work by all members of the Council family, 6) to identify research needed to improve assessments, reviews and fishery management in the future, and 7) to use assessment and review resources effectively and efficiently.

The STAR Panel represents one component in the assessment process. In particular, it's terms of reference include: 1) reviewing draft stock assessment documents and any other pertinent information such as previous assessments and STAR Panel reports, if available, 2) working with the STAT to ensure assessments are reviewed as needed, 3) documenting meeting discussions, and 4) reviewing summaries of stock status, prepared by the STAT, for inclusion in the SAFE document.

The STAR Panel's role is further defined as being responsible for determining if a stock assessment document is sufficiently complete. In doing so, it should identify scenarios that are unlikely or have a flawed technical basis. The Panel must also strive for a risk neutral approach in its reports and deliberations. Any recommendations or requests to the STAT for additional or revised analyses must be clear, explicit and in writing. It is recommended that these analyses be completed during the STAR Panel meeting.

Subsequent to the STAR Panel meeting, the Chair is responsible for providing the PFMC with the Panel's report. This should include: the minutes of the STAR Panel meeting, the names and affiliations of STAR Panel members, a list of the analyses requested by the

STAR Panel, comments on the technical merits an/or deficiencies in the assessment, explanations of any areas of disagreement regarding STAR Panel recommendations, unresolved problems and major uncertainties, and prioritized recommendations for future research and data collection.

It is recommended that the number of assessments reviewed per STAR Panel should not exceed two. If two assessments are reviewed, then the STAR Panel should consist of at least four members, the Chair, an SSC member, and at least one external member who is outside of the Council and not involved in the management or assessment of CPS. In addition to the Panel members, STAR meetings will include advisory representatives from the Coastal Pelagic Species Management Team (CPSMT) and the Coastal Pelagic Species Advisory Subpanel (CPSAS).

The STAR Panel meeting for Pacific Sardine and Pacific Mackerel was held at the Southwest Fisheries Science Center, in La Jolla, California, from June 21 to 24, 2004. The Panel was originally scheduled to meet until June 25th but concluded its deliberations and report on June 24th. This was the first formal PFMC stock assessment review for CPS.

The Panel consisted of four members: the Chair, an SSC member, and two external reviewers (including myself). In addition, there were two advisory representatives, one from the CPSMT and one from the CPSAS. There were two separate STAT's, one for Pacific Sardines which consisted of four members, and one for Pacific Mackerel which consisted of two members (see Appendix 1 for list of attendees). The meeting was also attended by various staff members from the Southwest Fisheries Science Center and by members of the general public representing different groups within the fishery.

One of the terms of reference for STAR Panels was not addressed. Normally, summaries of stock status, prepared by the STAT, are reviewed for inclusion in the SAFE report. However, a June 2004 Scientific and Statistical Committee report (Supplemental SSC Report F.2.b.) recommended that a separate STAR Panel be formed to deal with issues of yield and harvest formula for CPS species. Therefore, summaries of stock status and harvest guidelines were not reviewed by this STAR Panel as the focus of the meeting was to review assessment methodologies and not results.

Description of Review Activities

The STAR Panel terms of reference (Appendix 2) and all working documents (Appendix 3) were provided on a dedicated web site by Daniel Waldeck (PFMC coordinator) and Tom Barnes (STAR Panel Chair) approximately one week prior to the meeting. Upon receipt of the working papers and prior to the meeting, I made hard copies, read and reviewed each of the documents, summarized results, and developed questions to ask during the meeting.

For each of the stock assessments, a detailed presentation was given by the lead STAT member, Ray Consers for Pacific Sardine and Kevin Hill for Pacific Mackerel. This was followed by an extensive question, discussion, and review period. On several occasions, a STAT was asked to provide further analyses which were subsequently reviewed during the

meeting. Before the meeting ended, separate reports were completed for each of the assessments. This involved drafting and reviewing these documents until a consensus was reached by the Panel. André Punt (STAR Panel member) and I each acted as a rapporteur for these reports.

In this report, I have included conclusions and recommendations with the Summary of Findings. I have also divided the Summary of Findings into two parts: 1) a summary for each of the two assessed stocks, and 2) my perceptions of the process. The first part addresses the terms of reference of the meeting and follows very closely from the respective reports. The second part is based mostly upon my observations during the meeting and as such, represents my personal views. Acknowledging that they are personal views, I hope that they will provide an independent perspective to the STAR process and will aid in the development of the process.

Summary of Findings

1) Pacific Sardine

Background

The Panel focused exclusively on assessment models for Pacific Sardine. The terms of reference for CPS STAR Panels include consideration of management recommendations. The harvest guideline for Pacific Sardine is currently based on the catch control rule specified in the Fishery Management Plan. The STAR Panel did not review the basis for this catch control rule but noted that the SSC has recommended that a future STAR Panel should evaluate the catch control rule for Pacific Sardine (and Pacific Mackerel).

The purse seine fleet in California historically has taken CPS (market squid, Pacific sardine, northern anchovy, Pacific mackerel, jack mackerel, bonito), and tunas on an opportunistic basis. The fishery has progressed from one focused primarily on squid and Pacific Mackerel in the early 1980's to one that focuses substantially on squid and sardine, although the fishery still relies to some degree on all target species. In recent years a CPS purse seine fishery focused primarily on Pacific Sardine has developed in the Pacific Northwest.

The results from the assessment models presented to the Panel were preliminary and based on data through 2003. The Panel did not focus on the consequences of the results, and instead focused on the most appropriate framework for conducting future assessments of Pacific Sardine.

The STAT provided results for two assessment frameworks: CANSAR-TAM (catch-at-age analysis for sardine - two area model) and ASAP (age-structured assessment program). CANSAR-TAM has provided the basis for the assessment of Pacific Sardine since 1998. CANSAR-TAM is an extension to the CAGEAN approach to fisheries stock assessment that explicitly allows for migration of the northern component of the Pacific Sardine population from southern California to the Pacific Northwest. The assessment relies on indices of abundance for southern California to infer the status of the total population size.

The migration model underlying CANSAR-TAM is simple, and the values for the parameters related to migration are largely arbitrary. The treatment of fisheries in the Pacific Northwest in CANSAR-TAM is also *ad hoc*. In contrast, ASAP is a multi-fleet model that can deal relatively straightforwardly with the component of the population in the Pacific Northwest, both in terms of its contribution to the spawning biomass and to the catches. Both the STAT and Panel agreed that ASAP provides a more defensible basis for conducting future assessments of Pacific Sardine.

Technical Merits and/or Deficiencies of the Assessment

The STAT identified three areas of considerable (but largely unquantifiable) uncertainty in its presentation to the Panel: 1) stock structure and migration are not well understood, 2) fishery-independent data are limited to central and southern California, even though spawning occurs off Mexico and limited spawning has been reported to the north, and 3) biological data for the Mexican, Canadian and Pacific Northwest fisheries are limited.

The current stock assessment is based on the hypothesis that Pacific Sardine off northern Mexico, southern California, northern California and the Pacific Northwest constitute a single biological stock with substantial mixing and migration. However, there is considerable uncertainty regarding this hypothesis. Evidence that may support an alternative stock structure hypothesis includes the presence in the Pacific Northwest of some spawning and some zero-year-old fish, and the marked differences in mean weight-at-age among fish in the Pacific Northwest and those off southern California. There is also uncertainty regarding the relationship between fish found offshore and those elsewhere, and between Mexican fish and those elsewhere. The Panel emphasized the importance of research to resolve issues related to stock structure, and to develop abundance indices for areas other than southern California. The latter aspect is as important as the former because, if data are collected which provide support for an alternative stock structure hypothesis (e.g. separate California and Pacific Northwest stocks), abundance data for the Pacific Northwest will be required to conduct an assessment for the population in this area. Even if additional data confirm the present working hypothesis, there is still considerable value in obtaining abundance information for regions other than those that are currently available. It was agreed that for the present time, the assessment should be based on a single coast wide assessment.

The initial assessment, presented to the Panel, included four indices of abundance. The Panel noted that three of the indices were correlated with each other as they were based on the same underlying data, and that the fourth index was correlated among years because of the way that biological information from a single year was used to construct estimates for several years. The Panel and STAT agreed that the next assessment should be based on two indices only.

The ASAP model requires weight-at-age data for the population, in addition to that for the fishery. Weight-at-age in the catches off southern California are lower than weight-at-age in the population because larger individuals appear to be located outside the areas that are fished. Survey data were used to infer population weight-at-age. The Panel suggested that this is a crude approach and recommended that efforts be made to include data on weight-at-age from the fisheries in the Pacific Northwest when constructing population weight-at-age.

However, it was noted that this problem cannot be resolved easily without sampling offshore and in northern areas to determine the relative proportion of the population in these different areas.

The catch control rule relies on the estimate of 1+ biomass for the start of the last year of the assessment period. The STAT currently bases this estimate on population weight-at-age. However, the alternative of basing it on the fishery weight-at-age may be more appropriate. The Panel recommended that this issue should be considered when the catch control rule is reviewed by a future STAR Panel.

Recommendations

As a general recommendation, the Panel suggested that the Tri-national Sardine Forum should be utilized to share fishery, survey and biological information among researchers in Mexico, Canada, and the United States. The long-term benefits of this forum will be greatly enhanced if it can be formalized through international arrangements.

With regard to stock structure, the Panel made several recommendations: 1) growth data for Mexico, southern California, northern California, the Pacific Northwest and the offshore areas should be collected and analyzed to quantitatively evaluate differences in growth among areas, 2) the evaluation of growth data should account for differences between Mexico and the United States on how birth dates are assigned and the impact of spawning on growth, 3) the timing and magnitude of spawning off California and the Pacific Northwest should be examined, 4) the likelihood of various stock structure hypotheses should be examined using existing tagging data and additional tagging experiments or (preferably) techniques such as analyses of trace element composition, and 5) information which could be used in an assessment of the Pacific Northwest component of a single coast wide population or of a separate Pacific Northwest stock should be obtained. It was noted that synoptic surveys of Pacific Sardine on the entire west coast have the potential to provide such information as well as the basic data needed to address research questions 1) and 2) above.

The Panel made several recommendations regarding data and monitoring needs: 1) it endorsed the aerial survey which started in 2004 and emphasized the value and importance of rigorous survey protocols, 2) an aerial survey program should also be started in the Pacific Northwest as it would provide data for a component of the population currently not surveyed, 3) alternative methods for indexing the population (e.g. acoustics) should continue to be evaluated as these also have the potential to provide information on the relative abundance of the populations off southern California and the Pacific Northwest, 4) the catch-at-age data should be updated so that ages are defined in terms of a calendar year life cycle, 5) biological data for use in the daily egg production method (DEPM) must be collected and analyzed more routinely in the future, 6) the DEPM method should be extended so that constraints are placed on the extent to which the estimates of P_0 vary over time, 7) the impact of environmental variability on the California Cooperative Oceanic Fisheries Investigations index (CalCOFI) percent positive data should be examined, 8) the data on maturity-at-age should be reviewed to assess whether there have been changes over time in maturity-at-age, specifically whether maturity may be density-dependent, and 9) the algorithm used to determine the catch proportion-at-age data from the raw data collected from the fishery should be documented and included in the assessment report.

Specific recommendations were also made regarding modeling and assessment issues: 1) the November 2004 assessment for Pacific Sardine should be based on an extension of ASAP with several provisos, 2) an attempt should be made to move from a model that is based on a calendar year to one based on a biological year, 3) the extent of ageing error should be quantified, 4) the sensitivity of the assumption that recruitment is related to spawning biomass by a Ricker stock-recruitment relationship should be examined, 4) the sensitivity of the results of the assessment to the weight assigned to each data point / abundance index should be explored, 5) environmental co-variables should be considered when fitting the stock-recruitment relationship, and 6) confidence intervals for the data should be added to the time-series plots which compare observed versus model-predicted values. Data that should be considered for inclusion in assessments for years beyond 2004 include: additional indices of abundance for Oregon / British Columbia / Mexico, the results of the new spotter plane index (if the new index can be related to the historical index) and, an index based on the spawning volume for Pacific Sardine (if such an index can be developed). Sensitivity should also be examined to different southern boundaries for the "stock" (i.e. if there is separate stock off northern Mexico, how does it mix with the stock(s) exploited in the United States).

2) Pacific Mackerel

Background

This STAR Panel meeting was the first formal PFMC-sponsored stock assessment review of Pacific Mackerel. The STAR Panel terms of reference were adhered to, in that the Panel worked with the STAT to ensure that the assessment was reviewed as needed and that meeting discussions were documented. However, a recent SSC report (June 2004, Supplemental SSC Report F.2.b.) recommended a separate future STAR Panel to deal with issues of yield and harvest formula for CPS species. Therefore, summaries of stock status and harvest guidelines were not reviewed by this STAR Panel as the focus of the meeting was to review assessment methodologies and not results.

The CPS fishery in California takes market squid, sardine and mackerel. The fishery has progressed from one focused primarily on mackerel in the early 1980's, to one that focuses substantially on sardine, although the fishery still relies on all three species.

The most recent mackerel assessment, intended for PFMC management decisions during the period from July 1, 2004 to June 30, 2005, used a modified virtual population analysis model (ADEPT) to estimate Pacific Mackerel biomass. During the meeting, the Panel briefly reviewed the method and results from the ADEPT model. However, most discussion focused on a forward-projection age structured assessment program (ASAP) model which the STAT proposed for future assessments of Pacific Mackerel. The ASAP model is intended as an alternative statistical model to evaluate more fully the relationship between the species' population dynamics and associated fishery operations than is possible using ADEPT.

For illustrative purposes and to provide a basis for discussion, the STAT presented two ASAP model runs. The baseline approach attempted to mimic the ADEPT formulation for the

2004 assessment. It included the four indices used in ADEPT and fixed selectivity over the entire period (1929-2003). The alternative approach eliminated one index, combined two other indices, and separated the time series into two periods of selectivity.

In examining the results of the illustrative ASAP models, it was noted that results from both the baseline and alternative approach were very similar. Population numbers and biomass increased through the late 1970's and early 1980's similar to the ADEPT model, but peaked at much lower levels. The Panel and the STAT agreed that ASAP should form the basis for the next assessment. For continuity purposes, it was recommended that future assessments should include an ADEPT analysis as a sensitivity test.

Technical Merits and/or Deficiencies of the Assessment

The lack of catch-at-age and weight-at-age data from the Mexican (Ensenada) fishery is a major source of uncertainty, especially in recent years when Mexican landings have been as large as or larger than Californian landings.

Pacific Mackerel range from the Gulf of California to southeastern Alaska and are harvested from Ensenada to British Columbia. However, the abundance indices used in the assessment are all derived from the Southern California Bight, in a relatively small area compared to the distributional range. It was also noted that even within this area, there may be a spatial bias as most abundance indices are derived from the northern part of the spawning range, which is thought to extend from central Baja California to the Southern California Bight.

There are considerable inter-annual variations in the proportion of catch in different age classes, and these variations result in systematic patterns in the residuals to the catch-at-age data. The ASAP model is based on the assumption that all of the discrepancy between the observed and model-predicted age proportions is due to observation error. There are, however, alternative explanations: ageing error (both systematic and random), non-random sampling of the landings, the impact of seasonal variation in the fishery, and random changes in availability. The Panel could not fully review age composition data due to a lack of information on how they were developed.

Recommendations

The Panel did not prioritize its recommendations. However, in relation to the specific deficiencies or uncertainties outlined above, it made the following recommendations: 1) that fishery and survey data be acquired from Mexico and incorporated into future assessments, 2) that a concerted approach be made to develop a coast wide synoptic survey, ideally on an annual basis, to estimate an index of mackerel biomass, and 3) that an examination be made of the basis for the age composition data and the possible benefits of allowing for time-dependent selectivity.

Given the confusion regarding how the catch-at-age (in number) is developed, the Panel recommended that it be more fully explained in future assessments and that this requirement should be included in the STAR terms of reference.

With regard to a new aerial spotter survey, which commenced in 2004, the Panel recommended that rigorous protocols be incorporated into the survey design, including attempts to estimate school surface area. The Panel also recommended that an aerial spotter survey be commenced in the Pacific Northwest in conjunction with industry.

The Panel endorsed and encouraged overall greater collaboration with industry in the collection and analysis process for CPS, including Pacific Mackerel.

There were questions regarding the length of the time series to be included in the ASAP model, given uncertainties regarding landings data in the earlier part of the time series. Although it was decided to use the entire time series, the Panel recommended that the use of a truncated time series be further evaluated.

There was a brief discussion on the catch-at-age matrix, whether it should be extended beyond age 5+. It was noted that this may be more feasible if a truncated time series is used in the ASAP model. The Panel recommended that these issues be examined for the next assessment.

It is assumed, in the assessment, that Pacific Mackerel have a July 1st birth date. However, it was unclear how this assumed birth date was accounted for in a model with a calendar year basis. An error was detected in the catch-at-age data due to misapplication of the July 1st birth date which is used in assigning ages. This must be corrected, when aggregating catch-at-age data over a calendar year time period. As an alternative, the Panel recommended that, if practicable, the model year commence on July 1st to match the assumed birth date.

There were questions regarding the use of fishery-based weights-at-age to estimate population parameters when they are derived from only part of the population. The Panel recommended that this be examined and that a Von Bertalanffy growth curve be used if it can be shown to include samples from throughout the stock range.

There were specific issues relating to the abundance indices used in the model. It was noted that the relationship between the aerial spotter index and the remaining indices was not linear. In the ensuing discussion, it was questioned whether the aerial spotter index should be included in the ASAP model even though it is the only "recruitment index" available. This index assumes full selectivity across all ages. The Panel recommended that selectivity for the index be estimated within the model by creating a 'fleet' with no catch and no sampling. It was considered that this would at least provide selectivity estimates that could then be examined. The trades-offs for leaving this index in or out of the assessment are complex and not readily apparent; the Panel recommended that this decision be left to the STAT as work progresses on the next assessment.

There was a discussion regarding selectivity patterns for the commercial passenger fishing vessel (CPFV) index, which were estimated outside of the ASAP model. The Panel recommended that selectivity within the model be estimated by treating CPFV as a separate fishery using available biological data. There was also a question whether the CPFV index includes estimates of discards. It was noted that discard rates were only available in logbooks

since 1994. The Panel recommended that the magnitude of discards be examined for the next assessment.

Perceptions of the STAR Process

This was the first STAR Panel for CPS under the management of the PFMC. The terms of reference for the STAR Panel, provided by the Council, were very thorough and provided detailed information regarding the Panel's responsibilities (Appendix 2). Three of the four principal responsibilities of the STAR Panel were met: 1) draft stock assessment documents and other pertinent information were reviewed, 2) the Panel worked with the STAT's to ensure that the assessments were reviewed as needed, and 3) meeting discussions were documented. The fourth primary responsibility was that summaries of stock status, prepared by the STAT's, be reviewed for inclusion in the SAFE document. This responsibility was not met as a June 2004 Scientific and Statistical Committee report (Supplemental SSC Report F.2.b.) recommended that a separate STAR Panel be formed to deal with issues of yield and harvest formula for CPS species. Therefore, summaries of stock status and harvest guidelines were not reviewed by this STAR Panel as the focus of the meeting was to review assessment methodologies and not results.

As outlined in the STAR Panel terms of reference, the Panel met for one week and reviewed two assessments only. The Panel consisted of four members, two of which (including myself) were external to the assessment of west coast CPS species. Advisory representatives from the CPSMT and CPSAS were also present at the meeting.

Through its deliberations, the Panel concluded, by consensus, that the stock assessment documents for both Pacific Sardine and Pacific Mackerel were sufficiently complete. In its reports, the Panel identified the technical merits and/or deficiencies of each assessment. Recommendations and requests, made to the respective STAT's during the meeting for additional analyses, were clear, explicit and (in most cases) in writing. The majority of additional analyses, required in the stock assessments, were completed during the course of the meeting. Those that were not were included in future research recommendations. A summary of technical discussions and a list of all recommendations were included in the Panel's reports, the format of which followed that described in the terms of reference.

The Panel Chair set aside time each day during the meeting for public comment. He ensured that there was adequate discussion regarding such comments and that these discussions were included in the Panel's reports.

Given that this was the first STAR Panel for CPS, there was no previous STAR Panel report to review or to use as a template. There was some initial confusion during the meeting regarding the format of the report; however, this was quickly resolved, and rapporteurs were appointed for each assessment: André Punt for Pacific Sardine and I for Pacific Mackerel. The rapporteurs recorded the discussions each day and provided hard copies to the remaining Panel members for review and comments. The rapporteurs were then responsible for writing the respective reports. These were reviewed, in detail, during the final day of the meeting. The Chair then assumed responsibility for editorial changes and completion of the final Panel

reports.

Each of the four Panel members contributed considerable scientific expertise to the discussions. The Chair, Tom Barnes, although not a member of either STAT, had detailed knowledge of each of the assessed species through his research with the California Department of Fish and Game. The SSC representative, André Punt, was truly the technical expert on the Panel. His quantitative knowledge of the assessment models was outstanding, and his contribution towards the technical review was immeasurable. Rodolfo Serra brought a South American perspective to the Panel. Having been involved for many years with the assessment of Pacific Sardine in Chilean waters, he had an in-depth knowledge of the biology and life history of the species and was able to identify any deficiencies in the assessment data. I contributed information regarding the assessment of pelagic species in Atlantic Canada. In particular, I focused on future research requirements regarding development of new abundance indices throughout the species range.

It was my perception that the Panel would have benefited from additional scientific expertise. From past experience as a CIE representative on other panels, it is not unusual to have as many as twelve or more panel members. This provides for a broad knowledge base and greater interaction between the panel and assessment teams. By limiting the STAR Panel to four members, fewer opinions and views are incorporated in the review. This is not to suggest that the current review was inadequate; the STAR Panel provided a thorough, open, and independent review. However, it was restricted by the number of individuals available to provide the review.

The respective STAT's for each of the assessments were well prepared and had a thorough knowledge of their data bases and assessment models. They provided all information, including model codes, prior to the meeting; this allowed the assessments to be reproduced by the SSC expert, André Punt. Assessment presentations were clear and concise. The respective STAT's focused on alternative assessment models but were also very willing to conduct further analyses, as requested by the Panel, during the meeting. There were no unresolved areas of disagreement between the Panel and STAT's at the conclusion of the meeting.

Discussion during the meeting highlighted the need for further independent indices of abundance for both Pacific Sardine and Pacific Mackerel. For both species, it was recommended that a synoptic coast wide survey be conducted, preferably on an annual basis, to estimate an index of biomass. I found it surprising that such a survey was not already being conducted and more surprising that acoustic techniques had not been considered for assessing biomass, given that acoustic methods provide the primary fishery independent abundance indices for many of the world's major pelagic fish stocks.

Similarly, the assessment for both species did not include detailed biological and fishery data from Mexico, although the Mexican fishery represented a substantial part of the catch. The assessment teams indicated that they were attempting to access this information but suggested that formal international agreements were required. I concur that international agreements are necessary but also suggest that informal meetings between Mexican and United States scientists may provide the necessary ground work for obtaining information that

would be mutually beneficial to the fisheries in both countries.

I sensed during the meeting a level of mistrust in the assessment process. For example, industry representatives did not trust the assessment teams due to a perceived bias. Similarly, representatives from the Northwest States did not trust those from California to protect their interests. I found the assessment process to be open, transparent, and objective. In the research recommendations, I suggested a greater collaboration with industry in the collection and analysis process for these species. From my own experience, I have found that it is only through such collaboration and involvement that the level of trust can be increased between industry and scientists. Perhaps it would be beneficial to have an independent Chair, also appointed by the CIE.

Although it was outside the terms of reference of this STAR Panel to review the stock status of the two assessed species, I would strongly recommend that stock status be reviewed by a future STAR Panel, as recommended by the SSC. The Pacific Mackerel assessment indicated a reduced biomass, consistent with abundance indices and industry observations. However, the Pacific Sardine indicated that biomass was stable and at a relatively high level. This did not match industry observations in recent years in southern California where large fish were not readily available and harvest guidelines were not met. Stock status and harvest guidelines need to be reviewed for both species.

In closing, all those involved with the assessments of both Pacific Sardine and Pacific Mackerel should be congratulated. This represented the first formal review of assessment methods for both species. The assessment teams for both species provided detailed proposals for future assessments, and with help from the STAR Panel, substantially advanced the knowledge of the population dynamics of these species.

Appendix 1. List of Attendees

STAR Panel

Tom Barnes, California Department of Fish and Game (Chair)

André Punt, Univ. of Washington (SSC Representative and Pacific Sardine rapporteur)

Rodolfo Serra, IFOP, Valparaiso, Chile

John Wheeler, Department of Fisheries and Oceans, Canada (CIE and Pacific Mackerel rapporteur)

PFMC

Brian Culver, Washington Department of Fish and Wildlife, CPSMT

Diane Pleschner-Steele, CPSAS

Pacific Sardine STAT

Ray Conser, NOAA / Southwest Fisheries Science Center

Kevin Hill, NOAA / Southwest Fisheries Science Center

Suzanne Kohin, NOAA / Southwest Fisheries Science Center

Nancy Lo, NOAA / Southwest Fisheries Science Center

Pacific Mackerel STAT

Kevin Hill, NOAA / Southwest Fisheries Science Center

Paul Crone, NOAA / Southwest Fisheries Science Center

Appendix 2. CPS STAR Panel Terms of Reference

The principal responsibility of the STAR Panel is to carry out the following terms of reference.

The STAR Panel's work includes:

1. reviewing draft stock assessment documents and any other pertinent information (e.g.; previous assessments and STAR Panel reports, if available)
2. working with STAT Teams to ensure assessments are reviewed as needed;
3. documenting meeting discussions; and
4. reviewing summaries of stock status (prepared by STAT Teams) for inclusion in the SAFE document.

STAR Panels normally include a chair, at least one "external" member (i.e., outside the Council family and not involved in management or assessment of West Coast CPS), and one SSC member. The total number of STAR members should be at least "n+2" where n is the number of stock assessments and "2" counts the chair and external reviewer. In addition to Panel members, STAR meetings will include CPSMT and CPSAS advisory representatives with responsibilities laid out in their terms of reference.

STAR Panels normally meet for one week.

The number of assessments reviewed per Panel should not exceed two.

The STAR Panel is responsible for determining if a stock assessment document is sufficiently complete. It is the Panel's responsibility to identify assessments that cannot be reviewed or completed for any reason. The Panel's decision that an assessment is complete should be made by consensus. If a Panel cannot reach agreement, then the nature of the disagreement must be described in the Panel's report.

The STAR Panel's terms of reference concern technical aspects of stock assessment work. The STAR Panel should strive for a risk neutral approach in its reports and deliberations. Confidence intervals of indices and model outputs, as well as other measures of uncertainty that could affect management decisions, should be provided in completed stock assessments and the reports prepared by STAR Panels. The STAR Panel should identify scenarios that are unlikely or have a flawed technical basis.

Recommendations and requests to the STAT Team for additional or revised analyses must be clear, explicit and in writing. A written summary of discussion on significant technical points and lists of all STAR Panel recommendations and requests to the STAT Team are required in the STAR Panel's report. This should be completed (at least in draft form) prior to the end of the meeting. It is the chair and Panel's responsibility to carry out any follow-up review work that is required.

Additional analyses required in the stock assessment should be completed during the STAR Panel meeting. If follow-up work by the STAT Team is required after the review meeting, then it is the Panel's responsibility to track STAT Team progress. In particular, the chair is responsible for communicating with all Panel members (by phone, email, or any convenient means) to determine if the revised stock assessment and documents are complete and ready to be used by managers in the Council family. If stock assessments and reviews are not complete at the end of the STAR Panel meeting, then the work must be completed prior to the CPSMT meeting where the assessments and preliminary HG levels are discussed.

The STAR Panel, STAT Team, and all interested parties are legitimate meeting participants that must be accommodated in discussions. It is the STAR Panel chair's responsibility to manage discussions and public comment so that work can be completed.

STAT Teams and STAR Panels may disagree on technical issues. If the STAR Panel and STAT Team disagree, the STAR Panel must document the areas of disagreement in its report. The STAR Panel may request additional analysis based on alternative approaches. Estimates and projections representing all sides of the disagreement need to be presented in the assessment document, reviewed, and commented on by the SSC. It is expected that the STAT Team will make a good faith effort to complete these analyses.

The SSC representative on the STAR Panel is expected to attend CPSMT and Council meetings where stock assessments and harvest projections are discussed to explain the reviews and provide other technical information and advice.

The chair is responsible for providing Council staff with a camera ready and suitable electronic version of the Panel's report for inclusion in the annual SAFE report.

Suggested Template for STAR Panel Report

- Minutes of the STAR Panel meeting, including name and affiliation of STAR Panel members.
- List of analyses requested by the STAR Panel.
- Comments on the technical merits and/or deficiencies in the assessment and recommendations for remedies.
- Explanation of areas of disagreement regarding STAR Panel recommendations:
 - among STAR Panel members (majority and minority reports), and
 - between the STAR Panel and STAT Team .
- Unresolved problems and major uncertainties, (e.g., any special issues that complicate scientific assessment, questions about the best model scenario).
- Prioritized recommendations for future research and data collection.

Appendix 3. List of References Provided

Current Documents

Draft Stock Assessment of Pacific Mackerel (*Scomber japonicus*) in 2004. Kevin T. Hill and Paul R. Crone. June 2004.

Draft Pacific Sardine Stock Assessment Methodology: Back to Basics. June 2004. Ray Conser, Kevin Hill, Suzanne Kohin, and Nancy Lo.

Appendices to Draft Pacific Sardine Stock Assessment Methodology: Back to Basics. June 2004. Ray Conser, Kevin Hill, Suzanne Kohin, and Nancy Lo.

Appendix 1. Aged landings of Pacific Sardine from 1932-1965. Suzanne Kohin, Kevin T. Hill, and Ray Conser.

Appendix 2. ASAP ADMB template file (baseline model).

Appendix 3. Annotated ASAP input file (baseline model).

Appendix 4. ASAP report file (baseline model).

Stock Assessment of Pacific Sardine with Management Recommendations for 2004: Executive Summary. October 2003. Ramon J. Conser, Kevin T. Hill, Paul R. Crone, Nancy C.H. Lo, and Darrin Bergen.

A Flexible Forward Age-Structured Assessment Program. Christopher M. Legault and Victor R. Restrepo. September 1998. ICCAT Working Document SCRS/98/58.

Spawning Biomass of Pacific Sardine (*Sardinops sagax*) off California in 2003. October 2003. Nancy C.H. Lo.

Background Documents

Stock Assessment of Pacific Mackerel (*Scomber japonicus*) with Recommendations for the 2004-2005 Management Season: Executive Summary. Kevin T. Hill and Paul R. Crone. May 20, 2004.

Stock Assessment of Pacific Mackerel (*Scomber japonicus*) with Recommendations for the 2003-2004 Management Season: Executive Summary. Kevin T. Hill, Darrin R. Bergen, Paul R. Crone, and Ramon J. Conser. 28 May 2003.

Stock Assessment of Pacific Sardine with Management Recommendations for 2003. Ramon J. Conser, Kevin T. Hill, Paul R. Crone, Nancy C.H. Lo, and Darrin Bergen.

Stock Assessment of Pacific Sardine with Management Recommendations for 2002: Executive Summary. Ramon J. Conser, Kevin T. Hill, Paul R. Crone, Nancy C.H. Lo, and Darrin Bergen. October 2001.

Stock Assessment of Pacific Sardine with Management Recommendations for 2001: Executive Summary. Ramon J. Conser, Kevin T. Hill, Paul R. Crone, and Darrin Bergen. October 24, 2000.

Status of the Pacific Mackerel Resource and Fishery in 1999. Kevin T. Hill, Matthew Levey, and Michael Dege.

Stock Assessment of Pacific Sardine for 1998 with Management Recommendations for 1999. Kevin T. Hill, Larry D. Jacobson, Nancy C.H. Lo, Marci Yaremko, and Michael Dege. Marine Region Administrative Report 9914. 1999 Marine Region Administrative Report Series.

Catch-at-large analysis for Pacific sardine (*Sardinops sagax*), 1983-1995. Richard B. Deriso, J. Thomas Barnes, Larry D. Jacobson, and Paulo R. Arenas. In: Deriso et al.: Pacific Sardine Catch-At-Large Analysis, CalCOFI Rep., Vol. 37, 1996.

Status of Pacific mackerel and trends in biomass, 1978-1993. Larry D. Jacobson, Eddy S. Konno', and Juan P. Pertierra' . In: Jacobson et al.: Pacific Mackerel Status and Biomass Trends, 1978-93 CalCOFI Rep., Vol. 35, 1994.

Appendix 4. Statement of Work

General

The consultant will serve as a member of a Stock Assessment Review (STAR) Panel of the Pacific Fishery Management Council (PFMC) from June 21-25, 2004, in La Jolla, California. This review will focus on the stock assessment methods used for the annual assessments of Pacific sardine and Pacific mackerel. Under the PFMC's Coastal Pelagic Species Fishery Management Plan (CPS FMP), these assessments provide the basis for setting annual harvest levels of sardine and mackerel off the west coast of the United States.

The consultant should have hands-on experience in conducting fish stock assessments. Expertise with age-structured modeling is particularly important. Experience with coastal pelagic species assessment is desirable.

The consultant will be provided with the following:

- 1) Most recent stock assessment reports for Pacific sardine and Pacific mackerel, which provide the basis of current management.
- 2) Draft reports on methodology improvements for Pacific sardine and Pacific mackerel stock assessments.
- 3) An electronic copy of the data and the models used for the assessments (if requested by reviewer).

Specific

The consultant's duties shall not exceed a maximum total of 14 days: Several days prior to the meeting for document review; the five-day meeting; and several days following the meeting to complete the written report. The report is to be based on the consultant's findings, and no consensus report shall be accepted.

The consultant's tasks consist of the following.

- 1) Become familiar with the Pacific sardine and Pacific mackerel stock assessments; proposed methodological improvements; and background materials.
- 2) Participate in the STAR Panel meeting in La Jolla, California during June 21-25, 2004.
- 3) Comment on the strengths and weaknesses of current approaches and proposed improvements.

4) Recommend alternative methods and/or modifications of proposed methods, as appropriate during the STAR Panel meeting.

5) No later than July 9, 2004, submit a written report consisting of the findings, analysis, and conclusions, addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via email to mshivlani@rsmas.miami.edu.