

**Independent Peer Review Report on the STAR Panel Review
for
Pacific sardine and Pacific mackerel,
04-08 May 2009, La Jolla, California**

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Prepared for:

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Executive Summary

The STAR Panel Review for Pacific sardine and Pacific Mackerel was held at the NMFS Southwest Fisheries Science Center (SWFSC), in La Jolla, California from 8:00 Monday, May 4, 2009 through to 15:00 Friday, May 8, 2009. The three main objectives of the Panel were to review the 2009 mackerel assessment, the Daily Egg Production Method (DEPM) used to estimate spawning biomass for Pacific sardine, and a proposed aerial survey for Pacific sardine.

The background material was available almost two weeks in advance, allowing for plenty of time to prepare for the meeting. In general, the Panel review adhered closely to the agenda provided to attendees prior to the meeting, although the Chair was flexible to allow time for Panel requests to be prepared by the STAT. Much of the success of the STAR Panel Review can be attributed to the Chair who did an excellent job of keeping the group focused on the topic being addressed while at the same time allowing everyone, including observers, to express their views or contribute their expert opinion. The STAT members are also to be congratulated for their coherent presentations and their willingness to respond to numerous Panel requests.

As this was my first STAR Panel Review I was pleasantly surprised by the professional and respectable focus of the Panel members, presenters, and participants. Between the expertise of the Panel and the technical teams, I felt that virtually any issue could be addressed and that recommendations for improvement or a way forward could be achieved. The review also benefited from having members of the PFMC and observers who were able to add value to discussions on the fisheries through their expert knowledge. Overall the meeting was conducted in a constructive and productive manner and the comments, conclusions and recommendations were reflective of the healthy debate that occurred throughout the week. Personally speaking, the review process worked very well and made significant progress in addressing the issues identified in the terms of references for both the mackerel and sardine assessments. I can see no reason to change the process. There were no major areas of disagreement between the Technical Team and Panel.

The final STAR Panel Review report represents the consensus view of the STAR Panel and I fully concur with its content, recommendations, and conclusions.

Pacific sardine – DEPM

The STAR Panel reviewed the Pacific sardine daily egg production method, the ichthyoplankton survey design and subsequent biomass estimates for the purpose of developing improved survey methods, analytical procedures, and a better estimate of relative abundance for use in the assessment model. Several areas of improvements and uncertainties related to the DEPM and spawning biomass were identified by the Panel. However, a major deterrent limiting the Panel's ability to address specific issues during the review was the lack of access to the raw data. On several occasions requests were

made by the Panel to undertake an analysis which could not be completed. This limited the Panel's ability to investigate several areas of concern during the meeting a compromise analysis had to be undertaken. A major source of uncertainty in the DEPM was the small sample sizes used to estimate the adult parameters and the temporal disconnect between egg collections and adult sampling. The Panel also stressed the necessity for consistency in procedures used to calculate parameters in the time series and the need to document what was done throughout the series. The sardine assessment is dependent upon a single index of abundance. It is hoped that over the next few years another index of abundance will be developed from the proposed aerial survey. Overall, there were no major deficiencies in the operational design and computational procedures to estimate P_0 and spawning stock biomass. However, given that the SS model results are used to recommend management advice, the DEPM should be modified to estimate female, not total adult, spawning biomass.

Pacific sardine - Aerial Survey

The fishing industry has proposed an aerial survey with broad coverage for 2009 under EFP and the survey design was presented to the Panel for review. The technical team is acknowledged for a clear and well organized presentation on the proposed survey and for their willingness to address and to modify the design as suggested by the Panel. The two key issues of the survey center on determination of school area and school identification. In the 2009 sampling protocol only Type II error will be examined (fish schools identified as sardine schools when they were not sardine schools). Both Type I and Type II errors should be addressed over time. The current EFP of 1200t will only permit school size sampling (Calibration) from one of the two areas. An allocation of 2400t would be required to meet the school size sampling requirements for both areas (North and South) with sufficient precision.

For the 2009 survey data it was determined, assuming it was implemented as planned, that the current analytical model could handle the survey results as absolute sardine abundance with appropriate values of "q". However, it is anticipated that continuing the aerial survey annually over multiple years could lead to a new and additional relative index of abundance for input into the SS model.

Pacific mackerel

Currently management advice for Pacific mackerel, in terms of the Harvest Guidelines, is based on the results of an ASAP model. The review panel concentrated on four main tasks assigned to the STAT; 1) update the current ASAP model, 2) construct an SS alternative base-model that mirrors ASAP, 3) develop a suite of alternative SS models, and 4) select a preferred SS model. After the initial presentation the Panel agreed that the SS baseline model was adequately equivalent to the ASAP model and accepted the STAT's recommendation for a preferred model (S1_qa25) from the draft assessment. This model excluded the spotter and CalCOFI indices, and allowed the estimation of commercial selectivity in three time blocks and recreational selectivity in one. The remainder of the week was occupied with undertaking a series of sensitivity analyses. All

requests, reasoning for the requests, and the responses are described in the Panel Report. In the end the Panel and the STAT selected model “AA” as the basis for management advice, with the caution that there is a plausible alternative model indicating a severe decline in the resource. The “AA” model used annual time steps, an increased input σ_R of 1.0, doubled the weight on the recreational length compositions, and excluded both the CalCOFI and spotter indices.

Uncertainties and concerns were expressed about the assessment being dependent upon a single index of abundance based on data from a non targeted recreational fishery and the exclusion of the other indices, in particular, CalCOFI. Factors completely unrelated to the fish or the fishery could potentially have a significant impact on the index via a change in selectivity and/or catchability. The alternative model, which includes the CalCOFI index, estimates a different biomass trajectory than the “AA” model in recent years. Another indication that the biomass estimates may not as high as estimated is the fact the commercial fleet has been unable to catch anywhere near its allocation since about 2000. These uncertainties are further confounded by a probable spatial and temporal shift in mackerel distribution. These inconsistencies should be investigated further at the next full assessment.

1. BACKGROUND

An overview of the coastal pelagic species (CPS) assessment and review process, including its goals and objectives, and responsibilities, is described in the terms of references for a coastal pelagic species stock assessment review process (PFMC, 2009). Under this process, Pacific sardine (*Sardinops sagax caerulea*) and Pacific mackerel (*Scomber japonicus*) are to undergo an annual review that includes either a “Full” or “Update” assessment. The former, which generally occurs every three years for both species, involves a major review of the underlying assumptions, input data, and model parameters used in the stock assessment. During the intervening years, an “update assessment” that maintains the full assessment model structure with the addition of new data is undertaken. A full assessment that involves a new approach/methodology, structural changes, or significant revisions requires that a Stock Assessment Review (STAR) Panel be convened to review the assessment prior to its use for setting harvest guidelines (HG).

The terms of reference for the May 2009 STAR Panel are described in Appendix II. In accordance with this process, an independent reviewer was provided by the Center for Independent Experts (CIE) to participate as a full panel member to contribute to the Review Panel’s Consensus Summary Report and to comment on strengths, weaknesses of current approaches, propose improvements, and to recommend alternative methods and/or modifications of proposed methods (Appendix III).

The specific tasks for the CIE reviewer within the STAR process were to:

- 1) Become familiar with the Pacific mackerel stock assessments; proposed methodological improvements; and background materials.
- 2) Participate in the STAR Panel meeting in La Jolla, California during 1-3 May 2007.
- 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) Assisting with the generation of the STAR panel report, and to comment on the STAR panel process.

The principal responsibilities of the May 4-8, 2009 STAR Panel were to review the stock assessment and survey documents, data inputs, analytical models, and to prepare a STAR Panel consensus report for each of the species being reviewed. Two main goals of this review were:

- Goal 1. Provide an independent description of the process, data, model, and outcomes of the Pacific mackerel STAR panel review.

Goal 2. Provide an independent description of the strengths and weaknesses of the review process and the recommended outcomes of the STAR Panel review of the egg production method and the potential use of aerial survey techniques as a relative index of abundance as well as an absolute index of abundance.

The following report reflects my independent review for the CIE as identified in the terms of reference, statement of work, and the above goals and objectives.

2. REVIEW ACTIVITIES

The initial phase in the review process began with the provision of background material, published literature, and the assessment documents prepared by the STAT for review. This material was provided, via ftp site access, in adequate time (two weeks prior to the Panel Review) to prepare for the Panel Review (Section 5). The authors are commended for providing comprehensive and coherent reports in a timely manner.

The STAR Panel for Pacific sardine (*Sardinops sagax caerulea*) and Pacific mackerel (*Scomber japonicus*) convened at the NMFS Southwest Fisheries Science Center (SWFSC), La Jolla, California, from 4-8 May 2008. The meeting, which is generally considered public, was attended by the panel members, STAT members for each species, State and Federal representatives, members of the fishing industry, and observers. Participants in the review are listed in Appendix I. Details of the Terms of Reference for STAR Panels are provided in Appendix II, and the statement of work is documented in Appendix III.

Overall, the Panel review adhered closely to the agenda provided to attendee's prior to the meeting. The STAR Panel review can be divided into three broad tasks: A full assessment for Pacific mackerel; a review of the Pacific sardine daily egg production method; and a review of the proposed sardine aerial survey. For each of former two tasks, the STAT leader provided a detailed overview document of the input data, index development, assessment approach (past and present), and the results. The proposed aerial survey overview was presented by the project leader. During each presentation, STAR Panel members and other participants evaluated the material through questions of clarification and open discussion. Concurrent with the discussions, the Review Panel made specific requests for additional background information, data analyses, model reruns, and evaluations to be provided by the STAT and/or the project leader. All requests were documented as to the specific request, the reason for the request, and the response and are contained in the STAR Panel reports.

The main output of the STAR Panel Review is a consensus summary report that describes the week's activities, requests for information, new analyses, and the Panel's recommendations and conclusions. This year the Panel produced three, essentially independent reports covering Pacific mackerel assessment, the Pacific sardine DEPM, and the proposed sardine aerial survey. Each report provides a detailed summary of discussions, assessment related issues, data deficiencies, recommended methods,

uncertainties, and conclusions. As the reports are available to those interested in specific the specific details, I will only summarize deliberations and important aspects of the review. However, as a full member of the STAR Panel, I do agree with each reports content, and I fully concur with the conclusions and recommendations contained in the three STAR Panel Reports. Drafts of the reports were completed before the meeting adjourned on May 8 and final revisions are to be made available before May 15.

As this was my first STAR Panel Review, I was pleasantly surprised by the professional and respectable focus of the Panel members, presenters, and participants. I have attended similar review meetings in various parts of the world where specific individual agendas were deemed more important than the review. Much of the success of the STAR Panel Review can be attributed to the Chair who did an excellent job of keeping the group focused on the topic being addressed while at the same time allowing everyone, including observers, to express their views or contribute their expert opinion. The STAT members are also to be congratulated for their coherent presentations and their willingness to respond to numerous panel requests.

DISCLAIMER

The information in this review has been provided for review purposes only. The author makes no representation, express or implied, as to the accuracy of the information and accepts no liability whatsoever for either its use or any reliance placed on it.

3. Summary of Findings

The structure of this report is taken from the format described in the terms of reference and past CIE reviewer reports. Under this section entitled “summary of findings”, I have initially made some general comments that pertain to the overall review. These are followed by specific comments/recommendations related to each of the three main objectives. Furthermore, in keeping with past CIE independent review reports, I have not included the STAR Panel consensus report.

General Comments

Several previous STAR Panel Review and CIE review reports have identified the lack of data for both mackerel and sardine throughout their geographical range as a major source of uncertainty and a deficiency in the overall assessments. The reports have specifically identified the poor quality or absence of landings data, biological information, and survey results from Mexico, and the need to collaborate with both Canada and Mexico. From a current perspective this information is even more critical to the review process given that recent evidence suggests there has been a shift in temporal and spatial distribution or a broadening of spawning range for one or possibly both species. The 2009 reports presented at the review acknowledged some improvements in this area, but it is stressed that a concerted effort must continue to procure these data in a timely and consistent fashion.

There is a clear need to document how indices of abundance for mackerel and sardine have been developed, when changes have occurred that might affect the indices, and if corrections/substitutions have been made, for the entire time series in one place or table. On several occasions during the review, requests were made by the Panel to verify or to detail a process that may account for some uncertainty in an index. Unfortunately, this information was not readily available and members of the STAT had to retrieve the original documentation to answer the request. For some questions the data/information was not, or could not be, made available to the Panel during the review.

The Panel made also several requests for detailed data analysis requiring access to the raw data that could not be accommodated due to the inaccessibility of the data. Although the Panel report has identified this as a deficiency in the process that must be corrected, as the CIE expert, I would like to reiterate their concerns and stress the need to have the raw data available. In order to provide the best available advice on procedures and processes, all data used in the assessment should be available when a STAR Panel is convened. It should, however, be noted that the STAT made every effort to obtain the data or to provide a truncated analysis with what data were available.

For both mackerel and sardine, there is a definite need to improve sampling of the adult population throughout their geographical ranges to better characterize size at capture, age, and development stages. This is particularly true for fisheries occurring outside the typical areas off California. However, even within US waters, the amount of available samples is small and restrictive to data exploration. Currently, major assumptions or extrapolations are being based on a relatively small sample sizes that may be biased (see comments on stratification). Increased sample numbers would help to improve the assessment for both species in several areas.

While the mackerel harvest control rule (HG) was beyond the scope of the STAR Panel review, it is evident from the information present to the Panel that the input parameters to the rule should be reviewed. The current HG for mackerel is based on a fixed relationship established almost a decade ago at a time when the stock was at much lower abundance level. The only parameter that changes annually in the relationship is biomass estimated from the assessment model. The cutoff, the fraction harvested above the cutoff, and the 1+ biomass in US waters current harvest, remains constant with time. Given the strong indication that there have been spatial and temporal distributional changes, the current value of 70% may not reflect the average portion of mackerel in US waters. A similar situation may also be occurring for sardines. Consideration should be given to re-visiting these fixed parameters for both species at a future STAR Panel Review.

3.1 Pacific sardine

The STAR panel reviewed two survey indices related to components of Pacific sardine in support of the upcoming assessment scheduled for September of 2009. The current assessment model (i.e., Stock Synthesis' population model) uses a single survey time series (SWFSC's daily egg production method) of relative abundance to adjust estimates

of spawning stock biomass (SSB). Recently this index has been criticized by the fishing industry for covering only the core spawning area between when the northern population is believed to range from northern Mexico, to British Columbia, Canada. Further, because of the low harvest guidelines in 2008 and 2009, the industry initiated a test aerial survey in 2008 to contest the assessment model abundance estimate and to potentially develop another index of abundance for Pacific sardines. This led to a proposal to initiate an industry funded (EFP) aerial survey series in 2009. The STAR Panel reviewed both the traditional daily egg production method (DEPM) and the proposed aerial survey. Each survey is discussed separately in this and the STAR Panel report. The Panel did not evaluate the 2008 industry funded test aerial survey as it was considered a pilot project, and thus inappropriate for inclusion in the assessment.

3.1.1 Pacific sardine DEPM index of abundance

The current Pacific sardine assessment uses the Southwest Fisheries Science Center's (SWFSC) ichthyoplankton survey data to estimate daily egg production (P_0) and subsequently to estimate the spawning stock biomass (SSB) as a relative index of abundance. The single index of spawning stock biomass is used to tune the 'Stock Synthesis' population model to estimate total biomass which is then applied to the HG equation. This annual survey and the index have been criticized by the fishing industry for its limited range, covering only the 'core' spawning area between San Diego and San Francisco, when the exploited stock extends from northern Baja California, Mexico, to British Columbia, Canada. The STAR Panel reviewed the sardine survey design, methodologies, documents, and any other pertinent information on Pacific sardine surveys for the purpose of improving the survey methods and, to develop a better estimate of relative abundance for use in the assessment model. A summary of the survey design, data collections, and analytical procedures was presented by Nancy Lo.

Consistent with the terms of reference, the Panel reviewed the available material in terms of the following key questions:

- The design of sampling scheme used to collect the basic data used in the DEPM.
- The analytical treatment of the data in terms of the ability to estimate (A) absolute abundance and (B) trends in abundance.
- Consequences of the implementation of survey protocols.
- Use of DEPM estimates in stock assessments for Pacific Sardine.

The STAR Panel reports addresses each of these questions in detail; as such I will touch only on some of the more salient points within a general summary. I fully agree with the comments and recommendations regarding the Pacific sardine DEPM.

Overall there were no major deficiencies in the operational design and computational procedures to estimate P_0 and spawning stock biomass. These have been published and well reviewed in the peer reviewed literature. Similar approaches are also used around the

world for several different species. However, estimating only the female spawning biomass outside the assessment model (recommended later in this report) would remove the sex ratio component from the biomass equation.

The design scheme is essentially divided into two components: An adaptive phase for egg collections to estimate daily egg production based on the Continuous Underwater Fish Egg Sampler (CUFES); and the adult sampling to estimate adult spawning rate. The data are post-survey stratified using established criteria. The most significant problem with the DEPM is the lack of coverage of the total spawning area which appears to be variable from year to year. For example, between 2004 and 2007 the survey coverage was restricted to the area between San Diego and San Francisco, while the 2008 extended north to Cape Flattery, Washington. A large potential source of uncertainty occurred in several years when the highest egg densities were observed on the survey boundary transects, especially in the south. The extent to which these high density areas continued beyond the survey boundaries could have a significant impact on the estimated biomass. Survey results clearly show that in some years the densest areas extend south into Mexican waters for an unknown distance. While a similar survey is undertaken annually by Mexico, the data are not readily available to estimate or verify the extent of the high density egg distribution. Some data have been obtained recently; however, effort should continue to keep these data flowing.

Several issues and potential problems with the adult sampling rate were identified by the Panel. A major deficiency in the adult sampling program is the lack of samples to characterize the adult population. For some years the entire spawning population is defined by only a few samples containing less than a total of 200 fish, not necessarily associated with the egg sampling area. In 2008 the mature female parameters used in the DEPM were determined from 187 fish and the sex ratio from 353 fish. In 2001 and 2002 the parameters were based on only 9 and 23 mature females, respectively. There is also been a temporal difference in the sampling of eggs and adults. For example, in 1995, there is a major disconnect between the time of egg collections and adult sampling. Almost three weeks had transpired between the two events and the previous year's data were substituted to compute the biomass. These are major sources of uncertainty and potential source of bias depending upon the representativeness of the samples. Every effort should be made to increase the number of adult samples, sample adult fish at the time of egg collections, and to explore opportunities to obtain samples from other sources operating in the vicinity of the survey. This would enhance the data available to explore/test additional stratifications, and provide a better estimate of the DEPM input parameters, given the indication from preliminary analyses that there may be some north/south and inshore/offshore differences.

Another concern with the DEPM was the way the daily specific fecundity (RSF/W) ratio was estimated for years when it could not be computed from the available samples. It appears that there has been somewhat of an *ad hoc* or inconsistent approach to substituting the value if no data are available. Since 1994 (15 years), there have been only eight estimates of RSF/W with a constant of 23.55 used between 1995 and 2001. The method for calculating/substituting this parameter needs to be standardized and

documented so future reviewers will have an understanding of what transpired in the development of the index, what improvements have been made, and whether or not there may be some inherent biases associated with the index.. Furthermore, it was noted that several changes have occurred throughout the time series which have not been documented in the current report on DEPM made available to the Panel. No information is provided in the most recent document on the DEPM on what was done prior to 1994, although these years are contained in the time series. All factors affecting or changes should be documented in a single place and available to the review panel.

As for the use of the DEPM in the stock assessment, the Panel recommends the estimation of female spawning biomass, not the total adult biomass, be used for input to the SS assessment model. This would eliminate the need for the sex ratio in the DEPM. A summary of the Panels research recommendations are provided in Section 4.

3.1.2 Aerial Survey for Pacific Sardine

The fishing industry has proposed to undertake in 2009 a broad area aerial survey of Pacific sardines with coverage in both the northern and southern portions of the species range. The survey's proponent Technical Team presented a detailed overview of the survey which was described in Jagielo (2009). The main purpose of the Panel was to review the proposed aerial survey methodology from the documents provided as it relates to Pacific sardine with several key issues in mind. The Panel did not review aerial survey methods in general, nor make any comments regarding an alternative approach. The key issues were:

- The design of sampling scheme used to collect the basic data used in the proposed aerial survey.
- The analytical treatment of the data in terms of the ability to estimate (A) absolute abundance and (B) trends in abundance.
- Consequences of the implementation of survey protocols.
- Evaluation of precision and bias.
- Use of aerial survey abundance estimates in stock assessments for Pacific Sardine.

The STAR Panel discussed the above issues on several occasions throughout the week and the Panel Report on this survey addresses each of these issues in detail. As I agree with all of the comments and recommendations contained in the consensus report I will provide only a few general comments.

First of all, the Technical Team is to be commended for their clear presentation of the material and their willingness to answer questions, address issues, and modify the design to accommodate the Panels concerns and recommendations. If the Technical Team didn't have the information immediately at hand or needed to consider possible solutions, they generally did so the next day to the satisfaction of the Panel. Discussions amongst the participants were constructive and I believe resulted in an improved survey design, clear

understanding of what can feasibly be undertaken, what deliverables are expected, and how the results might be used in the assessment.

Unlike the other reports from this STAR Panel, the conclusions and recommendations are contained within the text of each category and sub-category. I have extracted them directly from the report and listed them in Section 4.

The Panel made recommendations for slight changes in the survey protocols (Stage 1) and calibration (Stage 2) procedures to address several identified issues or sources of uncertainty. The Panel has also stressed the need to keep accurate logs of all observations and to utilize the data collected to address multiple issues. For this survey, the two key issues center on determination of school area and school identification. The Technical team were confident that the pilots and those editing the photo images could confidently identify sardine schools; however, the Panel was not so sure and explored methods to determine both Type I (identified as non-sardine schools when they were sardine schools) and Type II (identified as sardine schools when they were not sardine schools) errors. Under the current sampling protocol only Type II error will be examined. It is recommended that if the survey is undertaken for more than one year that an experiment be incorporated to investigate Type I error.

Another factor associated with school identification that wasn't discussed in any great detail was the purity of the schools with respect to species composition. In many parts of the world, pelagic species of similar size school together to form a mixed species aggregation or school whose composition can vary from school to school. If a school were identified as sardine when in fact it contained a mixture of two or more species, it would introduce a positive bias or an overestimate biomass. While the technical team assured the Panel that the majority of schools identified as sardine contained mostly sardine, it is important that information on species composition be collected during the 2009 survey.

The Panel made several suggestions/recommendations regarding the determination of school area. Concern was expressed about edge distortion, incomplete coverage of a school near the outer boundaries of the image, and area adjustment due to distance from the camera for non-nadir schools. Overall, however, the Panel felt these concerns could be overcome and accommodated in the analytical procedures.

The calibration of biomass estimates (Stage 2) involves the capture of entire schools by purse seiner. The Panel again made several recommendations relating to how and what information should be collected. It was stressed that the point sets must be representative of the types and school sizes observed during Stage 1. In addition, if the vessels are equipped with a logging echo-sounder (e.g., Simrad ES 60 or Furuno) then data on school depth and thickness could be collected during calibration studies. Regarding the analytic treatment of the data, the Panel recommends converting from area to tonnage before integrating over the survey area to accommodate the potential nonlinearity of school tonnage and school surface area relationship.

The Panel and participants spent a fair amount of time discussing the survey sampling requirements and the EFP allocation. In the end it was decided that an allocation of 2400t was sufficient to meet the school size sampling requirements for both areas with sufficient precision. However, if only the current allocation of 1200t were available, it would allow for appropriate sampling in only one of the two survey areas (i.e., North or South). It was the Panel's view that the proposed number of samples should not be reduced. Furthermore, the sampling of large schools (>100t) would likely require an even greater EFP allocation. It is also important to collect biological and length frequency data to get an accurate estimate size composition, maturity stage and age for the surveyed fish. This will help to improve estimated parameters within the assessment model.

A summary table was developed to identify the general issues regarding precision and bias and is provided in the Panel report. Whenever possible, an estimate (i.e., best guess) of the bias direction was provided for each issue. Overall, the total biomass estimated from the aerial survey is expected to be an underestimate. Purely by design, given that the survey does not cover the entire range of sardine distribution, it will underestimate the total. However, there are several sources of uncertainty and bias that could lead to an overestimate.

How the biomass estimate from the survey is, or will be, used in sardine stock assessment was also discussed. First of all, it was concluded that the 2008 pilot survey should be considered in the assessment. For the 2009 survey data it was determined, assuming it was implemented as planned, that the current analytical models could handle the survey results as an absolute estimate of sardine abundance with appropriate values of "q". However, if the survey is continued on an annual basis, over time the series could lead to a new relative index of abundance. This is something that I would strongly recommend as the current assessment is dependent upon a single index. It is also important to denote the meaning of absolute biomass in terms of an input parameter to an assessment model compared to the literal definition. In the latter, the estimate is assumed to be a fixed and true estimate of biomass (or minimum biomass), yet in the former there is a fair amount of uncertainty associated with the estimate - "q" - being something less than 1. The two do not have the same meaning.

3.2 Pacific mackerel

Prior to 2004, the ADEPT model, a modified version of 'ADAPT' VPA, was used to evaluate Pacific mackerel stock status and to establish management quotas. At the 2004 review, the forward-simulation model "Age-structured Assessment Program" (ASAP) was introduced and adopted by the STAR Panel for Pacific mackerel. However, since 2007, an alternative model, the Stock Synthesis (SS), has been run, but not accepted/recommended by the Panel. Up to and including this year, both ASAP and SS have been presented to the STAR Panel annually, but only the ASAP model results were used for management advice. The main reason the SS model was not used, although the model should perform better than ASAP, is that the results were very sensitive to changes

in model specifications, and past STAR Panels concluded that the model formulations did not adequately fit the data.

The challenge for the 2009 STAT was to continue the transition process from ASAP to SS with the goal of having a single assessment model. The main objectives of the STAT were to:

- (1) Build the ASAP “management model”, i.e. update the current ASAP model using new data;
- (2) Construct an SS alternative base-model that mirrors ASAP;
- (3) Develop a suite of alternative SS models that are improvements to the SS base-model; and
- (4) Select a preferred SS model from the suite of alternative models.

In this respect, the STAT met all of its objectives, and its members are to be commended for their effort, long hours, comprehensive presentations, and meeting the numerous requests of the Panel.

The main outcome of this Panel review was the construction of an SS base-model that mirrored the ASAP. In this regard, the Panel agreed that the new formulation with additional years of data tracked the ASAP output well and that SS could now be used for the assessment. The STAT team presented a number alternative SS models, but in the end selected ‘S1_qa25’, which excluded the spotter and CalCOFI indices. The remainder of the week concentrated on specific requests to evaluate model sensitivities. The specific requests, reasoning, and responses are presented in the Panel’s Report. Overall, 26 sensitivity analyses were undertaken to explore a wide variety of factors such as starting year, block effects, inclusion of the CalCOFI index, age length fits, etc.

In the end the Panel and the STAT selected model ‘AA’ as the final base model. This model used annual time steps, an increased input σ_R of 1.0, doubled the weight on the recreational length compositions, and excludes both the CalCOFI and spotter indices. The return to annual rather than quarterly increments was made to overcome some model treatment effects of the steps. The ‘AA’ model like the ASAP shows a continued increase in abundance that began around 2002.

An alternative model (‘AB’) was constructed, but not explored to any great extent by the Panel. This model evaluated a possible change in selectivity by including an additional selectivity time block (starting 2000) for both the recreational and commercial fisheries and by splitting the CPFV index. The biomass outputs of the alternative model are substantially lower than the final base model. The output is, however, consistent with a suggested change in selectivity/catchability that may have occurred around 2000 and the difficulty note by the fishing industry in catching Pacific mackerel in recent years. I will return to this latter point below.

The Panel identified two unsolved problems and major uncertainties with the assessment at the end of the meeting:

- 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. Previous Panels recommended that efforts be made to obtain biological sampling data from the Mexican component 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. Obtaining data from the Mexican fishery 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 index used in the present assessment. Specifically, 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 based on fishery-dependent data, the use of CPFV index in the assessment as an index of stock abundance is predicated on the assumption that catchability and selectivity have not changed over time, or that the changes have been adequately included in the model configuration.

In addition to the concerns expressed above by the Panel, there are two areas of concerns or inconsistencies that were examined by the Panel, but which I feel need additional attention: The indices of abundance, and the commercial fishery not catching anything near the HG since about 2000. The ASAP model used for assessment and management advice prior to 2009 included three indices of abundance: The CPFV, the CalCOFI (ongoing survey) and the spotter (series terminated) time series. However, in the transition from ASAP to SS and the selection of a base model, the latter two indices were excluded from the model due to their poor fit and the presence of 0's in the data. This in itself would not be a concern, given the relative good fit with a single index (CPFV), if it were not for the source of the uncertainty associated with the relationship between a recreational fishery and a large commercially exploited fish stock. The CPFV is based on the catch and effort of mackerel from the recreational fishery which may or may not be targeting mackerel. Consequently, factors completely unrelated to the fish or the fishery could potentially have a significant impact on the index via a change in selectivity and catchability. For instance, the high cost of fuel in 2008 surely affected the distance recreational charters traveled. There is also some evidence that a change in "q" has occurred starting around 2000. Hence, the reliance on a single index such as the CPFV leaves some uncertainty about what is actually being tracked.

The Panel spent a fair amount of time discussing their concerns regarding the use of a single index and made several attempts to modify the CalCOFI index for input to the model through the use of super year-classes (multiple year-classes combined). However, in the end the Panel decided that the SS model configuration "AA" with only the CPFV index fit all of the data sources adequately. However, a plausible alternative model ("AB") was constructed but not developed which produced substantially lower biomass estimates from about 2000. The "AB" model should be investigated further at the next full assessment when new data are available.

While the CalCOFI larval production at hatch (P_h) was not used as an index of abundance in the final model formulation for Pacific mackerel, the survey continues and some effort should go into exploring how these data may be better utilized in the assessment. I would not want to see it completely discarded as a potential index of abundance because it should contain information on the spawning stock biomass, albeit within a limited geographical range. A few more years of data may improve the index.

The second concern I have, which was not discussed in any great detail by the Panel, is the inability of the fishing fleet to catch the tonnage allocated under the HG. For the past 4-5 years, the HG has far exceeded the landings. According to fishing representatives at the Review, the fish were simply not there for the taking. This appears to be counter-intuitive to the assessment and introduces some uncertainty into the model results. There are two possible explanations for these observations. One, the fish are not available because their total abundance is down or, two, there has been a shift in distribution such as a movement of fish north or south of the areas in which the fleet typically operates. Although the observations are consistent with the "AB" model, insufficient information was available to draw a conclusion.

The Panel supported the STAT's base model ("AA") as the basis for management advice, with the caution that there is a plausible alternative model indicating a severe decline in the resource.

4 Conclusions/Recommendations

The following is a list of the conclusions/recommendations for Pacific sardine and Pacific mackerel extracted directly from the Review Panel's Consensus Report, with which I fully agree. In addition, where appropriate, I have included a few conclusions and recommendations of my own regarding both species. There were no major areas of disagreement between the Technical Team and Panel for any of the reviews.

4.1 Pacific Sardine Recommendations

4.1.1 DEPM

General

- The Terms of Reference for Stock Assessments for CPS (and other Council FMP species) should be modified so as to require that raw data for key model inputs be available at STAR Panels to allow for further analyses

Tasks to be completed prior to the September 2009 sardine assessments

- The estimates of spawning biomass for 1985, 1986, and 1988 should be re-calculated using a statistical system that is consistent with the more recent DEPM estimates.
- Estimates of the adult reproductive parameters should be made using the same high and low production regions identified by the pelagic egg sampling survey.

- The two strata (regions 1 and 2) should be weighted by their relative adult abundance if adult parameters are not estimated separately by stratum.
- The DEPM estimates should be input to the stock assessment in the form of the biomass of spawning females (i.e. ignore the sex-ratio of mature animals when computing the estimates).
- The data for 2006 should be used in the assessment as an estimate of Total Egg Production (TEP) rather than as part of the DEPM series.
- Estimates of abundance based on the 1995 survey should not be included in the stock assessment at all.
- A complete and annotated table similar to Table 3 in the 2008 report, including the information from the 1980s CDFG surveys, should be available (and included in the stock assessment report) for the upcoming sardine assessment

Longer-term research priorities

- Efforts should be made to increase the number of samples of adults.
- A hierarchical modeling approach (a.k.a. random effects modeling) should be adopted for estimation of spawning rate parameters
- The use of day 2 and day 3 follicles should be explored as a way to estimate the spawning fraction.
- The relative abundance of fish deeper than can be sampled by the trawls should be determined (perhaps by means of acoustics) and an evaluation conducted to determine whether these fish represent a significant source of uncertainty.
- Additional sources of adult fish samples should be explored.

CIE reviewer recommendations

- Given the potential temporal and spatial changes in spawning distribution in recent, and likely past, years, a thorough review of the available information on sardine should be undertaken to evaluate the implications of the DEPM estimates.

4.1.2 Aerial Survey Recommendations/Suggestions

- Establish three alternative fixed starting points five miles apart, and choosing one of the three without replacement at the start of each replicate survey.
- It is important to be sure that informative features (e.g., edge properties) are not removed from the images during image processing.
- The log includes a record of qualitative information regarding the processing and the difficulty in assigning species and calculating school areas.
- An empirical calibration curve for edge distortion may be more reliable and robust than a theoretical calibration curve.
- Quantify differences between observers or photographic processing technicians by means of double-blind comparisons and similar techniques
- Targeted schools should be representative of the types and sizes of schools observed in the Stage 1 transects.

- Each school should be converted to an estimated tonnage before integrating over the survey area, to allow for nonlinearity in the relationship between school tonnage and school surface area.
- If only 1200 EFP tons are available it should be used in only one of the two possible survey areas.

4.2 Pacific Mackerel Recommendations

- Collect biological data on mackerel caught in Pacific NW.
- Improve collaboration with fishery researchers from Mexico and Canada. 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.
- The data on catches come from several sources. The catch history from 1926-27 to present should be documented in a single report.
- Reconsider the suite of indices and make recommendations for future assessments.
- Review and analyze the raw data on which the CPFV index is based and consider area blocks as a factor in GLM.
- Bolster the current monitoring program for CPFV fleet to improve data collection.
- Look at correlation of Pacific mackerel catch in CPFV with other CPS species to explore the possibility of changes in targeting practices within the CPFV fleet across years. Consider applying the MacCall and Stephens subsetting approach.
- Increase support of current port sampling and laboratory analysis programs for CPS. In particular, there is need to reanalyze biological parameters such as maturity-at-age, ageing error, sex ratio, sex-specific parameters, and natural mortality rates (M), including the possibility of larger M on 0- and 1-year-old Pacific mackerel.
- Ageing error should be revisited. There are currently very few otoliths that have been read multiple times so additional readings need to be made. 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 and other validation methods.
- Conduct a study to update the information used to determine maturity-at-length (and maturity-at-age).
- Do more research/assessment on related/competing species including anchovy and jack mackerel.
- Future SS assessments should consider fitting to the length-composition and the conditional age-at-length information. This may require estimating time-varying growth curves and may require multiple time-steps within each year.
- Future assessments should consider sex-structured models.

CIE Reviewer Recommendations

- Given the potential temporal and spatial changes in spawning distribution in recent, and likely past, years, a thorough review of the available information on mackerel should be undertaken to evaluate the implications of changes in “q” on the index of abundance and the model estimates.
- The inability of the fishing fleet to catch the tonnage allocated under the HG needs to be investigated further, given that in the past several years the HG has far exceeded the landings.
- A second index of abundance should to be developed (or the CalCOFI enhanced) for Pacific mackerel, given that the CPFV is based on the catch and effort of mackerel from a recreational fishery which may or may not be targeting mackerel abundance, especially in recent years. Perhaps the proposed aerial survey will evolve into a time series for this species.
- The “AB” model should be investigated further at the next full assessment when new data are available.

5. Bibliography of materials provided for the 2009 STAR Panel on Pacific sardine and Pacific mackerel.

CPS. 2009. Terms of reference for a coastal pelagic species stock assessment review process 2009. Pacific Fishery Management Council, April 2009. 17p.

Christopher M. Legault and Victor R. Restrepo. 1998. A Flexible Forward Age-Structured Assessment Program. ICCAT WORKING DOCUMENT SCRS/98/58. 15p.

Methot, Richard D. 2009. User Manual for the Stock Synthesis. Model Version 3.02c. NOAA Fisheries Service, Washington, Updated January 2009. 127p

Pacific sardine

Hunter, J.R. and Lo, N.C.H. 1993. Ichthyoplankton methods for estimating fish biomass introduction and terminology. *Bulletin of Marine Science*, 52(2):723-727.

Jagiello, Tom. 2009. West Coast Sardine Survey Application for Exempted Fishing Permit in 2009. Prepared by Resource Analysts International and Tom Jagiello Consulting. For California Wetfish Producers Association, Buellton California. 49p.

Lo, N.C.H., B.J. Macewicz, D.A. Griffith, and R.L. Charter. 2008. Spawning Biomass of Pacific Sardine (*Sardinops sagax*) of US in 2008. NOAA Technical Memorandum NMFS, November 2008. NOAA-TM-NMFS-SWFSC-430. 33p.

Lo, N.C.H., J.R. Hunter, and R Charter. 2001. Use of a continuous egg sampler for ichthyoplankton surveys: application to the estimation of daily egg production of Pacific sardine (*Sardinops sagax*) off California. *Fishery Bulletin*, 99: 554-571

Lo, N. Chyan-huei, Beverly J. Macewicz, David A. Griffith. 2005. Spawning biomass of Pacific sardine (*Sardinops sagax*) from 1994-2004 off California. *CalCOFI Rep.* 2005, Vol. 46, 2005, 93-112.

Resource Analysis International and Tom Jagiello Consulting. 2009. West Coast sardine survey – Application for Exempted Fishing Permit in 2009. California Wetfish Producers Association, Buellton, California. 44p.

Wespestad, Vidar G., Tom Jagiello, and Ryan Howe. 2008. The Feasibility Of Using An Aerial Survey To Determine Sardine Abundance Off The Washington-Oregon Coast In Conjunction With Fishing Vessel Observation Of Surveyed Schools And Shoals. Northwest Sardine Survey, LLC: 92p

Pacific Mackerel

Crone, P.R., Hill, J.D., McDaniel, J.D., and Lo, N.C.H. 2009. Pacific mackerel (*Scomber japonicus*) stock assessment for USA management in the 2009-10 fishing year. NOAA Technical memorandum NMFS, Draft Report May 2009. 201p.

PFMC. 2007. Scientific and Statistical Committee Report on Pacific Mackerel Stock Assessment and Harvest Guidelines for 2007-2008. Supplemental SSC Report June 2007.

PFMC. 2007. Scientific and Statistical Committee Report on Pacific Sardine and Pacific Mackerel Management. Supplemental SSC Report, November, 2007.

PFMC. 2008. Scientific and Statistical Committee Report on Pacific Mackerel Management for 2008-2009 Supplemental SSC Report June 2008.

Crone, P.R., Hill, J.D., McDaniel, J.D., and Lo, N.C.H. 2009. Pacific mackerel (*Scomber japonicus*) stock assessment for USA management in the 2009-10 fishing year. NOAA Technical memorandum NMFS, Draft Report May 2009. 201p.

Appendix 1: Participants in the 2009 STAR panel for Pacific sardine and Pacific mackerel held 4-8 May, SWFSC, La Jolla, California. USA.

Panel Members, PFMC representatives, STATs, technical teams, and observers participating in the May 2009, La Jolla STAR Panel for Sardine and Mackerel were:

STAR Panel Members:

André Punt (Chair), Scientific and Statistical Committee (SSC), Univ. of Washington,
Owen Hamel, SSC, NMFS, Northwest Fisheries Science Center
Gary Melvin, Center for Independent Experts (CIE),
Alec MacCall, External Reviewer, Southwest Fisheries Science Center (SWFSC)
Ken Burnham, External Reviewer, Colorado State University

Pacific Fishery Management Council (Council) Representatives:

Greg Krutzikowsky, Coastal Pelagic Species Management Team (CPSMT)
Mike Okoniewski, Coastal Pelagic Species Advisory Subpanel (CPSAS)
Mike Burner, Council Staff

Pacific Mackerel Stock Assessment Team:

Paul Crone, NMFS, SWFSC
Kevin Hill, NMFS, SWFSC
Jenny McDaniel, NMFS, SWFSC
Nancy Lo, NMFS, SWFSC

Sardine Daily Egg Production Method (DEPM) Technical Team:

Nancy Lo, NMFS, SWFSC
Beverly Macewicz, NWFS, SWFSC
Kevin Hill, NMFS, SWFSC

Sardine Aerial Survey Technical Team:

Tom Jagielo
Vidar Wespestad
Doyle Hanan
Ryan Howe

Others in Attendance:

Alexandre Aires-da-Silva, Inter-American Tropical Tuna Commission (IATTC)
Briana Brady, California Department of Fish and Game (CDFG), CPSMT
Tom Barnes, CDFG, SSC
Ray Conser, SWFSC, SSC
Doyle Hanan, Hanan and Associates
Sam Herrick, SWFSC, CPSMT
Rodger Hewitt, SWFSC
Ryan Kapp, Astoria Fisherman
Josh Lindsay, NMFS, Southwest Regional Office

Mark Maunder, IATTC
Sam McClatchie, SWFSC
Jonathan Phinney, SWFSC
Kevin Piner, SWFSC
Dianne Pleschner-Steele, California Wetfish Producers Association, CPSAS
Rosa Runcie, SWFSC
John Rutter, SWFSC
Bob Seidel, Astoria Holdings Inc.
Sarah Shoffler, SWFSC
Dale Sweetnam, CDFG, CPSMT
Akinori Takasuka, SWFSC
Russ Vetter, SWFSC
Ed Weber, SWFSC

Appendix II: STAR Panel Terms of Reference:

The principal responsibilities of the STAR Panel are to review stock assessment documents, data inputs, analytical models, and to provide complete STAR Panel reports. The objective of a STAR Panel review is to complete a detailed evaluation of the results of a stock assessment.

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 2009 CPS Terms of Reference April 2009
4. reviewing summaries of stock status (prepared by STAT Teams) for inclusion in the SAFE document.

STAR Panels normally include an SSC 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 additional member. The total number of STAR Panel 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 as 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 its 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 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 III: Statement of Work:

External Independent Peer Review by the Center for Independent Experts

STAR Panel Review of the Pacific Sardine Survey Methodologies and Pacific Mackerel Stock Assessment

May 4-8, 2009

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract to provide external expertise through the Center for Independent Experts (CIE) to conduct impartial and independent peer reviews of NMFS scientific projects. This Statement of Work (SoW) described herein was established by the NMFS Contracting Officer's Technical Representative (COTR) and CIE based on the peer review requirements submitted by NMFS Project Contact. The CIE reviewer is selected by the CIE Coordination Team and Steering Committee to conduct the peer review of NMFS science with project specific Terms of Reference (ToRs). The CIE reviewer shall produce a CIE independent peer review report with specific format and content requirements (**Annex 1**). This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project.

Project Description: The CIE reviewer will serve on a Stock Assessment Review (STAR) Panel having two separate objectives. The CIE reviewer will be expected to participate in the review of both objectives, placing greater emphasis on the first given the prerequisite and need for expertise in the area of sampling and survey design. The two objectives are:

1) Sardine Survey Methodologies

The Pacific sardine stock is assessed each year by SWFSC scientists, and the Pacific Fishery Management Council (PFMC) uses the resulting biomass estimate to establish an annual catch limit for the U.S. west coast fishery. The current assessment uses a single survey time series (SWFSC's daily egg production method survey) of relative abundance to adjust estimates of spawning stock biomass (SSB) in the 'Stock Synthesis' population model. Both the observed (survey) and model-derived estimates of SSB have recently decreased, resulting in dramatically lower harvest guidelines for 2008 and 2009. The SWFSC's current standard survey has been criticized by industry for only covering the 'core' spawning area between San Diego and San Francisco, while the exploited stock ('northern subpopulation') is believed to range seasonally from northern Baja California, Mexico, to British Columbia, Canada. As a consequence of lower quotas and lack of industry confidence in the SWFSC's survey, fishers from the Pacific Northwest initiated an industry-funded aerial spotter survey during the summer of 2008, with the hope of 1) refuting model estimates of abundance, and 2) providing a second time series of relative abundance for use in the model. Industry is currently planning to repeat the aerial survey off the Pacific northwest and possibly expand the area surveyed to include locations northward off British Columbia and southward to Monterey, California during the

summer of 2009. This STAR Panel will review sardine survey designs and methodologies, documents, and any other pertinent information for Pacific sardine surveys and produce a STAR Panel report for use by the PFMC and other interested persons for developing improved survey methodologies and, ultimately, better time series of relative abundance for use in the assessment model. The assessment model itself will be reviewed by a separate STAR Panel in September 2009, but it is presumed that the survey methodologies and recommendations of the May STAR Panel will be carried forward in the new assessment model.

2) Pacific mackerel stock assessment

The Pacific mackerel stock is assessed annually by SWFSC scientists, and the Pacific Fishery Management Council (PFMC) uses the resulting biomass estimate to establish an annual harvest level. This has a large potential impact on the fishery (up to 25-40% of the ex-vessel value). The stock assessment data and model are formally reviewed by a Stock Assessment Review (STAR) Panel once every three years, with the SSC reviewing updates in interim years. Independent peer review is required by the PFMC review process. The STAR Panel will review draft stock assessment documents and any other pertinent information for Pacific mackerel, work with the stock assessment teams to make necessary revisions, and produce a STAR Panel report for use by the PFMC and other interested persons for developing management recommendations for the fishery.

The PFMC's Terms of Reference (ToRs) for the STAR Panel review are attached in **Annex 2**. The tentative agenda of the Panel review meeting is attached in **Annex 3**. Finally, a Panel summary report template is attached as **Annex 4**.

Requirements for CIE Reviewer: One CIE reviewer shall have the background and expertise, and conduct an impartial and independent peer review in accordance with the SoW and ToR herein. The CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review process. Specifically, the CIE reviewer should have the necessary skills, qualifications, and work experience in the following areas of fishery science (presented in descending order of importance):

- Expertise in the design and execution of fishery-independent surveys for coastal pelagic fishes, particularly daily egg production method and aerial spotter surveys;
- Knowledge of life history strategies and population dynamics of coastal pelagic fishes;
- Familiarity in the application of fish stock assessment methods, particularly, length/age-structured modeling approaches, e.g., 'backward-simulation' models (such as Virtual Population Analysis (VPA)-like methods), and most importantly, 'forward-simulation' models.

Location/Date of Peer Review: The CIE reviewer shall conduct an independent peer review during the STAR Panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores, La Jolla, California from May 4-8, 2009 in accordance with the schedule of milestones and deliverables herein.

Statement of Tasks: The CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Prior to the Peer Review: Upon completion of the CIE reviewer selection by the CIE Steering committee, the CIE shall provide the CIE reviewer information (name, affiliation, and contact details) to the COTR, who forwards this information to the NMFS Project Contact no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the CIE reviewer. The NMFS Project Contact is responsible for providing the CIE reviewer with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The NMFS Project Contact is also responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COTR prior to the commencement of the peer review.

Foreign National Security Clearance: When CIE reviewer participates during a panel review meeting at a government facility, the NMFS Project Contact is responsible for obtaining the Foreign National Security Clearance approval for CIE reviewer who are non-US citizens. For this reason, the CIE reviewer shall provide requested information (e.g., name, contact information, birth date, passport number, travel dates, and country of origin) to the NMFS Project Clearance for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations (available at the Deemed Exports NAO website: <http://deemedexports.noaa.gov/sponsor.html>).

Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. The CIE reviewer shall read all documents in preparation for the peer review, for example:

- Current and past documents on survey methodologies, in particular, related to aerial surveys, DEPM ichthyoplankton and trawl surveys
- Recent stock assessment documents since 2007
- STAR Panel- and SSC-related documents pertaining to reviews of past assessments
- CIE-related summary reports pertaining to past assessments
- Miscellaneous documents, such as ToR, logistical considerations

Pre-review documents will be provided up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process, including a SoW modification to the schedule of milestones and deliverables. Furthermore, the CIE reviewer is responsible only for the

pre-review documents that are delivered to the reviewer in accordance to the SoW scheduled deadlines specified herein.

Panel Review Meeting: The CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs. **Modifications to the SoW and ToR cannot be made during the peer review, and any SoW or ToR modification prior to the peer review shall be approved by the COTR and CIE Lead Coordinator.** The CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified in the contract SoW.

Respective roles of the CIE reviewer and STAR Panel chair are described in Annex 2 (see p. 6-8). The CIE reviewer will serve a role that is equivalent to the other panelists, differing only in the fact that he/she is considered an 'external' member (i.e., outside the Pacific Fishery Management Council family and not involved in management or assessment of West Coast CPS). The CIE reviewer will serve at the behest of the STAR Panel Chair, adhering to all aspects of the PFMC's ToR as described in Annex 2. The STAR Panel chair is responsible for: 1) developing an agenda, 2) ensuring that STAR Panel members (including the CIE reviewer), and STAT Teams follow the Terms of Reference, 3) participating in the review of the assessment (along with the CIE reviewer), 4) guiding the STAR Panel (including the CIE reviewer) and STAT Team to mutually agreeable solutions.

The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Contract Deliverables - Independent CIE Peer Review Reports: The CIE reviewer shall complete an independent peer review report in accordance with the SoW. The CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. The CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: The CIE reviewer will assist the Chair of the panel review meeting with contributions to the Summary Report. CIE reviewer is not required to reach a consensus, and should instead provide a brief summary of their views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

Specific Tasks for CIE Reviewer: The following chronological list of tasks shall be completed by the CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

- 1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review;

- 2) Participate during the panel review meeting at the La Jolla, California, from May 4-8, 2009, as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Annex 2);
- 3) No later than May 22, 2009, the CIE reviewer shall submit an independent peer review report addressed to the “Center for Independent Experts,” and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, Dr. David Die, via email to ddie@rsmas.miami.edu. The CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2;
- 4) CIE reviewer shall address changes as required by the CIE review in accordance with the schedule of milestones and deliverables.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

31 March 2009	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
20 April, 2009	NMFS Project Contact sends the CIE Reviewer the pre-review documents
4-8 May 2009	The reviewer participates and conducts an independent peer review during the Panel review meeting
22 May 2009	CIE reviewer submits draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
5 June 2009	CIE submits CIE independent peer review reports to the COTR
12 June 2009	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: Requests to modify this SoW must be made through the Contracting Officer’s Technical Representative (COTR) who submits the modification for approval to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the CIE within 10 working days after receipt of all required information of the decision on substitutions. The COTR can approve changes to the milestone dates, list of pre-review documents, and Terms of Reference (ToR) of the SoW as long as the role and ability of the CIE reviewer to complete the SoW deliverable in accordance with the ToRs and deliverable schedule are not adversely impacted. The SoW and ToRs cannot be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW. As specified in the Schedule of

Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (the CIE independent peer review reports) to the COTR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COTR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards: (1) the CIE report shall have the format and content in accordance with Annex 1, (2) the CIE report shall address each ToR as specified in Annex 2, (3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon notification of acceptance by the COTR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COTR. The COTR will distribute the approved CIE reports to the NMFS Project Contact and regional Center Director.

Key Personnel:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.
2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Conclusions and Recommendations in accordance with the ToRs.
 - a. Reviewer should describe in their own words the review activities completed during the panel review meeting, including providing a detailed summary of findings, conclusions, and recommendations.
 - b. Reviewer should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where there were divergent views.
 - c. Reviewer should elaborate on any points raised in the Summary Report that they feel might require further clarification.
 - d. Reviewer shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.
 - e. The CIE independent report shall be a stand-alone document for others to understand the proceedings and findings of the meeting, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.
3. The reviewer report shall include as separate appendices as follows:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of the CIE Statement of Work

Appendix 3: Panel Membership or other pertinent information from the panel review meeting.

Annex 2: Terms of Reference for the STAR Panel Review of Pacific Sardine Survey Methodologies and Pacific Mackerel Stock Assessment

The CIE reviewer is one of the five equal members of the STAR panel. The principal responsibilities of the STAR Panel are to review stock assessment and survey documents, data inputs, analytical models, and to provide complete STAR Panel reports. Two goals of this review are:

Goal 1. Provide an independent description of the process, data, model, and outcomes of the Pacific mackerel STAR panel review.

Goal 2. Provide an independent description of the strengths and weaknesses of the review process and the recommended outcomes of the STAR Panel review of the egg production method and the potential use of aerial survey techniques as a relative index of abundance as well as an absolute index of abundance.

Along with the entire STAR Panel, the CIE Reviewer's duties include:

1. reviewing draft stock assessment and survey documents and other pertinent information (e.g.; previous assessments and STAR Panel reports, documents related to daily egg production and aerial surveys);
2. working with STAT Teams to ensure assessments are reviewed as needed;
3. documenting meeting discussions;
4. reviewing summaries of stock status (prepared by STAT Teams) for inclusion in the Stock Assessment and Fishery Evaluation (SAFE) document;
5. recommending alternative methods and/or modifications of proposed methods, as appropriate during the STAR Panel meeting, and;
6. 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.

The STAR Panel, including the CIE Reviewer, is responsible for determining if a stock assessment or technical analysis is sufficiently complete. It is their responsibility to identify assessments that cannot be reviewed or completed for any reason. The decision that an assessment is complete should be made by Panel consensus. If agreement cannot be reached, then the nature of the disagreement must be described in the Panels' and CIE Reviewer's reports.

The review solely concerns technical aspects of stock assessment or survey work. It is therefore important that the Panel strive for a risk neutral perspective in its reports and deliberations. Assessment results based on model scenarios that have a flawed technical basis, or are questionable on other grounds, should be identified by the Panel and excluded from the set upon which management advice is to be developed. The STAR Panel should comment on the degree to which the accepted model scenarios describe and quantify the major sources of uncertainty. 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.

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 of work that is required.

**Annex 3: Tentative Agenda for the STAR Panel Review of
Pacific Sardine Survey Methodologies and Pacific Mackerel Stock Assessment**

Monday 4 May

08:00	Introductions	Punt
	Facilities, e-mail, network, etc.	Lo
	Workplan and Terms of Reference	Burner
	Report Outline and Appointment of Rapporteurs [Likely: Hamel – Mackerel; MacCall – Surveys]	Punt
08:30	Pacific Mackerel assessment presentation	Crone
10:30	Break	
11h00	Panel discussion and analysis requests	Panel
12:30	Lunch	
13:30	Egg production method survey presentation	Lo
15:00	Break	
15:30	Aerial survey presentation	Jagiello
17:00	Close	

Tuesday & Wednesday 5 – 6 May

08:00	Pacific Mackerel responses	Crone
10:30	Break	
11h00	Survey methods discussion (and requests)	Panel
12:30	Lunch	
13:30	Pacific Mackerel reprise	Crone
15:00	Break	
15:30	Survey methods discussion	Panel
17:00	Close	

Thursday 7 May

08:00	Pacific Mackerel responses	Crone
10:30	Break	
11:00	Survey methods (report)	Panel
12:30	Lunch	
13:30	Report writing	Panel
16:00	Public comment general issues	
17:00	Close	

Friday 8 May

08:00	Pacific Mackerel responses	Crone
10:30	Break	
11:00	Report preparation	Panel
12:30	Lunch	
13:30	Report preparation	Panel
15:00	Close	

Annex 4: Summary Report (Template) for the STAR Panel Review of Pacific Sardine Survey Methodologies and Pacific Mackerel Stock Assessment

- Names and affiliations of STAR Panel members
- List of analyses requested by the STAR Panel, the rationale for each request, and a brief summary the STAT responses to each request
- 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 (including concerns raised by the CPSMT and CPSAS representatives)
 - 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, etc.
- Management, data or fishery issues raised by the public and CPSMT and CPSAS representatives during the STAR Panel

Prioritized recommendations for future research and data