# Center for Independent Experts (CIE) Independent Peer Review Report of:

**STAR Panel Review of the 2014-2015 Pacific Sardine Stock Assessment**

La Jolla
California
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# 1. Executive summary

The meeting to review the Pacific Sardine (*Sardinops sagax caerulea*) Stock Assessment took place in the Southwest Fisheries Science Center in La Jolla, California from 3-5 February 2014. The reports and presentations provided an excellent basis to evaluate the performance of the assessments. Following an extensive model exploration, the Panel agreed on a single model formulation that is accepted for estimating 1+biomass that is suitable for biomass estimation for management. The main differences between the initial model and the final model were different data weighting for survey conditional age at length and use of a common q for both spring and summer ATM surveys. The science reviewed was of a high standard and could be classed as 'of the best scientific information available'.

# 2. Background

The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Appendix 1**. This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

# 3. Description of the review and role in the review activities.

The STAR Panel Review met in the Southwest Fisheries Science Center in La Jolla California from 3-5 February 2014 to review Pacific sardine (*Sardinops sagax caerulea*) stock assessment. The review committee was composed of André Punt, SSC, University of Washington (Chair), Meisha Key, SSC, California Department of

Fish and Wildlife, José de Oliveira, CIE Reviewer, CEFAS - Centre for Environment, Fisheries & Aquaculture Science, UK, and John Simmonds, CIE Reviewer, ICES – International Council for the Exploration of the Sea, Denmark.

At the beginning of the meeting introductions were made (see list of attendees, Appendix 3), and the agenda was adopted (Appendix 3). A draft assessment document and background materials had been provided to the Panel in advance of the meeting on a SWFSC FTP site (Hill and Crone 2014). Paul Crone introduced the draft assessment report. Then David Demer, SWFSC, presented the Acoustic Trawl Survey (ATM) results. Emmanis Dorval, SWFSC, presented the Egg survey results (DEPM). Juan Zwolinski, SWFSC, presented the information on split of the fishery data into subpopulations. Paul Crone and Kevin Hill presented the assessment methodology and the results from a draft assessment utilizing the Stock Synthesis Assessment Tool, Version 3.24s to the Panel. The assessment report included many model options but concentrated on two main models (designated G and H in the draft report). The review examined the underlying assumptions of these two models, selected G as the methodologically most appropriate and then concentrated on exploring model G and a number of potential modified versions (see Section 4.4 below).

I participated in all aspects of the review, paying particular attention to input survey data, and its use in the assessment, which consisted of a) Acoustic Trawl Method (ATM) in spring and summer, b) egg surveys utilizing; total egg production method (TEPM), and daily egg and daily egg production method (DEPM), and c) combined aerial photogrammetric and fishing surveys of biomass. In addition, I also participated in the Panel review and exploration of the Pacific sardine stock assessment and the sensitivity analyses presented in the draft report and developed during the meeting.

Comments given throughout this report should not be read as direct criticism of what has been done, rather ideas of areas for development. In retrospect, one can always find room for improvement and, as such, minor suggestions have been made throughout this report. These should not be considered prescriptive or limiting but rather as aspects for careful consideration.

# 4. Findings by ToR

## *4.1. Introduction*

The complete ToR for the Pacific Sardine review are given in the statement of work (Appendix 2), the main aspects are repeated here.

1. Reviewing draft stock assessment and other pertinent information (e.g.; previous assessments and STAR Panel reports);
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.

Items 1 and 4 form the main body of the review, which is discussed in detail in this Section below. Items 2 and 3 and 6 were the process of the review, which are dealt with under proceedings of the review, Section 5 of this report. Item 5 is dealt with under recommendations and conclusions in Section 6.

## *4.2. Survey data available for the assessment*

### *4.2.1.* Acoustic survey

Use of the survey in the model: Two series of acoustic trawl surveys (ATM) are currently available for the assessment. The acoustic survey is carried out to a high standard. The procedures and performance of the ATM has been documented in the methodological review (2011), which concluded that it was possible to consider the ATM as an absolute estimate, but also considered that it would be necessary to check if the resulting residuals in the assessment were compatible with that assumption. As a general principle surveys with short time series that have q close to unity can be considered absolute initially; however, as the number of observations in the survey time series increases over time, it may in the end be possible to detect bias and fit the survey with an estimated q. The 2013 assessment used the ATM survey as absolute, Model G (See Section 4.4) presented in the draft assessment report, used both the spring and summer ATM as relative indices with separately estimated qs. The confidence intervals on these fitted qs included q=1 (ATM absolute) within the estimated range (Figure 4.1).

Survey procedures: Overall the survey is carried out to a high standard particularly in terms of the acoustic aspects, but there are a few aspects that should be examined to see if improvements can be made. The ATM survey takes night trawl samples and uses these to apportion observed daytime biomass between species and additionally uses the samples of Pacific sardine to estimate length and conditional age at length. In many cases catches are a high proportion of one species, so allocation to species is often quite precise. However, the local biomass estimates can be rather variable, so while the samples appear to be sufficient to obtain local estimates of species proportions to allocate to the acoustically derived biomass estimates, the procedure of using night time trawls to assign daytime biomass proportions is not ideal, as it assumes that the species encountered acoustically during the day are then available in the same proportions to night time fishing. Catch rates appear relatively low which is not encouraging. Also the catch rates and age sampling can end up giving only marginally sufficient information on length and conditional age at length. This issue is discussed in detail further under section 4.4.

Development of techniques either to allocate acoustic records directly to species or to obtain direct samples of daytime aggregations would greatly improve the confidence in the age and length structure, as well as for areas where mixtures are encountered the species proportions (see Section 6).

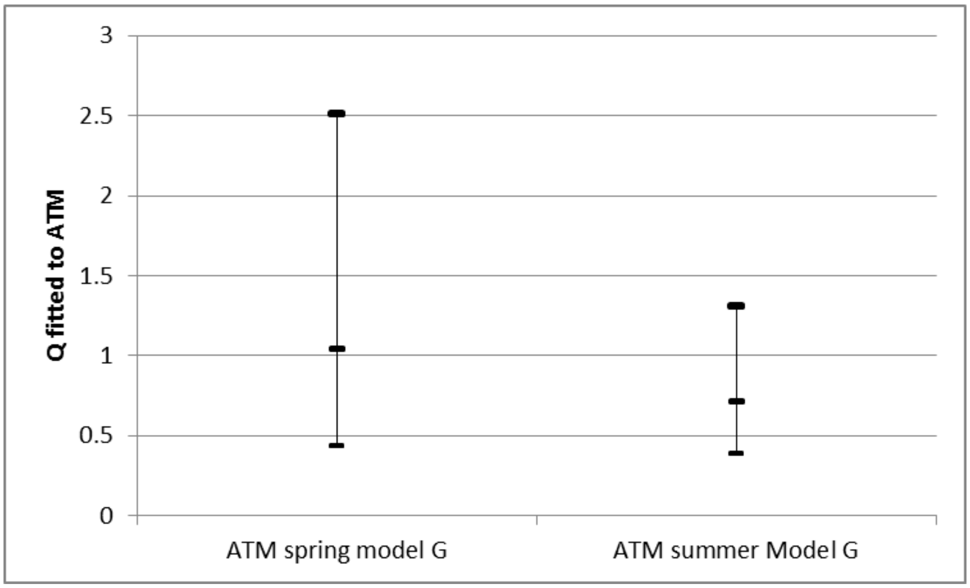


Figure 4.1 Estimated Q with 95% intervals from Model Q, assessment report.

***Construction of conditional age-at-length for the ATM survey***

Currently fish aged during the ATM survey are combined into an unweighted age-length key, and this is used to construct the conditional age-at-length data for each complete ATM survey. This treatment is not considered to be optimal given the possibility for age- and size-specific distribution of sardine. The use of separate conditional age-length keys for the MexCal and PacNW fleets suggests that there may be differences in age-length keys from these regions. The current method for estimating conditional age at length from the ATM surveys assumes that this is not occurring. The alternatives are to develop separate age-length keys for the different regions covered by the ATM survey, or to use appropriate biomass-based weighting for each part of the survey area.

## *4.2.2.* Egg Survey

The long running combined CALCOFI and DEPM survey provides the longest time series of relative abundance estimates for use in the assessment of Pacific sardine. The survey is well developed and the DEPM method is organized to give biomass estimates which are used to give relative estimates of sardine stock abundance. Because of the long time period over which this survey has been developed, the survey index has considerable utility in the assessment and provides biomass related information that is useful for the kind of model used.

Examination of the data collected and analytical methods highlights a number of areas which may benefit from improvement. Whilst these issues have been identified it seems unlikely that they result in sufficient uncertainty to warrant exclusion of series from the assessment. Thus it is appropriate that the survey is used in the assessment. The identified issues fall into two areas, sampling of adult sardine to obtain biological parameters, and analytical methods to obtain abundance indices.

***Sampling of adult sardine on the egg surveys***

The numbers of adult sardine samples to give fecundity (at age), proportion spawning on the sampling day and two previous days are only sufficient to provide at best global means. Sardine are known to distribute by size or age and currently the numbers obtained are very few and do not allow investigation of the dependence of the DEPM on any other factors. A better fish sampling scheme might allow the biological samples to be used to verify that the proportions at length or age that appear to be contributing to the egg abundance do or do not conform to the estimated population, this would help understand the underlying assumptions of the DEPM method.

***Analytical methods to derive DEPM estimates from the egg surveys***

The analysis of the egg survey has some minor issues, mostly to do with the raising of density to survey area. The survey design is intended to sample the region of higher density, because, ideally, the survey obtains lower values around the periphery. A high density stratum is then drawn around a group of observations that contain the higher values, by creating a 'simple' (relatively smooth) boundary using the location of the points. The main idea behind this approach recognizes that the survey objective is to map a peak density in space. There is therefore an assumption that the survey will have higher values towards the center of the area and lower values around the edges. This is then analyzed using a two stratum analysis approach which has two minor issues:

a) The current method for placing the boundary between high and low density areas by placing the boundary on the observation locations means the higher density area is smaller than the region represented by those observations, and conversely the low density area is a little larger resulting in a small underestimate of DEPM abundance. The method should be changed so that the area is allocated to include the correct area allocation for each sampling point included in each of the two strata. The effect is likely small on the index value used in the assessment because the current procedure is applied for all years and the DEPM is used as a relative index.

b) The post stratification and CV calculations may not be correctly calculating the CV used to weight the survey index values in the assessment. The post stratification may result in underestimation of the CV due to the process of separating into strata based not on some independent measure but on the observed values themselves. Such a post stratification procedure is known to be negatively biased. Conversely the use of simple variance based on the within-stratum observations in the two strata may result in overestimation as there is expected to be some spatial trend within each strata. As the two effects are in opposite directions, the end result may not be a major problem. An improved method which accounts for transect-based sampling and correlated observations that reflect the presence of a spawning aggregation would be an improvement.

### *4.2.3.* Aerial Survey

Previously this index had been used in the assessment. No new data from the Aerial Survey were presented at the meeting, though a copy of an Email indicating some work had been done was provided to the meeting and is attached to the main STAR Panel report. Historic Survey estimates were available and although it was indicated that new data was being prepared, no new data was provided to the group so it was not possible to extend the series. The previous values from this survey exhibit considerably more variability than other abundance indices (ATM and DEPM) over the same period (See Figure 20 in the draft assessment report (Hill and Crone 2014)).

The survey potentially provides a good method for estimating the number of near surface fish schools in the area. Though this may be degraded if the schools are too deep or visibility (due to weather) affects the coverage. However, counting schools alone may not give a very precise estimate of biomass. Marchal and Petigas (1993) partitioned variance between school counting and mean school size and school density estimation for a sardine survey. Estimating the number of schools through school counting was shown to be responsible for only a small part of the variance of the abundance estimate, whereas estimating within school density dominated the precision. The indications from the information on the aerial survey provided to the review panel was that while some limited school count data were collected this year and last year, school size information was spatially very limited and missing in some years. It is possible that shortage of good school identification, and possibly more importantly good school density information, is limiting the precision of the aerial survey.

## *4.3. Fishery data*

The assessment presented was based on a substantial subset of the fishery data. The sardine catches were partitioned into three major groupings, a) Canadian, Washington and Oregon fisheries, b) Mexican and Californian fisheries on the northern component of the Pacific sardine, treated as seasonally dependent groupings, and c) southern component. The primary assessment was based on parts a and b, and classed as the NSP component, though an additional assessment based on all three parts using reported catches from Ensenada in Mexico, USA, and Canada was also presented.

### *Splitting the catch among components*

A habitat based separation method was used to define regions in space and time that were allocated to northern and southern components of the Pacific Sardine. The method was based on 100% allocation to each component on a monthly basis derived from a 50% habitat threshold. The sensitivity to the choice of 50% decision threshold was investigated, and because generally the rate of change of this parameter was rapid in time, the resulting allocation was rather insensitive to the choice of threshold value. The consequences of the assumed temporal stability of the habitat choice were investigated during the review by extending or contracting the allocation period by a month. It was shown overall that the total catch was not substantially sensitive to the split. However, no information was presented on direct validation of component allocation by habitat by checking the correct population assignment of catches. An investigation of the environmentally-based stock splitting method should be carried out if management is to be based on separating the northern and southern subpopulations using the habitat model. It may be possible to develop simple discriminant factors to differentiate the two sub-populations by comparing metrics from areas where mixing does not occur. Once statistically significant discriminant metrics have been chosen these should be applied to samples from areas where mixing may be occurring or where habitat is close to the environmentally-based boundary. This can be used to help to set either a threshold or to allocate proportions if mixing is occurring. If mixed catches are occurring, the accuracy of 100% allocation among the alternate components will be sensitive to population size and may not be the best approach. A number of methods have been found useful to identify pelagic fish to stock component, body morphometrics, otolith morphology, otolith micro-structure, otolith micro chemistry, and possibly using more recent developments in genetic methods. In the case of herring stocks the low tech methods of morphology outperformed the more complex methods of genetics and otolith-microchemistry (see WESTHER project information http://www.clupea.net/westher/).

In addition to the split catch which was used in the main stock assessment model, the total catch was also made available and a second assessment run on the total available catch estimates from all catch Ensenada northwards. The assessment appears to perform equally well for the NSP or the total catch, so the sensitivity for managers only relates to the correct allocation of total catch.

### *Length and age data in the catch*

While sampling at length appears to provide a good description of the landings in all the areas included in the assessment, sampling for age was sparse. In particular both northern and southern extremes of the region were missing age information. In general age data is being treated with a lower priority. Although substantial length information is being collected, there are indications that the modeling assumptions of consistent growth over the years may be responsible for part of the uncertainty in the overall scaling that is the major issue with the assessment. In the absence of good age data it is difficult to determine if migration and the resulting selection are more correctly modeled by age or by length (see discussion in Section 4.4).

## 4.4. Stock Assessment

Paul Crone and Kevin Hill presented the assessment methodology and the results from a draft assessment (Hill and Crone 2014) to the Panel. The assessment utilized the Stock Synthesis Assessment Tool, Version 3.24s. The assessment report included results from many model runs and some sensitivity analyses. However, two specific model formulations were selected as the main models for consideration (Models G and H). The full model outputs for these runs were provided on the FTP prior to the review and the focus for Panel discussion concentrated on these models and Model G included the following features:

(a) The data were updated to 2013,
(b) The catches for the MexCal fleet were split from the total catch by the environmental-based method,
(c) The weight-length and maturity-at-length relationships were updated,
(d) The data for the aerial survey were omitted from the assessment,
(e) The ATM survey was split into spring and summer surveys (with separate catchability and selectivity parameters), with catchability parameters estimated,
(f) No additional data weighting for survey abundance data beyond input CVs (i.e. lambda=1),
(g) No additional data weighting for length composition data for fishery/surveys beyond input effective sample sizes (lambda=1),
(h) Weighting for conditional age-at-length data in addition to input effective sample sizes (lambda=0.5),
(i) The value for $\sigma_R$ was rounded and fixed to 0.75, and
(j) Recruitment was related to spawning stock size according to a Beverton-Holt stock-recruitment relationship with pre-specified steepness (set to 0.8).

Model H differed from Model G by assuming age- rather than length-specific selectivity patterns, by fitting to age-composition data rather than length-composition and conditional age-at-length data, and by fixing the parameters of the growth curve.

Table 1. Summary of the models requested of the STAT during the review. "F" indicates that the weights assigned to the composition type concerned were based on the Francis (2011) method, "F-pool" indicates that factor to weight the composition concerned pooled information across fleets / seasons, "split" under the "ATM Q" and "ATM selectivity" columns indicates that parameters were estimated for the spring / summer surveys separately, "equal" under the "ATM Q" and "ATM selectivity" columns indicates that the parameter concerned were assumed to be the same for the spring / summer surveys, "1" indicates that survey catchability was assumed to be 1. The "profile" in the last three lines implies than the STAT were requested to profile over the weighting factor concerned.

| | Lambda: Length composition | | | Lambda: Conditional age-at-length | | | ATM | |
|---|---|---|---|---|---|---|---|---|
| | MexCal (1+2) | PacNW | ATM | MexCal (1+2) | PacNW | ATM | Q | Sel |
| G | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | split | split |
| K | 1 | 1 | 1 | 1 | 1 | 1 | split | split |
| F | F | F | F | F | F | F | split | split |
| L | F-pool | F | F-pool | F-pool | F | F-pool | split | split |
| M | F | F | F | 1 | 1 | 1 | split | split |
| N | 1 | 1 | 1 | F | F | F | split | split |
| O | 1 | 1 | 1 | F | 1 | F | split | split |
| P | 1 | 1 | 1 | 0.5 | 0.5 | 0.5 | equal | equal |
| Q | 1 | 1 | 20 | 0.5 | 0.5 | 0.5 | equal | equal |
| R | 1 | 1 | 1 | 0.5 | 0.5 | 0 | equal | equal |
| S | 1 | 1 | 1 | 0.5 | 0.5 | 0 | 1 | equal |
| T | 1 | 1 | 1 | 0.5 | 0.5 | 0 | 1 | split |
| U | 1 | 1 | 1 | 0.01 | 0.01 | 0.5 | split | split |
| V | 1 | 1 | 20, excl spr12 | 0.5 | 0.5 | 0.5 | equal | equal |
| W | 1 | 1 | 1 | 0.5 | 0.5 | 0 | split | split |
| W-2 | 1 | 1 | 1 | profile | profile | 0 | split | split |
| W-3 | F-pool | F | F-pool | profile | profile | 0 | split | split |
| T-2 | 1 | 1 | 1 | profile | profile | 0 | 1 | split |

The stock assessment team had also explored an extensive number of model options within this framework to illustrate model sensitivity, but the results as presented were not conclusive and raised concerns regarding the sensitivity of the assessment, particularly to the data weighting. The weighting method presented was essentially *ad hoc* so it was difficult to justify without further exploration. Therefore further sensitivity analysis was conducted throughout the review, this sensitivity analysis concentrated mostly on weighting of different sources of length frequency and conditional age at length information, but also on the interaction of a few model assumptions such as the ATM survey q and ATM selectivity with the size and age data weighting. The main features explored during the review are given in Table 1 as a list of different model parameterizations. In addition to these main model formulations model T-2 (Table 1) was explored further with the sensitivity to two years of ATM length composition data (2011 and 2012) which were omitted from the ATM spring survey data series to resolve a specific switch in population state under different weighting assumption for the ATM length data.

Based on the set of sensitivity analyses given in Table 1 the following general conclusions were drawn:

1. Sensitivity to the weighting of the ATM conditional age at length data: Estimates of biomass were particularly sensitive to this weighting factor, and the information was not appropriately assembled (see Section 4.2.1 above). Due to both these considerations, the ATM conditional age at length data were excluded from the final model.
2. Sensitivity to the weighting of the ATM length composition data: Model results were insensitive to the use of a) Francis weights (see TA1.8 in Appendix A of Francis, 2011), b) weighting by haul, and c) arbitrary up-weighting (by a factor of 20). In conclusion weighting of ATM length composition was regarded as a minor issue. However, close examination of year 2011 and 2012 data from the ATM indicates potential incompatibility between the observed length frequencies and the model assumptions of invariant growth over years. The disparity resulted in the potential for two different states which depended on the data weighting. Sensitivity to these two years length composition data was tested (by omission of length from those years), and the weighting chosen that minimized the influence of these data. Overall it is unclear if the observations are correct and the growth assumptions in the assessment model are too simplistic or the precision of the local estimates used to raise local length compositions in the ATM survey are too large. (See research recommendations).
3. Sensitivity to weighting of the fishery conditional age at length data: A range of weighting factors less than 1 were explored. The sensitivity observed depended on whether ATM *q* was estimated or fixed (*q*=1). Model outputs were more stable when q was fixed.
4. Sensitivity to weighting of the fishery length composition data: Two options were investigated: weighting by haul and using the Francis (2011) method. When *q* is estimated, the use of Francis weights resulted in unrealistically low estimates of *q* (0.2-0.3). For haul-based weights, estimates of ATM *q* included the value of 1 within the range of weights considered.
5. Sensitivity to estimation of ATM *q*: Three options were explored: (a) separate estimated *q*s for the spring and summer surveys, (b) a single estimated *q* for both surveys, and (c) a fixed *q*=1 for both surveys. The sensitivity of the model output to how the fishery conditional age at length data are weighted was considerable. Given the rather arbitrary conditional age at length weights being applied for Model G, and that the sensitivity to these could be considerably reduced by fixing

$q$=1, it was decided to choose this option in the final model, thereby reducing the sensitivity of the model results to weighting which could not be easily justified.

6. Sensitivity to selectivity options for ATM survey: Two options were explored: a single selectivity pattern for both ATM surveys or separate selectivity patterns by survey. When estimated separately, selectivity for the spring survey was near-knife edge at around 16cm, and that for the summer survey shifted to higher lengths in comparison. When estimated as a single selection pattern, the result was a much longer shallower curve, starting in a similar place to that estimated for the spring survey and extending to even greater lengths than that estimated for the summer survey. This change probably results from a requirement to include fish between 15 and 18cm in the spring survey, while giving reduced selection at around 20cm for the summer survey. This results in a reduction in selectivity for a range of lengths greater than 22cm that were not observed for either of the surveys when used with the separate selection patterns. This change to catchability of larger sardine was considered an inappropriate model response resulting from an unreasonable limitation of a single selection pattern. Based on these considerations two separate selections patterns were used in the final model.

It was clear from the sensitivity exploration (Table 1) that solutions that gave plausible q close to unity for the ATM were preferred. This could be obtained by setting data weights to achieve this or explicitly including this requirement in the model. Given that the assessment would be used for at least one more year before further review data weighting, that might be sensitive to new data values, was considered a poor option and setting q=1 for the ATM was the preferred option.

The final base model incorporates the following specifications:

- two seasons (Jul-Dec and Jan-Jun) (assessment years 1993 to 2013);
- sex is combined;
- two fishery fleets (MexCal, PacNW), with an annual selectivity pattern for the PacNW fleet, and seasonal selectivity patterns (S1 and S2) for the MexCal fleet;
    - MexCal fleet:
        - double-normal (i.e. dome-shaped) length-selectivity with two periods of time-blocking (1993-1998, 1999-2012)
    - PacNW fleet:
        - asymptotic length-selectivity for the a single period
    - Length compositions with effective sample size set to 1 per haul and lambda weighting =1
    - Conditional age at length with effective sample size set to 1 per haul and lambda weighting = 0.2
- Beverton-Holt stock-recruitment relationship "steepness" set to 0.8;
- $M = 0.4\ \text{yr}^{-1}$; $\sigma_R = 0.75$ (fixed value);
- recruitment residuals estimated for 1987-2013;
- length-frequency and conditional age-at-length data for all fisheries;
- virgin ($R_0$) and initial recruitment offset ($R_1$) were estimated;
- initial $F$s set to 0 for all fleets;
- DEPM and TEP indices of spawning biomass; $q$ estimated;

- acoustic-trawl (ATM) survey biomass 2006-2013, $q$=1;
    - Length compositions with effective sample sizes set by dividing the number of fish sampled by 25 and lambda weighting =1
    - asymptotic length-selectivity separately for spring and summer surveys
    - Conditional age at length from the ATM surveys excluded
- NWSS aerial photogrammetric surveys of biomass excluded
  (The Panel agrees that the final base model represents the best available science regarding the status of the northern subpopulation of Pacific sardine. The Panel wishes to highlight that the level of variation in terminal biomass evident from the retrospective pattern (on the order of 100,000s of tons from one year to the next; Figure 7 of this report) is not unexpected and has been seen in previous assessments (PFMC, 2011). Changes in terminal 1+ biomass estimates used for management of this magnitude may occur when the 2015 assessment update take place.)

On the final day of the review, the STAT provided the Panel with additional model variants with three time blocks for selectivity for the Pacific Northwest fishery. The other settings were: ATM survey catchability was assumed to be 1 or estimated, separate selectivity patterns were estimated for the spring and summer ATM surveys, the weighting factors for the length-frequency, and the conditional age-at-length data were set to 1 for the fishery data and to zero for the ATM surveys. There was insufficient time to fully evaluate these options, but it is considered that it would be a valuable model configuration to consider along with sensitivity to data weighting for a future full assessment.

A further 'bases case' assessment based on applying the final base model (see above) in which the catch series is constructed by assuming that all catches off Ensenada and north are from the northern subpopulation (See Section 4.7). It is considered that this model could be used to form the basis for management advice if the model using the environmentally-based catch series cannot be used for management purposes.

Some additional aspects were considered relevant.

- There is some misalignment between the modeled and observed length. The time step in the model is 6 months, whereas the ATM survey is completed in around one month. Growth occurs through the six month period so the width (sigma) on the catch length distribution needs to be wider than the distribution at length observed by the survey. This can be seen in either bubble plots of residuals at length for the survey or observed and modeled length distributions. Such conflict which relates to the model formulation / time step might be resolved if age based data were used or the ATM survey given a different sigma for spread of length.
- While the ATM survey appears, at first glance, to pick up cohorts correctly, there is some mismatch between spring survey estimates at length in 2010 and 2011. This mismatch does appear to lead to some instability in the model estimates of abundance.
- There are indications that the overall growth assumptions do not align with the conditional age at length information. This is one reason for observed model

instability and the decision to remove the conditional age at length data for the ATM and to down-weight the conditional age at length data for the catch though the first of these was not necessarily assembled correctly and the latter is partial, missing Mexican and Canadian age at length data. Nevertheless it is unclear if fixing these deficiencies will solve the problems.

- If there is a desire to look for ways to stabilize the model, other than the assumption of ATM q=1, collection of more complete age at length data, on both ATM surveys and fisheries, may be one way to resolve whether the issues are that, fishery selection is changing due to different spatial distributions at length by season, or whether growth is more variable than the current model implies. As selection in the fisheries is dominated by the spatial interaction of the migrating stock and different locations of each of the regional fisheries, unlike selection based on gear characteristics it is not possible to determine a priori the form of the selection (by age or by length). Alternatives to the collection of more complete and better quality age data would be: a) to invest more in the aerial survey, both in terms of spatial coverage and more rigorous sampling for species identification and size, and more accurate school density estimation; and b) to investigate further what would be needed to improve the accuracy of the DEPM. However, both of these are likely to be much more expensive than improving the collection of age data.

## *4.5. Estimates of 1+ biomass in the advice year*

The assessment provided estimates of 1+ biomass which are required to give catch advice for Pacific sardine. However, the modeling environment does not provide estimates of precision of the 1+ biomass. It is understood that it is intended to extend the model output to include precision of this quantity, and this development should be encouraged. However, it needs to be kept in mind that a substantial part of the uncertainty regarding 1+ biomass comes from the model specification, not just from precision of the estimates given the model and the data. To fully include useful estimates of precision requires methodology that accounts for multiple models with precision, to at least account for some of the model uncertainty.

***Recruitment estimation and environmental variables***

The estimate of the most recent recruitment in the assessment model (age 1 in 2013) is rather uncertain and is estimated by the model to be close to the expected value from the stock-recruitment function. Deviations of sardine recruitment from a fitted stock-recruitment model of either Ricker or Beverton-Holt form is observed to be correlated in time, such that there appear to be periods of ‘high’ recruitment and separate periods of ‘low’ recruitment. Investigations of the potential for environmental factors to be informative have been conducted by Zwolinski and Demer (2014 in press). They showed that the variability in sardine recruitment in the California Current during the last three decades mimics aspects of the environment in the North Pacific indicated by the Pacific Decadal Oscillation (PDO) index. They report that the average number of recruits per biomass during "warm" periods was more than threefold higher than that during "cold" periods. In addition to the environmental conditions experienced by sardine larvae, variability in sardine recruitment is also partially explained by both the environmental conditions many months before the spawning season and the adult condition factor.

Management of the stock uses information on the biomass of age 1+ sardine when applying the Overfishing Level and Acceptable Biological Catch control rules.

Estimated recruitment in the last few years has been lower than expected from the stock-recruitment relationship used in the assessment model. Improved estimation (or prediction) of age 1 recruitment for the most recent year would improve management advice for the Pacific sardine stock as the assessment model currently leads to a rather imprecise and, because of the correlation, potentially biased estimate of this quantity. There are a number of potential approaches to improve on this:

1. Use of a prediction model based on recent recruitment and observed autocorrelation could be used to give potentially more likely estimates of recruits in the final year without assigning any specific underlying reason for the recruitment.
2. Development of a recruitment prediction index such as that proposed by Zwolinski and Demer (2014 in press) could be used outside the assessment to replace the assessed value with an alternative value based on a weighted mean of the assessed and index-derived values. One method of determining appropriate weights might be taken from Shepherd (1997).
3. Inclusion of informative environmental indices within the assessment.

When investigating environmental drivers to explain recruitment, a number of issues need to be considered:

- The spawning biomass and recruitment pairs estimated in an assessment are subject to uncertainty, and this needs to be accounted for when estimating the prediction intervals for any potential index.
- Development of environmental indices (for recruitment) through regression analysis needs to be undertaken with care. There are often many explanatory environmental variables available to be tested. The approach is often to examine many potential variables to establish the most powerful explanatory set. However, to understand the significance of the conclusions it is important to recognise that exclusion of unsuitable variables is effectively setting the coefficient for the relationship for that variable to zero. This needs to be accounted for correctly in tests for overall significance by, for example, removing one degree of freedom for every variable (or variable at lag) rejected. This can be done easily for variables formally tested, but may be more difficult to include where variables are rejected at an early stage based on simple graphical investigation. Currently there are 20 stock-recruitment pairs for Pacific sardine; rejection of 18 potential variables (and or lags) while a relationship is being developed should result in a perception of no significant fit. Failure to consider this can lead to an over-optimistic perception of the utility of explanatory functions;

see for example Gröger *et al*. (2010) who examined many potential indices and a wide variety of lags and considered they had found significant drivers for recruitment.

The stock assessment was based on NSP catch data only (See Section 4.3). The model can also be fitted to all catches from US, Canada and Ensenada, A comparison of the biomass trajectory for final model when it is applied to the NSP and total catch series shows a simple relationship and either estimate can be used for management of the fisheries depending on the stock definition requirements of managers.

## 4.6. Research Recommendations

Research recommendations have been provided in the STAR Panel report. Many, but not all, are repeated here as they result from this specific review.

***High priority***

1. The assessment would benefit not only from data from Mexico and Canada, but also from joint assessment, which includes assessment team members from these countries.
2. Modify Stock Synthesis so that the standard errors of the logarithms of 1+ biomass can be reported. These biomasses are used when computing the Overfishing Level, the Acceptable Biological catch, and the Harvest Level, but the CV used when applying the ABC control rule is currently that associated with spawning biomass and not 1+ biomass.
3. Investigate sensitivity of the assessment to the threshold used in the environmental-based method (currently 50% favorable habitat) to delineate the southern and northern subpopulations of Pacific sardine; the exploration of sensitivity in the present assessment was limited given time available, but suggested there would be some sensitivity to this cut-off.
4. Compute age-composition data for the ATM survey by multiplying weighted length-frequencies by appropriately constructed age-length keys (i.e. taking account of where the samples were taken).
5. Explore the disparity between ATM estimates at length and conditional age at length. Consider increased sampling at age to obtain clear understanding if differences at length are also the result of differences in age or just differences in growth.
6. Investigate alternative approaches for dealing with highly uncertain estimates of recruitment that have an impact on the most recent estimate of 1+biomass that is important for management. Possible approaches are outlined in Section 4.5 of this report.
7. Validation of the environmentally-based stock splitting method should be carried out if management is to be based on separating the northern and southern subpopulations using the habitat model. It may be possible to develop simple discriminant factors to differentiate the two sub-populations by comparing metrics from areas where mixing does not occur. Once statistically significant discriminant metrics (e.g. morphometric, otolith morphology, otolith micro-structure and possibly using more recent

developments in genetic methods) have been chosen, these should be applied to samples from areas where mixing may be occurring or where habitat is close to the environmentally-based boundary. This can be used to help to set either a threshold or to allocate proportions if mixing is occurring.

***Medium priority***

1. Continue to explore possible additional fishery-independent data sources.
2. The Panel continues to support expansion of coast-wide sampling of adult fish for use when estimating parameters in the DEPM method and when computing biomass from the acoustic-trawl surveys. Direct comparison between individual samples in survey and fishery should be used to inform model choices. Also encourage sampling in Mexican and Canadian waters.
3. Consider spatial models for Pacific sardine, which can be used to explore the implications of regional recruitment patterns and region-specific biological parameters. These models could be used to identify critical biological data gaps as well as better represent the latitudinal variation in size-at-age.
4. Consider a model which has separate fleets for Mexico, California, Oregon-Washington and Canada.
5. Consider model configurations which use age-composition rather than length-composition and conditional age-at-length data given evidence for time- and spatially-varying growth.
6. Compare annual length-composition data for the Ensenada fishery that are not omitted from MexCal data set for the NSP scenario with the corresponding southern California length compositions. Also, compare the annual length-composition data for the Oregon-Washington catches with those for the British Columbia fishery. This is particularly important if a future age-based model is to be applied.
7. Further explore methods to reduce between-reader ageing bias. In particular, consider comparisons among laboratories and assess whether the age-reading protocol can be improved to reduce among-ager variation.
8. Change the method for allocating area in the DEPM method so that the appropriate area allocation for each point is included in the relevant stratum. Also, apply a method that better accounts for transect-based sampling and correlated observations that reflect the presence of a spawning aggregation.
9. Consider future research on natural mortality. Note that changes to the assumed value for natural mortality may lead to a need for further changes to harvest control rules.

# 5. Panel review proceedings

Item 3 of the ToR involved documenting meeting discussion with reference to technical aspects of stock assessment work. Item 6 related to the requirement for the STAR Panel to provide ‘a risk neutral approach’ in its reports and deliberations.

I was impressed overall with the quality of this review and all who participated in it, I would like to thank all involved for their efforts. In particular I would like to thank the presenters for their hard work in prepared presentations and the chair for his work guiding the review and for the work assembling and editing the review group report. In particular I would like to thank Paul Crone and Kevin Hill for their willingness to carry out additional model runs to help clarify the model sensitivity and Andre Punt for this hard work as chair of the Panel.

All the data and assessment reports were provided on time. The presentations covered most issues well. A small improvement would be to ask presenters to refocus the presentation of the assessment results more to sensitivities than primarily the model results. The current approach was a description of the approach and the stages along the way, which provides an insight to the process rather than the results. The important aspects are the differences between the new model and previously agreed assessments, the changes resulting from new data and then the sensitivity to critical assumptions. Nevertheless these aspects are minor and I consider that overall the final review was of a high standard.

The final draft of the Star Panel report was completed on time.

# 6. Conclusion and Recommendations

The reports and presentations and additional model runs provided an excellent basis to evaluate the performance of the assessment. It is agreed that the assessments are effective in delineating stock status, they are particularly good at projecting probable short-term trends in stock biomass, fishing mortality, and catches. The science reviewed was of a high standard and could be classed as 'of the best scientific information available'. Comments given throughout this report should not be read as direct criticism of what has been done, rather ideas of areas for development. In retrospect one can always find room for improvement, and as such minor suggestions have been made throughout this report which should not be considered prescriptive or limiting but rather as aspects for careful consideration. A number of research recommendations are included in Section 4.6.

I fully endorse the panel agreement that the final base model represents the best available science regarding the status of the northern subpopulation of Pacific sardine. It is also important to reiterate that the level of variation in terminal biomass evident from the retrospective pattern (on the order of 100,000s of tons from one year to the next) is not unexpected and has been seen in previous assessments (PFMC, 2011). It is likely that changes in terminal 1+ biomass estimates used for management of this magnitude may occur when the 2015 assessment update takes place.

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# Appendix 1: Bibliography of materials provided for review

## Main report and outputs

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# Appendix 2: Statement of Work

**External Independent Peer Review by the Center for Independent Experts**

**STAR Panel Review of the 2014-2015 Pacific Sardine Stock Assessment**

**March 3-5, 2014**

**Scope of Work and CIE Process:** The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Appendix 1**. This SoW describes the work tasks and deliverables of the CIE reviewers for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

**Project Description:** The CIE reviewers will serve on a Stock Assessment Review (STAR) Panel and will be expected to participate in the review of Pacific sardine stock assessment. The Pacific sardine stock is assessed regularly (currently, every 1-2 years) by SWFSC scientists, and the Pacific Fishery Management Council (PFMC) uses the resulting biomass estimate to establish an annual harvest guideline (quota). The stock assessment data and model are formally reviewed by a Stock Assessment Review (STAR) Panel once every three years, with a coastal pelagic species subcommittee of 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 sardine, 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 **Appendix 2**. The tentative agenda of the Panel review meeting is attached in **Appendix 3**. Finally, a Panel summary report template is attached as **Appendix 4**.

**Requirements for CIE Reviewers:** Two CIE reviewers shall participate during a panel review meeting in La Jolla, California during 3-5 March, and shall conduct an impartial and independent peer review accordance with the SoW and ToRs herein. The CIE reviewers shall have the expertise as listed in the following descending order of importance:

- The CIE reviewer shall have expertise in the application of fish stock assessment methods, particularly, length/age-structured modeling approaches, e.g., 'forward-simulation' models (such as Stock Synthesis, SS) and it is desirable to have familiarity in 'backward-simulation' models (such as Virtual Population Analysis, VPA).
- The CIE reviewer shall have expertise in the life history strategies and population dynamics of coastal pelagic fishes.
- It is desirable for the CIE reviewer to be familiar with the design and execution of fishery-independent surveys for coastal pelagic fishes.
- It is desirable for the CIE reviewer to be familiar with the design and application of fisheries underwater acoustic technology to estimate fish abundance for stock assessment.
- It is desirable for the CIE reviewer to be familiar with the design and application of aerial surveys to estimate fish abundance for stock assessment.

The CIE reviewer's duties shall not exceed a maximum of 14 days to complete all work tasks of the peer review process.

**Location/Date of Peer Review:** The CIE reviewers shall conduct an independent peer review during the STAR Panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 8901 La Jolla Shores, La Jolla, California from March 3-5, 2014.

**Statement of Tasks:** The CIE reviewers shall complete the following tasks in accordance with the SoW, ToRs and Schedule of Milestones and Deliverables specified herein.

<u>Prior to the Peer Review</u>: Upon completion of the CIE reviewer selections by the CIE Steering committee, the CIE shall provide the CIE reviewers 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 reviewers. The NMFS Project Contact is responsible for providing the CIE reviewers 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.

<u>Foreign National Security Clearance</u>: When CIE reviewers participate 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 reviewers who are non-US citizens. For this reason, the CIE reviewers shall provide requested information (e.g., first and last name, contact information, gender, birth date, passport number,

country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact 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/compliance_access_control_procedures/noaa-foreign-national-registration-system.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 reviewers 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 reviewers shall read all documents in preparation for the peer review, for example:

- Recent stock assessment documents since 2013;
- STAR Panel- and SSC-related documents pertaining to reviews of past assessments;
- CIE-related summary reports pertaining to past assessments; and
- 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 reviewers are 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 reviewers 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 reviewers 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 reviewers and STAR Panel chair are described in Appendix 2 (see p. 6-8). The CIE reviewers will serve a role that is equivalent to the other panelists, differing only in the fact that he/she are 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 reviewers will serve at the behest of the STAR Panel Chair, adhering to all aspects of the PFMC's ToR as described in Appendix 2. The STAR Panel chair is responsible for: 1) developing an agenda, 2) ensuring that STAR Panel members (including the CIE reviewers), and STAT Teams follow the Terms of Reference, 3) participating in the review of the assessment (along with the CIE reviewers), 4) guiding the STAR Panel (including the CIE Reviewers) 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 reviewers shall complete an independent peer review report in accordance with the SoW. The CIE reviewers shall complete the independent peer review according to required format and content as described in Appendix 1. The CIE reviewers shall complete the independent peer review addressing each ToR as described in Appendix 2.

Other Tasks – Contribution to Summary Report: The CIE reviewers will assist the Chair of the panel review meeting with contributions to the Summary Report. The CIE reviewers are 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 Reviewers:** The following chronological list of tasks shall be completed by the CIE reviewers 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 in La Jolla, California during March 3-5, 2014 as called for in the SoW, and conduct an independent peer review in accordance with the ToRs (Appendix 2);
3) No later than March 24, 2014, the CIE reviewers 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 Dr. David Die., CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. The CIE report shall be written using the format and content requirements specified in Appendix 1, and address each ToR in Appendix 2.

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

| | |
|---|---|
| *January 20, 2014* | CIE sends reviewers contact information to the COTR, who then sends this to the NMFS Project Contact |

| | |
|---|---|
| *February 14, 2014* | NMFS Project Contact sends the CIE Reviewers the pre-review documents |
| ***March 3-5, 2014*** | The reviewers participate and conduct an independent peer review during the panel review meeting |
| *March 24, 2014* | CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator |
| *April 14, 2014* | CIE submits CIE independent peer review reports to the COTR |
| *April 22, 2014* | 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 Reviewers 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 Appendix 1, (2) the CIE report shall address each ToR as specified in Appendix 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.

**Support Personnel:**

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## Appendix 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.

## Appendix 2: Terms of Reference for the Peer Review of the Pacific sardine stock assessment

The CIE reviewers are one of the four equal members of the STAR panel. The principal responsibilities of the STAR Panel are to review stock assessment data inputs, analytical models, and to provide complete STAR Panel reports.

Along with the entire STAR Panel, the CIE Reviewer's duties include:
1. Reviewing draft stock assessment and other pertinent information (e.g.; previous assessments and STAR Panel reports);
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 Reviewers, are 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. 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.

# Appendix 3: Review Group Agenda CPS STAR PANEL and Participants

**Monday 3 March**

| | | |
|---|---|---|
| 08h30 | Call to Order and Administrative Matters | |
| | Introductions | Punt/Key |
| | Facilites, e-mail, network, etc. | Sweetnam |
| | Work plan and Terms of Reference | Griffin |
| | Report Outline and Appointment of Rapporteurs | Punt/Key |
| 09h00 | Pacific Sardine assessment presentation | Hill/Crone |
| 10h00 | Break | |
| 10h30 | Pacific Sardine assessment presentation | Hill/Crone |
| 11h30 | Acoustic and trawl survey | Zwolinski |
| 12h00 | Bayesian estimates of spawning fraction | Dorval |
| 12h30 | Lunch | |
| 13h30 | Pacific Sardine assessment presentation (continue) | Hill/Crone |
| 14h30 | Panel discussion and analysis requests | Panel |
| 15h00 | Break | |
| 15h30 | Public comments and general issues | |
| 17h00 | Adjourn | |

**Tuesday 4 March**

| | | |
|---|---|---|
| 08h00. | Assessment Team Responses | Hill/Crone |
| 10h30 | Break | |
| 11h00. | Discussion and STAR Panel requests | Panel |
| 12h30 | Lunch | |
| 13h30 | Report drafting | Panel |
| 15h00 | Break | |
| 15h30 | Assessment Team Responses | Hill/Crone |
| 16h30 | Discussion and STAR Panel requests | |
| 17h00 | Adjourn | |

**Wednesday 5 March**

| | | |
|---|---|---|
| 08h00. | Assessment Team Responses | Hill/Crone |
| 10h30 | Break | |
| 11h00. | Discussion and STAR Panel requests | Panel |
| 12h30 | Lunch | |
| 13h30 | Finalize STAR Panel Report | Panel |
| 15h00 | Break | |
| 15h30 | Finalize STAR Panel Report | Panel |
| 17h00 | Adjourn | |

## Participants 2014 Pacific Sardine STAR Panel

### STAR Panel Members
André Punt (Chair), SSC, University of Washington
Meisha Key, SSC, CDFW – California Department of Fish and Wildlife
José de Oliveira, CIE Reviewer, CEFAS - Centre for Environment, Fisheries & Aquaculture Science, UK
John Simmonds, CIE Reviewer, ICES – International Council for the Exploration of the Sea, Denmark
Diane Pleschner-Steele, CPSAS - Coastal Pelagic Species Advisory Sub panel Advisor to STAR Panel
Chelsea Protasio, CPSMT - Coastal Pelagic Species Management Team Advisor to STAR Panel

### STAT Report
Kevin Hill, SWFSC - Southwest Fisheries Science Center
Paul Crone, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER

### Other STAT presenters
David Demer, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Emmanis Dorval, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Juan Zwolinski, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER

### Other Attendees
Jenny McDaniel, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Beverly Macewicz, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Kirk Lynn, CDFG – California Department of Fish and Game
Dale Sweetnam, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Erin Reed, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Ed Weber, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Josh Lindsay, NMFS WCR National Marine Fisheries Service, West Coast Region
Russ Vetter, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Al Carter, Ocean Companies
Richard Carroll, Jessie's Ilwaco Fish Company
Elizabeth Helmers, CDFW
Nancy Lo, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Sam McClatchie, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Richard Parrish, NMFS Emeritus
Yukong Gu, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Jeff Laake, AFSC – Alaska Fisheries Science Center
Kevin Piner, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
William Watson, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Elaine Acuňa, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Anna Holder, CDFW – California Department of Fish and Wildlife
Joel Van Nord, CWPA – California Wetfish Producers Association
Noelle Bowlin, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Mike Okoniewski, Pacific Seafood
Cisco Werner, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Sarah Shoffler, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Kristen Koch, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Chris Francis, NIWA - National Institute of Water and Atmospheric Research
Emily Gardner, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Alex Da Silva, IATTC – Inter-American Tropical Tuna Commission
Steven Teo, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
George Cutter, SWFSC - SOUTHWEST FISHERIES SCIENCE CENTER
Mark Maunder, IATTC – Inter-American Tropical Tuna Commission