Center for Independent Experts (CIE) Independent Peer Review Report of Acoustic-Trawl Method Pertaining to Surveys of Coastal Pelagic Fish Species in the California Current Ecosystem.

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E J Simmonds

1. Executive Summary

The Chair identified six aspects that provided a focus for discussions during the review:

i. design of the acoustic and trawl sampling, representativeness of the data for the four CPS species;
ii. analysis of the survey data for estimating CPS abundances;
iii. evaluation of potential biases in sampling design and analysis;
iv. characterization of uncertainty in estimates of CPS biomass;
v. decision if acoustic-trawl estimates of CPS biomass can be used in stock assessments and management advice for Pacific sardine, jack mackerel, Pacific mackerel, and northern anchovy; and
vi. guidance for future research.

For orientation Dr Kevin Hill, SWFSC, gave a brief presentation of the most recent Pacific sardine stock assessment and management. Dr David Demer, Leader of the Advanced Survey Technologies Program (ASTP), SWFSC, gave a presentation of the acoustic-trawl method for assessing CPS, and this was followed by responses to several requests by the Panel for additional information.

The acoustic-trawl surveys also have the potential to provide estimates of fish distribution and behavior, as well as information for ecosystem-based fishery management. The review was, however, focused on the provision of abundance estimates and this report reflects that focus.

The ASTP prepared a thorough presentation, provided detailed background material, and were willing to respond to the Panel requests. They provided a highly competent review and presented information on all substantive aspects that required discussion.

In conclusion it is considered that the design of the acoustic-trawl surveys, as well as the methods of data collection and analysis, are adequate for the provision of advice on the abundance of Pacific sardine, jack mackerel, and Pacific mackerel, subject to caveats, in particular related to the survey areas and distributions of the stocks at the times of the

surveys. The acoustic-trawl surveys can be included in the 2011 Pacific sardine stock assessments as 'absolute estimates', contingent on the completion of two tasks; and estimates of jack mackerel and Pacific mackerel may also be useful in stock assessments and management. However, given the current size and abundance of the northern anchovy stock(s), the present surveys with fixed starting point and sparse transects cannot provide estimates of their abundance(s) for use in management.

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. A Statement of Work (Annex 2) is established by the NMFS Project Contact and Contracting Officer's Technical Representative, and reviewed by the 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. Further information on the CIE process can be obtained from www.ciereviews.org.

This independent reviewer was requested to participate in a panel-review meeting to conduct independent peer reviews of the acoustic-trawl method as it pertains to surveys of coastal pelagic fish species (CPS) in the California Current Ecosystem (CCE). The principal species for consideration is Pacific sardine, but the potential for also including jack mackerel, Pacific mackerel, and northern anchovy, depending on their biomasses and distributions, and the sampling effort afforded, was also to be considered. The survey area is the CCE off the west coast of the United States of America (US), generally between the Mexico-US and the US-Canadian borders. The latitudinal and offshore extents of the surveys are seasonal, extending further north in the summer and further offshore in the spring. Survey estimates are to include absolute biomasses, and their total random sampling errors, and spatial distributions. The review solely concerns technical aspects of the survey design, method, analysis, and results.

3. Description of the Reviewer's Role in the Review Activities

I am an expert in fisheries acoustics, assessment for pelagic stocks and their use in fish stock management. My background is that of a senior fisheries scientist working at European Commission Joint Research Centre (JRC), Ispra, Italy. I obtained BSc. and MSc. degrees in Electronics and Underwater Acoustics in UK. Before joining JRC I had worked in fisheries research for 37 years at FRS Marine Laboratory Aberdeen in

Scotland. I have worked with acoustic surveys for pelagic species for more than 30 years and carried out stock assessments involving acoustic-trawl, trawl and egg surveys for more than 15 years. I am author of a books on Fisheries Acoustics (1991 and 2nd Edition 2005). I have been responsible for developing approaches for combining acoustic-trawl, trawl and ichthyoplankton surveys in assessments for North Sea herring. I have worked on absolute assessments based on Total Annual Egg Production methods for North Eastern Atlantic mackerel. I have been involved in acoustic-trawl surveys for sardine and/or anchovy off Morocco, and in the Persian Gulf the South China Sea, Ecuador and Peru. Since 1990 I have developed extensive experience of fish stock assessment and fisheries management, chairing among other groups the ICES herring survey planning group 1991-95, the ICES Fisheries Acoustics WG 1993-96, the ICES herring assessment working group 1998-2000, and the ICES study group on Management Strategies from 2004-2009. I currently chair the STECF group that prepares evaluations of historic performance of management plans and the impact assessments for new multi-annual fisheries management plans.

I participated in all aspects of the review, paying particular attention to survey design and effort allocation, calculations of total biomass and its variance, and the utility of the results as an absolute estimate or relative index of abundance within the current SS3 assessment for Pacific sardine.

4. Findings by ToR

4.1. ToR 1- Reporting

Review documents detailing acoustic-trawl survey and data analysis methods and results according to the PFMC's ToR for CPS Stock Assessment Methodology Reviews. Document the meeting discussions. Evaluate if the documented and presented information is sufficiently complete and represents the best scientific information available.

Two primary documents were provided; a) Acoustic-trawl survey and data analysis methods and b) Acoustic survey result. In addition, 22 papers or reports (listed in Annex 2) were provided as background for the work. The presentations commenced with background information from Dr. Kevin Hill and then the rest of the day was occupied with a detailed presentation by Dr. David Demer on the survey work. This occupied the full day during which several aspects were identified for further investigation and presentations. These additional aspects were prepared by the survey group and presented during the remaining two days.

From the evidence provided it is clear that the project team is of high quality and can be relied upon to carry out work to high standards. The two main documents are substantively complete and provide a good basis for evaluating the conduct and results of the surveys. The presentations were of a very high standard and substantively cover the work. The team responded to all questions in a helpful and highly competent manner.

There are a number of areas, given below, where increased detail could be provided both in the methods and the survey results reports. These suggestions should not be taken as substantive criticism of the standard of reports, rather there are a few points that would allow the work to be verified more quickly and to support the assertion that they are being conducted well should any challenge to the methodology occur.

4.1.1. Methods report

Separation of reporting into a standard methods document and an individual survey report provides a good basis for documentation. The methods part forms a formal document which provides the standards to which the survey is being conducted and the details of the methodology. Having a single complete document of this type provides an efficient and effective way to both define the way work is carried out and support its validity. Such an archive should not be regarded as a fixed document, rather the record of the current approach so that others may continue the work if the current staff move on or are redeployed. Thus keeping it up to date is an essential part of good survey practice. Within the current version there are a number of areas where more information would be beneficial.

Flow diagrams give a good basis for understanding the process. Some elements of these flow charts, such as density estimation, are explicitly documented with formulas, others do not have that clear documentation need to be expanded.

The description of the identification of CPS using the VMR, frequency ranges, and Sv range is complete but difficult to follow and needed quite a long explanation, The fact that this is used as a classifier for selecting S_v values at 38kHz (and other frequencies) could be stated explicitly. It could be improved by numbering processing boxes in the flow chart and giving numbered paragraphs and equations.

There is a need to explicitly provide the equations for variance estimation for clarify what is considered a 'sample' for both jackknife and bootstrap estimation methods. This would help to clearly show that it is collapse transect values that are used, and that between transect segments are excluded.

The TS equations and sources are stated as TS (biomass) versus length. The measurements imply a specific weight/length equation and thus condition factor (which is effectively reported in the cited paper) through TS/individual equations. It is necessary to check if this condition factor (which may change seasonally) is appropriate, and to decide which is invariate TS/kg or TS/individual given length.

An additional rather trivial aspect (not discussed) regards Echo-view processing. From the documentation the 'bad data' methodology in Echoview is used. The exact numerical treatment of 'bad data' is not fully documented, the methodology in Echoview implies the need for slightly differing approaches depending on the basis for bad data classification. i.e. whether 'bad data' samples are classed as 'taken = zero' or 'taken

unknown' or 'not taken'. In this case the classification appears to be 'not taken', while Echoview treatment is 'taken = zero'. This aspect just needs clarification, but its impact on the results is thought to be negligible.

4.1.2. Survey results report

These reports provide a very good report of the surveys, tables and plots are sufficient to document the results for biomass. There are a number of minor additions that should be included.

Length: The original reports did not contain length distributions by number or biomass. These should be supplied. Currently this is probably the method by which acoustic results may best be related to the assessed population.

Calibration results: The survey reports should include calibration values and comparison with previous years

Correlation analysis: A representation of correlation of acoustic data should be plotted.

4.1.3. Conclusions to reporting

The reports and presentations provide an excellent basis to evaluate the performance of the acoustic-trawl survey. They are of a high standard and require only minor improvements which are detailed above.

4.2. ToR 2 –Evaluation

Evaluate and provide recommendations on the survey method used to estimate the abundances and distributions of Pacific sardine and other CPS, and associated sources of uncertainty. Recommend alternative methods or modifications to the proposed methods, or both, during the Panel meeting. Recommendations and requests to FRD for additional or revised analyses during the Panel meeting must be clear, explicit, and in writing. Comment on the degree to which the survey results describe and quantify the distributions and abundances of CPS, in particular Pacific sardine, and the uncertainty in those estimates. Confidence intervals of survey estimates could affect management decisions, and should be considered in the report.

4.2.1. Stratification / Transect design

The issue: does the current survey design and allocation of sampling effort spatially meet the objectives of the survey. Sampling must be designed to give representative information (acoustic and trawl) from which total abundance can be estimated.

Current approach: utilizes existing egg surveys designs for both spatial coverage and trawl data. Thus the design is not been chosen explicitly to carry out just an acoustic survey. The survey transect design is close to regular, but with higher effort, reduced transect spacing, in some areas of expected high abundance. Abundance is estimated by equal weight of transect abundances within strata and variance by bootstrap.

Comment: here I address estimation within the area surveyed, and the issue of selection of limits to the area is discussed below.

Abundance estimation: An equal spaced parallel transect design normal to the line of the coast with uniform spacing within any prior identified strata will give good abundance estimates and is preferred over any randomization of transect spacing. The rate of change of expected density might be expected to be greatest normal to the coast line, with generally greater continuity in the along coast direction. Thus sampling with the highest sample rate (along track) is expected to yield best results if the track is normal to the coast. Formally if the survey is to provide an 'absolute estimate' a random starting point is required (to give a probability that samples can be obtained from all locations). If for logistic reasons a random start is not possible, then there is a necessary condition: fish location must be assumed to be unrelated to geographical features on the scale of one transect spacing. This condition is probably an acceptable assumption for sardine and jack mackerel as the populations are extensive in geographical extent and mobile seasonally. However, given the sparsity of transects and small scale of coastally located stocks of Northern anchovy, I think this would not be case for this species. If an absolute estimate of Northern anchovy were required, either effort in those areas should increased (which could be considered anyway for other reasons) or for the current distribution of effort a random start would be required, though at this level of coverage the variance would be expected to be high. In order to provide an index of abundance, a fixed starting point for the grid is sufficient.

Variance estimation: for the transect sampling can be obtained via a variety of methods. As acoustic sampling for density is almost exhaustive along the transect (at 0.5 s per transmission and 10knots samples overlap by about 25m depth) a collapsed transect method that assumes measurements along the transect are effectively without error is an acceptable assumption. As the sampling is regular (non random transect placement) variance estimation requires checking for or including the effects of autocorrelation in the data. As an echosounder is capable of delivering independent samples on adjacent transmissions, an autocorrelation can be considered as a property of the fish stocks. In this case observed autocorrelation would indicate that the spatial structure of the stock was being well captured, however, simple treatment of variance calculation would overestimate the variability. The current approach is to identify one or two strata that form the main region of the distribution, check for significant autocorrelation and when it is found to be non significant, to use a classical variance estimator. This post stratification has a small influence on the variance estimation, formally for the classical estimator it would result in underestimation of variance, as placement of strata boundaries depend on observations, however, without the strata is likely that correlation would be significant

and an appropriate variance estimator, such as kriging estimation variance, would be lower than the classical estimator. Overall the approach is an acceptable approximation.

Conclusion: I consider that the current spatial allocation of transects allows abundance of CPS and variance of spatial sampling to be estimated. While not necessarily optimized, the current approach is adequate for estimation of sardine in the area surveyed, but not all of the species in the CPS can be estimated to the same quality. The survey is currently able to provide estimates of Pacific sardine and jack mackerel for the area covered. Rather imprecise estimates of Pacific mackerel are also possible; estimates of Northern anchovy and Pacific herring (not included in the review but included in the reports) should be treated with caution.

Improvement: For the survey design to be improved in the short term there is a need to determine if the survey objectives should include the full set of main CPS species or concentrate primarily on sardine. If there is a requirement to obtain abundance estimates of Northern anchovy and Pacific herring, some change of design is required.

The potential for using stratification of effort to obtain improved estimates of Pacific sardine is clearly demonstrated in the documents provided. Such an approach would have benefits in improving the precision of the sardine estimates, though this may have costs for the evaluation of other species. Stratification would need to be based on estimations of habitat that would be specific to season and year. There is evidence to suggest that some of this could be derived from data sources, such as satellite data, prior to the survey, but potentially could also be adapted during the survey from water mass observation during the survey.

If the survey is to be multispecies or ecosystem based, further work would be required to determine if stratification would be successful, or if a uniform spatial distribution of effort is optimal for a diverse range of objectives.

If the survey can be directed at a smaller area there is potential for increased sampling effort to reduce variance (auto correlation will also increase); however, this will require more complex variance estimation.

Currently I expect the transect design to deliver a good estimate of the abundance, however, its formal basis is not clearly defined and adequate variance estimate. It the reports reference is made to methods in Jolly and Hampton (1990), Petigas *et al.* (2003), Demer, (2004) and Simmonds *et al.*, 2009. However, these publications have a different statistical basis in their treatment of spatial autocorrelation, thus it is not fully clear what process is being followed. The report states that, "The current survey design ensures that the mean acoustic backscatter is independent between transects, which permits statistically-unbiased estimations of mean biomass densities and sampling variances for target species." However independence between transects is not a precondition of unbiased estimation, or sampling variance, though it will affect the method of variance calculation. There is no suggestion that the estimation process is wrong. Correlation between transects is beneficial to the precision of the survey and it is something to aspire

to, not attempt to show is not present. Accepting that the CPS distribution is spatially correlated is an explicit requirement for stratification and the advantage of regular transect designs. It would be preferable to fully embrace this aspect in the thinking as this will bring you a coherence of approach which is currently lacking.

4.2.2. Trawl sampling

The issue: do the current trawl samples provide information on species composition, size and weight as need for TS, abundance and biomass estimation.

The current approach: utilizes trawls obtained during the egg surveys to provide species proportions, length distributions, and weight at length. Trawls are generally on predetermined well spaced stations with the addition of some directed stations. The data is utilized to give species proportions that are applied to acoustic records of CPS, length and weight data to give TS and size information for calculating total abundance by size. The allocation method is through nearest neighbor method and variance uses jackknife.

Parameter Estimates: The results suggest that the region has considerable separation between species, particularly in summer, indicating that species proportions are relatively well established. Although nighttime catch rates may not fully match daytime observations this is considered to be a minor issue for Pacific sardine and jack mackerel because the areas occupied by these species are generally homogeneous, particularly in the summer survey. Though there are some concerns that in the minority parts of the area where mixtures are observed species selectivity of the gear may be an issue. There are potentially issues for size selectivity in the small parts of the areas where 'O' group sardine are caught.

In the short term if estimation of the full range of species is required, increased trawl effort will be required in areas dominated by minority species. It may be possible to identify if there are gross 'species selectivity' issues for the major species by comparing the ration of catch rates and acoustic abundance in areas where single species dominate.

Sampling for size and weight is limited to a maximum of 50 per species per haul. Reports indicate that even for sardine the numbers of individuals measured and used to estimate length can be quite low. The analysis procedure uses nearest neighbor allocation; this approach implies that within station sampling error is low or negligible, given that some positive hauls can have very few fish this may not be an appropriate assumption. It may be preferable to use weighted averages from several hauls to account for numbers of fish.

Variance estimation for trawl sampling is obtained through the use of a jackknife procedure, hauls taken are removed one at a time and the survey recalculated with the remaining set allocated to their area of influence accounting for the missing haul. This procedure mimics the concept that a haul in a location may or may not be taken. It intuitively represents the right kind of sampling uncertainty. However, for a single removal jackknife there is a requirement to inflate the variance to account for the number

of stations. This has not been done and it is not immediately obvious that this inflation can be fitted neatly into the integrated variance procedure due to the complex interaction of different factors. Thus the current method underestimates the variability associated with hauls. A number of potential approaches could be considered.

1. The most complex: Fit a multivariate surface for TS and length distribution; calculate the residuals; bootstrap these residuals over the surface
2. Move from nearest neighbor to weighed averages within a zone of influence, bootstrap the observations (multiple draws of same haul changes weighting).
3. Determine the number of hauls (n) to be removed randomly in the jackknife in order that variance inflation is not required. Check if the procedure can cause problems if mostly adjacent hauls are removed simultaneously, if so remove the n hauls from within n equally sized latitudinal groups.

The first of these is formally the best but the most complex and dependent on the model fit. The other two are simpler and probably adequate for what is thought to be a minor source of variance. Option 2 would be selected if the nearest neighbor method is replaced with an area influence weighting method. Option 3 would be appropriate if the current nearest neighbor method is found to be appropriate. There may be other methods not noted here.

Conclusion: The estimates are considered to be an acceptable method for estimating biological parameters, some exploration of other options and increased numbers of fish sample could be explored. An alternative variance estimation method is required.

4.2.3. Allocation of effort between trawl and transect data collection

Issue: Is the allocation of vessel time between trawl and transect data collection optimal.

The current approach: Currently the balance of time allocated to transect or trawl data collection is based on the needs of the egg surveys.

Comment: Currently the balance appears adequate to give useful results, though there may be potential for optimization in order to best meet the main objectives once they are specified. The current variance estimation could be utilized to obtain minimum variance estimates based on variance/effort relationships/assumptions. Some studies (Simmonds 1995, Simmonds 2009, Simmonds and Maclennan 2005) suggest that relating overall variance to effort reallocation between trawl and transect allocation results in a rather flat broad range of options with rather similar variance. This is because CV is follows a dependence on $1/\sqrt{n}$ giving a relatively shallow response curve for the two main sources of effort, and the minimum formed as effort is exchanged between them is not that sensitive to the choice. This suggests that optimization may not be a very critical issue.

4.2.4. Area coverage

Issue: Is the area (volume) covered by the survey correctly located and sufficiently large to substantively cover the distribution of the stocks of interest.

The current approach: The area evaluated is bounded vertically by the minimum depth limit of the acoustic system, and a maximum of 70m, latitudinally by ½ transect spacing to the north and south of the survey area and longitudinally by the coast and the outer limit of the transects.

Comment: this issue is addressed in three aspects: the vertical extent, latitudinal range (along coast), and longitudinal extent (both onshore and off shore limits).

Vertical extent: The upper limit is defined by the minimum range available from a 38kHz sounder mounted on a vessel. The evidence presented suggests the upper limit is appropriate, given the discussion of avoidance given below. The sounder systems used are capable of much greater ranges than the 70m maximum defined in the analysis, this appears to be appropriate and could easily be extended if required.

latitudinal range (along coast): Both surveys appear to cover the majority of the latitudinal extent of the distribution of sardine, anchovy, and jack mackerel, but evidence presented suggests this is not the case for Pacific mackerel. However, there is evidence of suitable habitat for sardine and some fisheries to the south and north that may be occupied, and there is also evidence of fisheries in these areas. The extent of potential habitat should be evaluated (by year) and compared with fisheries to try to determine how sensitive the results are to area boundaries. This is a necessary study to conduct before accepting the estimates can be accepted as absolute.

Longitudinal extend (on and offshore): From the information presented the offshore extent for spring surveys 2008 and 2010 appears to be appropriate for sardine and jack mackerel and anchovy, though there is some doubt concerning the 2006 survey for sardine. Currently estimates of the small section of the area between the transect ends and the coast are obtained from the transect means, however, evidence was presented (on request) concerning the abundance with off shore distance. This suggests rising densities of sardine towards the coast that might in some cases give 15% higher biomass. This aspect needs further exploitation. Although the distance from the cost is much less than a half transect spacing, the potential area estimated by transect ends, the existence of trend implies a need to evaluate this accounting for trend. Among others several options are possible:

- Develop a GLM (or GAM) to characterize trends and to use this to extrapolate the small missing segment.
- Krig the along transect data including data from the transect ends (Rivoirard *et al.,* 2000). Set the area boundaries into the area required, compare estimates for area bounded by transect ends with extended area (the advantage of this method is

it can potentially give an appropriate increase in variance accounting for sample locations via the geostatistical estimation variance).

- If the missing segment is very short an approximation would be to include the appropriate extra distance of track from the between transect values. This is the nearest available additional data.

The observations on distribution are supported by information provided from fisheries and some survey data from Canada. In addition information was provided by CPSAS representative regarding location an season of fisheries. Taking all of this into account the SWFSC group should evaluate the data in more detail and propose a method for inshore and seasonally related latitudinal extensions to the area of occupancy for Pacific sardine. The magnitude of the extrapolation by survey should be evaluated and presented separately, so its contribution to the absolute estimate can be checked.

4.2.5. Prescreening algorithms for extracting school data

The issue: The choice of method for the extraction of CPS echoes for the acoustic records.

The current approach: Utilizes variance mean ratio among several frequencies at fine scale and with 38kHz at a broader scale to separate CPS from other acoustic scatters, mostly plankton. The basis of this is the different pdf expected echoes from larger gas bearing targets from other non gas bearing or very much smaller organisms.

Comment: The general principle of extracting objects from daytime records and assigning these to individual or groups of species is a very well established approach for acoustic surveys. This is done manually by some practitioners (see PGHERS reports ICES 2007 and earlier) by directly picking out schools in a region or numerically using threshold and spatial continuity (Barange *et al.,* 1994) observed frequency response (Korneliussen and Ona, 2003). The current method utilizes the functionality of Echoview (Higgingbottom *et al.,* 2000). The method used here is based on a more formal approach, in terms of frequency ranges, though the spatial averaging at different stages is selected to match local situations. It appears to work well. As for most practitioners, variance estimation is not included.

4.2.6. Timing (day/night, school makeup)

The issue: Do the night trawl samples adequately provide information on species composition to be applied to daytime estimates of biomass.

The current approach: Samples from night trawls from predefined stations (with some additional stations) are used to obtained species proportions that are allocated through the nearest neighbor method to assign species proportions to schools extracted from the daytime acoustic records.

Comment: The use of night hauls to estimate species parameters for daytime observation on schools is not ideal. This method (day transect, night haul) is used elsewhere, for example in the eastern section of NS herring survey (ICES 2007 and earlier PGHERS repots). For other areas of the NS herring, fishing is on directed daytime hauls. This combined survey utilizing both methods is used in the ICES assessment of North Sea herring (Simmonds 2009).

The documentation shows that where CPS were acoustically mapped, and trawls were carried out CPS were caught in the trawls; where CPS were not acoustically observed, and trawls were carried out, CPS were absent from the catches. This is supportive of night catches being indicative of CPS.

Compared with directed fishing on schools in the daytime, there are some advantages and disadvantages to this approach.

Disadvantages of current method	Advantages of current method
1. Schools are not explicitly identified 2. If species distribute outside the fishing layer at night they may be missed, without this being apparent.	1. Mixed layers at night may contain more homogeneous species proportions, than individual schools 2. Catching at night may be more representative of size range as it involves less avoidance as fish don't see the net until it is very close 3. Catching at night may involve less species selection as fish don't see the net until it is very close; thus catches are less selective. 4. Catching success or probability during the day may be species specific so missed trawls may be species dependent, giving biased results.

In this particular situation, the key point is that the resulting species proportions obtained here show rather homogeneous areas with a single dominant species, which indicates that the species separation is particularly clear spatially so the allocation by species is rather precise. Acceptance that this approach is useful is highly dependent on the species separation that allows that conclusion. If the area were, in the future, to become occupied by multi species schools or more likely single species schools of different species, the use of this approach would need more attention. Under such circumstances, daytime fishing and school identification to species level might be required.

Improvement: In the longer term efforts should be made to evaluate if a change in fishing practices / gears would be beneficial. The objective would be to deploy a gear with the potential for daytime fishing. This would allow direct species identification to school level and could be supported acoustic identification to species level.

4.2.7. Trawl design-net, tow speed, etc

A rope trawl at 3.5knots which may have been the gear of choice on the older vessels now going out of service may not be the optimal choice for the new research vessels coming into service over the next few years. There are other options and some studies of pelagic fish capture; see, for example, Suuronen *et al.* (1997), McClatchie, *et al.* (2000).

4.2.8. Acoustic Equipment Specifications

The Simrad EK echosounder systems deployed to give primary abundance estimation are the scientific standard for marine acoustic surveys. A variety of sonars and multibeam scanners have been deployed to evaluate avoidance. There is no particular reason to prefer one over another except that simultaneous observation below and to the side of the vessel is required. There is a tradeoff in frequency; high frequency scanners provide better angular resolution giving improved spatial resolution but they are also more sensitive to fish directivity, making inference on relative fish abundance at angle more difficult to evaluate. It is very important to continue to collect data of fish distribution/ avoidance of the vessel.

4.2.9. Vessel avoidance

The issue: Do the CPS avoid the vessel and if so do the results of from vertical sounders give a biased estimate that is known to be to high or too low.

The current approach: A series of evaluations extensive of using scanning sonars have been carried out during the surveys. The results of these were presented. It was identified that avoidance occurs, fish schools are observed at deeper depths under the survey vessel than those seen to the side. That fish schools occur at shallower depths than those observed by the vertical sounder is in agreement with some observations by fishermen provided by the CPSAS representative.

Comment: Fish response to vessel passage has been documented for CPS found in other areas. If vessel passage causes fish to change their orientation in the water column, or exhibit some kind of consistent movement (avoidance or attraction), there is a potential for bias in abundance estimates from acoustic survey. Echosounders used in the CPS acoustic-trawl survey are mounted in or near the center of vessel and evaluations start at deeper than approximately 10 m. Sardines in particular are often found near the surface at least at some time of the year, and fishermen in the Northwest have noted strong avoidance responses. This is a critical issue to address when deciding how or whether to use the abundance estimates for stock assessment. The Panel considered the following information:

There is clear evidence that schools seen on the surface dive to at least 10m (Cutter and Demer 2007). This gives rise to concern that the abundance may not be correctly recorded. The technical team presented results from a number of studies using

multibeam sonar mount sideways or downwards. Two aspects were studied, the distribution of schools and distribution of backscatter underneath and to the side of the vessel. Counts of presence/absence showed a sharp peak under the vessel, and a steady reduction with distance away from the vessel tract and depth, suggesting no increase in schools off track. Other studies with similar equipment on Mediterranean sardine increased schools off track (Soria *et al*., 1996). In contrast, Chilean sardine (Gerlotto *et al*., 2004) show no increase in school off track. The distribution of backscatter to the side of the vessel shows a similar pattern, but without the sharp peak directly under the transducer. The technical team also presented results from a study of schools passing through the echosounder that did not find evidence of differences in depth or backscatter from the front end of the school to the rear end of the school.

Based on these results it was concluded that there is no strong evidence of bias due to vessel avoidance; however, these results are not definitive and continued monitoring and analysis is critical to provide verification of validity of the survey.

4.2.10. Target strength

The issue: Do the target strength formulas used give a sufficiently accurate TS value that mean biomass will be unbiased.

The current approach: Three formulas coming from peer-reviewed papers are used to give TS – length relationships. The values used are standardized to 20 log slope, and use weight at length conversion to biomass

Comment: The published values are for the same species for sardine and should be a good starting point. There is less good data on some other species and there may be small differences. The use of a common function for Pacific mackerel and jack mackerel is of some concern. The reports quoted (Peña, 2008) are published but don't contain strong evidence for the similarity between these species. Some species of mackerel (*Scomber*) are very different from jack/horse mackerel (*Trachurus)* thus there is some basis for concern, in contrast both these species have swimbladders, and their body forms are more similar than for some others members of the same genus, supporting the use of same TS. However some non peer reviewed studies off the African coast have suggested differences between these species. The authors are encouraged to investigate TS values locally and particularly for pacific mackerel if this is to be used as an absolute estimate.

4.2.11. Hydrography

A very minor point: changes in hydrography occur throughout the area during the survey. The documentation suggests a fixed sound velocity and absorption used throughout the area, though the latitudinal extent of the area is extensive and has upwelling, these two suggest some variability. However, the dominant stock is shown to be close to the transducer and in a limited range of water type, thus implying less of an issue. It would

be good to document the range of sound velocity (and absorption) to show this has been checked to have low impact in the context of range or equivalent beam angle dependence.

4.3. ToR 3

Evaluate and provide recommendations for the application of these methods for their utility in stock assessment models and for their ability to monitor trends at the population level for Pacific sardine and other CPS. Survey methods or results that have a flawed technical basis, or are questionable on other grounds, should be identified so they may be excluded from the set upon which stock assessments and other management advice is to be developed.

Use of acoustic-trawl survey data in stock assessments

This question is addressed specifically in the context of perceptions of the data already used in the SS3 assessment and the model formulation. Thus the recommendations are conditional on these aspects. Given a different model or other competing data sources the conclusion might be the same or different.

The acoustic-trawl data was considered for each of the four CPS species separately, noting that the information available differs markedly among these species and that the basis for the management advice differs between monitored and managed species. The focus for discussions was Pacific sardine, which is currently the species with the largest biomass. Not unexpectedly, there was less information for the other species and it is not possible to give such clear recommendations for jack mackerel, Pacific mackerel and Northern anchovy as it was for Pacific sardine.

The practice of using acoustic surveys as absolute estimates of abundance is different in areas. These differences depend both on the surveys and the other data in the assessment. In Europe the assessments are often hampered by uncertain historic catches (due to IUU fishing or discarding and slipping practices). These assessments are used primarily to advise on more on catch rates, quoting biomasses, but managing on F and 'virtual populations'. In these circumstances acoustic surveys for pelagic species such as herring are used as indices to tune VPA style assessments. Thus the survey might be absolute but the assessment is not. Using them as absolute might give poorer advice if historic catches are uncertain. Here the assessment requires some information on the absolute abundance, and inferring this directly from catch is difficult given the relatively low exploitation rate (~0.1), and the natural mortality (0.4). If an index is to be used the coefficient of proportionality (Q) for that series must be estimated in the model; for a short timeseries such as the Pacific sardine acoustic-trawl survey presented here, the power to estimate that Q will be low. The other data in the assessment do not come from very accurate measures of absolute abundance. As a series becomes longer the power to estimate Q will increase and it may be possible to clearly identify if Q=1 is appropriate. It is against this set of information that consideration of the use of the survey as absolute or relative is considered.

Pacific Sardine
Pacific sardine are an actively managed CPS species with an SS3-based stock assessment. Estimates of abundance based on acoustic-trawl data can be included in this stock assessment as absolute estimates of abundance or as relative indices of abundance.

For the survey method, the main area conclusions for are:

- The survey method is substantively sound.
- The variance estimate for the major source of uncertainty (transect data) is correct.
- The variance using jackknife estimator for trawl data needs revision (see above).

The major potential sources of uncertainty related to using the acoustic-trawl data are estimates of absolute abundance identified during the review were:

- The relationship between target strength and length are based on it situ measurements, but are taken from a different area.
- Sardine may avoid the vessel to some extent.
- Sardine are found outside of the area covered by the acoustic transects (north, south, offshore and inshore), with the proportion of the stock outside this area depending on season as well as environmental conditions.

Given the information provided, the first and second of these three sources of uncertainty are considered likely to be relatively minor (see Sections 4.2.9,10). Item three needs further evaluation (See Section 4.2.4).

Also, given current information, it is determined that the acoustic-trawl surveys can be considered estimates of absolute abundance for the survey area, and the assessment author should consider the use of these data in the September 2011 sardine assessment. Prior to the September 2011 assessment, analyses should be conducted using auxiliary information to provide best estimates for the biomass outside of the survey area as well as range of possible biomass levels. In addition, the CVs for the estimates need to be modified to fully account for the uncertainty of the trawl data.

Within this recommendation for use in the assessment, the following should be considered: (a) examine the sensitivity of the results to alternative acoustic-trawl abundance estimates, (b) determine whether assuming that the acoustic trawl indices are absolute indices of abundance lead to patterns in the residuals, (c) examine the implications of ignoring some or all of the acoustic trawl indices [e.g., the summer 2008 and spring 2006 surveys], and (d) treat these indices as relative measures of biomass.

In future STAR Panels, review any research conducted in relation to acoustic trawl surveys, and evaluate how these data are used to estimate absolute abundance, in the same way as is done for other indices.

Jack mackerel
Jack mackerel are a monitored CPS species. There are few recent data on which base estimates of abundance and distribution for this species. The acoustic-trawl survey data are the only scientific information on abundance for the area surveyed. Though there is less information available for this species than for Pacific sardine on the key uncertainties, the estimates of absolute abundance for the survey area can be used as estimates of the biomass of jack mackerel in US waters. The catchability for jack mackerel may not be the same as that for Pacific sardine. The estimate for summer may therefore be more reliable as the various CPS are more separated at that time.

Pacific mackerel
While there is no reason why the acoustic-trawl surveys cannot be used to provide estimates of abundance for Pacific mackerel, the estimates of abundance for Pacific mackerel are more uncertain as measures of absolute abundance than for jack mackerel or Pacific sardine. This is reflected by very high CVs for the spring surveys. A major concern for this species is that a sizable (currently unknown) fraction of the stock is outside of the survey area. While the estimates for survey area are valid, if the acoustic-trawl data are to be used to provide estimates of stock biomass, auxiliary information will be needed to estimate the annually varying proportion of the whole stock in the survey area.

Northern anchovy
There is also no reason why an acoustic-trawl survey cannot be used to estimate abundance for Northern anchovy. However, the current size of the population, along with its more inshore distribution, means that the present survey data cannot be used to provide estimate of relative or absolute abundance for Northern anchovy. A few Northern anchovy were sampled nearshore, mostly off Oregon and Washington (2006, 2008, and 2010), north of Monterey Bay (2006) and in the Southern California Bight (2006 and 2008). Apart from the occasional large catches (~ 300kg) off the mouth of the Columbia River and other likely locations such as off Santa Barbara and Monterey Bay, anchovy were scarce in these surveys, even off southern California where they once were the most abundant species. The sampling scheme would need to be modified (more transects and trawls in the areas where Northern anchovy are found) if estimates of abundance of Northern anchovy are needed given its current abundance.

4.4. ToR 4

Evaluate the effectiveness of the survey methods for detecting the appropriate spatial scale and seasonal timing for annually estimating stock abundances.

Pacific Sardine
Given current information, it is considered that the acoustic-trawl surveys can be considered estimates of distribution of abundance for the survey area. It is expected that the area survey covers the vast majority of Pacific sardine at the time when the surveys are conducted. There is a need for a number of analyses to be conducted using auxiliary information to provide best estimates for the biomass outside of the survey area as well as

range of possible biomass levels. In addition, the CVs for the estimates need to be modified to fully account for the uncertainty of the trawl data.

Jack mackerel
Jack mackerel are a monitored CPS species. The acoustic-trawl survey data are the only scientific information on abundance for the area surveyed. Even though less information is available for this species than for Pacific sardine on the key uncertainties, the estimates distribution by the survey area can be used for jack mackerel in US waters. The estimate for summer may be more reliable as the various CPS are more separated at that time.

Pacific mackerel
A major concern for this species is that a sizable (currently unknown) fraction of the stock is outside of the survey area. While the estimates for survey area are valid, and some information on distribution is available, if the acoustic-trawl data are to be used to provide estimates of stock biomass, auxiliary information will be needed to estimate the annually-varying proportion of the whole stock in the survey area.

Northern anchovy
The current size of the population, along with its more inshore distribution means that the present survey data cannot be used to provide estimate of relative or absolute abundance or distribution for northern anchovy. A few Northern anchovy were sampled nearshore, mostly off Oregon and Washington (2006, 2008, and 2010), north of Monterey Bay (2006) and in the Southern California Bight (2006 and 2008). Apart from the occasional large catches (~ 300kg) off the mouth of the Columbia River and other likely locations such as off Santa Barbara and Monterey Bay, anchovy were scarce in these surveys, even off southern California where they once were the most abundant species. The sampling scheme would need to be modified (more transects and trawls in the areas where Northern anchovy are found) if estimates of distribution of Northern anchovy were required.

4.5. ToR 5

Decide through Panel discussions if the ToRs and goals of the peer review have been achieved. If agreement cannot be reached, or if any ToR cannot be accomplished for any reason, then the nature of the disagreement or the reason for not meeting all the ToR must be described in the Summary and Reviewer's report. Describe the strengths and weaknesses of the review process and Panel recommendations.

The goals of the review have been substantively reached, and recommendations or answers have been made for each ToR. There was discussion on a number of important points. Had the reviewers operated separately they might have come to different conclusions; but with a discussion, the panel reached agreement, though there might remain some small differences between perceptions held by different members.

I found the review process generally of a high standard. It was important that the process included a meeting where initial differing opinions could be raised, discussed, and a

consensus reached. I would particularly like to commend the chairman for very clear view of needs which focused the meeting well and the balanced way he summarized the views.

All the documentation required was provided. The performance of the Acoustic-Trawl Survey Technical Team was of a particularly high standard, providing good documentation, which was well presented and explained. Where additional studies were requested these were provided efficiently and presented professionally.

It is perhaps necessary to recognize an aspect of the review process. The Acoustic-Trawl Survey Technical Team provided information of a high standard, and all information presented was based on data collected and published methods mainly from peer reviewed material. This is as it should be. However, some participants gave opinions or made assertions without the same level of verification and references required of the Technical Team. This is the nature of the review process, in that the forum involves non-experts and non-scientific members on the committee. I do not find this a problem, nor to I think it can or should be changed, but it does need to be recognized that different actors participating in the process are subject to different requirements. Provided this is clearly understood by those who read the review, it does not constitute a problem.

While generally the meeting facilities were good, two aspects presented a problem. First, access to the meeting room on Saturday was not fully supported by the institute, and this led to problems for at least one person (observer) who missed a session. Second, there were considerable technical difficulties with the network access provided by SWFSC, as this was barely functional, requiring additional printing and making exchange of documents difficult.

I was impressed overall with the quality of this review and all who participated in it, and I would like to thank all involved for their efforts. In particular, I would like to thank the Chairman for his hard work guiding the review and both he and the rapporteur are to be acknowledged for their hard work assembling and editing the Panel report.

5. Recommendations

Pacific Sardine: It is recommended that the acoustic-trawl surveys be considered estimates of distribution of abundance for the survey area.

It is recommended that a number of analyses be conducted using auxiliary information to provide best estimates for the biomass outside of the survey area, as well as range of possible biomass levels. In addition, the CVs for the estimates need to be modified to fully account for the uncertainty of the trawl data.

Jack mackerel: Even though less information is available for this species than for Pacific sardine on the key uncertainties, it recommended that the distribution estimates by the survey area can be used for jack mackerel in US waters.

Northern anchovy: It is recommended that if estimates were required, the sampling scheme would need to be modified.

There are a series of specific aspects detailed below:

1. Immediate (prior to the next stock assessments)

a. Analyses should conducted using auxiliary information (e.g. trends in density along transects, information from ichythoplankton surveys south of the survey area, catch information) to provide best estimates for the biomass outside of the survey area as well as the range of possible biomass levels.
b. The CVs for the estimates need to be modified to fully account for the uncertainty of the trawl data.

2. Short-term

a. Investigate 'gross' species selectivity effects by comparing the ratio of catch rates and acoustic density in areas where single species dominate.
b. Conduct sensitivity tests in which stations are pooled and allocated to acoustic values over a larger area.
c. Consult experts in trawl design to evaluate the current trawl design in relation to the survey objectives
d. Develop methods that categorize the acoustic record and thus support automatic species identification and continue to work on definition and precision of the VMR process and check the performance of the selection process on each survey.
e. Develop further studies on effect of avoidance: study trends in frequency response over depth strata in schools, compare results from the 18 kHz and other transducers to examine possible avoidance reactions.
f. Continue to consider the advantages and disadvantages of conducting acoustic-trawls surveys at different times of the year and extending the survey into Canadian and Mexican waters.
g. Evaluate the potential to give age-based abundance or biomass estimates for sardine and consider their utility in the SS3 assessment given the lack of contrast in length-at-age at older ages and the ability to directly estimate total mortality from the survey result.

3. Long-term

a. Evaluate if differing fishing trawling practices / gears would be beneficial.
b. Use a trawl/vessel configuration that can support directed trawl sampling.
c. Conduct repeated trawl sampling experiments to obtain better understanding of small-scale variability.
d. Test the efficiency and selectivity of the trawl by comparing samples from same area taken with the survey trawl and purse seine.
e. Apply state-of-the-art acoustic and optic technology to investigate fish behavior and escapement at various critical positions of the trawl.
f. Conduct validation tows on various kinds of backscatter to assure that the filtering algorithm is performing as intended to separate out CPS.

g. Make efforts to obtain *in situ* target strength measurements for CPS species in California Current Ecosystem.

6. Conclusion

The reports and presentations provide an excellent basis to evaluate the performance of the acoustic-trawl survey. They are of a high standard and require only minor improvements that are detailed above.

The acoustic-trawl surveys should be considered estimates of distribution of abundance of Pacific Sardine for the survey area, conditional on a number of analyses to be conducted using auxiliary information to provide best estimates for the biomass outside of the survey area as well as range of possible biomass levels. In addition, the CVs for the estimates need to be modified to fully account for the uncertainty of the trawl data.

7. References

Jolly, G.M., Hampton, I., 1990. A stratified random transect design for acoustic surveys of fish stocks. Canadian Journal of Fisheries and Aquatic Science 47, 1282-1291.

Barange, M. 1994. "Acoustic identification, classification and structure of biological patchiness on the edge of the Agulhas Bank and its relation to frontal features." South African J. Mar. Sci. 14: 333-347.

Gerlotto F., Castillo, J., Saavedra, A., Barbieri, M.A., Espejo, M. and P. Cotel, 2004. Three-dimensional structure and avoidance behavior of anchovy and common sardine schools in central southern Chile. ICES Journal of Marine Science, 61: 1120–1126.

Higginbottom, I. R., Pauly, T. J., and Heatley, D. C. 2000. Virtual echograms for visualization and post-processing of multiple-frequency echosounder data. In Fifth European Conference on Underwater Acoustics, ECUA 2000, pp. 1497–1502. Ed. by M. E. Zakharia.

ICES. 2007. Report of the Planning Group for Herring Surveys (PGHERS), 22–26 January, 2007, Charlottenlund, Denmark. ICES Document CM 2007/LRC: 01. 187 pp.

Korneliussen, R. J., and Ona, E. 2003. Synthetic echograms generated from the relative frequency response. ICES Journal of Marine Science, 60: 636–640.

Lawson, G. L., Barange, M., and Fre´on, P. 2001. Species identification of pelagic fish schools on the South African continental shelf using acoustic descriptors and ancillary information. ICES Journal of Marine Science, 58: 275–287.

McClatchie, S., Thorne, R. E., Grimes, P., and Hanchet, S. 2000. Ground truth and target identification for fisheries acoustics. Fisheries Research, 47: 173–191.

Scalabrin, C., Diner, N., Weill, A., Hillion, A., and Mouchot, M. C. 1996. Narrowband acoustic identification of monospecific fish shoals. ICES Journal of Marine Science, 53: 181–188.

Suuronen, P., Lehtonen, E., and Wallace, J. 1997. Avoidance and escape behaviour by herring encountering midwater trawls. Fisheries Research, 29: 13–24.

Rivoirard, J., Simmonds, E. J., Foote, K. G., Fernandes, P., and Bez, N. 2000. Geostatistics for Estimating Fish Abundance. Blackwell Science, Oxford. 206 pp.

Simmonds, E.J. 2009,. Evaluation of the quality of the North Sea herring assessment ICES Journal of Marine Science 66 (8), pp. 1814-1822

Simmonds, E. J., and Fryer, R. J. 1996. Which are better, random or systematic acoustic surveys? A simulation using North Sea herring as an example. ICES Journal of Marine Science, 53: 39–50.

Simmonds, E. J. 1995. Survey design and effort allocation: a synthesis of choices and decisions for an acoustic survey. North Sea herring is used as an example. ICES Document CM 1995/B: 9.

Simmonds, E. J., and MacLennan, D. N. 2005. Fisheries Acoustics: Theory and Practice, 2nd edn. Blackwell Publishing, Oxford.

Simmonds, E.J., Gutie´rrez, M., Chipollini, A., Gerlotto, F., Woillez, M., and Bertrand, A. 2009. Optimizing the design of acoustic surveys of Peruvian anchoveta. – ICES Journal of Marine Science, 66: 1341–1348.

Soria, M., Fréon, P. and F. Gerlotto. 1996. Analysis of vessel influence on spatial behavior of fish schools using a multi-beam sonar and consequences on biomass estimates by echosounder. ICES Journal of Marine Science, 53: 453-458.

Peña, H., 2008. In situ target-strength measurements of Chilean jack mackerel (Trachurus symmetricus murphyi) collected with a scientific echosounder installed on a fishing vessel. ICES Journal of Marine Science 65 (4), 594-604.

Appendix 1: Bibliography of materials provided for review

Primary Documents

David A. Demer, Juan P. Zwolinski, Kyle A. Byers, George R. Cutter, Josiah S. Renfree, Thomas S. Sessions, and Beverly J. Macewicz 2011 Acoustic-trawl surveys of Pacific sardine (Sardinops sagax) and other pelagic fishes in the California Current ecosystem: Part 1, Methods and an example application.

Juan P. Zwolinski, Kyle, A. Byers, George R. Cutter, Josiah S. Renfree, Thomas, S. Sessions, Beverly J. Macewicz, and David A. Demer 2011 Acoustic-trawl surveys of Pacific sardine (Sardinops sagax) and other pelagic fishes in the California Current ecosystem: Part 2, Estimates of distributions and abundances in spring 2006, 2008, and 2010

Background documents

Barange, M., Hampton, I., and Soule, M. 1996. Empirical determination of in situ target strengths of three loosely aggregated pelagic fish species. – ICES Journal of Marine Science, 53: 225–232.

Conti, S. G., and Demer, D. A. 2003. Wide-bandwidth acoustical characterization of anchovy and sardine from reverberation measurements in an echoic tank. – ICES Journal of Marine Science, 60: 617–624.

Cutter, G. R. Jr and Demer, D. A. 2007. Accounting for scattering directivity and fish behaviour in multibeam-echosounder surveys. – ICES Journal of Marine Science, 64: 1664–1674.

D. A. Demer, G. R. Cutter, J. S. Renfree and J. L. Butler: Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA.

Zwolinski, J. P., Emmett, R. L., and Demer, D. A. Predicting habitat to optimize sampling of Pacific sardine (Sardinops sagax). 2010 – ICES Journal of Marine Science, 68: 000–000.

Anon 2009. 2009 PACIFIC MACKEREL STOCK ASSESSMENT, STOCK ASSESSMENT REVIEW PANEL REPORT, SCIENTIFIC AND STATISTICAL COMMITTEE REPORT, AND, CPS MANAGEMENT TEAM AND ADVISORY SUBPANEL REPORTS www.pcouncil.org 2009 CPS SAFE Appendix 2 June 2009

Anon 2009 STATUS OF THE PACIFIC COAST COASTAL PELAGIC SPECIES FISHERY AND RECOMMENDED ACCEPTABLE BIOLOGICAL CATCHES STOCK ASSESSMENT AND FISHERY EVALUATION 2009 PACIFIC FISHERY MANAGEMENT COUNCIL, 7700 NE AMBASSADOR PLACE, SUITE 101, PORTLAND, OR 97220 www.pcouncil.org JUNE 2009

Anon 2009. 2009 PACIFIC SARDINE STOCK ASSESSMENT UPDATE, 2008 SCIENTIFIC AND STATISTICAL COMMITTEE STATEMENT AND SUBCOMMITTEE REPORT, AND CPS MANAGEMENT TEAM AND ADVISORY SUBPANEL REPORTS www.pcouncil.org 2009 CPS SAFE Appendix 1 June 2009

Anon 2010 Draft STATUS OF THE PACIFIC COAST COASTAL PELAGIC SPECIES FISHERY AND RECOMMENDED ACCEPTABLE BIOLOGICAL CATCHES STOCK ASSESSMENT AND FISHERY EVALUATION 2010. PACIFIC FISHERY MANAGEMENT COUNCIL, 7700 NE AMBASSADOR PLACE, SUITE 101 PORTLAND, OR 97220 www.pcouncil.org JUNE 2010

Kevin T. Hill,,Emmanis Dorval, Nancy C.H. Lo, Beverly J. Macewicz, Christina Show, Roberto Felix-Uraga, ASSESSMENT OF THE PACIFIC SARDINE RESOURCE IN 2007, FOR U.S. MANAGEMENT IN 2008. NOAA-TM-NMFS-SWFSC-413

Kevin T. Hill,,Nancy C.H. Lo, Beverly J. Macewicz, Paul R. Crone, Roberto Felix-Uraga. 2010 ASSESSMENT OF THE PACIFIC SARDINE RESOURCE IN 2009 FOR U.S. MANAGEMENT IN 2010 NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-452

Kevin T. Hill, Nancy C.H. Lo, Beverly J. Macewicz, Paul R. Crone and Roberto Felix-Uraga 2010. ASSESSMENT OF THE PACIFIC SARDINE RESOURCE IN 2010 FOR U.S. MANAGEMENT IN 2011 NOAA-TM-NMFS-SWFSC-469

Tom Jagielo, Doyle Hanan and Ryan Howe 2009 West Coast Aerial Sardine Survey Sampling Results in 2009 Prepared by for California Wetfish Producers Association c/o Diane Pleschner-Steele, Executive Director PO Box 1951 Buellton, Ca 93427 and Northwest Sardine Survey, LLC c/o Jerry Thon, Principal 12 Bellwether Way, Suite 209 Bellingham, Washington 98225

Anon 2009 Aerial Survey Methods for Pacific Sardine Report of STAR Panel Meeting NOAA / Southwest Fisheries Science Center La Jolla, California May 4-8, 2009

Tom Jagielo, Doyle Hanan, Ryan Howe, and Meghan Mikesell 2010. West Coast Aerial Sardine Survey Sampling Results in 2010. Northwest Sardine Survey, LLC c/o Jerry Thon, Principal 12 Bellwether Way, Suite 209 Bellingham, Washington 98225 and California Wetfish Producers Association c/o Diane Pleschner-Steele, Executive Director PO Box 1951, Buellton, Ca 93427, October 15, 2010

Yorgos Stratoudakis, Miguel Bernal, Konstantinos Ganias and Andre´s Uriarte The daily egg production method: recent advances, current applications and future challenges F I SH and F I SHERI E S , 2006, 7, 35–57

Nancy C.H. Lo, Beverly J. Macewicz, Richard L. Charter 2007. SPAWNING BIOMASS OF PACIFIC SARDINE (Sardinops sagax) OFF CALIFORNIA IN 2007. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-411

Nancy C. H. Lo, Beverly J. Macewicz, David A. Griffith 2010. Biomass and reproduction of Pacific sardine (Sardinops sagax) off the Pacific northwestern United States, 2003–2005 Fish. Bull. 108:174–192 (2010).

Nancy C. H. Lo, Beverly.J. Macewicz, and David A. Griffith 2010. SPAWNING BIOMASS OF PACIFIC SARDINE (Sardinops sagax) off the U.S. in 2010. NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-463.

Collecting Adult Coastal Pelagic Fish Using the Nordic 264 Rope Trawl: A Guide to Deployment and Sample Processing SWFSC mimeo 12pp

Anon 2010 TERMS OF REFERENCE FOR A COASTAL PELAGIC SPECIES STOCK ASSESSMENT METHODOLOGY REVIEW PROCESS PACIFIC FISHERY MANAGEMENT COUNCIL 7700 NE AMBASSADOR PLACE, SUITE 101 PORTLAND, OR 97220 www.pcouncil.org

Appendix 2: Statement of Work for John Simmonds

External Independent Peer Review by the Center for Independent Experts

Panel Review of an Acoustic-Trawl Method for Surveying CPS

3-5 February 2011

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 the 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 **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: The Pacific Fishery Management Council (PFMC) uses information from surveys to make decisions related to harvest guidelines for managed coastal pelagic species (CPS) (i.e., Pacific sardine and Pacific mackerel) and Overfishing Levels (OFLs) / Acceptable Biological Catches (ABCs) for monitored CPS (i.e., northern anchovy, jack mackerel and market squid). The current assessments for Pacific sardine and Pacific mackerel are based on the 'Stock Synthesis' framework. The assessment for Pacific sardine uses age- and length-composition data from four fisheries, the results from an aerial survey, and measures of female spawning biomass and total egg production (DEPM) from combined trawl and egg surveys, to estimate the parameters of a population-dynamics model. The survey outcomes and hence model-derived estimates of Pacific sardine spawning-stock biomass (SSB) have recently decreased, resulting in dramatically lower harvest guidelines for 2008 and 2009. The Southwest Fisheries Science Center's (SWFSC's) current standard survey covers the 'core' spring-spawning area between San Diego and San Francisco. The exploited stock ('northern subpopulation') is believed to migrate seasonally, potentially from northern Baja California, Mexico in the spring to British Columbia, Canada in the summer. The DEPM is an indirect measure of fish distribution and abundance. As the sardine population recovered from historic lows and recently reoccupied its former historic range, migrating as far north as Canada in the summer, multiple types and more direct estimates of CPS biomass, particularly sardine biomass, may be needed to improve stock assessments.

Three CIE reviewers will serve on a Panel to evaluate an acoustic-trawl method for surveying CPS. The SWFSC's Fisheries Resources Division (FRD) has explored the use of acoustic-trawl methods, which are commonly used by other regions and countries to estimate the abundances and distributions of CPS. Acoustic-trawl methods may provide a more robust (i.e., accurate and precise) and efficient means to routinely survey the Pacific sardine populations as well as the populations of jack mackerel, Pacific mackerel, and northern anchovy. In spring 2006, 2008, and 2010, and summer 2008, FRD conducted acoustic-trawl surveys off the U.S. west coast, from the Mexican to Canadian borders, and developed methods for estimating the abundances and distributions of CPS from these data. The Panel will review the acoustic-trawl survey design and analysis methods, documents, and any other pertinent information for acoustic-trawl surveys of Pacific sardine, Pacific mackerel, jack mackerel, and northern anchovy.

The Panel report will be used to guide improvements to the acoustic-trawl survey and analysis methods, the resulting time series of estimates of abundance and distribution for CPS species, and estimates of their uncertainty. The report will also be used to evaluate the appropriateness of using the results from the survey as inputs to the assessment model for Pacific sardine and Pacific mackerel. The assessment models for Pacific sardine and Pacific mackerel will be reviewed by separate Stock Assessment Review (STAR) Panels. However, the report of this Methods Review Panel will be considered by the assessment analysts and STAR Panels.

An overview of the ToRs for the Panel are attached in **Annex 2**. The tentative agenda of the Panel review meeting is attached in **Annex 3**. Finally, an outline of the summary report of the Panel is attached as **Annex 4**.

Requirements for CIE Reviewer: Three CIE reviewers shall participate in the Panel and conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. Three CIE reviewers shall have expertise and work experience in the design and execution of fisheries-independent acoustic-trawl surveys for estimating the abundance of coastal pelagic fish species, and expertise with sardines is desirable. The CIE reviewers shall have knowledge of the life history strategies and population dynamics of coastal pelagic fish species.

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

Location/Date of Peer Review: The CIE reviewers shall participate as independent peer reviewers during the panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, California, 92037-1023, during 3-5 February 2011 in accordance with the agenda (Annex 3).

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

Prior to the Peer Review: Following the CIE reviewer selections by the CIE Steering committee, the CIE shall provide the CIE reviewers' information (name, affiliation, and contact details) to the Contracting Officer's Technical Representative (COTR), who will forward 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 (reviewer hereafter). The Project Contact is responsible for providing the reviewer with the background documents, reports, foreign national security clearance, and information concerning other pertinent meeting arrangements. The Project Contact is also responsible for providing the Panel Chair (Chair hereafter) a copy of the SoW in advance of the Panel. 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 a reviewer who is a non-US citizen participates in a panel review meeting at a government facility, the Project Contact is responsible for obtaining a Foreign National Security Clearance for the CIE reviewers. For the purpose of their security clearance, each reviewer shall provide requested information (e.g., name, contact information, birthdate, passport number, travel dates, and country of origin) to the Project Contact 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 review, the Project Contact will electronically send to each reviewer, by email or FTP, all necessary background information and reports for the review. If the documents must be mailed, the Project Contact will consult with the CIE on where to send the documents. The CIE reviewers shall read all documents in preparation for the review, for example:

- documents on current survey methods, in particular, related to DEPM and aerial surveys of sardine and other CPS;
- document on SWFSC acoustic-trawl surveys conducted between 2006 and 2010;
- documents from past Panels; and
- miscellaneous documents, such as the ToR, SoW, agenda, schedule of milestones, deliverables, logistical considerations, and PFMC's ToR for CPS Stock Assessment Methodology Reviews.

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. Any delays in submission of pre-review documents for the CIE review will result in delays with the CIE review process, including a SoW modification to the schedule of milestones and deliverables.

Panel Review Meeting: Each CIE reviewer shall participate in the Panel and conduct an independent review in accordance with the SoW and ToRs. **Modifications to the SoW and ToR cannot be made during the review, and any SoW or ToR modification prior to the review shall be approved by the COTR and CIE Lead Coordinator.** Each reviewer shall actively participate in a professional and respectful manner as a

member of the Panel, and their review tasks shall be focused on the ToRs as specified in the contract SoW.

Respective roles of the CIE reviewers and Chair are the PFMC's ToR for CPS Stock Assessment Methodology Review (see p. 6-8). The CIE reviewers will serve a role that is equivalent to the other panelists, differing only in the fact that they are considered 'external' members (i.e., outside the PFMC's membership and not involved in management or assessment of west coast CPS, particularly sardine). The reviewers will serve at the behest of the Chair, adhering to all aspects of the PFMC's ToR as described in Annex 2. The Chair is responsible for: 1) developing an agenda; 2) ensuring that Panel members (including the Reviewers) and those being reviewed (the "proponents") follow the ToR; 3) participating in the review of the methods (along with the Reviewers); and 4) guiding the Panel (including the Reviewers), FRD, and NWSS to mutually agreeable solutions.

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

Contract Deliverables - Independent CIE Peer Review Reports: In addition to participating in the Panel, each CIE reviewer shall also complete an independent-review report in accordance with the SoW, i.e., in the required format as described in Annex 1; and addressing each ToR as described in Annex 2.

Other Tasks – Contribution to Summary Report: Reviewers will assist the Chair with contributions to the Summary Report. The Panel is not required to reach a consensus and, therefore, the reviewers should provide a brief summary of their views on the findings and conclusion reached by the Panel in accordance with the ToRs (format defined in Annex 1).

Specific Tasks for CIE Reviewer: 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) prepare for the review by thoroughly reading the documents provided by the Project Contact;
2) participate in the panel review meeting in La Jolla, CA during 3-5 February 2011 as indicated in the SoW, and conduct an independent review in accordance with the ToRs (Annex 2); and
3) write an independent-review report, addressed to the "Center for Independent Experts," and submit it to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu, no later than 17 March 2011 indicated in the SoW. The report shall be written using the format and content requirements specified in Annex 1, and address each ToR in Annex 2.

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

28 December 2011	The CIE sends the CIE reviewers' contact information to the COTR, who forwards it to the Project Contact.
10 January 2011	The Project Contact sends the pre-review documents to the CIE reviewers.
3-5 February 2011	The CIE reviewers participate in the Panel review meeting and conducts an independent review.
3 March 2011	The CIE reviewers submit their reports to the CIE Lead Coordinator and CIE Regional Coordinator for final review and revisions.
17 March 2011	The CIE submits independent peer review reports to the COTR for contractual compliance.
24March 2011	The COTR distributes the final reports to the Project Contact and the regional Center Director.

Modifications to the Statement of Work: Requests to modify this SoW must be made through the 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 ToR of the SoW as long as the role and ability of the Reviewer to complete the SoW deliverable in accordance with the ToRs and the deliverable schedule is 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 reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, the 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 email 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; and (3) the CIE report 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 email the final CIE reports in pdf format to the COTR. The COTR will distribute the approved CIE reports to the Project Coordinator, the regional Center Director, and the PFMC.

Key Personnel:

William Michaels, Program Manager, COTR
NMFS Office of Science and Technology
1315 East West Hwy, SSMC3, F/ST4, Silver Spring, MD 20910
William.Michaels@noaa.gov Phone: 301-713-2363 ext 136

Manoj Shivlani, CIE Lead Coordinator
Northern Taiga Ventures, Inc.
10600 SW 131st Court, Miami, FL 33186
shivlanim@bellsouth.net Phone: 305-383-4229

NMFS Project Contact:

Dr. Russ Vetter, Director, FRD,
National Marine Fisheries Service, Southwest Fisheries Science Center,
8604 La Jolla Shores Dr., La Jolla, CA 92037
Russ.Vetter@noaa.gov Phone: 858-546-7125

Dr. David Demer, FRD
National Marine Fisheries Service, Southwest Fisheries Science Center,
8604 La Jolla Shores Dr., La Jolla, CA 92037
David.Demer@noaa.gov Phone: 858-546-5603

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

1. The CIE report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations.

2. The main body of the Reviewer's report shall consist of the following sections, in accordance with the ToRs: Background, Description of the Reviewer's Role in the Review Activities, Summary of Findings for each ToR, and Recommendations and Conclusion.

   a. The Reviewer should describe in their own words the review activities completed during the panel meeting, including providing a detailed summary of findings, recommendations, and conclusion.

   b. The Reviewer should discuss their independent views on each ToR even if these were consistent with those of other panelists, and especially where they were divergent.

   c. The Reviewer should elaborate on any points raised in the Summary Report that might require clarification.

   d. The Reviewer shall provide a critique of the review process, including suggestions for improving both the process and products.

   e. The CIE report shall be a stand-alone document for others to understand the proceedings and findings of the meeting without having to read the Panel report. The report shall be an independent review of each ToR, and shall not simply repeat the contents of the Panel report.

3. The Reviewer's report shall include the following separate appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: The CIE Statement of Work
   Appendix 3: Panel Membership or other pertinent information from the review meeting.

Annex 2: Terms of reference (ToRs) for the peer review of the acoustic-trawl method for surveying Pacific sardine and other CPS

The CIE reviewers will participate in the panel-review meeting to conduct independent peer reviews of the acoustic-trawl method as it pertains to surveys of coastal pelagic fish species (CPS) in the California Current Ecosystem (CCE), principally Pacific sardine, but potentially also including jack mackerel, Pacific mackerel, and northern anchovy, depending on their biomasses and distributions, and the sampling effort afforded. The survey area is the CCE off the west coast of the United States of America (US), generally between the Mexico-US and the US-Canadian borders. The latitudinal and offshore extents of the surveys are seasonal, extending further north in the summer and further offshore in the spring. Survey estimates are to include absolute biomasses, and their total random sampling errors, and spatial distributions. The review solely concerns technical aspects of the survey design, method, analysis, and results, and addresses the following ToR:

ToR 1 – Review documents detailing acoustic-trawl survey and data analysis methods and results according to the PFMC's ToR for CPS Stock Assessment Methodology Reviews. Document the meeting discussions. Evaluate if the documented and presented information is sufficiently complete and represents the best scientific information available.

ToR 2 – Evaluate and provide recommendations on the survey method used to estimate the abundances and distributions of Pacific sardine and other CPS, and associated sources of uncertainty. Recommend alternative methods or modifications to the proposed methods, or both, during the Panel meeting. Recommendations and requests to FRD for additional or revised analyses during the Panel meeting must be clear, explicit, and in writing. Comment on the degree to which the survey results describe and quantify the distributions and abundances of CPS, in particular Pacific sardine, and the uncertainty in those estimates. Confidence intervals of survey estimates could affect management decisions, and should be considered in the report.

ToR 3 – Evaluate and provide recommendations for the application of these methods for their utility in stock assessment models and for their ability to monitor trends at the population level for Pacific sardine and other CPS. Survey methods or results that have a flawed technical basis, or are questionable on other grounds, should be identified so they may be excluded from the set upon which stock assessments and other management advice is to be developed.

ToR 4 – Evaluate the effectiveness of the survey methods for detecting the appropriate spatial scale and seasonal timing for annually estimating stock abundances.

ToR 5 – Decide through Panel discussions if the ToRs and goals of the peer review have been achieved. If agreement cannot be reached, or if any ToR cannot be accomplished for any reason, then the nature of the disagreement or the reason for not meeting all the ToR

must be described in the Summary and Reviewer's report. Describe the strengths and weaknesses of the review process and Panel recommendations.

The Reviewer’s report should be completed, at least in draft form, prior to the end of the meeting.

Annex 3: Participants and Agenda

Participants

Methodology Review Panel Members:
Martin Dorn, SSC, NMFS, Alaska Fisheries Science Center
François Gerlotto, Center for Independent Experts (CIE)
Olav Rune Godø, Center for Independent Experts (CIE)
André Punt (Chair), Scientific and Statistical Committee (SSC), Univ. of Washington
John Simmonds, Center for Independent Experts (CIE)

Pacific Fishery Management Council (Council) Representatives:
Kerry Griffin, Council Staff
Greg Krutzikowsky, Coastal Pelagic Species Management Team (CPSMT)
Mike Okoniewski, Coastal Pelagic Species Advisory Subpanel (CPSAS)

Acoustic-Trawl Survey Technical Team:
Kyle, A. Byers, NMFS, Southwest Fisheries Science Center
George R. Cutter, NMFS, Southwest Fisheries Science Center
David Demer, NMFS, Southwest Fisheries Science Center
Josiah Renfree, NMFS, Southwest Fisheries Science Center
Beverly J. Macewicz, NMFS, Southwest Fisheries Science Center
Juan P. Zwolinski, NMFS, Southwest Fisheries Science Center

THURSDAY, FEBRUARY 3, 2011 – 8:00 A.M.

A. Call to Order, Introductions, Approval of Agenda, and Appointment of Rapporteurs

B. Terms of Reference for the CPS Methodology Reviews
(8:30 a.m., 0.5 hour)

C. Presentation on the acoustic-trawl survey — David Demer
(9:00 a.m., 1.5 hours)

BREAK

C. Presentation on the acoustic-trawl survey (Continued) — David Demer
(11 a.m., 1 hour)

LUNCH

C. Presentation on the acoustic-trawl survey (Continued) — David Demer
(1 p.m., 1.5 hours)

D. Panel discussion — Panel
(2.30 p.m., 1 hour)

BREAK

E. Requests to FRD — Panel
(4.00 p.m., 1 hour)

FRIDAY, FEBRUARY 4, 2010 – 8:30 A.M.

F. Responses to Panel Requests (FRD) David Demer
(8.30 a.m., 2 hours)

BREAK

G. Panel discussion Panel
(11 p.m., 1 hour)

LUNCH

H. Requests to the FRD Panel
(1 p.m., 1 hour)

I. Report drafting Panel
(2.30pm, 1 hours)

BREAK

J. Responses to Panel Requests (FRD) David Demer
(4 p.m., 0.5 hours)

K. Requests to FRD Panel
(4.30 p.m., 0.5 hours)

SATURDAY, FEBRUARY 5, 2010 – 8:30 A.M.

K. Responses to Panel Requests (FRD) David Demer
(8.30 a.m., 1.5 hours)

BREAK

L. Report Drafting Panel
(11am , 1 hours)

LUNCH

M. Report review Panel
(1 p.m+)

Annex 4: Panel Summary Report (Template)

- Names and affiliations of Panel members

- List of analyses requested by the Panel, the rationale for each request, and a brief summary of the proponent's 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 Panel recommendations:
  - among Panel members; and
  - between the Panel and the proponents

- Unresolved problems and major uncertainties, e.g., any special issues that complicate survey estimates, estimates of their uncertainty, and their use in stock assessment models.

- Management, data, or fishery issues raised the public (i.e., non-Panel and proponent participants) at the Panel meetings.

- Prioritized recommendations for future research, and data collections and analyses.

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

Andre Punt (PFMC, Chair),	aepunt@u.washington.edu
Martin Dorn (AFSC),	Martin.Dorn@noaa.gov
François Gerlotto (CIE),	francois.gerlotto@ird.fr
Olav Rune Godø (CIE),	olav.rune.godoe@imr.no
John Simmonds (CIE),	ejsimmonds@googlemail.com
M. Okoniewski (CPSAS),	mokoniewski@pacseafood.com
G. Krutzikowsky (CPSMT),	Greg.Krutzikowsky@state.or.us
Kerry Griffin (PFMC),	Kerry.Griffin@noaa.gov
Mike Burner (PFMC),	Mike.Burner@noaa.gov
observers, and SWFC/FRD.	

Bill Michaels <William.Michaels@noaa.gov>,
Vetter Russ Russ.Vetter@noaa.gov