Review of The Collaborative Optically-assisted Acoustic Survey Technique (COAST) for Surveying Rockfishes

Center for Independent Experts (CIE) review prepared by

Dr. Stéphane Gauthier

March 2012

List of acronyms used throughout this document

ADZ:	Acoustic Dead Zone
CCA:	Cowcod Conservation Area
CIE:	Center for Independent Experts
COAST:	Collaborative Optically-assisted Acoustic Survey Technique
FRD:	Fisheries Resources Division
GAM:	Generalized Additive Model
NMFS:	National Marine Fisheries Service
NOAA:	National Oceanic and Atmospheric Administration
PFMC:	Pacific Fisheries Management Council
ROV:	Remotely Operated Vehicle
SAC:	Sportfishing Association of California
SCB:	Southern California Bight
SWFSC:	Southwest Fisheries Science Center
ToR:	Terms of Reference
TS:	Target Strength

Contents

Executive Summary

The Collaborative Optically-assisted Acoustic Survey Technique (COAST) was developed by the Fisheries Resource Division of the Southwest Fisheries Science Center to estimate the distribution and abundance of rockfish in the Southern California Bight (SCB). It is a methodology in which the data from fisheries acoustics survey are partitioned to species based on non-destructive optical samples obtained from an underwater platform (ROV), which also provides estimates of species length composition. The COAST methodology makes novel use of multifrequency acoustic data to estimate the acoustic dead zone near the ocean floor for each transmission and extract acoustic metrics for seabed classification. Some of the key points and recommendation relevant to the acoustic methodology are:

- To evaluate different approaches of correcting for the biomass of rockfish potentially residing in the acoustic dead zone. Some experiments (using the ROV) are also recommended to test assumptions of distribution in areas of high and low relief, as well as potentially high and low rockfish density habitats
- Continue research into species-specific target strength and test its effect on survey results.
- Provide better length composition estimates for all species using stereo-cameras systems.

The major point of contention of the COAST is the interpretation of the acoustic data from the optical samples, and the fact that it is based on proportions (which magnifies potential biases). Although this method is analogous to species partitioning based on trawl catches, the problem is exacerbated by the high species richness of rockfish in the SCB. To be valid this method must assume that the acoustic detectability of the various species is proportional to their availability to the optical sampling tool. Species-specific differences in vertical distribution, behavior, and responses to a moving platform close to the seafloor are likely to substantially challenge this assumption. This review suggests alternatives to address these issues and identifies areas where research should focus in order to provide more confidence in the biomass estimates derived from this method. Some of the key recommendations to address the optical sampling are:

- Allocate more efforts to the optical transects, and provide comparisons of species proportion in all strata.
- Define robust protocols for optical sampling, including direction (with limited deviations), speed, sampling across vertical environment, and proportional weighing of observations (based on altitude and tilt orientation).
- Use alternative methods (drop system, sonars, acoustic tags and pop-up archival tags) to gain more insight into the distribution and behavior of rockfish species.

Relevance of the method is likely to differ for various species of rockfish, as well as their spatial coverage, so emphasis on comparisons with other methods, as well as consultation with the wider expert community is encouraged. The COAST methodology shows a lot of promise for use in stock assessment, but I am using a cautionary approach here and encourage focus on research to address critical issues that could impair the biomass estimates obtained from these surveys.

Background

The Collaborative Optically-assisted Acoustic Survey Technique (COAST) was developed by the SWFSC's Fisheries Resources Division (FRD) for estimating the distributions and abundances of rockfishes in the Southern California Bight (SCB). The method basically makes use of non-destructive optical sampling (video and still images information obtained from an ROV) to partition acoustic survey results to fish species. An overview of the approach was provided as follows:

> *The COAST uses historical fishing maps or other habitat information to initially define survey areas; data from ship-based multi-frequency echosounders to map the acoustic backscatter from rockfishes in these areas; and video and still images from cameras deployed on a remotely operated vehicle (ROV) to quantify the proportions of species, and their size-distribution, in acoustically-detected mixed assemblages. The optical information is used to apportion the rockfish backscatter to species, calculate their length-dependent target strengths, and estimate and map their biomasses. The optical information could be obtained using other camera platforms, e.g., submarines or autonomous underwater vehicles. In 2003, 2004/5, and 2007/8, the FRD conducted COAST surveys, in collaboration with the Sportfishing Association of California (SAC), to estimate the distributions and abundances of rockfishes, by species, throughout the SCB.*

A review panel was convened at the Torrey Pines Laboratories of the NOAA NMFS Southwest Fisheries Science Center (SWFSC) in La Jolla, California from February 15 to February 17, 2012 to evaluate the methodology behind COAST. The review panel was composed of the following members:

Martin Dorn (chair), Scientific and Statistical Committee, Alaska Fisheries Science Center
André Punt, Scientific and Statistical Committee, University of Washington
Stéphane Gauthier, Center for Independent Experts
Luiz Mello, Center for Independent Experts
Gary Melvin, Center for Independent Experts

The task of the reviewers and panel was to evaluate the technical aspects of the survey design, method, analysis and results of the COAST methodology following specific Terms of References (ToR) listed in the following section of this document.

After a welcoming address and introduction to the COAST program by the SWFSC director Cisco Werner, the meeting started with detailed presentation by Kevin Stierhoff (SWFSC) on the background biology of rockfishes and the optical methods used during COAST surveys (ROV transects and data analyses). These were followed by presentations by David Demer (SWFSC) on the acoustics and overall survey design and implementation of COAST (as well as a collateral presentation on the sardine acoustic-trawl survey). Kyle Byers, Randy Cutter, and Juan Swolinski (all SWFSC) were also present as part of the COAST technical team. Another important member (John Butler, SWFSC) was unfortunately sick and could not attend the meeting.

Several analogies were made between the acoustic-optical technique used for rockfish and the acoustic-trawl technique more commonly used for pelagic or demersal species. The data extracted from the optical samples collected from the ROV are pretty much used the same way as trawl samples results to partition acoustic backscatter in "conventional" acoustic surveys. The main difference is that acoustic-trawl surveys typically deal with one or few species (ideally in mono-specific aggregations). Having such a diverse species assemblage of rockfish as the one encountered in the SCB is the biggest limitation/concern with the COAST and will be discussed in further details throughout this document.

This review has been organized to follow as close as possible each of the Terms of References (ToRs) established in the CIE Statement of Work. For each of these ToR I will discuss the relevant summary finding from the panel review as well as detailed aspects that I recognized or consider as being pertinent to the material.

During the review panel I was assigned the role of taking notes on the acoustic methods and analyses portion discussed throughout the meeting. By the nature of the survey design, this necessarily included discussions on the integration of the optical information into the acoustic analyses.

Terms of References (ToRs)

This review solely concerns technical aspects of the survey design, method, analysis, and results of the COAST and focus on the Terms of References as expressed in the CIE Statement of Work (appendix 2). Each Term of Reference (ToR) will be addressed and related to the discussions held during the review panel meeting.

ToR 1

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

The panel members were presented with four main documents: a paper summarizing the COAST, and three edited survey reports, one for each of the COAST survey in 2003, 2004, and 2007. In addition to these central documents, many background papers (peer-reviewed journal articles) were provided to support analytical methods used for the COAST, as well as a number of stock assessment reports and related documentation. As a reviewer I was impressed with the amount of work and efforts that were put into the COAST and felt that the documentation provided was adequate and of high quality. A few aspects of the methodology were not clear or detailed enough in the main documents, and these were addressed through clarifications made to the panel or responses to official panel requests (list provided in appendix 3).

I will discuss the aspects of the COAST in the same order as they were approached by the review panel, starting with the acoustic methodology, then discussing the optical method, and finally addressing how these were integrated together, along with a critical view of the overall survey approach and design.

Acoustics

The Collaborative Optically-assisted Acoustic Survey Technique (COAST) makes novel use of multifrequency conventional fisheries echosounders to extract a wealth of information on the backscattering environment. Through new and robust methodologies, such as multifrequency biplanar interferometric imaging and statistical-spectral method for echo-classification, the COAST has gathered an impressive data set over the Southern California Bight (SCB). These methods enabled the estimation of the Acoustic Dead Zone (ADZ) for every transmission (a novel and very useful asset), as well as seabed classification to identify potential rockfish habitats. Gathering this information over the full range of rockfish sites in the SCB was an ambitious project.

One limitation of acoustics is the lack of resolution near complex boundaries. The Acoustic Dead Zone (ADZ) near the ocean floor can be large in areas of high relief, and is certainly a source of error to consider for species that have a strong association with the seabed (Rooper *et al*. 2010). The COAST can evaluate the height of the ADZ for each acoustic transmission, providing a detailed estimate of the volume not properly sampled by the sounders. It was however not clear to the Panel what proportion of the survey area (especially in those with high rockfish densities) had significant acoustic dead zone heights, and what potential bias this could have on the estimation of rockfish biomass. Acoustic transmissions in which the ADZ was estimated to be more than 3 m were excluded from the COAST analyses. This assumes that the densities of fish in the areas of high ADZ height are the same as the ones with low ADZ heights; an assumption that may not necessarily be valid. A better understanding of the proportion of the total area with high ADZ heights was requested by the Panel. Response to the panel indicated that the bulk of the surveyed area (for one site) had ADZ height less than 3 m (appendix 3). This suggests that areas of very high ADZ are relatively small, and that bias due to the above assumption is likely to be small.

To date, no correction or extrapolation to account for the proportion of fish potentially residing in the ADZ has been implemented. A request was therefore also made to investigate what proportion of the biomass potentially reside in the ADZ, using in the first order the assumption that fish density in the ADZ is the same as in the 1 m just above it. Preliminary results suggest that up to 15% of the biomass may be in the ADZ (appendix 4), so corrections or extrapolations for this un-surveyed volume may be significant and should be explored in further details. Discussions on the ADZ also raised the issue of acoustic detectability. If certain species are thought to always reside within the ADZ (when undisturbed by the ROV) should they be excluded when total acoustic biomass is assigned to species? The answer to this question is yes, but the challenge remains in identifying such species. Although the technical team had compiled a table to address this issue (provisionally excluding six species of rockfish from the analyses), it was apparent to me that larger bodies of evidence than those referenced were available to address this in finer detail.

The issue of which species to include/exclude from the acoustic analysis does not only pertain to fish vertical distribution within the ADZ and association to the seafloor, but also to potential species segregation within the upper water column. For example, ocean whitefish (*Caulolatilus princeps*) can be found on top of seamounts in what appears to be mono-specific aggregations. These aggregations often appear higher in the water column than rockfish echoes. If the backscatter from these "pelagic" species can be isolated and excluded from the backscatter of rockfish it may reduce some biases, particularly if such species are likely to have different availability (or detectability) to the optical platform used to apportion species (see optical section below for more details). I think this is a topic that deserves more attention, and again where information from the expert community could be further beneficial.

Another important source of error or bias in acoustic surveys is the target strength (TS) of the animals being insonified. If the relationship of animal size to target strength is wrong, then the estimates of biomass derived from these will also be erroneous. Relatively small changes in TS can lead to large errors in biomass estimates. This effect will be amplified in the case of multi-species assemblage with varying species proportions. Furthermore if the slope of the TS to length relationship differs significantly from its true form, the errors can vary within species depending on fish size. For these reasons it is always preferable to have accurate information on the target strength for each species being considered in an acoustic survey. This is not always feasible, and it is widely accepted that the target strength of individual fish will inherently be highly variable (Horne 2008). Currently, COAST is using one TS to length model for all rockfish species in the SCB (Kang and Hwang 2003). This model was developed based on *ex situ* (cage) experiments on one species of rockfish, the Korean rockfish (*Sebastes schlegeli*), which is not even present in the SCB. The COAST team presented preliminary results on TS measurements of four local rockfish species (bocaccio, vermillion, speckled, and squarespot) that supported the use of the current model. However, the sample size for some of these species were very small (particularly for speckled and squarespot rockfish). Other models on *Sebastes* are suggesting a lower target strength than the one currently used (Gauthier and Rose, 2001, 2002), albeit these values were obtained from measurements on Atlantic species.

More work needs to be done on the target strength of rockfish and associated species in the SCB. Efforts should be directed not only at species of high economic importance (e.g. bocaccio) but also on species that are numerically abundant at the surveyed sites (such as squarespot rockfish), since the method rely on species relative proportions against total backscatter, which will amplify errors. In the interim, it could be wise to model (through bootstraps or Monte Carlo simulations) the potential effect of varying target strength models/values for the main species, as target strength is likely an important source of uncertainty when calculating biomasses.

Optical information

Video and still images from an ROV have been used to identify and count species to apportion the acoustic data. The key question here is whether the optical samples are accurate representations of the backscatter being recorded in the absence of an ROV. Because behavior is species-specific and depends on a wide range of factors, the potential for bias is huge.

Backscatter of rockfish has been observed up to 20-30 m (or more) above the bottom, yet the ROV samples were taken mostly at an altitude of a few meters, with the cameras predominantly looking towards the seabed. The COAST technical team has argued that under the presence of an ROV, rockfish tend to dive and compress towards the bottom. An example of this has been presented to the Panel, but this information has not been quantitatively analyzed or put together in a comprehensive synthesis. This type of behavior is likely to differ between species and should be investigated in greater details to determine the availability of rockfish to such optical sampling. Also, it is not known whether rockfish species are distributed randomly within this ROV compression zone, or if there will be vertical structure in species composition near the bottom. To this effect, it was not clear to the panel how the raw optical data were exactly used to estimate species proportion, and if these observations were stratified or weighed by altitude. The technical team explained how visually unidentified species were categorized and assigned to closest identified species or otherwise allocated proportionally to total counts, and that total counts for a transect were simply added together to calculate species proportions (appendix 3). Acoustic information was used to allocate ROV efforts if necessary (e.g. to look up once in a while when there was backscatter observed higher in the water column), but no weighing for the volume sampled at different altitude and orientation was done. I think that survey efforts should be distributed more evenly across ROV altitudes and tilt orientations, and that the observations should be weighted accordingly to account for any vertical species partitioning. The technique could benefit from a more regimented approach to ROV sampling as opposed to what sometimes appear as ad hoc observations. The data could be looked at in closer detail and stratified based on effort (e.g. tilt angle) to test if the assumption of random vertical distribution is valid. Since the operator can control the tilt of the ROV (and tilt information is being logged), all of this is feasible.

Another important aspect to consider is the reaction of fish to a moving platform (ROV) when they are close(r) to the bottom. Differential reaction to the platform can induce a significant bias in fish counts. The technical team had identified three major categories of rockfish reactions to the ROV. They: 1) remain stationary (act ready to "fight"); 2) flee (take "flight"); or 3) take cover (get "out of sight"). I would argue that there is a fourth category (attraction), which is harder to quantify or observe. If some species are attracted to and follow the ROV, they may go in and out of the camera field of view, and this can potentially lead to "double-count" effects. Distance of the reaction to the ROV may also differ by species: if a particular species flees the ROV path well before it is in the field of view of the cameras, it will simply never be included in species apportionment. Some participants at the panel meeting seem to believe this could be the case with chilipepper rockfish (*Sebastes goodei*), which they argued should be more predominant in the COAST survey results. All these issues are notoriously difficult to quantify (especially considering the species richness in the SCB), but are nonetheless real, and efforts should be directed at better understanding these potential sources of bias. Some recommendations on how to do this will be discussed in the following section (ToR 2).

The optical data were also used to estimate the length composition of the different species of rockfish surveyed. To date, this has been done using two pairs of stereo-lasers mounted on the ROV. Good data on length composition are required for the estimation of target strength, and also for use in stock assessment models. Precise measurements using lasers is difficult, and require the fish to be perpendicular to the field of view, as well as relatively close to the laser end points. Using this technique will yield relatively low numbers of precise measurements, which is not ideal. A greater number of coarse measurements (with fish categorized in size bins) is obtained and fitted to Gaussian distribution. This approach is acceptable but better detail on length composition is needed, especially if this method is ever used for stock assessment purposes. Ideally, photogrammetry using a pair of parallel cameras should be used. Once properly calibrated, such system can be used to yield relatively large numbers of measurement with minimal operational efforts (Bower *et al*. 2011).

Data integration and survey design

The sites for the COAST surveys were selected in collaboration with the Sportfishing Association of California (SAC), based on historical fishing efforts and collective knowledge of the fishing fleet. Although this is probably a comprehensive assessment for some key species, it may not necessarily reflect all potential habitats for relevant rockfish species in the SCB. Sites that have been depleted or that may be slowly recovering may have been ignored or inadvertently missed by the fleet. Some sites may also have high densities of rockfish species that are currently of no interest to fishers. If the COAST intention is to provide absolute biomass for rockfish in the SCB, this will need to be explored in further detail, by convening with the expert community.

Each survey site was post-stratified into shallow (≤ 150 m) and deep (>150 m) areas. These were further stratified into potentially high rockfish density habitat and low rockfish density habitat using a Generalized Additive Model based on rockfish backscatter and seabed classification derived from the acoustic metrics. For each of these four strata, rockfish density where averaged over all sites and scaled to their relative area to obtain biomass. I don't see any problems with this analytical approach, but I do believe further stratification is warranted, especially when considering the density (and assemblages) of rockfish inside and outside the Cowcod Conservation Areas (CCAs). Calculating biomass on a site basis (as opposed to collective strata) may also provide interesting inter-site comparisons within these general areas. Alternative variance estimation based on different stratification scenarios should be explored.

The acoustic data were allocated to species based on the nearest optical sample available within a site (seamount). When an optical sample was not available at the same time (survey) as the acoustic data collection, an optical sample from the same site but taken on a different survey was used. In cases where this was not available, the closest sample (geographically and in time) was used, and sometimes an optical sample neither at the same site or survey was used. The priority order for allocation of sample was thus:

1: same site, same survey (ideal situation)
2: same site, different survey
3: different site, same survey
4: different site, different survey

This was of concern to the panel, as ideally acoustic data should always be related to acoustic samples taken at the same site during the same survey. Site is given priority over survey time because of the expected high site fidelity of rockfish, but this violates the assumption that each survey is independent from one another. A request was made to tabulate the frequency of these allocation scenarios from all the surveys. It turns out that most of the samples were collected during the same time (appendix 3), but this issue identifies the need to increase the optical survey efforts. Furthermore, it would be useful to test whether species composition in areas of potentially high rockfish density habitats are the same as those in potentially low rockfish density areas. This could be done by post-stratifying the optical transect based on the acoustic analysis and ensuing GAM.

ToR 2

Evaluate and provide recommendations on the survey method used to estimate the abundances and distributions of bocaccio, cowcod, vermillion/sunset, bank and other rockfishes in the SCB, 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 rockfishes, and the uncertainty in those estimates. Confidence intervals of survey estimates could affect management decisions, and should be considered in the report.

The evaluation of the method was largely addressed under ToR 1; so to avoid redundancy, I will re-iterate (in simple bullet form) the main technical problems I have identified and provide list of recommendations to address these issues. I will finally address more general issues pertaining to the survey approach and confidence intervals in biomass estimates. A draft of the official panel requests made to the technical team during the meeting, as well as their responses, is provided in appendix 3.

Problem: Some species should be excluded from the COAST analyses.

Recommendations:

- Explore the acoustic data to examine if potential vertical segregation and different avoidance reactions to ROV warrant the exclusion of a species (e.g. ocean whitefish).
- Convene with the expert community to gather further evidence on the habitat preference and behavior of all species.
- Use some of the experiments described below (see reaction to optical platform) to gather further information on species that could potentially be excluded.
- Explore different sets of rules to exclude species from the analyses and evaluate how this would impact overall survey results.

Problem: The Acoustic Dead Zone (ADZ) near the seafloor is a potential source of error when estimating rockfish biomass.

Recommendations:

- Explore different extrapolation techniques to correct for the ADZ. Use information on rockfish vertical distribution (from other observation platform, and/or from areas of low ADZ height) to decide on the form of the extrapolation curve.

- Use the ROV to test the assumption that species proportion and distribution in areas of high ADZ height is the same as those with low ADZ heights.

Problem: The Target Strength (TS) of various rockfish species is likely to differ.

Recommendations:

- Continue field work, experiments, and modeling on the estimation of species-specific TS, focus on both economically important species and numerically abundant species.
- Model the effect of varying TS models on species proportion using simulation models (e.g. through bootstraps).

Problem: The vertical distribution of fish during the optical sampling may not be random.

Recommendations:

- Document, analyze, and quantify the compression effect of the ROV on the different rockfish assemblages.
- Allocate the efforts of the ROV more evenly across altitudes and orientation within the water column. Define robust protocols to follow during optical transects.
- Weight the observation made based on altitude and orientation of the ROV to get a more representative mean proportion. This will require more accurate estimates of the volume sampled by the camera under varying conditions (e.g. looking up *vs* looking down).
- Use alternative sampling methods such as landers with various observation devices (camera, DIDSON), drop camera systems, hook and line experiments, and acoustic and/or archival pop-up tagging experiments to gain more insight on the vertical distribution and behavior of various rockfish species.

Problem: Species reaction to the optical platform may bias the observation.

Recommendations:

- Analyze species distribution across the camera's horizontal field of view. Species always on the edge of the field of view, or always recorded fleeing should be flagged as being under-estimated.
- Design experiments with multi-beam sonars and/or DIDSON systems to evaluate the reaction of fish as the ROV is passing through.
- Try to quantify the potential for species attraction to the ROV (e.g. by performing 180° rotations to observe if fish are following). Establish ROV transect protocols that would minimize potential double-count bias (surveying in straight-line with minimal deviation and constant speed).

Problem: Information on the length composition of the various rockfish species is imprecise.

Recommendations:

- Use photogrammetry with stereo cameras to obtain accurate measurement on a larger number of individuals.

<u>Problem</u>: Optical data may be insufficient to properly partition species to backscatter.

<u>Recommendations</u>:

- Allocate more effort to the optical sampling (at the potential cost of having less acoustic coverage).
- Post-stratify optical transects into potentially high and low rockfish density habitats based on the acoustics. If species proportions are comparable, this will provide grounds for combined survey strategies.
- Compare species composition across sites, strata, and surveys to establish more robust protocols of sample allocation when acoustic and optical transects are not available for the same site/strata on the same survey.

Another important question with the COAST is to determine for which species it can provide absolute and relative indices of biomass. The COAST survey results should be compared to all other available source of data (e.g. trawl survey, hook and line survey). This may provide valuable insight on species that can be missed or under-sampled by COAST, as well as species that have ranges outside of the areas covered by COAST. Another interesting comparison would be to use the optical samples as independent estimates of biomass, which would eliminate the potential bias associated to proportion allocation. Such an experiment could be conducted on a limited number of sites where optical sampling efforts could be significantly increased to allow for more statistical power.

Currently, COAST is treating each (stratified) site as independent samples (a site is analogous to a single transect in a conventional acoustic survey). In principle this is an acceptable approach. However, site-specific estimates of biomass could provide more analytical power (e.g. between-site comparisons based on various factors) and would require a different approach to partition variance. This could be done by gridding or partitioning the acoustic efforts at each site to minimize auto-correlation and characterize random sampling error. Most of the variance estimation issues can be addressed in post-processing.

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 multiple rockfish species. 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.

The COAST could provide reliable estimates of biomass for use in stock assessment provided that the estimations of species proportion from optical samples are unbiased (or have quantifiable biases). This is still debatable, and more work on the topic should be conducted as per the recommendations made under ToR 2. I favor a precautionary approach, where efforts should focus on background research and assumption testing before such method is used in stock assessments. The method is also likely to provide varying degrees of precisions for different species of rockfish, depending partly on their behavior (and detectability) as well as range distribution. Preliminary results suggest high level of site fidelity in the SCB sites, and the method would certainly monitor trends for the main species responsible for the acoustic backscatter. However, the COAST team should evaluate the power of the method to detect changes in the abundance of species that are less abundant and of concern for the council, such as Cowcod (*Sebastes levis*).

ToR 4

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

COAST surveys were conducted in 2003, 2004 and 2007. So far, complete biomass estimates for the entire SCB are not available. At the time of the meeting, 21 out of 44 sites had been analyzed. The coverage of COAST is meant to be exhaustive, and should provide enough spatial resolution, especially at the site-level. The temporal aspect of COAST has not been under scrutiny and at this point it is difficult to say if this could be an issue. More work on site fidelity (through acoustic data analyses, tagging experiment, etc.) should help in identifying potential issue with survey timing.

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.

During the panel review meeting, there was a strong agreement between the panel members in identifying areas of uncertainty and potential problems with the COAST methodology. I feel that the ToRs and goals of the peer review have been successfully achieved. COAST is still in its infancy, having conducted a pilot survey in 2003, and full surveys of the Southern California Bight (SCB) in 2004 and 2007. Estimates of biomass for the entire SCB were not available at the time of the panel review. Therefore our ability to comment on survey results has been limited, but since the focus of the review has been on methodological aspects I do not feel this was a major impairment.

Summary of findings, recommendations, and conclusion

The Collaborative Optically-assisted Acoustic Survey Technique (COAST) is a novel methodology to assess the distribution and abundance of rockfish species from acoustic survey results partitioned to species based on non-destructive optical sampling. The principle challenge of this methodology is in accurately estimating species proportion from the optical platform in a way that is representative of the acoustic backscatter being measured. This challenge is confounded by the high diversity of rockfish present in the Southern California Bight. For this method to be valid, we have to assume that the acoustic detectability of a species is proportional to its availability to optical sampling. This basic assumption incorporates a plethora of considerations that have not necessarily been properly addressed to date. These include the vertical distribution of rockfish species (both undisturbed and within the ROV compression zone) and their relative reaction to a moving optical platform near the bottom. These are the areas into which the COAST team should focus their research before the method can be used in stock assessment with any significant level of confidence. I realize that measuring with accuracy the vertical distribution and behavioral responses of all species in the SCB is a titanic, if not impossible, task. Those issues are however very real, and a better understanding of the potential biases for the most abundant species and those of concerns to the PFMC are paramount to the success of such survey. I provided a list of recommendations for many of these issues under the ToR 2 section.

Review Process

The review process was satisfactory. The technical team was collaborative and answered all of the questions raised from the review panel members. The process could potentially be improved by having a preliminary round of questions/requests provided to the panel members shortly before the meeting (e.g. one week in advance). This would allow for detailed clarifications and further analyses to address pertinent issues. This approach could provide panel members with additional relevant material, and further evidence to support some of the claims made during the meeting. The main weakness of this review process is thus the short time frame available for clarifications and requests (must be done on a day-to-day basis). This is particularly limiting for a program such as COAST, a highly technical approach still in its preliminary phase. Other than this minor recommendation, I was very pleased with the review process and appreciated the professionalism expressed by all participants.

Additional References Cited

Bower, M.R., Gaines, D. B., Wilson, K.P., Wullschleger, J.G., Dzul, M.C., Quist, M.C. and Dinsmore, S.J. 2011. Accuracy and Precision of Visual Estimates and Photogrammetric Measurements of the Length of a Small-bodied Fish. North American Journal of Fisheries Management, 31: 1, 138-143.

Kang, D., and Hwang, D. 2003. *Ex situ* target strength of rockfish (*Sebastes schlegeli*) and red sea bream (*Pagrus major*) in the Northwest Pacific. *ICES Journal of Marine Science* 60: 538-543.

Gauthier, S. and Rose, G.A. 2002. *In situ* target strength studies on Atlantic redfish (*Sebastes* spp.). *ICES Journal of Marine Science* 59: 805-815.

Gauthier, S. and Rose, G.A. 2001. Target strength of encaged Atlantic redfish (*Sebastes* spp.). *ICES Journal of Marine Science* 58: 562-568.

Horne, J.K. 2008. Acoustic ontogeny of teleost fish. Journal of Fish Biology 73: 1444-1463.

Rooper, C.N., Hoff, J.N. and De Robertis, A. 2010. Assessing habitat utilization and rockfish (*Sebastes* spp.) on an isolated rocky ridge using acoustics and stereo image analysis. Canadian Journal of Fisheries and aquatic Sciences 67: 1658-1670.

Appendix 1: Bibliography of materials provided for review

Documents prepared for the meeting

Demer, D.A., Zwolinski, J.P., Cutter, G.R., Byers., Jr. K.A., Stierhoff, K.L., Murfin, D., Renfree, J.S., Mau, S., Sessions, T.S., Franke, K., and Butler, J.L. 2012. The Collaborative Optical-Acoustic Survey Technique (COAST) for estimating the abundances and distributions of rockfishes, and mapping their seabed habitats.

Demer, D.A. (Ed.) 2003 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique. COAST03.

Demer D.A. (Ed.) 2004 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique COAST04.

Demer, D.A. (Ed.) 2007 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique COAST07.

Background documents provided to support/complement the methods

Conti, S.G., Demer, D.A., Soule, M.A., and Conti, J.H.E. 2005. An improved muliple-frequency method for measuring in situ target strengths. ICES Journal of Marine Science 62: 1636-1646.

Cutter, G.R. and Demer, D.A. 2009. Multifrequency Biplanar Interferometric Imaging. IEEE Geoscience and Remote Sensing Letters 7: 171-175.

Demer, D.A. 2004. An estimate of error for the CCAMLR 2000 survey estimate of krill biomass. Deep-Sea Research II 51: 1237-1251.

Demer, D.A., Conti, S.G., De Rosny J., and Roux, P. 2003. Absolute measurement of total target strength from reverberation in a cavity. Journal of the Acoustical Society of America 113: 1387-1394.

Demer, D.A., Cutter, G.R., Renfree, J.S., and Butler, J.L. 2009. A statistical-spectral method for echo classification. ICES Journal of Marine Science 66: 1081-1090.

Demer, D.A., Soule, M.A. and Hewitt, R.P. 1999. A multiple-frequency method for potentially improving the accuracy and precision of ins itu target strength measurements. Journal of the Acoustical Society of America 105: 2359-2376.

Demer, D.A. Zwolinski, J.P., Byers, K.A., Cutter, G.R., Renfree, J.S., Sessions, T.S., and Macewicz, B.J. 2012. Prediction and confirmation of seasonal migration of Pacific sardine (*Sardinops sagax*) in the California Current Ecosystem. Fisheries Bulletin 110: 52-70.

Širović, A. and Demer, D.A. 2009. Sounds of captive rockfishes. Copeia 3: 502-509.

Širović, A., Cutter, G.R., Butler, J.L., and Demere, D.A. 2009. Rockfish sounds and their potential use for population monitoring in the Southern California Bight. ICES Journal of Marine Science 66: 981-990.

Zwolinski, J.P., Emmett, R.L., and Demer, D.A. 2011. Predicting habitat to optimize sampling of Pacific sardine (*Sardinops sagax*). ICES Journal of Marine Science 68: 867-879.

Zwolinski, J.P., Demer, D.A., Byers, K.A., Cutter, G.R., Renfree, J.S., Sessions, T.S., and Macewicz, B.J. 2012. Distributions and abundances of Pacific sardine (*Sardinops sagax*) and other pelagic fishes in the California Current Ecosystem during spring 2006, 2008, and 2010, estimated from acoustic-trawl surveys. Fisheries Bulletin 110: 110-122.

Stock assessment reports and related documents provided as background information

Dick, E.J., Ralston, S., Pearson, D., and Wiedenmann, J. 2009. Updated status of Cowcod, *Sebastes levis*, in the Southern California Bight. NMFS Southwest Fisheries Science Center.
Dorn, M. (Ed). 2005. Cowcod Star Panel Report, NMFS Southwest Regional Office.
Field, J.C., Dick, E.J., Pearson, D., and MacCall, A.D. 2009. Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterrey, and Eureka INPFC areas for 2009. NMFS Southwest Fisheries Science Center.
Gertseva, V.V., Cope, J.M., and Pearson, D.E. 2009. Status of the U.S. splitnose rockfish (*Sebastes diploproa*) resources in 2009. NMFS Nortwest Fisheries Science Center.
Harms, J.H., Wallace, J.R., and Stewart, I.J. Analysis of fisheries-independent hook and line-based for use in stock assessment of bocaccio rockfish (*Sebastes paucispinis*). Fisheries Research 106: 298-309.
Helser, T.E. 2005. Stock assessment of the blackgill rockfish (*Sebastes melanostomus*) off the West coast of the united States in 2005. NMFS Nortwest Fisheries Science Center.
MacCal, A.D. 2005. Assessment of Vermillion rockfish in Southern and Northern California. NMFS Southwest Fisheries Science Center.
Piner, K., Dick, E.J., and Field J. 2005. 2005 Stock status of Cowcod in the Southern California Bight and future prospect. NMFS Southwest Fisheries Science Center.
Ralston, S. and MacFarlane, B.R. 2010. Population estimation of bocaccio (*Sebastes paucispinis*) based on larval production. Canadian Journal of Fisheries and Aquatic Science 67: 10005-1020.
Stauffer, G. (compiler). 2004. NOAA protocols for groundfish bottom trawl survey of the Nation's fishery resources. NOAA Technical Memorandum NMFS-SPO-65.
Stewart, I.J., Wallace, J.R. and McGilliard, C. 2009. Status of the U.S. yelloweye rockfish in 2009. NMFS Nortwest Fisheries Science Center.

Appendix 2: CIE Statement of Work

Statement of Work for Dr. Stéphane Gauthier

External Independent Peer Review by the Center for Independent Experts

Panel Review of the
Collaborative Optical–Acoustic Survey Technique (COAST)
for Surveying Rockfishes

15-17 February 2012

Scope of Work and CIE Process: The National Marine Fisheries Service (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. The CIE reviewers are selected by the CIE Steering Committee and the CIE Coordination Team to conduct the independent peer review of the 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 NMFS project. Further information on the CIE process can be obtained from www.ciereviews.org.

Project Description: Three CIE reviewers will serve on a five-person Panel to evaluate the Collaborative Optical–Acoustic Survey Technique (COAST), developed by SWFSC's Fisheries Resources Division (FRD) for estimating the distributions and abundances of rockfishes in the Southern California Bight (SCB). However, the method could be used to survey other demersal fishes in other areas. The COAST uses historical fishing maps or other habitat information to initially define survey areas; data from ship-based multi-frequency echosounders to map the acoustic backscatter from rockfishes in these areas; and video and still images from cameras deployed on a remotely operated vehicle (ROV) to quantify the proportions of species, and their size-distribution, in acoustically-detected mixed assemblages. The optical information is used to apportion the rockfish backscatter to species, calculate their length-dependent target strengths, and estimate and map their biomasses. The optical information could be obtained using other camera platforms, e.g., submarines or autonomous underwater vehicles.

In 2003, 2004/5, and 2007/8, the FRD conducted COAST surveys, in collaboration with the Sportfishing Association of California (SAC), to estimate the distributions and abundances of rockfishes, by species, throughout the SCB. The information from these and future surveys may be used to: improve assessments of multiple rockfish species; investigate the relationships between rockfishes and environmental factors, e.g., temperature, salinity, oxygen concentration, and depth; and scientifically evaluate the effectiveness of the Cowcod Conservation Area (CCA) and other management strategies. The Panel report will be used to guide improvements to the COAST survey and analysis methods, the resulting time series of estimated rockfish abundances and distributions, and estimates of their uncertainty. The Panel report will be considered by assessment analysts, but Stock Assessment Review (STAR) Panels will review the assessment models.

The Pacific Fisheries Management Council's (PFMC's) ToRs for the Panel review are attached in **Annex 2**. The tentative agenda of the Panel review meeting is attached in **Annex 3**. A Panel Summary Report Template is attached as **Annex 4**.

Requirements for CIE Reviewers: Three CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. The CIE reviewers shall collectively have the working knowledge and recent experience in the application of fisheries acoustic and optical sampling methods; survey design; and stock assessment. The duties of each CIE reviewer 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 referees during the panel review meeting at NOAA Fisheries, Southwest Fisheries Science Center, 3333 North Torrey Pines Court, La Jolla, California, 92037-1023, during 15-17 February 2012 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.

<u>Prior to the Peer Review</u>: Following selections of CIE reviewers by the CIE Steering committee, the CIE shall provide the reviewers' information (names, affiliations, and contact details) to the COTR, who will forward this information to the NMFS Project Contact (PC) no later the date specified in the Schedule of Milestones and Deliverables. The CIE is responsible for providing the SoW and ToRs to the Reviewers. The NMFS project contact is responsible for providing the Reviewers 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 STAR Panel Chair (Chair) with 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 a CIE reviewer who is a non-US citizen participates in a meeting at a government facility, the NMFS project contact is responsible for obtaining a Foreign National Security Clearance for that reviewer. For the purpose of their security clearances, the reviewer shall provide requested information (e.g., name, contact information,

birth date, 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 NMFS project contact will electronically send to the reviewers, by email or FTP, all necessary background information and reports for the panel review. If the documents must be mailed, the project contact will consult with the CIE on where to send the documents. The reviewers shall read all documents in preparation for the panel review, for example:

- documents on current survey methods, in particular, related to ichthyoplankton and hook-and-line sampling of rockfishes, and landings data;
- documents on SWFSC COAST surveys conducted since 2003;
- documents from past panel reviews of rockfish sampling methods;
- documents from STAR panel reviews of rockfish assessments, and;
- other documents, including the ToR, SoW, agenda, schedule of milestones, deliverables, logistical considerations, and PFMC's ToR for Groundfish Stock Assessment Methods Reviews.

Each CIE reviewer is responsible only for the pre-review documents that are delivered to that 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 conduct the 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 reviewers and Chair are described in **Annex 2** (see p. 6-8). Each reviewer will serve a role that is equivalent to the other panelists, differing only in the fact that he/she is considered an "external" member (i.e., outside the PFMC's membership and not involved in management or assessment of west coast rockfishes). Each reviewer 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 FRD follow the ToR; 3) participating in the review of the methods (along with the reviewers); and 4) guiding the Panel (including the reviewers) and FRD to mutually agreeable solutions.

The NMFS 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: Each CIE reviewer shall complete an independent CIE-review report in accordance with the SoW, i.e., in the required format as described in **Annex 4**, and addressing each ToR as described in **Annex 2**.

Other Tasks – Contribution to Summary Report: The reviewers will assist the Chair with contributions to the Summary Report. The CIE reviewers are not required to reach a consensus, and should provide a brief summary of their views on the findings and conclusion reached by the review panel in accordance with the ToRs (**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 panel review by reading the background material and reports provided by the NMFS Project Contact in advance of the peer review.
2) Participate in the panel review meeting in La Jolla, California during the dates specified in the schedule of milestones and deliverables herein.
3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) Submit, no later than 3 March 2012, an independent peer review report addressed to the "Center for Independent Experts," to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and to Dr. David Die, CIE Regional Coordinator, via email to ddie@rsmas.miami.edu. Each CIE reviewer shall write their report 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.

January 20, 2012	The CIE sends the Reviewer's contact information to the COTR, who forwards it to the NMFS Project Contact.
Feb 1, 2012	The NMFS Project Contact sends the pre-review documents to each reviewer.
Feb 15-17, 2012	Each Reviewer participates in the panel meeting and conducts an independent review.
March 3, 2012	Each CIE reviewer submits their draft report to the CIE Lead Coordinator and CIE Regional Coordinator.
March 17, 2012	Following any necessary revisions and approval by the CIE Steering Committee, the CIE submits the CIE reports to the COTR.
March 24, 2012	The COTR distributes the final reports to the NMFS 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 each 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, they 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. Each CIE report shall: (1) have the format and content in accordance with Annex 1; (2) address each ToR as specified in Annex 2; and (3) 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 PC, and the regional Center Director.

Support 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

Key Personnel:

Dr. David Demer, FRD (**Project Contact**)
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

Dr. John Butler, FRD
National Marine Fisheries Service, Southwest Fisheries Science Center
8604 La Jolla Shores Dr., La Jolla, CA 92037
John.Butler@noaa.gov Phone: 858-546-7149

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

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. Each 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. Each 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. Each reviewer should elaborate on any points raised in the Summary Report that might require clarification.

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

   e. Each 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. Each 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 for the Peer Review of the COAST for surveying Rockfishes

The reviewers will participate in the Panel-review meeting to conduct independent peer reviews of the COAST as it pertains to surveys of rockfishes off the west coast of the United States of America (US), principally bocaccio, cowcod, vermillion/sunset, and bank rockfishes in the SCB. The principal survey area is between the Mexico-US border and Point Conception. 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 COAST survey and data analysis methods and results according to the PFMC's ToR for Stock Assessment Methods 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 bocaccio, cowcod, vermillion/sunset, bank and other rockfishes in the SCB, 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 rockfishes, 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 multiple rockfish species. 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.

Annex 3: Tentative Agenda

Panel Review of
The Collaborative Optical–Acoustic Survey Technique (COAST)
for Surveying Rockfishes

15-17 February 2012

Panel Review of The Collaborative Optical–Acoustic Survey Technique (COAST) for Surveying Rockfishes

Day 1

0.0 Orientation (Dorn/DeVore) (1/2 hr)
1.0 Overview of rockfish biology, habitat, behavior (Butler) (1 /2 hr)
2.0 Overview of rockfish sampling, assessment, and management (Butler) (1/2 hr)
3.0 Overview of optical surveys for (Butler) (1 1/2hr)
  3.1 Optical sampling devices and platforms
    3.1.1 Video, still, stereo, high-definition cameras
    3.1.2 Divers, submarines, AUVs, and ROVs
  3.2 Sampling, classifying, and mapping seabed habitats of rockfishes
  3.3 Estimating species mixtures and their sizes
  3.4 Estimating biomasses and distributions of rockfishes, by species
  3.5 Estimating systematic and random measurement and sampling errors
  3.6 Summary of the advantages and limitations of optical sampling methods
4.0 Overview of acoustic-trawl surveys for estimating the abundances, distributions, and demographics of epi-pelagic fishes, and classifying and mapping their oceanographic habitat (Demer) (1/2 hr)
  4.1 Acoustic sampling devices and platforms
    4.1.1 Multi-frequency echosounders
    4.1.2 Ships
  4.2 Sampling, classifying, and mapping oceanographic habitats of epi-pelagic fishes
  4.3 Estimating species mixtures and their sizes
  4.4 Estimating biomasses and distributions of epi-pelagic fishes, by species
  4.5 Estimating systematic and random measurement and sampling errors
  4.6 Summary of the advantages and limitations of acoustic-trawl sampling methods
5.0 Description of acoustic-optical surveys for estimating the abundances, distributions, and demographics of rockfishes, and classifying and mapping their seabed habitats (Demer) (3 hr)
  5.1 Acoustic sampling devices and platforms
    5.1.1 Multi-frequency echosounders
    5.1.2 Ships and AUVs

5.2 Sampling, classifying, and mapping seabed habitats of rockfishes
5.3 Estimating species mixtures and their sizes (refer to 3.3)
5.4 Estimating biomasses and distributions of rockfishes, by species
5.5 Estimating systematic and random measurement and sampling errors
5.6 Summary of the advantages and limitations of optical-trawl sampling methods

6. Panel Requests to Analytical Team on Day 1 Topics (Dorn) (1/2 hrs)

Day 2

7.0 Applications of the COAST (Collaborative Optical-Acoustic Survey Technique) (Demer) (2 1/2 hrs)
7.1 COAST Surveys
7.1.1 2003 pilot survey
7.1.2 COAST 2004 survey of the SCB
7.1.3 COAST 2007 survey of the SCB
7.2 COAST survey estimates of rockfishes by species and strata
7.2.1 Behaviors
7.2.2 Distributions
7.2.3 Seabed habitats
7.2.4 Abundances and estimates of error

8.0 Utility of the COAST estimates for assessments of rockfishes (Demer) (1/2 hr)
8.1 Using estimates of rockfish behavior, demographics, distribution, and abundance, and maps of their seabed habitat
8.1.1 Species for which the method is appropriate
8.1.2 Scaling survey density estimates to population level
8.2 Future work

9.0 Panel Requests to Analytical Team on Day 2 Topics (Dorn) (1/2 hrs)

10.0 Review Work Assignments and start drafting report (Dorn) (4 hrs)

Day 3:

11.0 Review Work Assignments and continue drafting report (Dorn) (8 hrs)

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 by 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: Draft Panel Report Requests and Answers

A. Provide the algorithm used to allocate raw data on optical observations to estimate species proportions (including how account is taken of unidentified species, observations at different pitch angles, etc.)
Rationale: The documentation provided to the Panel did not include this information.

Response: The equation to apportion the s_A of all rockfishes to the s_A by species is given in Equation 2 under the section **Target strength estimation**. The weighting factor w_i represents the summed species biomass within the part of the Remotely Operated Vehicle (ROV) track that spans the respective depth stratum and TS_i is the average target strength for the ith species. Fish counted as unidentified were assigned to one of five categories (Sebastomus, Sebastes, Complex 1, Complex 2 and Complex 3; Table 1). Fish not assigned to the Sebastomus complex were attributed to the nearest species along the ROV track that was a member of their complex. The counts of unidentified species were partitioned proportionally to all the fish on the track when both the previous and the following species counts along the ROV track did not match any of the potential species. Fish counted as Sebastomus were apportioned proportionally to the counts of the species assigned to the category.

Table 1. Species groups used to assigning unidentified species to putative species.

Group	Potential species			
Complex 1	*S. hopkinsi*	*S. rufus*	*S. ovalis*	*S. entomelas*
Complex 2	*S. moseri*	*S. wilsoni*	*S. ensifer*	*S. semicinctus*
Complex 3	*S. chlorostictus*	*S. rosenblatti*		
Sebastes	*S. hopkinsi*	*S. moseri*	*S. ovalis*	*S. wilsoni*
Sebastomus	*S. chlorostictus*	*S. constellatus*	*S. rosaceus*	*S. ensifer*

B. Estimate the biomass in the deadzone for an example bank under the assumption that the density just above the deadzone matches that in the deadzone
Rationale: The density in the deadzone is currently assumed to zero, and the Panel wished to obtain an impression of the likely size of the negative bias associated with this assumption.

Response: For Cherry Bank, distributions of s_A were presented by three classes of deadzone height (Fig. 1). The net consequence of correcting for the deadzone by extrapolating the s_A in the 1m bin above the deadzone to the deadzone was an increase to the nominal biomass of rockfish of approximately 15%.

C. Construct a table of the frequency of the use of the four methods for assigning species proportions to sites (same site and survey, same site different survey, different site same survey, different site and survey)

Rationale: Ideally, the species proportions for each site and survey should be based on optical transects during that survey at that site. However, this does not always occur. The Panel wished to understand the extent to which extrapolation of species proportions is occurring.

Response: Shallow strata were targeted preferentially, so with limited ROV sampling time the deep stratum was often under-sampled.

Table 2. Distribution of ROV surveys by depth strata

Strata	Same site, same survey	Same site, different survey	Different site, same survey	Different site, different survey
Shallow	30	4	-	-
Deep	11	7	11	5

D. Provide a histogram of the deadzone height (50cm bins above the bottom) by stratum (high vs low density; deeper or shallower than 150m).

Rationale: The Panel wished to understand the potential amount of deadzone. The algorithm used to analyse the data excludes samples with deadzone height > 3m.

Response: Figure 2 shows the distribution of deadzone heights for Cherry Bank (integrated over strata) while Figure 3 shows the distributions of deadzone heights for 43 Fathom Bank. More than 90% of the samples for 43 Fathom Bank had a deadzone height < 3m. The only stratum in Figure 3 with appreciable amounts of deadzone > 5m was the high density deep stratum (~55% of samples), but there was little biomass in this stratum. For the remaining strata, the bulk of the deadzone heights was < 1m.

E. Provide the estimates of biomass by deep and shallow strata and site categorized by the four methods for assigning species proportions to sites

Rationale: The Panel wished to further understand the implications of having to use data from different surveys or sites to apportion total biomass to species.

Response: Most of the biomass is in the shallow startum, for which more than 95% of the biomass is derived from optical samples taken at the same site and survey (Table 3). However, more than 67% of the biomass in the deep stratum was obtain form one of the other method of assigning species (Table 4).

Table 3 Estimates of total abundance in the shallow stratum, by method of assigning species. Total biomass = 28183.3 t.

Site	Biomass	
	same site, same survey	same site, different survey
S Tanner	3542.473	
Osborn	2148.575	
S Cortes	505.109	
NCortes	6656.820	
Cherry	1776.978	
S Cortes s.g.	82.755	
E S. Nicolas	2144.645	
NW S Nicolas	1774.177	
Potato	4317.055	
Hidden reef	152.346	
60 mile bank		1106.428
China point reef	870.700	
Del Mar	32.654	
Farnsworth	597.761	
Lasuen	209.495	
Mission beach reef	306.333	
N Cortes s.g.	495.145	
NW S Clemente	507.811	
S.Cruz canyon	268.449	
W. S. Clemente	472.632	
43 Fathom	214.952	
Proportion	**96.0%**	**3.92%**

Table 2 Estimates of total abundance in the deep stratum, by method of assigning species. Total biomass = 3369.8 t.

Site	Biomass same site, same survey	same site, different survey	different site, same survey	different site, different survey
S Tanner			24.375	
Osborn			232.923	
S Cortes				
NCortes	422.613			
Cherry		425.443		
S Cortes s.g.			230.986	
E S. Nicolas			118.779	
NW S Nicolas			97.183	
Potato		66.985		
Hidden reef			470.854	
60 mile bank	601.813			
China point reef			35.751	
Del Mar				
Farnsworth				
Lasuen		221.280		
Mission beach reef	84.941			

N Cortes s.g.		140.727		
NW S Clemente				86.804
S.Cruz canyon				19.074
W. S. Clemente				50.566
43 Fathom	38.773			
Proportion	**32.9%**	**26.5%**	**35.9%**	**4.6%**

F. Provide the equation for the calculation of biomass and variance.
Rationale: The Panel wanted clarification on the calculation of biomass and its variance.

Response: The estimate of abundance (biomass) is given by:

$$B_y = \sum_i \sum_s d_{i,s,y} A_{i,s,y} \qquad (1)$$

where B_y is the biomass during year (or survey) y for a given species,
$d_{i,s,y}$ is the estimated density for stratum s site i during y, and
$A_{i,s,y}$ is the area for stratum s site i during y.

The variance of the abundance estimate is:

$$VAR(B_y) = \sum_i \sum_s \frac{A_{i,s,y}^2}{n_y - 1} \sum_y [d_{i,s,y} - \bar{d}_{i,s}]^2 \qquad (2)$$

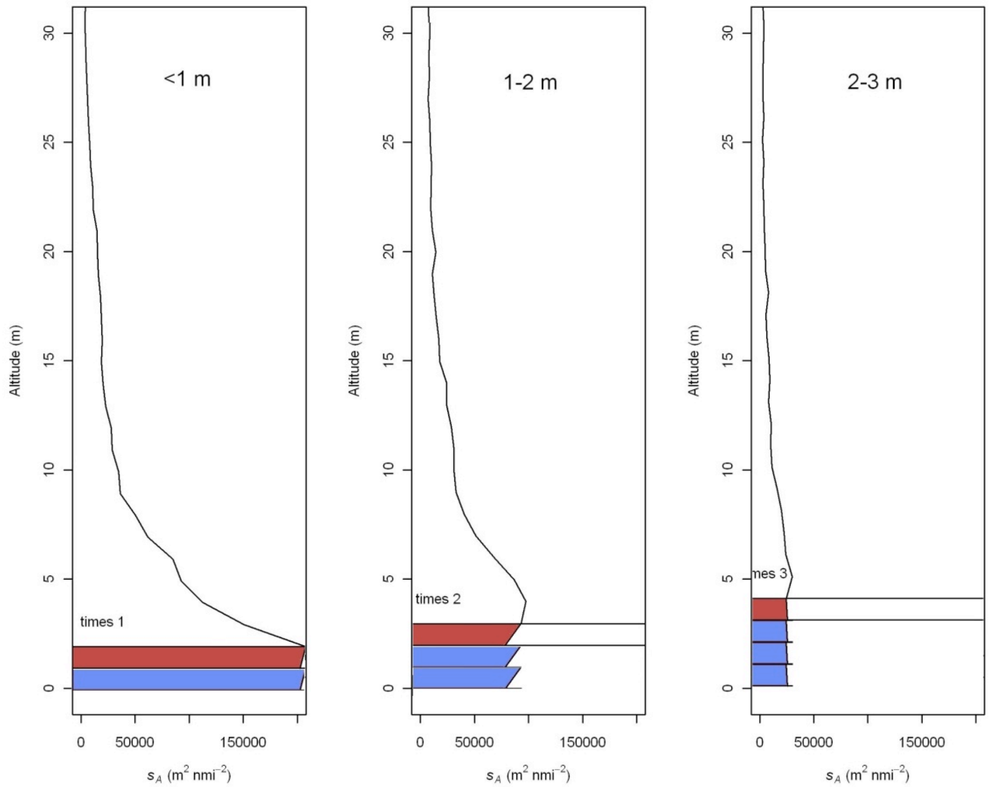

Figure 1. Distributions of s_A by distance from the bottom for Cherry Bank, the s_A in the 1m bin just above the deadzone (brown bar) and the s_A assigned to the deadzone (blue bars).

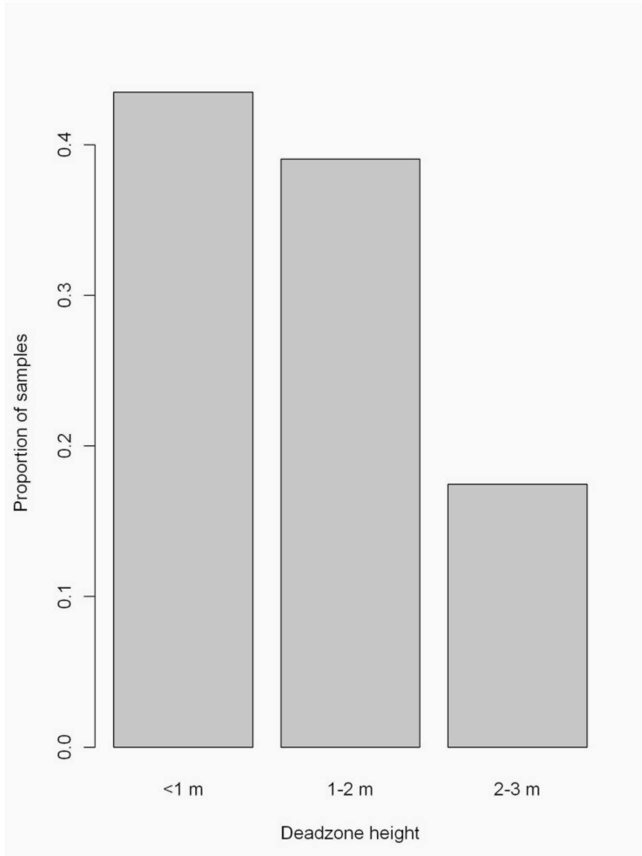

Figure 2. Frequency of acoustic samples by deadzone height for Cherry Bank

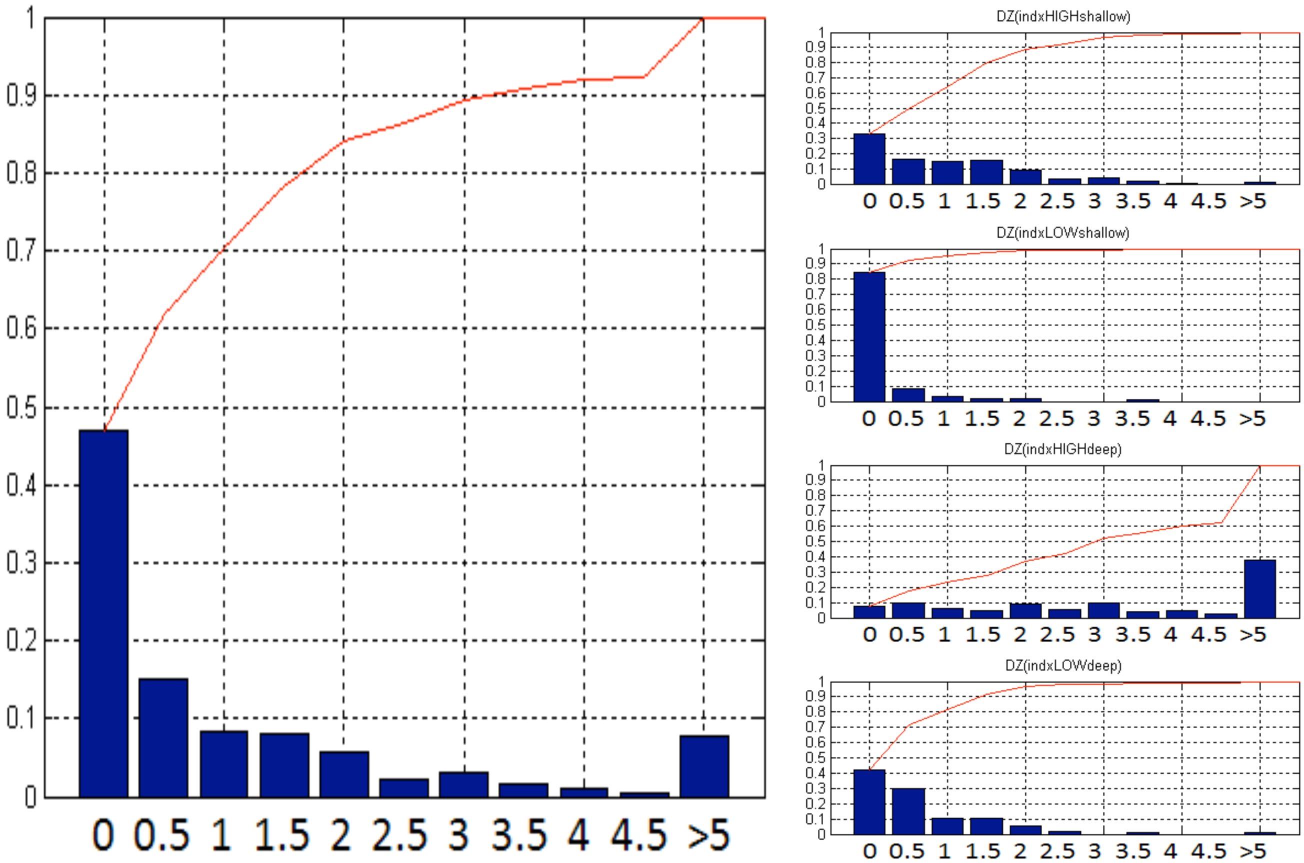

Figure 3. Distributions of deadzone height for 43 Fathom Bank.