Center for Independent Experts (CIE) Independent Peer Review Report

NWFSC Southern California Shelf Rockfish Hook and Line Survey

Seattle, Washington. April 4-5, 2012

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Executive Summary

I conclude that the survey design is appropriate for generating abundance indices for shelf rockfish species under current stock conditions. However, stock conditions (esp. size and spatial distribution) may not have to change much to create problems with the survey design. The problems will likely result in decreasing survey catchability. I see two main reasons for this. The first is the cowcod conservation area (CCA). It is quite likely that abundance will increase more inside a closed area than outside, for stocks that are not highly mobile, such as most rockfish species. The hook and line survey will only reflect changes in rockfish abundance in the survey area, and not the stock as a whole. The second reason is the effects of gear saturation.

Site effects in the survey seem large. If the interaction between year and sites is not large then the fixed site design is a good approach. If there are large interactions then adding random sites has may have utility. If different sites have different time trends in catch rates then a fixed-site design may give biased estimates of stock trends.

Estimation of abundance indices from the survey data was deficient in two aspects. The first was gear saturation, which is an issue even when only 50% of hooks are occupied. The consequence of gear saturation is a decreasing index catchability as stock size increases. The change in catchability can be large. There seems to be fairly simple ways to correct for gear saturation effects when the amount of saturation is not too large. Stock size indices should be based first on the rockfish community level because this is what affects gear saturation. Species specific indices can be inferred from an analysis of the distribution of species at a site, similar to how length-distributions are estimated. The second deficiency was the approach for combining catch rates across different sites. It is based on ideas for CPUE standardization. The average catch rate (over all years) at a site is treated as a nuisance parameter and removed for the calculation of the index. More can be done for the hook and line survey. Conceptually, I suggest that each site be treated as a stratum, and that an overall abundance index should be based on the strata size-weighted average catch rate.

Background

The purpose of the meeting was to provide an external peer review of the Northwest Fisheries Science Center's (NWFSC) Southern California Shelf Rockfish Hook and Line Survey. This survey was designed to collect fishery-independent data for ground fish associated with rocky habitats that are not well-sampled using trawl surveys. Survey data are analyzed to generate annual indices of relative abundance and time series of biological data for use in the stock assessments for several species of shelf rockfish (Genus: *Sedates*) including bocaccio (*S. paucispinis*) and greenspotted rockfish (*S. chlorostictus*).

The CIE (Center for Independent Experts) reviewer was tasked with conducting an impartial and independent peer review in accordance with the Statement of Work (SoW) and Review Workshop (RW) Terms of Reference (ToRs; Annex 2). The overall goal of the review was to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey were suitable for achieving the survey's objectives. The specific goals of the review meeting were to:

1. evaluate the hook and line survey's design and protocols;
2. examine the analytical methods used to generate abundance indices; and
3. Provide suggestions regarding potential expansion of the survey's geographical range and species for which abundance indices are generated - particularly for data-poor and data-limited species.

The agenda of the panel review meeting is attached in Annex 3. The Review Panel (RP) was composed of a Chair and two CIE reviewers. The CIE reviewers were independent, and had working knowledge and recent experience in the application of fish population dynamics, stock assessment methods, and fishery survey design.

Role of reviewer

I attended the NWFSC Southern California Shelf Rockfish Hook and Line Survey meeting in Seattle, Washington during April 4-5, 2012. I reviewed presentations and reports and participated in the discussion of these documents, in accordance with the SoW and ToRs (see Appendix 2). This report is structured according to my interpretation of the required format and content described in Annex 1 of Appendix 2.

I reviewed the background documents I was provided. These are listed in Appendix 1. I also reviewed four other relevant background documents I found in a quick literature review I did, and these are also listed in the Appendix.

Summary of findings

During the review workshop it became apparent that some of the terms of reference (e.g. utility of expanding the survey) could only be adequately addressed by reviewing additional information (from stock assessments, etc.) about rockfish that was not presented during the review workshop. This would include rockfish components outside the Southern California Bight (SCB). I decided to focus the majority of my attention on ToR's 3 and 6, which is where my background and expertise is. An important issue considered at the review meeting, related to

ToR6, involved the relationship between survey catch rates and population size. This could be confounded by gear saturation.

ToR 1: The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.

Substantial information was presented to address the goals of the review. More specific goals are identified in remaining ToR's, which is where I present my findings.

ToR 2: Review recent literature (to be provided as background materials) to become familiar with the key species and the primary science and management issues within the Pacific Fishery Management Council (PFMC) umbrella for groundfish in general and structure-associated shelf rockfish in particular.

Background materials were provided, and they are listed in Appendix 1. They provided good background on the hook and line survey. I reviewed three additional papers related to the effects of gear saturation and soak times on catch rates, and their ability to indicate stock size. I also reviewed a paper dealing with large catches of rockfish in bottom trawl surveys. References for these papers are also provided in Appendix 1.

ToR 3: Evaluate the suitability of the survey sampling design. Specifically, is the design appropriate for generating abundance indices for shelf rockfish species? Comment on the benefits and drawbacks of the current fixed-site design. Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?

<u>Is the design appropriate for generating abundance indices for shelf rockfish species?</u>

I will include the survey gear as part of the survey design. *I conclude that the survey design is appropriate for generating abundance indices for shelf rockfish species under current stock conditions*.

An appropriate survey design should cover the habitat range of the species. It is preferable that this range include the presently occupied habitats, and those habitats that may be occupied in the "near" future. Otherwise the survey coverage will have to adapt to possible changes in the future distribution of rockfish, and such design changes may be difficult for a variety of reasons including logistical ones. On the other hand, there is little point in expending a lot of survey effort in areas where rockfish are currently not. The important point for the survey design is to make sure that there are not large amounts of the targeted rockfish species that are outside the survey area.

The cowcod conservation area (CCA), which is closed to rockfish fishing, is a problem for survey coverage. It was suggested during the review meeting that recent time trends in rockfish abundance within the CCA are different than those outside. This makes sense – management authorities close areas to recover populations. If stocks are not sufficiently mobile then it is quite likely that abundance will increase more inside a closed area than outside. I do not know of any way that the results from the present survey can be adjusted to account for stock components in the CCA. There survey design will have to be modified to deal with the CCA.

At the review meeting the use of ROV non-lethal survey methods were discussed. My general impression was that these are fairly laborious to implement and to achieve wide survey coverage will require substantial increase in survey effort. I noted at the review meeting that the current survey design uses sounders to identify aggregations to sample at each site, suggesting that rockfish tend to be acoustically detectable – at least partially. A joint acoustic + hook and line survey should be considered, where only the acoustic component is extended into the CCA. This could be a modification of the TAPAS design. Spencer (2012) has evaluated this design using simulations based on a rockfish species. The acoustic component may only give information on total rockfish abundance for all species, and species, size, and other biological information would have to be inferred from hook and line catches outside the CCA. This is not ideal but better than nothing.

At present it is important to recognize for stock assessment that the CCA is one reason why survey Q may be changing (esp. decreasing) over time. This is confounded with the fact that recent landings are also from outside the closed area, and that over time most stock assessments will basically be assessing the status of the stock components that are fished.

Survey staff indicated that they felt the survey sites were representative of the rockfish habitat as a whole. Little information was presented to evaluate this claim. I think the survey staff could do more to substantiate or verify the representativeness of the survey sites. My understanding is that in 2003 an exercise was conducted with commercial and sport fishermen to identify rockfish hotspots. What hotspots meant was not clear to me, and in subsequent surveys many of the hotspot sites did not produce catches of rockfish. Some of the sites that did not result in rockfish catches were subsequently dropped from the survey.

This is a complicated issue. Survey sites may currently be representative of habitat that rockfish currently occupy, but they may not be representative of rockfish habitat if these stocks increase in size in the future. The issue is whether rockfish will increase in abundance throughout their habitat in proportion to the current distribution of abundance, or will the abundance distribution change in the future. Perhaps future increases will occur in habitats that currently have low abundance (the reverse of the basin hypothesis), or perhaps the local carrying capacity will determine something different.

What could help here is to census the low, medium, and high quality rockfish habitat (location, depth, substrate type, etc.) in the SCB, and then examine how the distribution of these habitat variables for the entire SCB compares with the distribution at the sampled sites. Just because rockfish are currently not found in some habitats does not mean these are not rock fish habitats, as the 2003 exercise demonstrated.

For some species like bocaccio there were clearly deficiencies in the survey design because the survey did not cover some habitat where bocaccio are known to be found, such as depths greater than 230m which was the limit on the depth of survey sites. Older bocaccio are thought to prefer greater depths and this is one reason why the survey catchability will be ‘domed-shaped’. This means that it will be difficult to determine total mortality rates from changes in size composition information for bocaccio because reductions in catch rates for larger and presumably older bocaccio will be caused by movement outside of the survey area in addition to mortality.

How abundance indices are generated can be treated as a separate issue, although the survey design and methods of analysis are linked. I address analyses issues for abundance indices under ToR6.

<u>Benefits and drawbacks of the current fixed-site design</u>

If the fixed sites were randomly selected in some past survey design then the surveys follow a common longitudinal (i.e. over time) survey design in which sites are randomly selected and “followed” over time. A common inferential framework in the survey sampling literature in this situation treats the time-series of catches at a site as a multivariate observation. The catches at a site may be auto-correlated over time.

A fixed site sampling design may give more precise estimates of stock trends. However, if different sites have different time trends in catch rates then a fixed-site design may also give biased estimates of stock trends. A random site design will give unbiased but less precise estimates of stock trends. To understand this more, let Y_{ti} denote the catches in year t and site i. A conceptual model for the catch is

$$Y_{ti} = \mu_t + \delta_{ti} + \varepsilon_{ti},$$

where μ_t is the year effect, δ_{ti} is the site effect each year, and ε_{ti} is a measurement error term that I assume is iid (independent and identically distributed) with mean zero. The site effects are deviations from the overall mean (μ_t), so $\Sigma_i\delta_{ti} = 0$. The sum is over the entire population of sites and not just the sampled sites.

In a random site design, the sampling and measurement error expectation (e.g. see Chen et al. 2004 for a description of the two types of expectations) of an observation is $E(Y_{ti}) = \mu_t$. This implies the sample mean will be unbiased for μ_t, and the average survey catch will be unbiased for average exploitable abundance over the whole survey area. In a fixed site design $E(Y_{ti}) \neq \mu_t$ **in general** and we have to assume more. If the δ_{ti}'s are constant over time (i.e. $\delta_{ti} = \delta_i$ for all t) then the average survey catch has constant bias and correctly indicates stock trends. In this case the average of the δ's will be constant over time in a fixed-site design, whereas in a random site design this average will vary from year to year (but always have expectation of zero) and is a source of additional variability in survey catch rates. When site effects are large (which seems to be the case for rockfish in SCB) then this source of variability in a random site design may dominate total variance and obscure stock trends.

It will usually not be appropriate to assume that the δ_{ti}'s are constant over time. Stock trends will rarely be the same at all sites. It is often the case that the trends can be quite different, with abundance at some sites going up and some down or not changing. It will often be reasonable to consider the between-site difference in trends as random. In this case δ_{ti}'s are auto-correlated over time (within sites, i) and this should be accounted for when deriving standard errors for trend estimates. It also suggests that trend estimates from a fixed site design may be auto-correlated. The stock assessment models I am familiar with treat stock size indices from different years as independent, but this may not be a valid assumption for indices from a fixed site design. This is not a problem for a random site design because mostly different sites are sampled each year, particularly when the number of sites in the population (i.e. sampling frame) is large.

Generalized linear mixed-effects models (GLMMs) similar to that described above (but with a log-link!) can be used for such data. There are a variety of packages that can fit such a mixed effects model. I have used such models to deal with missing data in bottom trawl surveys, where sometimes an entire stratum or many strata are missed because of weather, mechanical breakdowns, etc. The GLMM framework is a good way to deal with count data with zeros, which is difficult to transform to normality. I usually find Negative Binomial type Poisson over-dispersion in the bottom trawl survey data I work with. GLMM packages in R and SAS have not included this type of variance structure so I developed ADMB code for this purpose. This approach could be extended to deal with auto-correlated site effects; however, I suspect there may be challenges to estimate the correlation when not all the fixed sites are sampled each year.

<u>Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?</u>

There may be benefits to modify the existing design to include some measure of a random component.

Warren (1994) discussed the bias-variance trade-off of fixed versus random site selections. He also considered a design with both fixed and random sites. An important issue is how "persistent" or auto-correlated over time are catch rates at sites. Quantitative results to address this were not presented at the review, but my sense from the stem and leaf plots for bocaccio (descriptive results presentation) was that the autocorrelation was not large. However, site effects in GLM's seemed large. If the interaction between year and sites is not large then I suggest that the fixed site design is a good approach. If there are large interactions then the weight that sites are given in the total index is much more important. In this case, a stratified approach seems better (see ToR6). Adding random sites has more appeal in this latter situation.

However, my conclusion is rather speculative and it is not difficult to evaluate the efficiency of fixed versus random site designs (or some combination in between) using simulations designed to mimic the catch rate data for the three main target species in this survey. This is a good project for a master's student in a statistics or resource management program.

Changing the way sites are selected, by including a random component, may not disrupt the continuity of the survey time series. This conclusion is linked to the methods of analysis. If the survey area is stratified and the index was based on a stratum size-weighted average, then the important issue is that all strata are sampled.

ToR 4: Evaluate the appropriateness of the gear used during the hook and line survey: rod and reel, mainline, gangion specifications, terminal tackle specifications, etc.

I have no background with fishing for rockfish, and little basis to evaluate this ToR. The very low percent of missing hooks indicate that the anglers can very successfully deploy and retrieve the survey gear.

Ideally it would be useful to use more hooks per drop to reduce the effects of gear saturation. However, information presented at the review meeting about angler and hook effects suggest that adding more anglers or adding more hooks per gangion could create some bias in the index because of angler and hook effects. Such effects should be considered and corrected for (when significant) when computing abundance indices. I am also not sure if the survey wants to start removing much more rockfish, and I suggest that techniques to better utilize acoustic information that could be collected at each sample site may be a better strategy.

ToR 5: Evaluate the fishing and biological sampling protocols used during the hook and line survey.

The sampling protocols seemed thorough and extensive, with good error checking.

For stock assessment it would be very beneficial to collect age information. I understand that there are technical difficulties in aging rockfish, and I encourage researchers to continue their efforts in this direction.

ToR 6: Evaluate the methods and assumptions used to analyze the survey data as well as the associated uncertainty of the abundance estimates.

The survey indices for shelf rockfish species may only be reliable under current stock conditions. This is a rather weak conclusion because usually a survey is designed to generate stock size indices over a wide range of stock sizes. The main point of doing a survey is to measure changes in stock size. I expect that rockfish hook and line survey indices will have catchabilities that depend on stock size, and that the catchabilities will decrease smoothly as stock size increases. My rationale for this conclusion is presented in the following section.

Estimation of abundance indices from the survey data was deficient in two aspects. My comments are grouped to address these two specific issues.

Gear Saturation

The survey staff suggested that this is not yet an important issue for rockfish because complete saturation of hooks has been uncommon so far. In some areas (Conception and Miguel) it could be an issue. However, gear saturation is an issue even when only 50% of hooks are occupied. This has been addressed in some literature dealing with longline surveys. In the remainder of this section I present some theoretical results on this issue, and propose how to correct catch rates for gear saturation when saturation is not too extreme.

Consider that there is a population of n fish at a site, and they all have the same probability p of getting caught on a hook and they behave independently of each other with respect to capture. I first assume that only one hook is fished. Let C denote the catch; C = 0 indicates no catch and C = 1 indicates a catch. It is obvious that $Pr(C=0) = (1-p)^n$; hence, $Pr(C=1) = 1 - (1-p)^n$. Note that if n = 0 then $Pr(C=1) = 0$ as we would expect, and if $p > 0$ then as $n \rightarrow \infty$ then $Pr(C=1) \rightarrow 1$. The expected catch is $Pr(C=1)\ 1 - (1-p)^n$. The expected catch is a function of the capture probability and abundance (n).

Expected catch per angler in the hook and line survey

This stochastic model can be extended to five hooks. Assume

- each fish detects the gear with probability p_o,
- they select a hook with probability p_i, i=1,…,5, $\sum_i p_i = 1$, and
- having selected a hook, a fish is captured with probability p_{hook}.

The probability that a fish selects the i'th hook is $f_i = p_o p_i$. The probability a fish does not select a hook is $f_o = 1 - p_o$. Note that $\sum_{i=0}^{5} f_i = 1$. If there are n fish at a site, then the number of fish that target a hook can be modeled as a multinomial random variable. Let X_i denote the number of fish that target hook i=1,..,5 and let $X_. = X_1 + \ldots + X_5$. The distribution of fish that select a hook is given by

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$$\Pr(X_1 = x_1, \ldots, X_5 = x_5) = \frac{n!\, f_o^{n-X.} \prod_{i=1}^{5} f_i^{X_i}}{(n - X_.)! \prod_{i=1}^{5} X_i!} \quad (1)$$

In this distribution, n - X. fish do not select a hook.

Given that X_i fish select hook i, $\Pr(C_i = 0) = (1 - p_{hook})^{X_i}$ and $\Pr(C_i = 1) = 1 - (1 - p_{hook})^{X_i}$. The conditional probability of catching c_i fish (c_i = 0 or 1) on hook i = 1,…,5 is given by

$$\Pr(C_1 = c_1, \ldots, C_5 = c_5 | X_1 = x_1, \ldots, X_5 = x_5) = \prod_{i=1}^{5} \{1 - (1 - p_{hook})^{X_i}\}^{c_i} (1 - p_{hook})^{(1-c_i)X_i}.$$

Let $p_C(X_i) = \Pr(C_i = 1) = 1 - (1 - p_{hook})^{X_i}$. The marginal distribution, $\Pr(C_1 = c_1, \ldots, C_5 = c5$, is obtained using equation (1):

$$\Pr(C_1 = c_1, \ldots, C_5 = c_5 | n) = \sum_{\substack{X_1 = c_1 \\ X_1 + \cdots + X_n \le n}}^{n} \cdots \sum_{X_5 = c_5}^{n} \left[\prod_{i=1}^{5} \{p_C(X_i)\}^{c_i} \{1 - p_C(X_i)\}^{1-c_i} \frac{f_i^{X_i}}{X_i!} \right] \frac{n!\, f_o^{n-X.}}{(n - X_.)!}$$

This is complicated, but if p_{hook} is very close to one then more simple results can be derived. When p_{hook} = 1 then Pr(C = 0 | x = 0) = 1 and Pr(C = 1 | x > 0) = 1. In this case Venn diagrams can be used to derive the probabilities of capture.

There are 2^5 = 32 possibilities, with probabilities

Table 1. Capture probabilities**.**

Hook 1	Hook 2	Hook 3	Hook 4	Hook 5	Probability
0	0	0	0	0	Po = f_o^n
1	0	0	0	0	P1 = $(f_1 + f_o)^n$ – Po
0	1	0	0	0	P2 = $(f_2 + f_o)^n$ – Po
0	0	1	0	0	P3 = $(f_3 + f_o)^n$ – Po
0	0	0	1	0	P4 = $(f_4 + f_o)^n$ – Po
0	0	0	0	1	P5 = $(f_5 + f_o)^n$ – Po
1	1	0	0	0	$(f_1 + f_2 + f_o)^n$ – P1 – P2 – Po
1	0	1	0	0	$(f_1 + f_3 + f_o)^n$– P1 – P3 – Po
1	0	0	1	0	$(f_1 + f_4 + f_o)^n$– P1 – P4 – Po
1	0	0	0	1	$(f_1 + f_5 + f_o)^n$– P1 – P5 – Po

0	1	1	0	0	$(f_2 + f_3 + f_o)^n$– P2 – P3 – Po
0	1	0	1	0	$(f_2 + f_4 + f_o)^n$– P2 – P4 – Po
0	1	0	0	1	$(f_2 + f_5 + f_o)^n$– P2 – P5 – Po
0	0	1	1	0	$(f_3 + f_4 + f_o)^n$– P3 – P4 – Po
0	0	1	0	1	$(f_3 + f_5 + f_o)^n$– P3 – P5 – Po
0	0	0	1	1	$(f_4 + f_5 + f_o)^n$– P4 – P5 – Po
1	1	1	0	0	$(f_1 + f_2 + f_3 + f_o)^n$–Po-P1-P2-P3-P12-P13-P23
1	1	0	1	0	$(f_1 + f_2 + f_4 + f_o)^n$-Po-P1-P2-P4-P12-P14-P24
1	1	0	0	1	$(f_1 + f_2 + f_5 + f_o)^n$-Po-P1-P2-P5-P12-P15-P25
1	0	1	1	0	$(f_1 + f_3 + f_4 + f_o)^n$-Po-P1-P3-P4-P13-P14-P34
1	0	1	0	1	$(f_1 + f_3 + f_5 + f_o)^n$-Po-P1-P3-P5-P13-P15-P35
1	0	0	1	1	$(f_1 + f_4 + f_5 + f_o)^n$-Po-P1-P4-P5-P14-P15-P45
0	1	1	1	0	$(f_2 + f_3 + f_4 + f_o)^n$-Po-P2-P3-P4-P23-P24-P34
0	1	1	0	1	$(f_2 + f_3 + f_5 + f_o)^n$-Po-P2-P3-P5-P23-P25-P35
0	1	0	1	1	$(f_2 + f_4 + f_5 + f_o)^n$-Po-P2-P4-P5-P24-P25-P45
0	0	1	1	1	$(f_3 + f_4 + f_5 + f_o)^n$-Po-P3-P4-P5-P34-P35-P45
1	1	1	1	0	$(f_1 + f_2 + f_3 + f_4 + f_o)^n$-Po-P1-P2-P3-P4-P12-P13-P14-P23-P24-P34-P123-P124-P134-P234
1	1	1	0	1	$(f_1 + f_2 + f_3 + f_5 + f_o)^n$-Po-P1-P2-P3-P5-P12-P13-P15-P23-P25-P35-P123-P125-P135-P235
1	1	0	1	1	$(f_1 + f_2 + f_4 + f_5 + f_o)^n$-Po-P1-P2-P4-P5-P12-P14-P15-P24-P25-P45-P124-P125-P145-P245
1	0	1	1	1	$(f_1 + f_3 + f_4 + f_5 + f_o)^n$-Po-P1-P3-P4-P5-P13-P14-P15-P34-P35-P45-P134-P135-P145-P345
0	1	1	1	1	$(f_2 + f_3 + f_4 + f_5 + f_o)^n$-Po-P2-P3-P4-P5-P23-P24-P25-P34-P35-P45-P234-P235-P245-P345
1	1	1	1	1	1 – sum of the above

Equation (1) must be modified if n < 5, because in this case the sample space is smaller than indicated in Table 1. If fish select hooks at random (p_i =1/5) then the situation is much easier, and we can just consider the total number of fish caught. In this case f_i=f= p_o/5. The total catch probabilities are

Table 2.

#fish	Capture Probability
0	f_o^n
1	$5\{(f + f_o)^n - f_o^n\}$
2	$10\{(2f + f_o)^n - 2(f + f_o)^n + f_o^n\}$
3	$10\{(3f + f_o)^n - 3(2f + f_o)^n + 3(f + f_o)^n - f_o^n\}$
4	$5\{(4f + f_o)^n - 4(3f + f_o)^n + 6(2f + f_o)^n - 4(f + f_o)^n + f_o^n\}$
5	$1 - \sum_{t=0}^{4} \Pr\,(total = t)$

I plotted the expected catch (EC) for some interesting choices of n and p to understand how the fixed number of hooks may affect catch rates. EC is shown in Figure 1 for three choices, p_o =0.001, 0.1, and 0.5. EC is plotted as a function of np_o, which is the EC using an infinite number of hooks. I refer to this as the “potential exploitable stock size” (PES).

Definition: Potential exploitable stock size (PES) is the conceptual and unsaturated expected catch (EC) obtained using an infinite number of hooks. EC = np_o.

For each choice of p_o and PES, n = PES/ p_o. When EC < 1 then EC is a good indicator of change in stock size (n), but when EC > 1 the relationship breaks down. For example, when $p_o = 0.5$ then an increase in EC from 1.0 to 2.0 (indicated by horizontal grey lines in Fig. 1) corresponds to an increase in stock size (as indicated by PES) from approximately 1.1 to 2.6. A further increase in EC from 1 to 3 corresponds to an increase in stock size from approximately 1.1 to 4.6. Over this range of EC, changes in EC are not exactly proportional to changes in stock size.

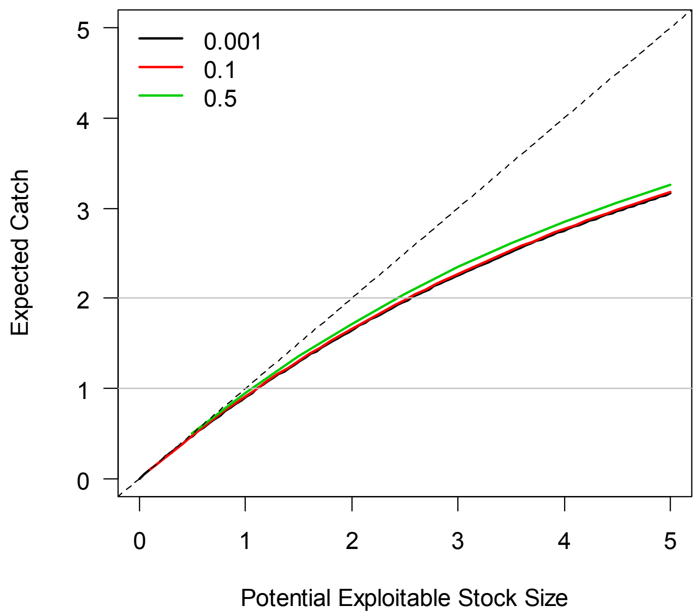

Figure 1. Expected catch versus PES (i.e. np_o). The solid lines correspond to values of p_o, which are indicated in the figure legend. A dashed 1:1 reference line is shown, along with two grey reference lines at 1 and 2.

If fish do not randomly select hooks then the situation is more complicated. The selection probability plays a role in the distribution of total catch. For example, if some hook has a zero probability of catching a fish then this implies that there is a zero probability of catching 5 fish in total. The results presented at the review meeting suggested that the hook selection probabilities changed approximately monotonically as a function of hook position (1, 2,…, 5). The selection probabilities could increase or decrease, depending on the species behavior (i.e. distributed close to bottom or higher in the water column). To investigate how this could influence the relationship between catch and PES, I modeled the f_i's using a power function, $f_i = p\alpha\gamma^i$, where α is selected so that $\alpha\sum_{i=1}^{5}\gamma^i = 1$; that is, $\alpha = {}^{1-\gamma}\!\big/_{\gamma(1-\gamma^5)}$. The f_i's are illustrated in

Figure 2, for $p_o = 0.13$ and $\gamma = 0.75$. This choice for γ implies that the ratio of the capture-probability of the 1st hook compared to the 5th hook is 0.32. This is a strong 'hook' effect and I chose this level to illustrate the potential implications of variable hook selection probabilities.

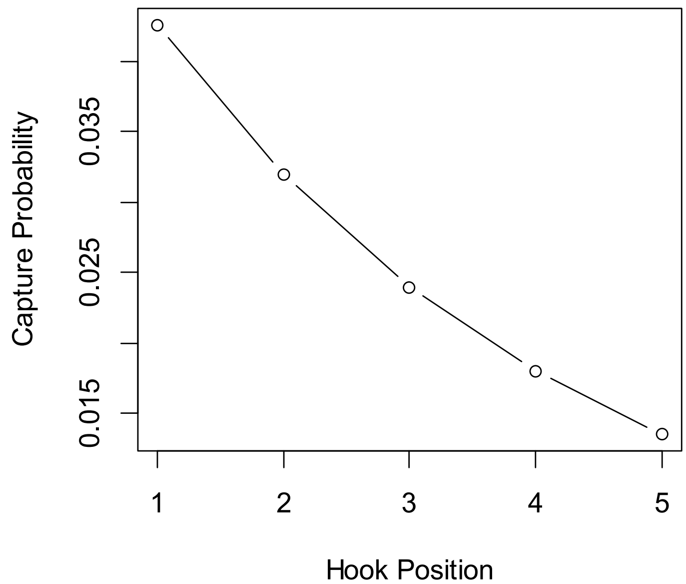

Figure 2.

Capture probabilities are shown in Table 3 in a form more amenable to computing, although computing these probabilities is not trivial. The notation S_x indicates the distinct combinations of subsets of size x from the sequence 1,…,5. There are $\binom{5}{x}$ elements in S_x.

Table 3. Capture probabilities**.**

Hook 1	Hook 2	Hook 3	Hook 4	Hook 5	Probability
0	0	0	0	0	f_o^n
1	0	0	0	0	$(f_i + f_o)^n - f_o^n$
0	1	0	0	0	
0	0	1	0	0	
0	0	0	1	0	
0	0	0	0	1	
1	1	0	0	0	$(\sum_i f_i + f_o)^n - \sum_i (f_i + f_o)^n + f_o^n$
1	0	1	0	0	
1	0	0	1	0	
1	0	0	0	1	
0	1	1	0	0	
0	1	0	1	0	
0	1	0	0	1	
0	0	1	1	0	
0	0	1	0	1	
0	0	0	1	1	
1	1	1	0	0	$(\sum_i f_i + f_o)^n - \sum_i \left(\sum_{j \neq i} f_j + f_o\right)^n + \sum_i (f_i + f_o)^n - f_o^n$
1	1	0	1	0	
1	1	0	0	1	
1	0	1	1	0	

1	0	1	0	1	
1	0	0	1	1	
0	1	1	1	0	
0	1	1	0	1	
0	1	0	1	1	
0	0	1	1	1	
1	1	1	1	0	$(\sum_i f_i + f_o)^n - \sum_{i \in S_3}\left(\sum_{j \in S_{3i}} f_i + f_o\right)^n + \sum_{i \in S_2}\left(\sum_{j \in S_{2i}} f_j + f_o\right)^n - \sum_i (f_i + f_o)^n + f_o^n$
1	1	1	0	1	
1	1	0	1	1	
1	0	1	1	1	
0	1	1	1	1	
1	1	1	1	1	1 – sum of the above

The grouped equations apply to each of the corresponding rows, with zeros omitted. Let $g_x = \sum_{i=1}^{\binom{k}{x}}\left(\sum_{j \in S_{xi}} f_j + f_o\right)^n$ where S_{xi} is the ith row of S_x. Define $g_0 = 0$. Note that $g_k = 1$. The catch probabilities (for k=5 hooks) are

Table 4

#fish	Capture Probability
0	$g_0 + f_o^n$
1	$g_1 - \binom{k}{1} f_o^n$
2	$g_2 - \frac{\binom{2}{1}\binom{k}{2}}{\binom{k}{1}} g_1 + \binom{k}{2} f_o^n$
3	$g_3 - \frac{\binom{3}{2}\binom{k}{3}}{\binom{k}{2}} g_2 + \frac{\binom{3}{1}\binom{k}{3}}{\binom{k}{1}} g_1 - \binom{k}{3} f_o^n$
4	$g_4 - \frac{\binom{4}{3}\binom{k}{4}}{\binom{k}{3}} g_3 + \frac{\binom{4}{2}\binom{k}{4}}{\binom{k}{2}} g_2 - \frac{\binom{4}{1}\binom{k}{4}}{\binom{k}{1}} g_1 + \binom{k}{4} f_o^n$
5	$1 - \frac{\binom{5}{4}\binom{k}{5}}{\binom{k}{4}} g_4 + \frac{\binom{5}{3}\binom{k}{5}}{\binom{k}{3}} g_3 - \frac{\binom{5}{2}\binom{k}{5}}{\binom{k}{2}} g_2 + \frac{\binom{5}{1}\binom{k}{5}}{\binom{k}{1}} g_1 - \binom{k}{5} f_o^n$

EC's are shown in Figure 3. The effect of variable hook selection probabilities (i.e. $\gamma = 0.75$) is not large. An EC of 3 corresponds to a PES of approximately 4.9, compared to 4.6 when $\gamma = 1$ (i.e. Figure 1).

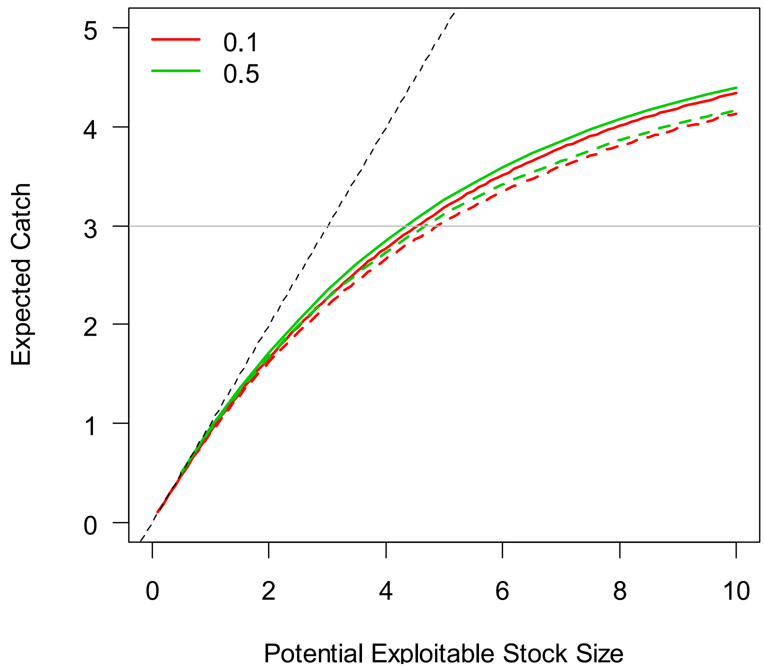

Figure 3. Expected catch versus PES (i.e. n p_o). The solid lines correspond to $\gamma = 1$ and values of p_o, which are indicated in the figure legend. The dashed color lines indicate $\gamma = 0.75$. A dashed 1:1 reference line is shown, along with a grey reference line at 3.

I speculate that the total catch probabilities for an arbitrary number of hooks, k, is given by

$$\Pr\left(\sum_i C_i = x\right) = \begin{cases} f_o^n, x = 0 \\ g_1 - k f_o^n, x = 1 \\ g_x + \sum_{i=1}^{x-1} \left\{ \frac{(-1)^i \binom{x}{x-i} \binom{k}{x}}{\binom{k}{x-i}} g_{x-i} \right\} + (-1)^x \binom{k}{x} f_o^n, x > 1 \end{cases} \tag{2}$$

I have verified that Equation (2) is correct when k=1,..,3. When k=5, Equation (2) reproduces the probabilities in Tables 2 and 4.

Expected catch per drop

So far I have only considered catches on one line. The rockfish hook and line survey uses three anglers (i.e. lines) per drop, which increases the number of hooks from 5 to 15. This increases the sample space to $2^{15} = 32768$ possible outcomes, which I will not write down. I use Equation (2) to compute the capture probabilities. The basic configuration I consider is similar to that described above, but with the addition of an angler (or line) selection probability. I will revise my notation. Let l_i denote the angler (or line) selection probability, $\sum_{i=1}^{3} l_i = 1$, and let h_i denote the hook selection probability, $\sum_{i=1}^{5} h_i = 1$. Let p_o denote the fishing array detection probability.

The probability that a fish is caught by angler i (i=1,2,3) and hook j (j=1,…,5) is $f_{i,j} = p_o l_i h_i$. This gives the probability that a fish is caught on each of the 15 hooks. I extend Equation (2) to 15 hooks instead of 5.

I illustrate the probability distribution function in Figure 4. I used $\gamma = 0.75$ to specify the hook selection probabilities, and I set the angler selection probabilities to 0.4, 0.3, and 0.3. The expected catch was selected to be about the level observed in the Miguel Island area in the hook and line survey, for both bocaccio and vermilion species combined. With $p_o = 0.1$ then n=123 fish were required to give EC = 8. Note that PES = 12.3 which indicates a substantial hook-saturation effect, although rarely in this situation will all 15 hooks be "occupied".

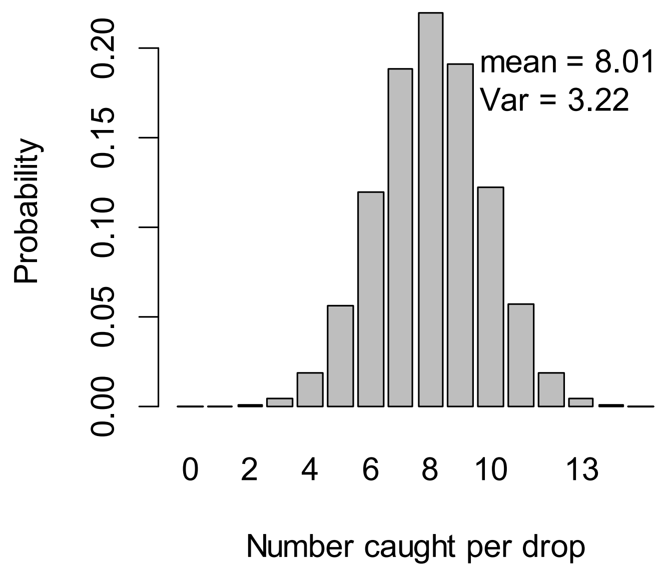

Figure 4. Probability distribution of total catch per drop, when n=123, $p_o = 0.1$, $\gamma = 0.75$, and l = (0.4,0.3,0.3).

EC per drop is plotted versus PES in Figure 5 for three values of p. There is some nonlinearity in the relationship between average catch, over the range [0,10], and abundance. The slope (proportional to Q in a stock assessment model) decreases as n increases. In Figure 6 I demonstrate that large differences in the angler selection probabilities "boosts" the saturation bias in the index. The same thing will happen if there are large differences in hook selection probabilities.

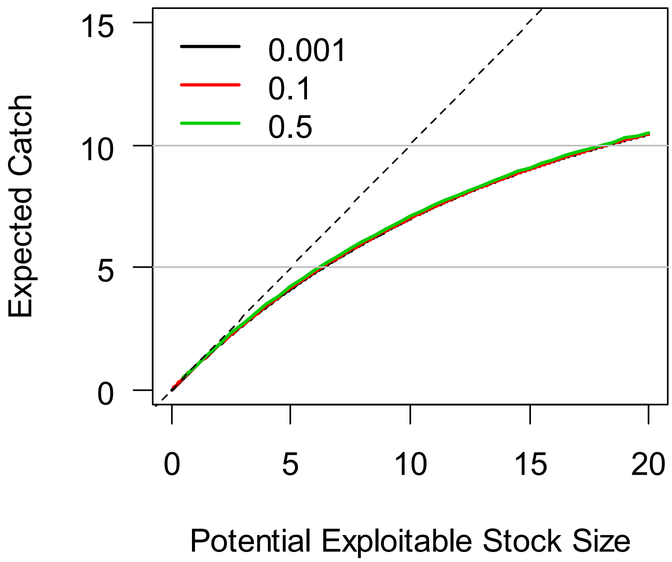

Figure 5. Expected catch versus PES (i.e. np_o). The solid lines correspond to values of p_o, which are indicated in the figure legend. $\gamma = 0.75$ and $l = (0.4,0.3,0.3)$. A dashed 1:1 reference line is shown, along with grey reference lines at 5 and 10.

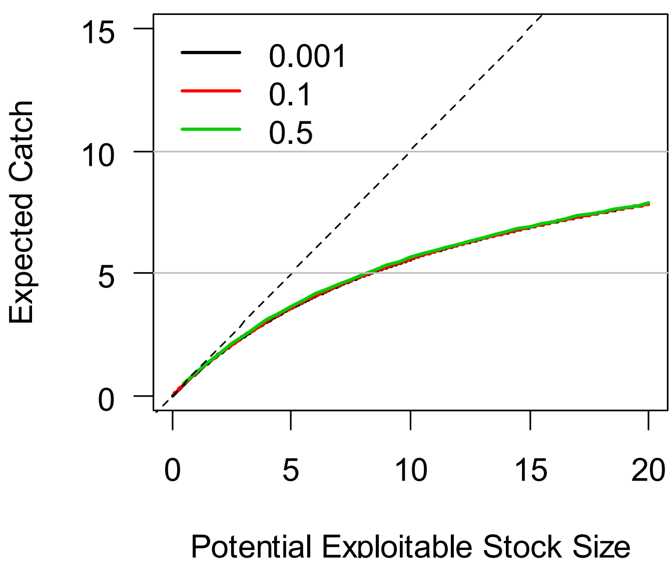

Figure 6. Expected catch versus PES (i.e. np_o) and $l = (0.8,0.1,0.1)$. The solid lines correspond to values of p_o, which are indicated in the figure legend. $\gamma = 0.75$. A dashed 1:1 reference line is shown, along with grey reference lines at 5 and 10.

The index catchability ($I = Qn$) should be proportional to the slope of the curves in Figure 5. The slope of the $p_o = 0.001$ curve in Figure 5 is shown in Figure 7. These results suggest that, for example, the index catchability when PES is around 9 will be only 50% of the catchability when the index is near zero. This could have important consequences if the index is used in a stock assessment model when the index values vary greatly. I realize this is currently not a problem.

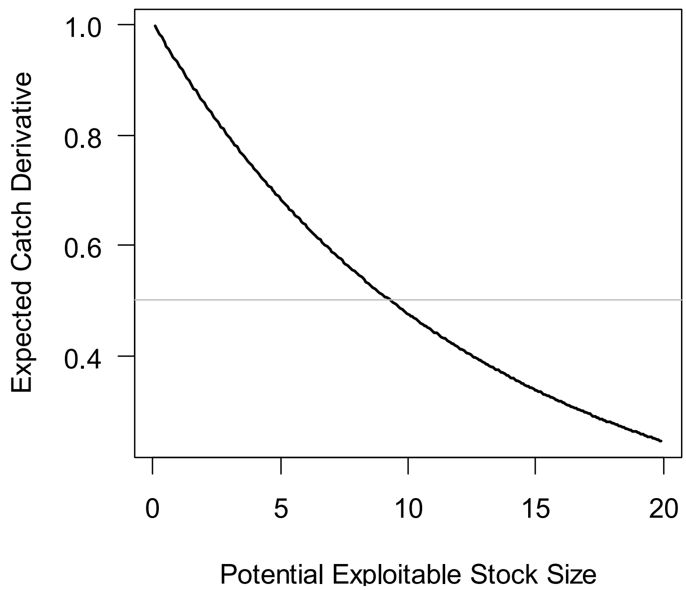

Figure 7. Slope of the EC curve for $p_o = 0.001$ in Figure 5. The slope is with respect to PES. A grey reference lines at 0.5 is shown.

The slope of the EC curve decreases linearly with EC (see Figure 8). This is the generating mechanism for the Von Bertalanffy growth curve. This is not surprising, for reasons I outline at the end of this section. This suggests that the saturation effect in the hook and line survey index can be well described by a Von Bertalanffy equation, and this equation can then be inverted to infer PES from average survey catches. I explored two approximations. The first was based on least squares estimates of the slope and intercept in Figure 8, and the second approximation was with the Von Bertalanffy asymptote fixed at 15 (the saturation level) and the growth parameter estimated.

The first approximation is shown in Figure 9, along with the EC's in Figure 5. The approximation is very accurate. The equation is

$$EC = 13.68(1 - e^{-0.072 \times PES}).$$

The second approximation is

$$EC = 15(1 - e^{-0.062 \times PES}).$$

These equations can be used to infer PES from EC. Using the first equation, EC's of 1, 5, and 10 corresponding to PES's equal to 1.06, 6.33, and 18.3. Using the second equation, EC's of 1, 5, and 10 corresponding to PES's equal to 1.11, 6.54, and 17.7. There is a technical problem with the first equation because it cannot be used to infer PES's for EC's > 13.68. The second equation does not have this problem. Note that these results are simply illustrative, and depend on the illustrative assumptions I made for hook effects, anglers effects, etc. I am not suggesting that they be used in practice, but I hope I have outlined a practical strategy to partially correct for hook saturation.

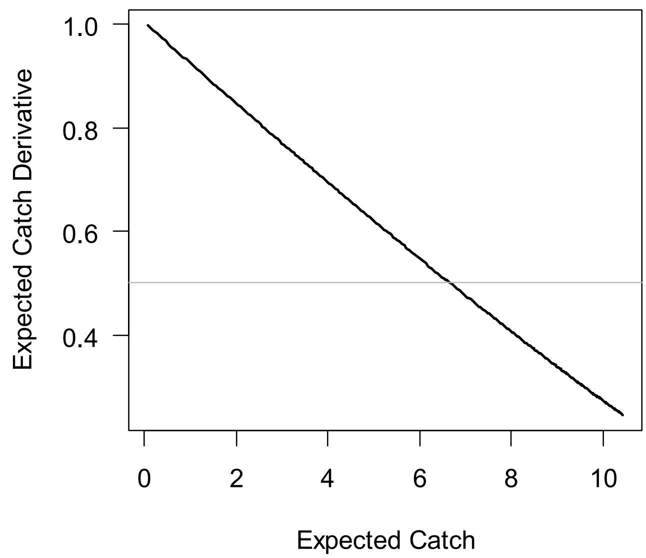

Figure 8. Slope of the EC curve for $p_o = 0.001$ in Figure 5. The slope is with respect to PES, but plotted versus EC.

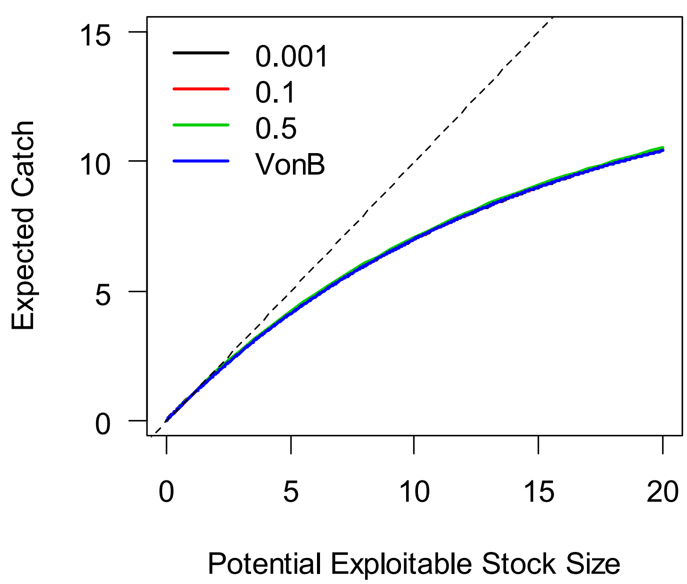

Figure 9. Expected catch versus PES (i.e. np_o). The blue line is the Von Bertalanffy approximation with slope and intercept derived from the results in Figure 8. See Figure 5 for other details.

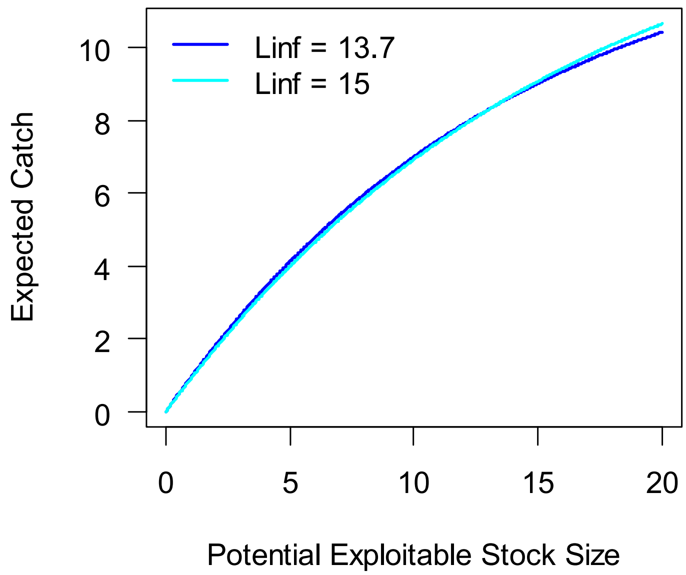

Figure 10. Comparison of the two Von Bertalanffy approximations, with maximum EC fixed at 15 or estimated. Linf refers to the asymptotic catch.

The Von Bertalanffy approximation will be exact in some situations, particularly when n is large and p_o is small. First note that if $n \rightarrow \infty$ such that $np_o = \mu$ is fixed then it can be shown that, in the limit, Equation (1) is a product of Poisson densities, each with mean parameter $\mu_i = \mu p_i$. The distribution of catch at a hook can be derived from a Poisson distribution with mean μ_i; that is, $Pr(C_i = 0) = exp(-\mu_i)$ and $Pr(C_i = 1) = 1 - exp(-\mu_i)$. EC is the sum of $Pr(C_i = 1)$ for all hooks, so

$$EC = k - \sum_{i=1}^{k} e^{-\mu_i} = k - \sum_{i=1}^{k} e^{-PES \times f_i}.$$

This equation, as a function of PES, is not invertible but it could be used to infer PES from EC and estimates of f_i's using numerical methods. If the f_i's are all equal to $1/k$ then $EC = k\left(1 - e^{-PES/k}\right)$, which is Von Bertalanffy in form. Note that if $f_i = 0$ for hook i then EC < 14, which makes sense. Similarly, if two hooks have zero selection probabilities then EC < 13, etc. It is easy to adapt this approach if hook retention probabilities are less than one.

The efficacy of this approach when n is small is a consideration; however, the close similarity of the curves in Figures 5 and 6, which are based on very different n's, suggests that the Poisson approximation will be very reliable for most practical situations. I would also like to understand why there are small differences in the curves for $p_o = 0.1$ and 0.5 in Figure 3, but not in Figures 5 and 6.

The multinomial approach for generating the probability distribution of hook and line catch assumes that fish select a hook with the same probability if the hook is occupied or not. The situation in more complicated if the hook selection probability depends on whether it is already occupied. If the selection probability is zero when the hook is already occupied, and fish simply target the remaining hooks with higher probability, then saturation will occur more quickly. I have not pursued this issue.

Improved index of abundance

It seems possible to derive a formula to infer PES from catch rates. The Poisson approximation is a simple approach that seems to provide reliable corrections. This strategy of inferring PES from EC is conceptually similar to corrections proposed by Rothschild (1967), Somerton and Kikkawa (1995), and others.

There is no "free lunch" however. As the relationship between EC and PES flattens-out, I expect that the variance of a "saturation-corrected" PES derived from average catch will get large, and at high levels of rockfish abundance, average catches from the hook and line survey will not provide useful indices of stock size. Nonetheless, I speculate that it is possible to produce improved stock size indices that are more reliable over a larger range of stock sizes compared to indices derived directly from average catches.

Five drops are conducted at each site, and this can be thought of as a depletion experiment. If stock size at a site is low then one would expect catch rates to decline with successive drops. However, at the review meeting it was mentioned that there can be complex behavioral changes as the survey vessel passes over a rockfish aggregation, and factors other than changes in stock size may affect catch rates from drop to drop. Additional information will be required to address this problem. However, for stock assessment purposes it is not necessary to estimate n, and good estimates of np (i.e. an index) are useful.

Soak times varied somewhat. Anglers retrieve their lines early if they think that most of their hooks have caught fish. Lines are retrieved early to minimize the chance of losing captured fish. It was suggested during the review meeting that some rockfish species strike the gear almost immediately, and catches would not increase with increasing soak times and they might decrease because fish could free themselves from the hooks. Hence, there seems to be somewhat complex and species specific relationships between captures probabilities and soak times, and capture "loss" probabilities. I cannot make useful recommendations to address these issues; however, Ward, Myers and Blanchard (2005) considered these issues for longline surveys, and their approaches may be useful for the rockfish hook and line survey. The methods I outlined above would require fairly straight-forward modifications to account for variable soak times if a reliable functional relationship between soak time and capture+retention probability exists.

I suggest that inferences about PES should be based first on the rockfish community level because this is what affects gear saturation. Species specific catch rates can be inferred from an analysis of the distribution of species at a site, similar to how length-distributions are estimated. A complication here will be species-specific gear-detection probabilities, which could alias more aggressive feeding by particular species, so that catch rates may not reflect the relative abundance of different species. I don't think there is any information in the hook and line survey information that would allow species-specific gear-detection probabilities to be estimated.

Correcting catch rates for covariate effects

Much was done in this regard. There are several reasons why one wants to correct for covariate effects when estimating trends in abundance. It is clearer to me now than at the review meeting that it is important to account for between-angler and between-hook variations in capture probabilities. Such variations, when large, can have important implications on the level of exploitable abundance one would infer from catch rates. Saturation effects will be larger when the variation in capture probabilities is larger.

Covariate effects on catch rates can introduce bias in estimates of exploitable population size if the covariate values change from year to year. This is well known in the survey sampling literature. However, if the covariate values are approximately fixed each year (like vessel number) then there may not be a bias issue. Another reason to include a covariate effect is to better fit the catch data which may result in lower variance estimates and narrower confidence intervals.

An important issue when including covariate effects in the catch rate model is to make sure that covariate effects are not aliased or confounded with spatial or temporal changes in stock abundance. In highly parameterized models it is possible to attribute a change in the response to the wrong covariate, and this could have important consequences on inferences. For the hook and line survey, I suggest that year and site effects be given higher priority in modeling catch rates than other effects. I suggest a sequential procedure where the data are first fit with a year+site effects model, and then other effects are examined using residuals plots (residuals vs. other covariates), and estimated with careful attention to how year and site effects change with the incorporation of additional covariates. It is difficult to be very prescriptive in how this should be done.

However, the survey team did a good job of examining the reliability of the covariate effects in their catch rate model, and I encourage them to continue with this.

Combining catch rates across sites

The current approach for combining catch rates across different sites does not seem adequate for the survey. It is based on ideas for CPUE standardization, and more can be done for the hook and line survey.

Catch rates are basically mean-standardized for each site then combined equally across all sampled sites. The mean standardization is the same for all years, but will change from year to year as additional survey data are collected. Nonetheless, removing site effects does not seem appropriate. Sites with large amounts of rockfish should get greater weight in the overall index than sites with low amounts of rockfish. The amount of habitat a site represents should also play a role. Conceptually, I suggest that each site be treated as strata, and that an overall abundance index be based on the strata size-weighted average catch rate. Determining the size of the strata that each site represents will probably require additional sampling or habitat measurements. Some spatially contiguous sites/strata could be combined if it was felt that the species and size compositions in those strata are approximately homogenous. I would not combine sites that are not spatially contiguous, unless there were good reasons for doing this.

Saturation corrections should be applied within years and sites to produce estimates of site-specific potential exploitable stock size (PES); that is, the catch rates one could conceptually be obtained using a very large number of hooks. Stock PES should be based on the strata size-weighted average, as described above.

ToR 7: Evaluate the utility of hook and line survey data for species encountered consistently at a subset of sites, but for which the survey's coverage may be near the margins of their range (e.g., copper rockfish, widow rockfish, yellowtail rockfish) and other species we encounter episodically in each survey year (e.g, chilipepper). Identify modifications to the survey's design, protocols, or analyses which may improve the utility of survey data for stock assessments of additional species.

Survey's coverage near the margins of the range of some species

A good survey should cover a large fraction of a stock. Otherwise, between-year changes in the survey index will reflect change in stock size as well as changes in spatial distribution. The latter change is much less relevant for stock assessment, although it is good to be aware of this. If a survey covers only a small fraction of the stock then the index may not reflect trends in stock size. The only way it could is if the spatial distribution of the stock does not change from year to year, and a change in abundance in a small part of the stock is the same as the overall stock size change. Similar arguments can be applied to biological sampling results.

The basic way to improve this is to extend the survey to cover the majority of those stocks that are near the margins of their range in the current survey design.

Species caught episodically each year

I assume this is the "large catch" problem. This is a difficult problem and there have been several publications dealing with this. This was basically the topic of my PhD thesis (Cadigan, 1999). I utilized a fairly simple mixture model approach that split catches into two types – regular and enormous. Regular catches were modeled as a function of spatial location (lat., long.) and depth using nonparametric regression methods – in particular, kernel smoothers. The enormous catches were considered to be independent samples from high density aggregations, and the mean of these high density aggregations was constant over time. The motivation for this assumption was that there is an upper limit on how densely fish can aggregate, and the enormous catches come from this limiting density. What changed from year to year was the probability of encountering a high density aggregation, which is proportional to the area of the high density aggregations, as a fraction of total surveyed area. This part was fairly speculative because there was not much information in the survey data to estimate this on an annual basis. My approach resulted in substantial smoothing of the survey time-series, and a great reduction in survey year effects.

This approach was conceptually similar to Thorson, Stewart, and Punt (2011), although they were more focused on explaining the occurrence of large catches and they did not seem to focus on producing a more reliable index time-series. They did not assume the high density mean was constant; they modeled it using a log-linear model that included a separate parameter for each year. Basically the mean of the high density catches was estimated separately each year, as I understand it, and this would not result in a reduction in the index variability caused by large catches.

Nonetheless, I think some type of mixture model approach is a good strategy to deal with large catches. The mixing parameter can be interpreted as the fraction of the stock area that contains these high-density aggregations. This probability, along with the mean of the high-density aggregations, will tend to be difficult to estimate. Good methods to do this remain an open research problem.

I cannot make specific recommendations for any rockfish species because we did not review the survey data for species that are caught episodically.

ToR 8: Potential survey expansion and other possible enhancements or modifications to the survey which could lead to additional objectives

- ***Does the current design lend itself to expansion?***

  If there is similar rockfish habitat to the north or south of the survey, then I see no reason why the current design could not be expanded to include new sites.

- ***Evaluate whether expanding the survey's sampling area would yield information useful for the assessment of structure associated rockfish***

  If the expansion covers the majority of the stock in question then the survey should yield useful information for the assessment of this stock. Separate indices will have to be developed for the 'traditional' and expanded survey areas. The expanded index will be more useful for stock assessment as the time series accumulates. In time, it might be possible to extend indices back to the start of the hook and line survey, depending on the spatial variability of the species. If accumulated evidence suggests that the spatial distribution of the species does not change substantially from year to year then it is possible to use catch rates from part of the species range to infer the catch rates that would be obtained over a broader range.

- ***What are the scientific benefits and drawbacks of expanding the survey into adjacent areas currently not included in the survey area such as north of Pt. Conception or into the Cowcod Conservation Areas?***

  The benefits are more information, and better stock size indices for those species that have substantial components outside the current survey area.

  If potential expansions are associated with a loss of sample sites in the current survey then this will affect the quality of the indices currently produced.

  The main drawbacks are increased survey effort, and increased catches of rockfish which may be undesirable in the CCA. If the existing survey vessels cannot be used to sample all sites in an expanded survey design, and if additional boats are used for the expanded sampling, then there is a potential that vessel effects could be confounded with site effects. Comparative fishing may help with this problem.

  If the expansion occurs by increasing the length of the survey then synopticity becomes an issue if the survey were to be conducted over several months. At this time scale there could be substantial movement of some species. Also, survey catchability may change as a function of day length.

- ***Would the methods used by this survey be effective for collecting data and generating abundance indices for other structure-associated rockfish with high commercial or recreational importance elsewhere along the coast (e.g., yelloweye rockfish off the WA or OR coast?).***

  This is hard for me to say. I am not sure that this type of fishing could work in more northerly areas, where weather conditions could be more severe. This is a question better asked to commercial fishermen in those areas.

Summary of conclusions and recommendations

ToR 1: The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.

Conclusions are provided under ToR's 3-8.

ToR 2: Review recent literature (to be provided as background materials) to become familiar with the key species and the primary science and management issues within the Pacific Fishery Management Council (PFMC) umbrella for groundfish in general and structure-associated shelf rockfish in particular.

No conclusions.

ToR 3: Evaluate the suitability of the survey sampling design. Specifically, is the design appropriate for generating abundance indices for shelf rockfish species? Comment on the benefits and drawbacks of the current fixed-site design. Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?

I conclude that the survey design is appropriate for generating abundance indices for shelf rockfish species under current stock conditions. However, stock conditions (esp. size and spatial distribution) may not have to change much to create problems with the survey design for generating indices of shelf rockfish species abundance. The problems involve changing survey catchability.

There should not be large amounts of important target species outside of the survey area. The cowcod conservation area (CCA), which is closed to rockfish fishing, is a problem for survey coverage. It is quite likely that abundance will increase more inside a closed area than outside, for stocks that are not highly mobile. There survey design will have to be modified to deal with the CCA. A joint acoustic + hook and line survey should be considered, where only the acoustic component is extended into the CCA.

It is important to recognize for stock assessment that the CCA is one reason why survey Q may be changing (esp. decreasing) over time. The effect of gear saturation is another factor (see ToR6).

It was not clear to me how 'representative' were the survey sites of rockfish habitat throughout the SCB.

The conclusion that the survey design is appropriate for generating abundance indices for shelf rockfish species under current stock conditions is not a strong conclusion, because a good monitoring survey should provide reliable trend information over a wide range of stock sizes. If the survey design has to be modified frequently to deal with changes in stock conditions then this will create problems, because there will be some uncertainty about whether changes in a stock size index are related to changes in stock size or changes in survey design.

A fixed site sampling design may give more precise estimates of stock trends. However, if different sites have different time trends in catch rates then a fixed-site design may also give biased estimates of stock trends. Indices may be auto-correlated over years in a fixed site design.

A random site design will give unbiased but less precise estimates of stock trends. When site effects are large (which seems to be the case for rockfish in SCB) then this source of variability in a random site design may dominate total variance and obscure stock trends.

There may be benefits to modify the existing design to include some measure of a random component. However, site effects in the GLM seemed large. If the interaction between year and sites is not large then the fixed site design is a good approach. If there are large interactions then adding random sites may have utility. This could be examined in a simulation exercise.

Changing the way sites are selected, by including a random component, may not disrupt the continuity of the survey time series. This conclusion is linked to the methods of analysis. If the survey area is stratified and the index was based on a strata size-weighted average, then the important issue is that all strata are sampled.

ToR 4: Evaluate the appropriateness of the gear used during the hook and line survey: rod and reel, mainline, gangion specifications, terminal tackle specifications, etc.

The very low percent of missing hooks indicate that the anglers can very successfully deploy and retrieve the survey gear.

ToR 5: Evaluate the fishing and biological sampling protocols used during the hook and line survey.

The sampling protocols seemed thorough and extensive, with good error checking.

ToR 6: Evaluate the methods and assumptions used to analyze the survey data as well as the associated uncertainty of the abundance estimates.

Estimation of abundance indices from the survey data was deficient in two aspects.

Gear Saturation

Gear saturation is an issue even when only 50% of hooks are occupied. The consequence of gear saturation is a decreasing index catchability as stock size increases. The change in catchability can be large.

The Poisson approximation results I presented show a fairly simple way to correct for gear saturation effects when the amount of saturation is not too large. When saturation is large and the correction is used, then the standard error of the index will be large.

Stock size indices should be based first on the rockfish community level because this is what affects gear saturation. Species specific indices can be inferred from an analysis of the distribution of species at a site, similar to how length-distributions are estimated.

An important issue when including covariate effects in the catch rate model is to make sure that covariate effects are not aliased or confounded with spatial or temporal changes in stock abundance. However, the survey team did a good job of examining the reliability of the covariate effects in their catch rate model, and I encourage them to continue with this.

The current approach for combining catch rates across different sites does not seem adequate for the survey. It is based on ideas for CPUE standardization, and more can be done for the hook and line survey. Conceptually, I suggest that each site be treated as a strata, and that an overall abundance index be based on the strata size-weighted average catch rate. Saturation corrections should be applied within years and sites to produce site-specific estimates of potential exploitable stock size (PES); that is, the catch rates one could conceptually obtained using a very large number of hooks.

ToR 7: Evaluate the utility of hook and line survey data for species encountered consistently at a subset of sites, but for which the survey's coverage may be near the margins of their range (e.g., copper rockfish, widow rockfish, yellowtail rockfish) and other species we encounter episodically in each survey year (e.g, chilipepper). Identify modifications to the survey's design, protocols, or analyses which may improve the utility of survey data for stock assessments of additional species.

Survey's coverage near the margins of the range of some species

The survey has limited utility for such species. A good survey should cover a large fraction of a stock. Otherwise, between-year changes in the survey index will reflect changes in stock size as well as changes in spatial distribution. The only way it could reflect only change in abundance is if the spatial distribution of the stock does not change from year to year, and a change in abundance in a small part of the stock is the same as the overall stock size change. Similar arguments can be applied to biological sampling results.

Species caught episodically each year

I assume this is the "large catch" problem. A mixture model approach is a good strategy to deal with large catches. The mixing parameter can be interpreted as the fraction of the stock area that contains high-density aggregations that produce large catches. This probability, along with the mean of the high-density aggregations, will tend to be difficult to estimate. Methods to do this remain an open research problem.

ToR 8: Potential survey expansion and other possible enhancements or modifications to the survey which could lead to additional objectives

- ***Does the current design lend itself to expansion?***

  I had no specific conclusion.

- ***Evaluate whether expanding the survey's sampling area would yield information useful for the assessment of structure associated rockfish***

  If the expansion covers the majority of the stock in question then the survey should yield useful information for the assessment of this stock.

- ***What are the scientific benefits and drawbacks of expanding the survey into adjacent areas currently not included in the survey area such as north of Pt. Conception or into the Cowcod Conservation Areas?***

  The benefits are more information, and better stock size indices for those species that have substantial components outside the current survey area. The main drawbacks are increased survey effort, and increased catches of rockfish which may be undesirable in the CCA. If the expansion occurs by increasing the length of the survey then synopticity becomes an issue if the survey were to be conducted over several months.

- ***Would the methods used by this survey be effective for collecting data and generating abundance indices for other structure-associated rockfish with high commercial or recreational importance elsewhere along the coast (e.g., yelloweye rockfish off the WA or OR coast?).***

  I had no specific conclusion.

Critique of the NMFS review process

I found ToRs 7 and 8 to be somewhat vague. We did not review in enough detail survey information on rockfish caught near the margins of the survey, nor those caught episodically, to make specific recommendations on these ToRs. Consideration of extending the survey to other areas would have benefited from reviewing commercial catch and other survey information (e.g. bottom trawl catches) in these areas. The review meeting should have been longer to allow more in depth consideration of ToRs 7 and 8.

Appendix 1: Bibliography of materials for review

Agency reports provided

Dick, E.J., D. Pearson and S. Ralston. 2011. Status of Greenspotted Rockfish, *Sebastes chlorostictus*, in U.S. waters off California**.** Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

Field, J.C., E.J. Dick, D. Pearson and A.D. MacCall. 2009. Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas for 2009. Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

Field, J.C., E.J. Dick, D. Pearson and A.D. MacCall. 2011. Status of bocaccio, *Sebastes paucispinis*, in the Conception, Monterey and Eureka INPFC areas as evaluated for 2011. Pacific Fishery Management Council Stock Assessment and Fishery Evaluation.

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Lea, R.N., R. D. McAllister and D.A. VenTresca. 1999. Biological Aspects of Nearshore Rockfishes of the Genus Sebastes from Central California With Notes On Ecologically Related Sport Fishes. Fish Bulletin 177.

Love, M.S., P. Morris, M. McCrae, and R. Collins. 1990. Life history aspects of 19 rockfish species (*Scorpaenidae: Sebastes*) from the Southern California Bight. NOAA Tech. Rep. NMFS 87, 38 p.

MacCall, A. D. 2002. Status of bocaccio off California in 2002. In: Status of the Pacific Coast Groundfish Fishery Through 2002 Stock Assessment and Fishery Evaluation Vol 1. Pacific Fishery Management Council.

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Research and Data Needs 2000-2002. Pacific Fishery Management Council.

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Sakuma, K. M., S. Ralston, and V. G. Wespestad. 2006. Interannual and spatial variation in young-of-the-year rockfish, *Sebastes spp.*: expanding and coordinating the sampling frame. CalCOFI Reports 47: 127-139.

Stewart, I.J., J.R. Wallace and C. McGilliard. 2009. Status of the U.S. yelloweye rockfish resource in 2009.

Journal articles provided

Harms, J.H., J.R. Wallace, I.J. Stewart. 2010. A fishery-independent estimate of recent population trend for an overfished U.S. West Coast groundfish species, bocaccio rockfish (*Sebastes paucispinis*). Fisheries Research 106: 298-309.

Hyde, J.R., Kimbrell, C.A., Budrick, J.E., Lynn, E.A., Vetter, R.D., 2008. Cryptic speciation in the vermilion rockfish (*Sebastes miniatus*) and the role of bathymetry in the speciation process. Mol. Ecol. 17, 1122–1136.

Additional reports reviewed subsequent to review meeting

Rothschild, B. J. (1967). Competition for gear in a multiple-species fishery. ICES J. Mar. Sci., 31:102–110.

Somerton, D. A. and Kikkawa, B. S. (1995). A stock survey technique using the time to capture individual fish on longlines. Can. J. Fish. Aquat. Sci., 52: 260–267.

Thorson, J.T, Stewart, I.A. and Punt, A.E. (2011). Accounting for fish shoals in single- and multispecies survey data using mixture distribution models. Can. J. Fish. Aquat. Sci., 68: 1681–1693.

Ward, P., Myers, R.A., and Blanchard, W. (2004). Fish lost at sea: the effect of soak time on pelagic longline catches. Fish. Bull. 102: 179–195.

Other literature cited

Cadigan, N. G. (1999). Statistical inference about fish abundance: An approach based on research survey data. Ph.D. thesis, Department of Statistics and Acturial Science, University of Waterloo, Waterloo, ON.

Chen, J., M.E. Thompson, and C. Wu. (2004). Estimation of fish abundance indices based on scientific research trawl surveys. Biometrics 60: 116-123.

Warren, W.G. (1994). The potential of sampling with partial replacement for fisheries surveys. ICES J. Mar. Sci. 51: 315-324.

Spencer, P.D., D.H. Hanselman, and D.R. McKelvey. (2012). Simulation modeling of a trawl-acoustic survey design for patchily-distributed species. Fish. Res. In press.

Appendix 2: A copy of the CIE Statement of Work

Attachment A: Statement of Work for Dr. Noel Cadigan

External Independent Peer Review by the Center for Independent Experts

NWFSC Southern California Shelf Rockfish Hook and Line Survey

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Technical Representative (COTR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance with the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in 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: The Northwest Fisheries Science Center's (NWFSC) Southern California Shelf Rockfish Hook and Line Survey was designed to collect fishery-independent data for use in the stock assessments of groundfish associated with rocky habitats that are not well-sampled using trawl surveys. Survey data are analyzed to generate annual indices of relative abundance and time series of biological data for several species of shelf rockfish (Genus: Sebastes) including bocaccio (S. paucispinis) – a species declared overfished by the Pacific Fishery Management Council (PFMC) and NOAA Fisheries and designated as a species of concern by NOAA Fisheries.

Hook and line survey data are also used to calculate abundance indices for several other species of shelf rockfish, and in some cases may be the only fishery-independent data available for use in stock assessments for those species. In addition to bocaccio, an abundance index and biological data from this survey have been incorporated into the Southwest Fisheries Science Center (SWFSC) 2011 stock assessment for greenspotted rockfish (S. chlorostictus). Abundance indices have also been calculated for starry rockfish (S. constellatus), speckled rockfish (S. ovalis), vermilion rockfish (S. miniatus) and its recently-delineated cryptic pair, sunset rockfish (S. crocotulus). A stock assessment for vermilion rockfish was conducted by the SWFSC in 2005; however its results were not endorsed by the PFMC's Science and Statistical Committee for use in management in part due to newly-identified evidence of a cryptic species pair within the vermilion rockfish complex. Because this survey collects genetic information from all captured individuals, it is possible to generate separate abundance indices and biological data profiles for both vermilion and sunset rockfish retrospectively from the survey's start in 2004.

This information may be helpful for re-visiting the stock assessment process for vermilion rockfish (and/or initiating the process for sunset rockfish.)

The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The specific goals of the proposed review meeting are to: 1) evaluate the hook and line survey's design and protocols; 2) examine the analytical methods used to generate abundance indices; and, 3) provide suggestions regarding potential expansion of the survey's geographical range and species for which abundance indices are generated - particularly for data-poor and data-limited species. The Terms of Reference (ToRs) of the peer review are attached in Annex 2. The tentative agenda of the panel review meeting is attached in Annex 3.

Requirements for CIE Reviewers: Two CIE reviewers shall conduct an impartial and independent peer review in accordance with the SoW and ToRs herein. CIE reviewers shall have working knowledge and recent experience in the application of fish population dynamics, stock assessment methods, and fishery survey design. 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 of Peer Review: Each CIE reviewer shall conduct an independent peer review during the panel review meeting scheduled in Seattle, Washington tentatively during April 4-5, 2012.

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

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

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

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

Panel Review Meeting: Each CIE reviewer shall conduct the independent peer review in accordance with the SoW and ToRs, and shall not serve in any other role unless specified herein. Modifications to the SoW and ToRs cannot be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COTR and CIE Lead Coordinator. Each CIE reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the ToRs as specified herein. The NMFS Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact is responsible for ensuring that the Chair understands the contractual role of the CIE reviewers as specified herein. The CIE Lead Coordinator can contact the Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

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

Other Tasks – Contribution to Summary Report: Each CIE reviewer may assist the Chair of the panel review meeting with contributions to the Summary Report, based on the terms of reference of the review. Each CIE reviewer is not required to reach a consensus, and should provide a brief summary of the reviewer's views on the summary of findings and conclusions reached by the review panel in accordance with the ToRs.

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

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

2. Participate in the panel review meeting in Seattle, Washington during April 4-5, 2012.

3. In Seattle, Washington during April 4-5, 2012 as specified herein, conduct an independent peer review in accordance with the ToRs (Annex 2).

4. No later than 20 April 2012, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Manoj Shivlani, CIE Lead

Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to David Die ddie@rsmas.miami.edu. Each CIE 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: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

5 March 2012	CIE sends reviewer contact information to the COTR, who then sends this to the NMFS Project Contact
21 March 2012	NMFS Project Contact sends the CIE Reviewers the pre-review documents
4-5 April 2012	Each reviewer participates and conducts an independent peer review during the panel review meeting
20 April 2012	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
4 May 2012	CIE submits CIE independent peer review reports to the COTR
11 May 2012	The COTR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COTR within 10 working days after receipt of all required information of the decision on changes. The COTR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COTR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (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) each CIE report shall completed with the format and content in accordance with Annex 1,

(2) each CIE report shall address each ToR as specified in Annex 2,

(3) the CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

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

Support Personnel:

William Michaels, Program Manager, COTR
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Roger W. Peretti, Executive Vice President
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Key Personnel:

Stacey Miller
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Stacey.Miller@noaa.gov Phone: 541-961-8475

John Harms
NMFS Northwest Fisheries Science Center (NWFSC)
2725 Montlake Blvd. E, Seattle WA 98112
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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs.

a. Reviewers should describe in their own words the review activities completed during the panel review meeting, including providing a brief summary of findings, of the science, conclusions, and recommendations.

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

c. Reviewers should elaborate on any points raised in the Summary Report that they feel might require further clarification.

d. Reviewers shall provide a critique of the NMFS review process, including suggestions for improvements of both process and products.

e. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed, regardless of whether or not they read the summary report. The CIE independent report shall be an independent peer review of each ToRs, and shall not simply repeat the contents of the summary report.

3. The reviewer report shall include the following appendices:

Appendix 1: Bibliography of materials provided for review

Appendix 2: A copy of the CIE Statement of Work

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

Annex 2: Tentative Terms of Reference for the Peer Review

2012 NWFSC Southern California Shelf Rockfish Hook and Line Survey

- The overall goal of this review is to evaluate whether the design, protocols, and analytical methods developed for the NWFSC's hook and line survey are suitable for achieving the survey's objectives. The survey's primary objective is to generate information for use in stock assessments of structure-associated rockfish, particularly those species which are poorly sampled by trawl gear used in coast-wide surveys. Such information includes fishery-independent indices of abundance as well as biological data on size, age and maturity.

- Review recent literature (to be provided as background materials) to become familiar with the key species and the primary science and management issues within the Pacific Fishery Management Council (PFMC) umbrella for groundfish in general and structure-associated shelf rockfish in particular.

- Evaluate the suitability of the survey sampling design. Specifically, is the design appropriate for generating abundance indices for shelf rockfish species?

    - Comment on the benefits and drawbacks of the current fixed-site design. Are there benefits to replace or modify the survey's existing fixed-site design with one that includes a random component? If so, do the benefits outweigh the drawbacks associated with disrupting the continuity of the survey's current 8-year time series?

  - Evaluate the appropriateness of the gear used during the hook and line survey: rod and reel, mainline, gangion specifications, terminal tackle specifications, etc.

  - Evaluate the fishing and biological sampling protocols used during the hook and line survey.

  - Evaluate the methods and assumptions used to analyze the survey data as well as the associated uncertainty of the abundance estimates.

  - Evaluate the utility of hook and line survey data for species encountered consistently at a subset of sites, but for which the survey's coverage may be near the margins of their range (e.g., copper rockfish, widow rockfish, yellowtail rockfish) and other species we encounter episodically in each survey year (e.g, chilipepper). Identify modifications to the survey's design, protocols, or analyses which may improve the utility of survey data for stock assessments of additional species.

- Potential survey expansion and other possible enhancements or modifications to the survey which could lead to additional objectives.

- o Does the current design lend itself to expansion?
- o Evaluate whether expanding the survey's sampling area would yield information useful for the assessment of structure associated rockfish.
- o What are the scientific benefits and drawbacks of expanding the survey into adjacent areas currently not included in the survey area such as north of Pt. Conception or into the Cowcod Conservation Areas?
    - o Would the methods used by this survey be effective for collecting data and generating abundance indices for other structure-associated rockfish with high commercial or recreational importance elsewhere along the coast (e.g., yelloweye rockfish off the WA or OR coast?)
- Final panel report
    - o The report will be divided into sections corresponding to design, protocols, analysis, and survey expansion. Each section should contain the reviewers' understanding of the survey's objectives for that component, followed by analysis and commentary, strengths/weaknesses, and recommended changes/modifications (if any). We also request a prioritization of recommended changes and an evaluation of the potential repercussions if the recommendations cannot be implemented due to budget constraints.

Annex 3: Tentative Agenda

2012 Hook & Line Survey Review Panel Meeting

Seattle, Washington

<u>Wednesday, April 4, 2012</u>

8:00-8:30: Welcome, Introductions, and Objectives of the Review Panel

8:30-9:45: Presentation on Survey Background, Rationale, Objectives, and Design

9:45-10:30: Presentation on Survey Operations and Sampling Protocols

10:30-10:45: Break

10:45-12:00: Discussion of Presented Material

12:00-1:15: Lunch

1:15-2:00: Presentation on Analytical Methods

2:00-3:00: Discussion of Analytical Methods

- Basic approach
- Model selection

3:00-3:15: Break

3:30-4:30: Continued Discussion of Analytical Methods

- Variance estimation
- Power analysis

4:30: Meeting ends for the day.

<u>Thursday, April 5, 2012</u>

8:00-8:15: Re-cap of Yesterday's Discussion

8:30-10:15: Continued Discussion on Analytical Methods and all Presented Material

10:30-10:45: Break

10:15-11:00: Presentation on Potential Survey Expansion

11:00-12:00: Discussion of Potential Survey Expansion

12:00-1:15: Lunch

1:15-2:00: Continued Discussion of Potential Survey Expansion

2:00-3:00: Additional Discussion (Open Topic; as Necessary)

3:00-3:30: Instruction to Panel on Final Reports

3:30pm: Meeting Adjourns

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

Appendix 3: Panel Membership

Review Panel

Chair: Mark Wilkins, AFSC (ret.)

Noel Cadigan (CIE)

Sven Kupschus (CIE)

Hook & Line Survey Team

Matt Barnhart (PSMFC/NWFSC)

Jim Benante (PSMFC/NWFSC)

John Harms (NOAA/NWFSC)

Ian Stewart (NOAA/NWFSC)

John Wallace (NOAA/NWFSC)

Other Participants

Aimee Keller (NOAA/NWFSC)

Patty Burke (NOAA/NWFSC)

Michelle McClure (NOAA/NWFSC)

Capt. Joe Villareal (F/V Mirage)

Capt. Mike Thompson (F/V Aggressor)