Report on the 2008 NWFSC --- Workshop to Evaluate Approaches for Incorporating Prior Information Regarding the Survey Catchability Coefficient (q) into Stock Assessments for West Coast Groundfish Species

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Prepared for

Center for Independent Experts

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Contents

Executive Summary

The 2008 Northwest Fisheries Science Center (NWFSC) survey trawl net catchability prior elicitation workshop was reviewed. I attended the workshop at Hotel Deca, Seattle, Washington, from September 23 - September 25 2008. Several field survey and field experimental studies on survey catchability and fish density were presented to the workshop attendees, and the validity of the catchability coefficient (q) prior elicitation procedure was discussed. A proposed q prior elicitation method for west coast groundfish species was presented, discussed and reviewed.

The purpose of this workshop was to identify and evaluate approaches for incorporating expert knowledge regarding bottom trawl survey catchability *q* into stock assessments for west coast groundfish species. The immediate goal of the CIE peer review is to provide an impartial review, evaluation, and recommendations on the workshop. The ultimate goal is to ensure that the best available science is utilized in the workshop and for future National Marine Fisheries Service management decisions related to the q prior application in fisheries stock assessment.

There have been some field experimental studies on trawl survey efficiency, density differentiation among habitats, and untrawlable areas, but none of these studies are thorough enough for us to develop a picture on seasonal and spatial variations. Several environmental factors, such as light intensity, current strength and gear variations, are found to influence either fish behaviour or gear performance, and further influence the survey trawl efficiency. Densities in trawlable and untrawlable areas are found to be largely different for some species. Well-designed field experiments on q uncertainty and methods to integrate the uncertainty in the future are suggested to better understand q.

The intention to elicit expert priors of q is considered to be very useful for better stock assessment of species with short time series, and/or limited contrary in the data. It will also help to understand q variation caused by fish behaviour, environmental factors, and geographic and trawl behaviour from field experience rather than from the stock assessment model. The prior elicitation protocol proposed by Thomas Helser, Ian Stewart, and E.J. Dick is considered adequate for primary expert knowledge elicitation, although additional suggestions and comments were provided during the workshop. The proposed q prior elicitation protocol is considered for use to collect expert knowledge of 5 species including sablefish. For each species, 5 or 6 factors will be considered during the parameter values elicitation. The post data analysis will be further validated for eliciting priors of q based on the expert knowledge of the 5 or 6 factors, and on various scenarios of organizing the expert knowledge.

Some key recommendations are summarised below:

- More information on q should be secured from historical surveys, or field experiments; future surveys such as systematically designed video surveys on untrawlable and trawlable areas will help our “expert”.

- The proposed 2-stage snowball expert selection process is good, but corresponding background information needs to be well prepared before questions are sent to the experts. The snowball expert selection process is a process in which the workshop organizer and workshop attendees were treated as first-stage experts, and these first-stage experts in turn recommended additional experts that they knew, to expand the expert pool multiplicatively.

- There were disagreements on what kind of background information should be exposed to the experts, such as the suggestions of similar species and the fishery independent survey relative abundance. However, it is agreed that information on survey trawl behaviour and fish behaviour is critically needed.

- Multiple alternative approaches for q prior elicitation after the “expert knowledge” is collected may be performed to test the robustness of the proposed approach.

1. INTRODUCTION

1.1. Background

This report reviews the 2008 workshop to evaluate approaches for incorporating prior information regarding the survey catchability coefficient (q) into stock assessments for west coast groundfish species, at the request of the Center for Independent Experts. I was provided with a literature review of catchability studies, a summary report of the west coast groundfish trawl survey, and access to relevant presentations.

The purpose of this workshop was to identify and evaluate approaches for incorporating expert knowledge regarding bottom trawl survey catchability *q* into stock assessments for west coast groundfish species. Specifically, the workshop would

1) Assemble expert pools in fields such as trawl survey gear and performance, fish behaviour and ecology, the use of survey data in stock assessments, and Bayesian methods,
2) Identify areas of common understanding regarding the factors affecting catchability for particular species or species groups.
3) Discuss methods of *q* prior elicitation, and how to incorporate these priors into stock assessment using Bayesian approach.

The following paragraphs in this section were transcribed from the workshop organization panel and explain the rationality of the workshop, including needed clarification of q and its relationship on catch efficiency (Q). Preparatory Activities were also included and the document was prepared by the workshop organization panel.

Estimates of relative abundance from bottom trawl surveys provide the primary source of fishery-independent data useful to model trends in population biomass for stock assessment models of west coast groundfish. For nearly all of these assessments annual survey biomass is derived from swept-area density estimates of the average tow and expanded to the total survey area based on a stratified random sampling frame. Several factors may contribute to a survey biomass estimate not being regarded as an absolute measure of the amount of a species contained within the surveyed area. When these factors are present, the relationship between estimates of biomass measured by the survey and those estimated within assessment models is expressed as a proportional equation. This proportional coefficient is referred to as the survey catchability coefficient, q. In theory, q is a vector of values comprised by the products of age- or size-specific qs and selectivities.

Catchability can be highly uncertain for several reasons. First, the time series of survey biomass estimates may provide the assessment model with little information regarding the absolute level of biomass, producing a relatively flat likelihood profile (in the margin of q). This situation may occur when the time series is short, without much contrast, or characterized by large coefficients of variation. Second, survey q can be highly confounded with other uncertain model parameters, such as natural mortality (M) and selectivity. Third, the ratio of swept-area biomass to true biomass is

influenced by factors such as fish behavior (herding or net-avoidance) and survey coverage of species distribution, whose effects on q cannot be precisely specified. In most west coast groundfish assessments the factors discussed above, either singly or in combination, serve to compound assessment uncertainty.

Therefore, the purpose of this workshop is to assemble experts in fields relating to the variability of q and to identify methods by which prior knowledge of q can be incorporated into stock assessments in order to reduce the uncertainty of scientific guidance regarding the status and harvest of West Coast groundfish species. The scope of the workshop will provide an opportunity to develop consistent and scientifically sound approaches for incorporating q uncertainty in stock assessments for a wide range of groundfish species. Where possible, the workshop will seek to develop prior distributions for qs of individual species or groups, based on ancillary information from multiple species. In a Bayesian context, these priors provide a straightforward method for including uncertainty in the q parameter into stock assessments. Towards this end, the workshop will consider all relevant factors affecting trawl survey catchability, which are discussed below.

The model of proportionality between the survey swept-area biomass at age or size i (I_{it}) and true population biomass at time t is:

(1) $$I_{it} = q_i B_{it}^{1+q'} \varepsilon_{it}$$

where q is the catchability coefficient, q' is the power parameter for q if the relationship between survey biomass and population biomass is nonlinear, B_t is the population biomass available to the survey and ε_t are lognormally distributed random errors given as $\ln(\varepsilon_{it}) \sim N(-0.5\sigma_i^2, \sigma_i^2)$, σ_i^2 is the standard error of $\ln(I_{it})$. The catchability coefficient q in Equation 1 is the bulk catchability which relates the total swept area biomass available to the survey to an appropriate measure of the true stock biomass through the selectivity at age/length. Somerton et al. (1999) suggested that independent estimates of survey q can be quantitatively informed from experimental estimates of trawl efficiency (Q) because q and Q are proportional. Furthermore, the influence of these factors can vary with fish age, size and sex, so the equations used to estimate q will take the form of Equation 2:

(2) $$q_i = Q_i P_i$$

where P is the proportion of the stock within the survey area, and i again indexes age or size (and possibly sex). This workshop will focus on both Q and P, since certain species exhibit avoidance or herding behavior as trawls approach and the habitats preferred by many rockfish are not accessible with the type of trawl gear used in West Coast surveys.

Preparatory Activities

The ultimate objective of the workshop is to identify, where possible, prior distributions for values of survey q, for individual species or species groups, that can be incorporated into West Coast groundfish stock assessment models. In support of that objective, efforts will be made to conduct the following types of data analysis and literature reviews for distribution prior to the workshop:

1. Compiling information for west coast groundfish species of interest from biological reference sources and west coast groundfish surveys, conducted by the Northwest and the Alaska Fisheries Science Centers. The degree to which the spatial extent of the surveys

encompass the distribution of groundfish species of interest and the degree to which the surveys have sampled all of the habitats in which each species is found will be reviewed.

2. Organizing data on depth and latitude distributions, and any other factors that may be useful in identifying species ranges and availability within the survey area considered.
3. Developing, with the aid of trawl survey data and habitat maps, a data base of trawlable and untrawlable habitats which may provide some indication of the proportion of stocks that are found within areas accessible to trawl surveys.
4. Documenting changes in survey operations through time, such as survey timing, towing speed, net type, vessel type and selection, and summarizing data that may be useful in assessing whether these changes have affected the availability of species to the survey.
5. Reviewing and summarizing, for west coast groundfish species, or related species in other regions, existing studies and analyses that identify factors influencing the values of survey *q* or age-/size-selectivity in relation to fish behavior or gear performance.
6. Explore existing data sources that could be used to develop quantitative or semi-quantitative estimates of a factor's influence on *q*. For instance, underwater observations conducted in the same areas as bottom trawl hauls have been conducted may provide information on the proportion of species occupying untrawlable grounds. Differences in the relative density of species between low- and high-relief habitats, and co-occurrence or behavioral information may be useful for grouping species.
7. Examine risk assessment literature for methods of quantitative elicitation of expert opinion and develop a formal framework to implement a procedure to elicit a Bayesian prior for survey catchability from expert opinion.

1.2. Terms of Reference (revised by the workshop organizer)

The Workshop included participants encompassing expertise in trawl survey gear and performance, fish behavior, use of survey data in stock assessments, and Bayesian methods. Participants were asked to review the information compiled in steps 1-7 above and assisted in identifying areas of common understanding regarding the factors affecting catchability for west coast groundfish.

A subset of individual groundfish species were likely to have substantially more data or direct observations upon which conclusions regarding catchability can be based. Species with more data may potentially serve as the basis for informing conclusions regarding *q* for "similar" species with less information. Of particular importance was determining whether general agreement can be reached in identifying the most influential individual factors (i.e. avoidance, escapement, herding, fraction available to trawlable areas) affecting survey q and whether a suitable process of eliciting expert judgment for development of a Bayesian prior distribution is possible.

Additional questions for discussion included:

1) What is known about density-dependent catchability both in terms of *q* and *Q*.

2) Have alternative survey methods matured sufficiently to provide estimates of species or species group density between flat bottom and rocky habitat? Can the proportion of the species that are in non trawlable areas be estimated (*P*).
3) Is there evidence that environmental factors, for which data are currently being collected on surveys (bottom temperature, ambient light, etc.), might play quantifiable roles in determining Q?

The final stage of the workshop was to involve the attempt to specify prior distributions of survey *q* for each species or species group. If possible, probability distributions for each factor affecting *q* would be specified and multiple probability distributions will be combined to produce an expected distribution for *q*. The range of these distributions across species/groups will be informed by the abundance of data and observations, the content of the data/observations with respect to *q*, and by the general level of agreement among participants regarding those relationships.

1.3. Workshop Participants

The following people attended the workshop:

Name (First Last)	Affiliation
Yan Jiao	CIE
Keith Bosley	NMFS, NWFSC
Russ Brown	NMFS, NEFSC
Carey McGillard	UW, Seattle
Henry Cheng	WDFW, Olympia
Elizabeth Clarke	NMFS, NWFSC
Jason Cope	NMFS, NWFSC
EJ Dick	NMFS, SWFSC
Martin Dorn	NMFS, AFSC
Guy Fleischer	NMFS, AFSC
Wendy Gabriel	NMFS, NEFSC
Vladlena Gertseva	OSU, Newport
Melissa Haltuch	NMFS, NWFSC
Owen Hamel	NMFS, NWFSC
Dana Hanselman	NMFS, AFSC
Jim Hastie	NMFS, NWFSC
Thomas Helser	NMFS, NWFSC
Aimee Keller	NMFS, NWFSC
Stan Kotwicki	NMFS, AFSC
Bob Lauth	NMFS, AFSC
Michael Martin	NFSC, AFSC
Murdock McAllister	UBC, Vancouver
Richard Methot	NMFS, Seattle
Stacey Miller	NMFS, NWFSC
Dan Nichol	NMFS, AFSC
Wayne Pallson	WDFW, Mill Creek
Andre Punt	UW, Seattle

David Sampson	OSU, Newport
Rick Stanley	DFO, Naniamo
Ian Stewart	NMFS, NWFSC
Theresa Tsou	WDFW, Olympia
Waldo Wakefield	NMFS, NWFSC
Farron Wallace	WDFW, Olympia
John Wallace	NMFS, NWFSC
Ken Weinberg	NMFS, AFSC
Mark Wilkins	NMFSC, AFSC

1.4. Review activities

The groundfish trawl catchability workshop was held at the Continental Conference Room - Hotel Deca, Seattle, Washington, from September 23-September 25, 2008. The meeting comprised one invited reviewer from the Center for Independent Expert (Yan Jiao), and a panel of research staff from the NWFSC and AFSC (see the list of workshop participants, above). Several professors and students from the University of Washington and Oregon State University were invited (see the list of workshop participants). Experimental studies on trawl efficiency, herding, densities in trawlable and untrawlable areas, and methods for estimating trawlable vs. untrawable areas were presented to the attendees. Observations, models, and the preliminary proposal for the prior elicitation procedure were evaluated through open discussion during the meeting. Conclusions were then drawn on whether to agree on the factors influencing survey catch efficiency, and whether to accept the prior elicitation procedure proposed by NWFSC. A summary of answers to other questions listed in the statement of work was provided, and the Terms of Reference for the workshop were reviewed to ensure that they had been answered, and that the best available science is utilized for National Marine Fisheries Service management decisions.

Prior to the meeting, the CIE reviewer reviewed the material produced by the Working Groups and read background reports. During the Open meeting, the CIE reviewer participated as a peer reviewer in the discussions on survey materials identified and provided, and the proposed prior elicitation process; provided appropriate feedback to the assessment scientists on the sufficiency of their analyses. After the Open meeting, the CIE reviewer prepared an Independent CIE Report. This report followed the format provided in the statement of the work for the reviewer.

2. SUMMARY OF FINDINGS

Considerable research effort has been devoted to identify and quantify the factors that influence fishing efficiency, and the proportion of habitat that is trawlable. Prior elicitation methodologies in other fields have been reviewed to support the development of a prior elicitation framework appropriate for NWFSC survey trawl

catchability. The factors identified during the workshop as influences on the elicitation of a q prior were regarded as appropriate, but further quantification or integration of these factors is needed. In the q prior elicitation framework, appropriate priors and elicitation approaches have been discussed. The method can be implemented for current use, but more detailed evaluations of existing data sources, expert pool, expert training, and criteria of prior re-elicitation (Bayesian updating) need to be considered. NWFSC staff investigated new methods and studies on catch efficiency quantification, prior probability distribution functions, the expert opinion elicitation process, and possible difficulties in real problem solving, which are most valuable.

2.1 Summary of findings in accordance to the Terms of Reference

TOR: The Workshop will include participants encompassing expertise in trawl survey gear and performance, fish behavior, use of survey data in stock assessments, and Bayesian methods. Participants will be asked to review the information compiled in steps 1-7 above (Preparatory Activities) and assist in identifying areas of common understanding regarding the factors affecting catchability for west coast groundfish.

Information compiled and presented in the workshop helps the participants to understand and identify factors affecting q for west coast groundfish trawl surveys. Some of the factors may be elicited as semi-quantifiable variables if full quantification is not possible. For example, escapement may be elicited as very low (0-0.01), low (0.01-0.1), moderate (0.1-0.5), high (0.5-0.8), very high (0.8-1). Semi-quantification may take the form of subjective ratings or weightings of regimes, zones, categories, or indicator. This is less accurate than full quantification, but more accurate than a quality analysis. In many cases quantifiable and semi-quantifiable variables need to be integrated together, e.g., for management strategies evaluation, benefit and cost analysis, or economic and social consequences. Quantification and semi-quantification of these factors tend to be difficult. For the species that have been selected for the q prior elicitation process, further exploitation of previous surveys and research on both trawl behaviour and fish behaviour are strongly suggested.

TOR: A subset of individual groundfish species are likely to have substantially more data or direct observations upon which conclusions regarding catchability can be based. Species with more data may potentially serve as the basis for informing conclusions regarding q for "similar" species with less information. Of particular importance will be determining whether general agreement can be reached in identifying the most influential individual factors (i.e. avoidance, escapement, herding, fraction available to trawlable areas) affecting survey q and whether a suitable process of eliciting expert judgment for development of a Bayesian prior distribution is possible.

There was not enough discussion on eliciting q priors for “similar” species with less information. Some workshop panel members expressed concern that the identification of similar species by the NWFSC may influence “expert” judgement. Borrowing data from similar species with better information on q is still suggested for species with limited information on q. A suitable strategy to avoid bias caused by the identification of similar species may be to design, in parallel, different ‘similar species’ groups (e.g., species in the same genus or family as the target species, vs. species that are in related genera or families but have similar behaviours) and comparatively test the robustness of q borrowed from these different groups of “similar” species.

The workshop attendants reached a general agreement on identifying the most influential factors affecting survey q, which will be considered in developing the q prior. These (5) factors are: *E*=Escapement (net efficiency); *H*=Horizontal herding (net efficiency); *G* = Proportion of species biomass within survey area; *S* = Fraction of the surveyed species range that is untrawlable (elicited or data-derived); *D* = Relative density in untrawlable areas). E may be split into two factions: horizontal and vertical escapement, to give 6 factors. The split between horizontal and vertical escapement applies to species that are distributed in the water column with a significant percentage of individuals above the vertical range of the trawl.

The prior elicitation protocol developed by the NWFSC was considered adequate for primary expert knowledge elicitation, although additional suggestions and comments were provided by workshop participants. Expert opinions on q prior variables are collected will be further validated with reference to the appropriate approaches for eliciting priors of q based on the expert knowledge of the 5 or 6 factors, and on various scenarios of organizing the expert knowledge. There were disagreements on what kind of background information should be exposed to the experts. However, it was agreed that information on survey trawl behaviour and fish behaviour is critically needed. Multiple approaches on q prior analyses after the data are collected may be performed to test the robustness of the proposed approach. Detailed suggestions are listed in section 3.

2.2 Summary of findings in accordance to the other questions in the statement of work

Additional questions for discussion include:

1) What is known about density-dependent catchability both in terms of q and Q?

Most workshop attendants felt that we knew little about density-dependent catchability. No well-designed surveys and quantifications were provided prior and during the workshop specifically for west coast groundfish species. Studies from

other locations and surveys are available as references, however (Harley et al. 2001).

2) Have alternative survey methods matured sufficiently to provide estimates of species or species group density between flat bottom and rocky habitat? Can the proportion of the species that are in non trawlable areas be estimated (P)?

Most workshop attendants felt that the information provided was not enough to quantify species or species group density differences between flat bottom and rocky habitat. Survey data and videos that were provided did shed some light on this question, however. These surveys and videos had not been designed to analyze species density differences among habitats, but the primary quantifications may serve as priors for species with good observations and data.

Based on the discussion among workshop participants, the proportion of the species that are in non-trawlable areas (P) can be estimated in a probabilistic way for those species with more information, but not for species with limited information.

3) Is there evidence that environmental factors, for which data are currently being collected on surveys (bottom temperature, ambient light, etc.), might play quantifiable roles in determining Q?

Based on the discussion among workshop participants, environmental factors for which data are currently collected or synthesized during surveys (bottom temperature, ambient light, etc.), might play quantifiable roles in determining Q, especially for species that are target species, or frequently occur in the surveys, or otherwise have more information available.

4) The final stage of the workshop will involve the attempt to specify prior distributions of survey q for each species or species group. If possible, probability distributions for each factor affecting q will be specified and multiple probability distributions will be combined to produce an expected distribution for q. The range of these distributions across species/groups will be informed by the abundance of data and observations, the content of the data/observations with respect to q, and by the general level of agreement among participants regarding those relationships.

There was no discussion on species-specific or species group-specific prior elicitation of q. Tom Hesler presented the proposed prior distribution for describing expert knowledge for each factor. Ian Stewart presented the proposed prior elicitation protocol and the proposed approaches for post data synthesis, which combines distributions of each factor into a prior distribution of q. The proposed priors for each factor and the data synthesis approach for priors of q were considered adequate among workshop participants. Other approaches were suggested to be explored after the expert opinions were received, such as defining

a combined q distribution by accumulating individual q distributions from individual expert opinions; or, alternatively, accumulating the distribution of factors from the individual expert opinions and then deriving a combined prior of q based on the distributions of the factors.

Since only five species will go through the q prior elicitation process, it will not be possible to summarize the q prior distributions across species/species groups. Workshop participants discussed possible correlations among factors, such as herding and escapement, relative density in untrawlable areas, and fraction of species' habitats that is untrawlable. These considerations will be included in the design of questions for the elicitation process. Workshop participants also discussed expert weighting and categorization after the data are collected, which will further serve as sensitivity analysis for future stock assessment.

3. CONCLUSIONS AND RECOMMENDATIONS IN ACCORDANCE TO THE TERMS OF REFERENCE

Field and survey information and expert knowledge should be full and appropriately used given species with different situations. More information should be secured from historical surveys, or field experience; future surveys such as systematically designed video surveys on untrawlable and trawlable areas will help our "expert". In situations where high- to moderate-quality field surveys are available, information/estimation from these surveys may be more reasonable to use as priors than information elicited from "experts" from all kinds of fields; or priors from experts working on these surveys should be heavily weighted in this situation. In situations where no, or limited field surveys are available, the use of expert opinions as proposed in this workshop is a good attempt, and should help to improve the stock assessment. The approach of borrowing strength and/or priors, such as meta-analysis (Harley et al. 2001) and hierarchical models (He and Sun 1998), from similar species is strongly suggested for further investigation in the near future.

The proposed two-stage snowball expert selection process is very good, but corresponding background information needs to be well prepared before questions are sent to the experts. The organizer is suggested to consider the types of the material and the length of the material. The organizer is also suggested to have a social scientist(s) to review the wording of the questions that will be released to the experts. The weights assigned to survey results need to be species/situation specific. For species with more surveys and experiments, knowledge from scientists working on these surveys and experiments should be much more heavily weighted.

There were disagreements on what kind of background information should be exposed to the experts, such as the suggestions of similar species and the fishery independent survey relative abundance. However, it was agreed that information

on survey trawl behaviour and fish behaviour is critically needed. This question should be resolved independently by the workshop organizer.

Multiple approaches for q prior elicitation after the “expert knowledge” are collected may be performed to test the robustness of the proposed approach. Possible approaches/analyses include:

- Monte Carlo analysis as proposed by the workshop organizer
    - Alternative plausible distributions should be examined to determine if structural differences have important effects on the output of the analysis (in both the region of the central tendency and in the tails).
    - If possible, correlations among the five (or six) factors need to be diagnosed and incorporated into the Monte Carlo simulation.
- In applications where only bounds are available for factor(s) or where joint distributions are hard to elucidate, probability bounds analysis may be appropriate to explore in the future (Ferson 1996).
- Hierarchically structured (or multi-level) priors may be considered as one approach, i.e., treat the experts’ opinions as hierarchically structured, with the mean of a factor following two (or three) levels of priors, while the variance of a factor can be treated as either single-level or multi-level. Multi-level priors tend to result in robust posterior distributions (Roberts and Rosenthal 2001).

4. REFERENCES

Ferson, S. 1996. What Monte Carlo methods cannot do. Human and Ecological Risk Assessment. 2:990-1007.

Harley, S.J., Myers, R A., and Dunn, A. 2001. Is catch-per-unit-effort proportional to abundance? Canadian Journal of Fisheries and Aquatic Sciences 58:1760-1772.

He, Z., and Sun, D. 1998. Hierarchical Bayes Estimation of Hunting Success Rates. Environmental and Ecological Statistics. 5: 223-236.

Roberts, G.O., and Rosenthal, J.S. 2001. Infinite hierarchies and prior distributions. Bernoulli. 7: 453–471.

Appendix 1: Bibliography of Materials used prior and during the workshop

Bibliographies prior to the workshop

NWFSC. 2008. Trawl survey Q literature review. Evaluating approaches to incorporate prior information on the survey catchabiity coefficient (q) into west coast groundfish stock assessment.

NWFSC. 2008. A summary report from the NWFSC bottom trawl survey workshop held by the NWFSC in 2006.

Jenkisnon, D. 2005. The elicitation of probabilities, a review of the statistical literature.

Keller, A.A., B.H. Horness, E.L. Fruh, V.H. Simon, V.J. Tuttle, K.L. Bosley, J.C. Buchanan, D.J. Kamikawa, and J.R. Wallace. 2008. The 2005 U.S. West Coast Bottom Trawl Survey of Groundfish Resources off Washington, Oregon, and California: Estimates of Distribution, Abundance, and Length Composition.

NEFSC. 2008. Construction of informed priors for trawl survey qs used during the 2007 Stock Assessment process for west coast groundfish.

Bibliographies during the workshop

Shono, H. 2008. Application of the Tweedie distribution to zero-catch data in CPUE analysis. Fisheries Research. 93:154-162.

PowerPoint presentations during the workshop

See workshop agenda

Appendix 2: Statement of Work

Statement of Work for Dr. Yan Jaio

External Independent Peer Review by the Center for Independent Experts

Workshop to Evaluate Approaches for Incorporating Prior Information Regarding the Survey Catchability Coefficient (q) into Stock Assessments for West Coast Groundfish Species

Project Background:

The purpose of this workshop is to identify and evaluate approaches for incorporating expert information regarding bottom trawl survey catchability *q* into stock assessments for west coast groundfish species. Specifically, the workshop will assemble experts in fields such as trawl survey gear and performance, fish behavior and ecology, using survey data in stock assessments, and Bayesian methods, with the aim of identifying areas of common understanding regarding the factors affecting catchability for particular species or species groups. In addition, workshop participants will discuss methods by which knowledge of *q* can be elicited from a wider set of experts and then incorporated into Bayesian priors in order to reduce the uncertainty of scientific guidance regarding the status and harvest of West Coast groundfish species.

Overview of CIE Peer Review Process:

The Office of Science and Technology implements measures to strengthen the National Marine Fisheries Service's (NMFS) Science Quality Assurance Program (SQAP) to ensure the best available high quality science for fisheries management. For this reason, the NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict

of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact. Further details on the CIE Peer Review Process are provided at http://www.rsmas.miami.edu/groups/cie/

Requirements for CIE Reviewers:

One CIE reviewer shall participate in the workshop to Evaluate Approaches for Incorporating Prior Information Regarding the Survey Catchability Coefficient (q) into Stock Assessments for West Coast Groundfish Species. The CIE reviewer shall have expertise in trawl survey gear and performance, fish behavior, use of survey data in stock assessments, and Bayesian methods.

The CIE reviewer's duties shall not exceed a maximum total of 7 days for pre-review preparations involving review of documents, participation during the 3-day workshop, and completion of the CIE independent peer review report.

The CIE reviewer shall have the requested expertise necessary to complete an impartial peer review and produce the deliverables in accordance with the SoW and ToR herein.

Statement of Tasks for CIE Reviewers:

The CIE reviewer shall conduct necessary preparations prior to the workshop, participate in the workshop, and complete the deliverables in accordance with the ToR and milestone dates as specified in the Schedule section.

Prior to the Peer Review: The CIE shall provide the CIE reviewer's contact information (name, affiliation, address, email, and phone), including information needed for foreign travel clearance when required, to the Office of Science and Technology COTR no later than the date as specified in the SoW. The Project Contact is responsible for the completion and submission of the Foreign National Clearance forms (typically 30 days before the peer review), and must send the pre-review documents to the CIE reviewers as indicated in the SoW.

Foreign National Clearance: The CIE shall provide the necessary information (e.g., name, birth date, passport, travel dates, country of origin) for the CIE reviewer to the COTR who will forward this information to the Project Contact. The Project Contact is responsible for the completion and submission of required Foreign National Clearance forms with sufficient lead-time (30 days) in accordance with the NOAA Deemed Export Technology

Control Program NAO 207-12 regulations at the Deemed Exports NAO link http://deemedexports.noaa.gov/sponsor.html

Pre-review Documents: Approximately two weeks before the peer review, the Project Contact will send the CIE reviewer the necessary background documents for the workshop. The CIE reviewer shall read the pre-review documents in preparation for the peer review. The following materials may be prepared in support of the workshop and potentially included as background information:

1. Summary of information for west coast groundfish species of interest from biological reference sources and west coast groundfish surveys, conducted by the Northwest and the Alaska Fisheries Science Centers. This may include a summary of species co-occurrence, depth and latitude distributions, body size similarities, and any other factors that may be useful in developing groupings of species that have similar characteristics.
2. Information regarding trawlable and untrawlable habitats which may provide some indication of the proportion of stocks that are found within areas accessible to trawl surveys.
3. Summary of changes in survey operations through time, such as survey timing, towing speed, net type, vessel type and selection. A summary analysis of survey data that may be useful in assessing whether these changes have affected the availability of species to the survey.
4. A review and summary of existing studies and analyses that identify factors influencing the values of survey *q* or age-/size-selectivity in relation to fish behavior or gear performance.
5. A matrix summarizing the "known" effects on catchability, quantitatively or qualitatively, for each West Coast groundfish species or species group, of interest.
6. A summary of other existing data sources that could be used to develop quantitative or semi-quantitative estimates of a factor's influence on *q* where gaps exist in the summary matrix.

Additional background documents may also be provided.

Peer Review during the Workshop: The CIE reviewer shall participate in the workshop, dates and location of the meeting are specified in the Schedule of Milestones Deliverable, and attached tentative Agenda (Annex 2). The Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Lead Coordinator can contact the Project Contact to confirm the facility arrangements.

Independent CIE Peer Review Reports:
The primary deliverable of the SoW is an independent CIE peer review report that the CIE reviewer shall complete and submit in accordance with the ToR, and the CIE report shall be formatted as specified in Annex 1.

The CIE report is to be based on the CIE reviewer's findings in accordance with the ToR, and no consensus report shall be accepted.

Terms of Reference:
Workshop participants will be asked to review the background information compiled and provided prior to the workshop, assist in identifying areas of common understanding regarding the factors affecting catchability for particular species or species groups, and synthesize this information for use in stock assessments.

Of particular importance will be determining whether general agreement can be reached regarding both the definition of species groups, which share characteristics that exert similar influences on q, and the quantification of catchability factors for those groups. This process will involve identifying the most influential individual factors (i.e. avoidance, escapement, herding, fraction available to trawlable areas) affecting survey q and defining a plausible range and most likely value for q (if possible).

Additional questions for discussion include:
1) What is known about density-dependent catchability both in terms of q and Q?
2) Have alternative survey methods matured sufficiently to provide estimates of species or species group density between flat bottom and rocky habitat? Can the proportion of the species that are in non trawlable areas be estimated (P)?
3) Is there evidence that environmental factors, for which data are currently being collected on surveys (bottom temperature, ambient light, etc.), might play quantifiable roles in determining Q?

The final stage of the workshop will involve a discussion of an exercise to elicit knowledge from additional experts in an attempt to specify prior distributions of survey q for each species or species group. If possible, probability distributions for each factor affecting q will be specified and multiple probability distributions will be combined to produce an expected distribution for q. The range of these distributions across species/groups will be informed by the abundance of data and observations, the content of the data/observations with respect to q, and by the general level of agreement among study participants regarding those relationships.

Specific tasks:
The CIE reviewer will be responsible for the following tasks:

1) Review background materials;
2) Actively participate in the workshop to be held in Seattle, Washington, from September 23-25, 2008;
3) Complete a final CIE independent peer review report after the completion of the STAR Panel meeting in accordance with the ToR and the Schedule of Milestones and Deliverables.

Schedule of Milestones and Deliverables:

25 August 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
9 September	The Project Contact will send the CIE Reviewers the pre-review documents
23-25 September	Each reviewer shall participate and conduct an independent peer review during the panel review meeting
10 October	CIE shall submit draft CIE independent peer review reports to the COTRs
24 October	CIE will submit final CIE independent peer review reports to the COTRs
31 October	The COTRs will distribute the final CIE reports to the Project Contact

Acceptance of Deliverables:

The CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, which shall be formatted as specified in Annex 1. The report shall be sent to Dr. David Die, CIE Regional Coordinator, via email at ddie@rsmas.miami.edu and Mr. Manoj Shivlani, CIE Lead Coordinator, via email at shivlanim@bellsouth.net on October 10, 2008. Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

Key Personnel:

Contracting Officer's Technical Representative (COTR):

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ANNEX 1:

Format and Contents of CIE Independent Reports

1. The report should be prefaced with an Executive Summary with concise summary of goals for the peer review, findings, conclusions, and recommendations.

4. The main body of the report should consist of an Introduction with
    a. Background
    b. Terms of Reference
    c. Workshop Participants
    d. Description of Workshop Activities

5. Summary of Findings in accordance to the Term of Reference, including answers to each question in the Statement of Work

6. Conclusions and Recommendations in accordance to the Term of Reference

5. Appendix for the Bibliography of Materials used prior and during the workshop.

6. Appendix for the Statement of Work

7. Appendix for the final workshop agenda.

8. Appendix for other pertinent information for the CIE peer review.

ANNEX 2:

Workshop to Evaluate Approaches for Incorporating Prior Information Regarding the Survey Catchability Coefficient (*q*) into Stock Assessments for West Coast Groundfish Species.

Hotel Deca
September 23-25, 2008
Seattle, WA

Tuesday, September 23:

AM Session: *Factors affecting bottom trawl survey catchability - empirical and experimental observations.*

9:00 - 9:30 Opening Remarks - Thomas Helser and Jim Hastie, NWFSC.
9:30 - 10:00 Gear efficiency of a bottom trawl for flatfish - Ken Weinberg, AFSC.
10:00 - 10:30 Escapement under a trawl footrope by crabs, gadids and flatfish - Stan Kotwicki, AFSC.
COFFEE BREAK
11:00 - 11:30 Escapement in front of a survey trawl footrope at liftoff: a possible reason for dome shaped selectivity - Mark Wilkins, AFSC.
11:30 - 12:00 12:00 - 12:30 Herding by the trawl bridles of gadids and flatfish - Stan Kotwicki, AFSC.
12:00 - 12:30 Discussion
LUNCH
PM Session: *Factors affecting bottom trawl survey catchability - empirical and experimental observations - continued.*
2:00 - 2:30 Thornyhead q estimation with a camera sled - Bob Lauth, AFSC.
2:30 - 3:00 Video-trawl pilot study: implications regarding survey bottom trawl catchability for canary rockfish - David Sampson, OSU.
3:00 - 3:30 Video observations of trawl performance from the West Coast bottom trawl survey - Keith Bosley and Victor Simon, NWFSC.
COFFEE BREAK
4:00 - 5:00 Discussion

Wednesday, September 24:

AM Session: *Relative density of groundfish in trawlable and untrawlable habitat.*
9:00 - 9:30 Rockfish behavior around bottom trawls and comparative measures of relative density between trawlable and untrawlable habitat - Waldo Wakefield, NWFSC.
9:30 - 10:00 Empirical estimates of rockfish density in trawlable vs. untrawlable habitat off Washington based on submersible dives - Farron Wallace, WDFW.
10:00 - 10:30 Calculation of untrawlable habitat in the NWFSC West Coast bottom trawl survey - Curt Whitmire and Ian Stewart, NWFSC.
COFFEE BREAK

11:00 - 11:30 Large scale changes in survey catchability: calibrating for simultaneous changes in survey vessel, gear and sampling protocols - Russ Brown, NEFSC.

11:30 - 12:00 Accounting for systematic changes in survey catability using a multispecies GLMM - John Wallace and Thomas Helser, NWFSC.

12:00 - 12:30 Discussion

LUNCH

PM Session: *Methods for eliciting and application of a Bayesian prior for survey catchability.*

1:30 - 2:00 Rockfish catchability in bottom trawl surveys: developing first estimates of a Bayesian prior through consultation with harvetors - Rick Stanley, DFO Canada.

2:00 - 2:30 A Bayesian model to formulate a multivariate prior for survey catchability for several different trawl surveys - Murdoch McAllister, UBC, Canada.

COFFEE BREAK

3:00 - 3:30 Expert elicitation of a Bayesian prior distribution for bottom trawl survey catchability: Concept to application - Thomas Helser, Ian Stewart and E.J. Dick, NWFSC.

3:30 - 4:00 A graphically assisted expert elicitation with application to bottom trawl survey catchability: Preliminary results using the Graphical Expert Elicitor (GEE) - Ian Stewart, Thomas Helser and E.J. Dick - NWFSC.

4:00 - 5:00 Discussion

Thursday, September 25:

AM Session:

9:00 - 12:00 Group discussion: Where do we go from here? Will the elicitation approach proposed and resultant prior distribution on survey catchability be adequate for use in stock assessments?

* Note: We will be requesting extended abstracts (to include several figures and/or tables) or preliminary papers for inclusion in a NOAA Technical Memorandum which will serve as the workshop report.

Appendix 3: Final Workshop Agenda

Workshop to Evaluate Approaches for Incorporating Prior Information Regarding the Survey Catchability Coefficient (*q*) into Stock Assessments for West Coast Groundfish Species.

Hotel Deca
September 23-25, 2008
Seattle, WA

Tuesday, September 23:

AM Session: *Factors affecting bottom trawl survey catchability - empirical and experimental observations.*

9:00 - 9:30 Opening remarks - Jim Hastie and Thomas Helser, NWFSC.

9:30 - 10:00 Literature review of bottom trawl catchability: behavior of fishes, nets and models - Owen Hamel and Melissa Haltuch, NWFSC.

10:00 - 10:30 Estimating capture probability of a survey bottom trawl. Part 1: Trawl efficiency – escapement under the footrope and hearding. - Stan Kotwicki, Dave Somerton, Ken Weinberg, and Dan Nichol, AFSC.

COFFEE BREAK

11:00 - 11:30 Escapement in front of a survey trawl footrope at liftoff: a possible reason for dome shaped selectivity - Michael Martin and Mark Wilkins, AFSC.

11:30 - 12:00 Estimating capture probability of a survey bottom trawl. Part 2: Vertical availability - Stan Kotwicki, Dave Somerton, Ken Weinberg, and Dan Nichol, AFSC.

12:00 - 12:30 Discussion

LUNCH

PM Session: *Factors affecting bottom trawl survey catchability - empirical and experimental observations - continued.*

2:00 - 2:30 Thornyhead q estimation with a camera sled - Bob Lauth, AFSC.

2:30 - 3:00 Video-trawl pilot study: implications regarding survey bottom trawl catchability for canary rockfish - David Sampson, OSU.

3:00 - 3:30 Video observations of trawl performance from the West Coast bottom trawl survey - Keith Bosley and Victor Simon, NWFSC.

COFFEE BREAK

4:00 - 5:00 Discussion

Wednesday, September 24:

AM Session: *Relative density of groundfish in trawlable and untrawlable habitat.*

9:00 - 9:30 Rockfish behavior around bottom trawls and comparative measures of relative density between trawlable and untrawlable habitat - Waldo Wakefield, NWFSC.

9:30 - 10:00 Empirical estimates of rockfish density in trawlable vs. untrawlable habitat off Washington based on submersible dives - Farron Wallace, WDFW.

10:00 - 10:30 Calculation of untrawlable habitat in the NWFSC West Coast bottom trawl survey - Curt Whitmire and Ian Stewart, NWFSC.

COFFEE BREAK

11:00 - 11:30 Large scale changes in survey catchability: calibrating for simultaneous changes in survey vessel, gear and sampling protocols - Russ Brown, NEFSC.

11:30 - 12:00 Accounting for systematic changes in survey catability using a multispecies GLMM - John Wallace and Thomas Helser, NWFSC.

12:00 - 12:30 Discussion

LUNCH

PM Session: *Methods for eliciting and application of a Bayesian prior for survey catchability.*

1:30 - 2:00 Rockfish catchability in bottom trawl surveys: developing first estimates of a Bayesian prior through consultation with harvetors - Rick Stanley, DFO Canada.

2:00 - 2:30 A Bayesian model to formulate a multivariate prior for survey catchability for several different trawl surveys - Murdoch McAllister, UBC, Canada.

COFFEE BREAK

3:00 - 3:30 Elicitation of a Bayesian prior for survey catchability from expert opinion: Concept to application - Thomas Helser, Ian Stewart and E.J. Dick, NWFSC.

3:30 - 4:00 A graphically assisted expert elicitation with application to bottom trawl survey catchability: Preliminary results using the Graphical Expert Elicitor (GEE) - Ian Stewart, Thomas Helser and E.J. Dick - NWFSC.

4:00 - 5:00 Discussion

Thursday, September 25:

AM Session:

9:00 - 12:00 Group discussion: Is there agreement on the principal factors affecting bottom trawl survey catchability? Where do we go from here? Will the elicitation approach proposed and resultant prior distribution on survey catchability be adequate for use in stock assessments?

* Note: We will be requesting extended abstracts (to include several figures and/or tables) or preliminary papers for inclusion in a NOAA Technical Memorandum which will serve as the workshop report. An extended abstract should include 1-2 pages of text and accompanying tables and figures.

Appendix 4: Other pertinent information for the CIE peer review

None