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Région du Pacifique

**Proceedings of the Pacific Region
Science Advisory Process on Pacific
ocean perch in Queen Charlotte
Sound, British Columbia**

**Compte rendu du processus d'avis
scientifique régional sur le sébaste du
Pacifique au Détroit de la Reine-
Charlotte, Colombie-Britannique**

**November 24, 2010
Nanaimo, British Columbia**

**24 novembre 2010
Nanaimo (Colombie-Britannique)**

**Greg Workman
Chair**

**Greg Workman
Président**

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May 2012

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

A regional advisory process meeting was held November 24, 2010 in Nanaimo (BC) to conduct a science peer review of the status of Pacific ocean perch (*Sebastes alutus*) in Queen Charlotte Sound, British Columbia. The science review was conducted in response to a request from DFO Fisheries and Aquaculture Management (FAM) for advice regarding the current stock status of Pacific ocean perch (POP) in Groundfish management areas 5AB and 5CD. Advice was requested on recommended limit reference point (LRP), upper stock reference point (USR) and target reference point (TRP), and the supporting rationale for their application to management of the POP stock in Queen Charlotte Sound. Harvest options were requested in the form of decision tables that summarize the expected effects of a range of catches relative to unfished stock size, current stock size and the future stock trajectory. Additional information needed to implement ecosystem-based fisheries management consistent with Sustainable Fisheries Framework (SFF) was also requested.

The Participants reviewed a working paper that described the development of an age and sex-structured catch at age model which was applied to the available data for POP in Queen Charlotte Sound. Four hypotheses distinguished by values of stock-recruitment steepness and natural mortality were evaluated using the model. Two hypotheses where steepness was freely estimated were (i) accepted as the basis for harvest advice, (ii) produced stock reconstructions with similar trends, and (iii) provided different characterizations of current stock status with respect to B_{MSY} -based reference points. The median posterior female spawning biomass at the beginning of 2011 is estimated to be 0.26 (0.12 to 0.43) when natural mortality is freely estimated and 0.14 (0.08 to 0.24) of the unfished equilibrium level when natural mortality is fixed at 0.06 (numbers in brackets denote the 2.5th and 97.5th percentiles of the posterior distribution of female spawning biomass). Estimates of annual exploitation rates have increased since the 1980s and are approaching, or have reached, the historic high levels associated with large catches by foreign fleets that occurred when the stock showed significant depletion in the late 1960s and 1970s. The exploitation rate in 2010 is estimated to range from 0.04-0.15, or 0.09-0.22, depending on the values of steepness and natural mortality. Following an increase in the stock biomass in the mid to late 1980s, the POP stock in Queen Charlotte Sound declined to historic lows by 2006/07 and has since increased slightly. Advice on future harvest is provided in the form of decision tables that show the probability of female spawning biomass, B_t , exceeding $0.4B_{MSY}$, $0.8B_{MSY}$, and B_{MSY} in each year of a five-year projection from 2011 to 2016.

SOMMAIRE

Une réunion sur le processus de consultation régionale a eu lieu le 24 novembre 2010 à Nanaimo, en Colombie-Britannique afin de procéder à un examen scientifique par les pairs de l'état du sébaste du Pacifique (*Sebastes alutus*) au Détroit de la Reine-Charlotte, en Colombie-Britannique. L'examen scientifique a été réalisé en réponse aux demandes de consultation formulées par Gestion des pêches et de l'aquaculture (GPA) du MPO concernant l'état du stock actuel du sébaste du Pacifique dans les zones de gestion du poisson de fond 5AB et 5CD. On a demandé conseil sur le niveau de référence limite (NRL), le niveau de référence supérieur (NRS) et le point de référence cible (PRC) recommandés. La justification appuyant l'utilisation de ces références dans le cadre de la gestion du sébaste du Pacifique au Détroit de la Reine-Charlotte devait également être fournie. On a demandé des renseignements sur les options de récolte sous forme de tableaux de décisions résumant les répercussions attendues selon différentes récoltes relativement à la taille du stock non exploité, à la taille du stock actuel et au trajet migratoire du stock futur. On a aussi demandé d'autres renseignements sur la mise en œuvre d'une gestion des pêches axée sur l'écosystème conformément au Cadre pour la pêche durable (CPD).

Le Comité a examiné un document de travail qui décrit la mise au point d'un modèle de récolte selon l'âge dont la structure se base sur l'âge et le sexe qu'on a appliqué aux données disponibles pour le sébaste du Pacifique au Détroit de la Reine-Charlotte. Quatre hypothèses qui se distinguent par les valeurs de variations stock-recrutement et du taux de mortalité naturel ont été évaluées selon ce modèle. Deux hypothèses selon lesquelles le taux de variation a été estimé librement (*i*) ont été acceptées en tant que fondement pour les conseils sur les récoltes, (*ii*) ont produit des données de reconstitution des stocks ayant des tendances semblables et (*iii*) ont fourni différentes caractéristiques de l'état actuel du stock conformément aux points de référence basés sur la B_{RMS} . La moyenne à posteriori de la biomasse féconde au début de 2011 est estimée à 0,26 (0,12 à 0,43), alors que le taux de mortalité naturelle est estimé librement et à 0,14 (0,08 à 0,24) du niveau d'équilibre du stock non exploité et que la mortalité naturelle est établie à 0,06 (les nombres entre parenthèses représentent le 2,5^e et le 97,5^e centile de la probabilité à posteriori de la biomasse féconde). Les taux d'exploitation annuelle estimatifs ont augmenté depuis 1980 et ils ont atteint, ou ils sont en voie d'atteindre, les hauts niveaux historiques des grandes récoltes de flottes étrangères qui avaient lieu lorsqu'un déclin important des stocks a été constaté à la fin des années 60 et 70. L'estimation du taux d'exploitation de 2010 se chiffre entre 0,04-0,15, ou 0,09-0,22, compte tenu des valeurs de la variation et du taux de mortalité naturelle. Entre le milieu et la fin des années 80, la biomasse du stock a connu une augmentation, le stock de sébastes du Détroit de la Reine-Charlotte a ensuite diminué pour atteindre les bas taux historiques de 2006 et 2007, depuis une légère augmentation a été constatée. Les conseils sur les récoltes futures sont fournis dans des tableaux de décisions qui illustrent la probabilité de la biomasse féconde, en G_t , surpassant $0,4B_{RMS}$, $0,8B_{RMS}$ et la B_{RMS} de chaque année pour une prévision de cinq ans (de 2011 à 2016).

INTRODUCTION

A Pacific region science advisory process peer review of Pacific ocean perch (POP, *Sebastes alutus*) in Queen Charlotte Sound, British Columbia was conducted in Nanaimo (BC) on November 24, 2010. The terms of reference for the science review were developed by the Centre for Science Advice Pacific (CSAP) office, (Appendix 1) in response to a request from Fisheries Management (FAM). Notifications of the science review and conditions for participation were sent to identified industry associations, non-governmental organizations, and First Nations organizations with an interest in the Pacific ocean perch resource of Queen Charlotte Sound, British Columbia on November 2, 2010 (Appendix 2, 3).

A working paper was prepared and made available for review by meeting participants on November 15, 2010:

Stock Assessment for Pacific ocean perch (*Sebastes alutus*) in Queen Charlotte Sound, British Columbia for 2010. Andrew M. Edwards, Paul J. Starr, and Rowan Haigh.

The meeting began at 9:00 AM, Wednesday, November 24, 2010. Chair G. Workman welcomed participants, explained room arrangements and reviewed the agenda (Appendix 4) for the meeting. The chair asked meeting participants to introduce themselves (Appendix 3). The chair then reviewed the rules of exchange for the meeting, reminding participants that the meeting was a science review although all participants were encouraged to voice their comments and questions. Rapporteur duties were assigned to K. Holt (Science, Pacific Region).

The proceedings presented in this series focus on the main points discussed in the presentations and deliberations stemming from the activities of the stock assessment regional review. The regional review is a process opened to all participants who are able to provide a critical outlook on the status of the assessed resources. In this regard, all participants are invited to take part in the meeting's activities. Proceedings also focus on recommendations made by the meeting participants.

CONTEXT

Pacific ocean perch is a commercially important species of rockfish that inhabits the marine canyons along the coast of British Columbia. Of the current annual Total Allowable Catch (TAC) of rockfish on the west coast of Canada, POP is the species that has the largest single-species quota at 6,148 t for the 2010/11 fishing year. By weight, POP represents approximately 25 percent of the bottom trawl landings of groundfish species in BC. This stock has supported a domestic trawl fishery for decades and was heavily fished by foreign fleets from the mid-1960s to mid-1970s. The trawl fishery is allocated 99.98% of the TAC, with the remainder allocated to the hook and line fishery. The status of POP in Queen Charlotte Sound, British Columbia is assessed under the assumption that it is a single stock harvested entirely in Pacific Marine Fisheries Commission major areas 5A, 5B and 5C. The last update of the status of POP was conducted in 2001; the last comprehensive assessment was in 1999. Updated harvest advice was requested to determine if current harvest levels are sustainable and whether management actions are compliant with both the "DFO Sustainable Fisheries Framework" (SFF) policy and "A fishery decision-making framework incorporating the Precautionary Approach" (PA) policy.

STOCK ASSESSMENT FOR PACIFIC OCEAN PERCH (*SEBASTES ALUTUS*) IN QUEEN CHARLOTTE SOUND, BRITISH COLUMBIA IN 2010

The working paper was presented by authors A. Edwards, P. Starr and R. Haigh. The presentation was organized into six sections:

- Review of fishery and catch history and definition of the stock area;
- Review of input data;
- Model description and results from maximum posterior density (MPD) analysis;
- Bayesian analysis of model outcomes;
- Reference points, projections, and decision tables;
- Conclusions and recommendations

The authors reviewed the history of the POP fishery and historical catches. The geographic extent of the assessment area was described, including the rationale for combining data from Moresby, Mitchell's and Goose Island gullies which was based on pragmatic considerations and the lack of evidence for genetic separation of stocks with the assessment area. Data selected for inclusion in the stock reconstruction included historical catches, three fishery-independent survey indices, and ageing data derived from both the commercial trawl fishery and fishery-independent surveys.

The development of an age-structured catch-at-age model with separate sexes was described by the authors. Parameters estimated externally to the model and input as fixed values included sex-specific von Bertalanffy growth parameters, maturity schedules, length-weight relationships, and the selectivity function for the Queen Charlotte Sound bottom trawl survey. Key model assumptions included that a single stock exists in Queen Charlotte Sound which is closed to immigration-emigration, Beverton-Holt stock-recruitment, catches are known without error, time-invariant growth and maturity, and time-invariant commercial and survey selectivity. The stock was assumed to be at an unfished equilibrium in 1940. Selectivity was modeled as an age-based process by imposing an asymptotic function to ensure that there was no decline in the selectivity for older fish. Model fits were conditioned using iterative re-weighting of likelihood components; this process is an attempt to weight the input data such that statistical error assumptions for each set of input data are more closely met. Alternative hypotheses were considered in the characterization of stock status, distinguished by the values of stock-recruitment steepness, h , and natural mortality, M . Steepness was either fixed at $h=0.67$ or allowed to be estimated subject to a Bayesian prior. Natural mortality was either fixed at $M=0.06$ for both sexes or allowed to be feely estimated subject to Bayesian priors. This produced four model hypotheses:

1. Fixed natural mortality and steepness, "Fixed M & h ";
2. Fixed natural mortality, estimated steepness, "Estimate h ";
3. Estimated natural mortality, fixed steepness, "Estimate M "; and,
4. Estimated natural mortality and steepness, "Estimate M & h "

Comparison of observed and predicted values for stock indices and ageing data showed that the model fits were qualitatively similar, although there is no statistical means of model

selection. Iterative re-weighting leads to different data weightings that preclude the application of formal model selection criteria. Inspection of the MPD estimates obtained for each hypothesis shows that estimating M caused larger differences in model outcome than estimating steepness. Estimates of h and M were greater than their corresponding fixed values which meant that stock productivity was estimated to be higher in comparison to results when these parameters were fixed. Unfished biomass, B_0 , was greater for hypotheses where M was estimated which meant that both the stock depletion, B_t / B_0 , and exploitation rate at maximum sustained yield, U_{MSY} , were greater in comparison to when h and M were fixed.

The characteristics of the Bayesian posterior distributions corresponding to each hypothesis were presented; the authors argued that the Markov Chain Monte Carlo (MCMC) algorithm used to obtain the posterior distributions had converged based on visual inspection of marginal posterior trace plots, i.e., there was little evidence of serial auto-correlation in the trace plots. The hypothesis "Estimate M & h " was advanced as the preferred model configuration by the authors as it included the most uncertainty among the four alternatives and produced a marginal posterior distribution for survey catchability that was more plausible, in the author's view.

Reference points were estimated by projecting the model forward to equilibrium over a range of incremental catch levels until less than a 1% change in spawning biomass was observed. The catch level corresponding to that point was taken as the estimate of maximum sustained yield, and the exploitation rate and spawning biomass levels were taken as U_{MSY} and B_{MSY} , respectively. The limit and upper stock reference points were set at $0.4B_{MSY}$ and $0.8 B_{MSY}$. Decision tables were presented that showed the probability of female spawning biomass, B_t , exceeding three reference points ($0.4B_{MSY}$, $0.8B_{MSY}$, B_{MSY}) in each year of a five-year projection. Probabilities were calculated at fixed annual catch levels that ranged from 0 to 6,000 t in increments of 500 t. The expected ratio of B_t / B_{MSY} was also calculated at the same range of annual catch levels. Status outcomes for female spawning biomass in 2011 relative to B_{MSY} varied widely depending on the hypothesis. The distribution of B_{2011}/B_{MSY} for the "Fixed M and h " hypothesis indicated 0 probability of the stock being in the Healthy zone, with most of the distribution in the Cautious zone but a significant probability of being in the Critical zone. In contrast the distribution of B_{2011}/B_{MSY} for the "Estimate M and h " hypothesis indicated a high probability of the stock being in the Healthy zone, significant probability of being in the Cautious zone, and 0 probability of being in the Critical zone. The authors concluded that the hypotheses with fixed M were implausible because estimates of survey catchability were too high. They also noted that the recent annual catches of approximately 3,500 t (the 2006-2010 average catch) appeared to be near the MSY level.

After noting the caveats that there are no stock index data available prior to 1967 and no ageing data prior to 1978, the authors provided recommendations that emphasized the need for continuing the multi-species bottom trawl surveys and, in particular, the gathering of age-structured information to improve estimation of selectivity for all surveys used in the assessment.

A Science participant commented on the choice to manage POP in Queen Charlotte Sound as a single stock. He reported that significant exploitation of Moresby Gulley POP had occurred following the departure of the foreign fleets from Canadian waters. The age structure of POP sampled during the early exploitation of Moresby Gulley was consistent with a relatively unexploited population despite the longer history of removals at other troughs within the Queen Charlotte Sound region, e.g., Goose island Gulley. This observation suggested some location affinity by POP that could support arguments for a finer scale of stock management. However,

the participant agreed with the decision to treat Queen Charlotte Sound as a single stock for the current assessment.

DISCUSSION OF REVIEWS

Participants considered reviews by J. Schnute, N. Taylor, and S. Martell following the presentation of the working paper.

Reviewer 1 provided a summary of data and model trends noting that (i) the Queen Charlotte Sound survey had declined by half from a relative biomass of ~20,000 t to ~10,000 t between 2004 and 2009, and (ii) reduced representation of old female POP in recent age data. He noted that all four hypotheses produced model results that indicate female spawning biomass is currently estimated to be at a historic low level and all show significant depletion from B_0 . Recruitment estimates suggest that occasional large recruitments upon which the stock and fishery have depended have not occurred since the 1970s, which is of concern given the life history strategy of long-lived rockfishes. He concluded the review summary with the point that the assessment results show that the spawning stock biomass has undergone persistent decline since the mid-1960s and has experienced persistently increasing exploitation rates since the early 1980s. In particular, the rate of increase in exploitation rates appears to have accelerated since 2000. The reviewer advocated the adoption of hypotheses with fixed natural mortality. The reviewer also suggested that the assumption that the standard deviation of recruitment anomalies is 0.9 may lead to optimistic projections. In response, the authors pointed out that the projections were largely determined by recruitments already observed because of the five year time horizon. He also remarked that he appreciated the author's attempts to portray a range of hypotheses and the efforts to portray uncertainty in model outcomes.

Discussion of the reviewer's points focussed on the relative absence of older females in 2009. An industry participant pointed out that old females were under-represented in samples from the late 1970s and late 1980s but had re-appeared in subsequent years. The reviewer attributed this to the onset of large recruitments that reduced the relative proportions of older fish, but commented that explanation was less plausible for 2009 data given the lack of evidence for a recent strong recruitment. A Science participant offered the view that the 2009 age structure is probably a transitory result of sampling, as it is unlikely that 30 years of older fish disappeared from 2008 to 2009.

Reviewer 2 provided an overview of key concerns contained in his written review. These concerns included (i) auto-correlation in recruitment anomalies, (ii) the need for convergence diagnostics for MCMC chains, (iii) criteria for choice of the preferred model hypothesis, (iv) inconsistencies in reference point outcomes, and (v) interpretation of stock status. The reviewer made the point that there was high autocorrelation in the recruitment residuals for the current assessment, a result that can lead to biased estimates of steepness as demonstrated by Ianelli (2002). He suggested that this potential bias be considered in subsequent assessments. The authors agreed to report the autocorrelation in the recruitment anomalies in revisions to the working paper. The reviewer commented on the need to determine convergence of the MCMC chain, taking the view that although diagnostics may not demonstrate convergence they can provide evidence for the lack of convergence and therefore invalid credibility intervals.

The opinion of Reviewer 2 was that the rationale for selection of the "Estimate M & h " hypothesis as the preferred basis for management advice was not well-supported by model fit arguments. He further noted that median U_{MSY} estimates ranged from 0.070 to 0.098 which is consistently higher than natural mortality median estimates of 0.066 to 0.067. This concern was

shared by Reviewer 3. He noted the SFF guidance that suggests that when two or more characterizations of stock status cannot be discriminated that the more precautionary outcomes should be the basis for advice. The implication of this guidance is that the preferred hypothesis should include fixed $M=0.06$.

Reviewer 3 provided his synopsis of key assessment concerns. First, the analyses suggested the available stock abundance time series provide a "one-way trip" index of stock trajectory that potentially confounds interpretation, i.e., is the stock small but productive, or a large stock that has been progressively depleted? Second, the reviewer found the recent increasing trend in exploitation rates to be of significant concern because the trend suggested that depensation could be occurring. However, the Participants noted this conclusion was based on the MPD plot of exploitation rates; examination of plots of the Bayesian posterior of the same quantities showed a drop in exploitation rates after 2006 for the "Estimate h " and "Estimate M and h " hypotheses. Finally, the reviewer suggested that the low depletion level associated with the estimates of B_{MSY} were a concern, as posterior median depletion ranged from 0.242 to 0.285 over the four hypotheses. A discrepancy between the reviewer's estimates of reference points and those contained in the paper was resolved following the meeting when it was determined that the reference points reported in the paper were correct. The reviewer asked for the presentation of pair-wise plots of the marginal posterior distributions of model parameters to check for high correlations and therefore potential non-convergence of the MCMC chain. These plots were presented to the Participants and no convergence problems were indicated.

The reviewer suggested that the authors revise their conclusions that (i) management has halted the decline in abundance from levels in the early 2000s, and (ii) that current catches are at about the MSY level because the stock has not increased. He pointed out that there should be no expectation of increasing stock abundance when catches are relatively unchanged and exploitation rates are increasing. He also remarked that given the age at which POP recruit to the fishery, the 2000 and 2001 year classes are just now beginning to make an appearance in the commercial fishery age samples. Thus, he concluded that attempts to assess the effects of management measures in the early 2000s are premature. The authors agreed and will revise the working paper accordingly.

Arguments contained in the working paper to portray the "Estimate M and h " hypothesis as more credible than the alternative hypotheses were criticized by the reviewer because of the lack of formal model selection criteria, or even a clearly presented informal rationale. The authors responded that comparisons of the values of objective functions (e.g., Akaike Information Criterion statistics) to select a model was not possible because of the different data weightings implied by the application of iterative re-weighting during the fitting process. The reviewer closed his comments by suggesting the assumption that the stock was at unfished equilibrium in the 1940s might be reviewed. He suggested the influence of that assumption on assessment outcomes could be examined by assuming a value like $0.9B_0$ in the 1940s to acknowledge the effects of pre-1940 removals.

All three reviewers re-iterated their opinions that the influence of the 1999 and 2000 year classes on the future stock trajectory should be viewed with caution at this time as these year classes have only recently started to recruit to the fishery.

GENERAL DISCUSSION

The Chair reviewed the requirements of the working paper identified in the terms of reference (Appendix 1), asked that discussion be framed around the questions raised by the reviews, and opened general discussion to the Participants.

Discussion was centred on the themes of (i) reliability of the catch reconstruction, (ii) reliability of the ageing data, (iii) industry perspective on stock status, and (iv) selection of the preferred model hypothesis.

An industry participant questioned the reliability of the catch reconstruction prior to 1996 which he expected would be least accurate early in the time series. He suggested that the estimation of large recruitments early in the stock reconstruction may be a product of inaccurate historical catch reporting during that period. It was noted by an author that documentation of catch reconstruction methods for rockfishes is in preparation. A FAM participant suggested that the catch reconstruction report should be peer reviewed given the likelihood of broad application to rockfish assessments.

An industry participant reported that fishing masters have reported an increase in POP abundance along the entire BC coast in recent years, and in particular that the average size of POP fish has increased in the last 4 to 5 years. He stated the view of industry was that the status of POP in Queen Charlotte Sound over the recent several years was better than inferred by the concerns of the reviewers. He found the assessment results to be contrary to recent fishing experience, and in particular the results for the two hypotheses with fixed $M=0.06$ seemed counter-intuitive.

Participant discussion of the preferred model hypothesis was focussed on the issue of whether steepness should be estimated or fixed. A Science participant noted that B_{MSY} / B_0 is a function of steepness so the choice to fix steepness determines MSY. Recent work by Mangel et al. (2010) that argues steepness should never be fixed was cited as support for eliminating hypotheses that apply fixed steepness values. An industry participant expressed the view that the "Fixed M and h " hypothesis resulted in MPD estimates of survey catchability that he considered implausible. A Science participant suggested that the requirement for a precise prior on M indicates that natural mortality cannot be reliably estimated in this assessment. The Participants agreed that hypotheses with fixed steepness should not be used as the basis for advice, i.e., only the "Estimate h " and "Estimate M and h " hypotheses should be used as the basis for advice to fishery managers.

A Science participant commented that the five year projection horizon is too short to evaluate long-term harvest policy effects given the generation time of POP and the SFF guidance to evaluate stock and fishery performance over 1.5 to 2 generations. The authors commented that the request for advice did not specify a time horizon, and the Participants accepted the time horizon of 5 years reported in the decision tables for this assessment. A reviewer highlighted the policy implications of being too optimistic because of asymmetric cost function, e.g., overfishing will cost much more in five years if the stock is depleted further when compared to a reduction in harvest now designed to promote stock growth.

The Participants discussed how often this assessment should be updated. An author argued that the POP stock should receive high priority because it is a key species in the commercial trawl fishery. A reviewer suggested that given model development work is completed the assessment could be updated each year. A Science participant stated that a two year cycle

would be adequate and would allow time for interim examination of the long-term performance of competing PA compliant harvest strategies, and comparison to the fixed catch strategy used in the current assessment.

REVIEW OF TERMS OF REFERENCE

The Chair opened discussion on whether the working paper had met the requirements of the Terms of Reference. Each requirement was reviewed and any associated discussion is provided below.

1. Assess the current biomass and status of Pacific ocean perch in Queen Charlotte Sound.

The Participants agreed that the working paper provides an acceptable characterization of stock status and reflects uncertainty adequately by presenting alternative model hypotheses and by adopting a Bayesian formulation to capture uncertainty associated with each hypothesis.

2. In the context of developing Precautionary Approach (PA) compliant stock assessments, recommend candidate Limit Reference Point (LRP), Upper Stock Reference Point (USR), Target Reference Point (TRP) and removal reference for each of the Pacific Ocean Perch stocks; and

3. Provide rationale used to select recommended candidate reference points. Rationale should be provided if the candidate points differ from the PA framework default reference points.

The Participants agreed that the B_{MSY} -based limit reference, upper stock reference and target reference points provided in the working paper were consistent with the PA harvest strategy policy.

4. Provide in the assessment document decision tables forecasting the impacts of varying harvest levels in comparison to historic (un-fished), current and future population trends;

The Participants recommended that decision tables provided for the “Estimate M and h ” and “Estimate h ” hypothesis be used as Science advice for management decision-making. Future stock status was cast relative to B_{MSY} instead of unfished biomass as requested, however the Participants accepted B_{MSY} as the basis for determining reference points for this assessment. The decision tables show the probability of female spawning biomass, B_t , exceeding $0.4B_{MSY}$, $0.8B_{MSY}$, and B_{MSY} in each year of a five-year projection from 2011 to 2016 for fixed annual catch levels.

The harvest policy represented by the decision tables is a fixed annual catch policy. Such a policy does not comply with the SFF/PA requirement to reduce the removal rate in response to declining stock status. The Participants noted that the long-term performance of the harvest policy cannot be assessed using a five year time horizon and recommended that the next assessment includes examination of variable harvest rate control rules evaluated over a longer time frame to achieve greater compliance with PA harvest strategy policy.

5. Identify additional information needed to enhance appropriate stock assessment advice consistent with goal of implementing ecosystem-based fisheries management, as articulated in the Sustainable Fisheries Framework.

The working paper reported the species caught concurrently with Pacific ocean perch and the depth range over which commercial bottom trawl activities occur with the assessment area. The interception of species of conservation concern (e.g., Boccacio, roughey rockfish, canary rockfish, yellowmouth rockfish) was reported and determined to be within bounds established by management measures related to conservation of those species.

The Participants accepted the working paper subject to revisions. The Participants determined that the endorsement of the "Estimate M and h " hypothesis as the sole basis for management advice was not well supported on the basis of model fit criteria. The Participants recommended that management advice be based on model outcomes and decision tables that arise from the "Estimate M and h " and "Estimate h " hypotheses.

LITERATURE CITED

Ianelli, J.N. 2002. Simulation analyses testing the robustness of productivity determinations from West Coast Pacific ocean perch stock assessment data. *North American Journal of Fisheries Management* 22(1): 301-310.

Mangel, M., Brodziak, J., and DiNardo, G. 2010. Reproductive ecology and scientific inference of steepness: a fundamental metric of population dynamics and strategic fisheries management. *Fish and Fisheries*, 11:89-104.

APPENDIX 1: TERMS OF REFERENCE FOR THE MEETING.

Terms of Reference

Stock Assessment for Pacific ocean perch (*Sebastes alutus*) in Queen Charlotte Sound, British Columbia

Pacific Regional Science Advisory Process

November 24, 2010

Nanaimo, British Columbia

Chairperson: Greg Workman

Context

The last assessment of Pacific Ocean Perch (POP) was conducted in 2001; the last comprehensive assessment was in 1999. Of the annual Total Allowable Catch of rockfish on the west coast of Canada, Pacific ocean perch (POP) is the species that has the largest single-species quota. POP accounts for 25% of the total weight of rockfish landed by bottom trawl gear. Recent trends in survey abundance indices, plus reports from industry, indicate the stock may be showing signs of decline, at least in some areas. Updated harvest advice is required to determine if current harvest levels are sustainable and are compliant with the DFO Sustainable Fisheries Framework's Decision-making Framework incorporating the Precautionary Approach (PA). The request was initially submitted to Science by staff in the Fisheries and Aquaculture Management's (FAM) Groundfish Management Unit (GMU) in 2007. Due to personnel changes and limited resources it has not been possible to address this request prior to now.

Objectives

The following working paper will be reviewed during this science advisory review process: *Stock assessment for Pacific ocean perch (Sebastes alutus) in Queen Charlotte Sound, British Columbia*. Guided by the DFO Sustainable Fisheries Framework, the following objectives for this assessment have been established:

- Assess the current biomass and status of Pacific ocean perch (POP, *Sebastes alutus*) in Queen Charlotte Sound (current groundfish management areas 5AB and 5CD).
- In the context of developing Precautionary Approach (PA) compliant stock assessments, recommend candidate Limit Reference Point (LRP), Upper Stock Reference Point (USR), Target Reference Point (TRP) and removal reference for each of the Pacific Ocean Perch stocks.
- Provide rationale used to select recommended candidate reference points. Rationale should be provided if the candidate points differ from the PA framework default reference points.
- To provide in the assessment document:
 - decision tables forecasting the impacts of varying harvest levels in comparison to historic (un-fished), current and future population trends;
 - identification of additional information needed to enhance appropriate stock assessment advice consistent with goal of implementing ecosystem-based fisheries management, as articulated in the Sustainable Fisheries Framework.

Expected Publications

CSAS Science Advisory Report (1)

CSAS Research Document (1)

CSAS Proceedings to document the discussions of the meeting.

Participation

Participants (approx. 25) will include authors, reviewers, internal DFO representatives and invitees from academia, First Nations, NGO's and industry.

Additional Information and References

DFO. 2009 A fishery decision-making framework incorporating the Precautionary Approach. <http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm>. For further information on participation in the peer review process: http://www.dfo-mpo.gc.ca/csas/csas/Process-Processus/ExtPart-PartExt/Ext-Part-RAP_e.htm

APPENDIX 2: EXAMPLE LETTER OF NOTIFICATION

Example letter of notification (to external participants) regarding the CSAP Science Advisory Process review of Pacific ocean perch in Queen Charlotte Sound, British Columbia, November 24, 2010.

Invitation to External Participants

Fisheries and Oceans Canada's **Centre for Science Advice Pacific** (CSAP, previously known as **PSARC**) routinely conducts Regional Advisory Processes (RAP), at which the Pacific scientific assessments on issues of importance to fisheries, habitat, ecosystem, Species at Risk and integrated oceans management are reviewed, and science-based advice and recommendations developed to inform management decisions.

You are invited to participate in the RAP scheduled to review the following working paper related to the provision of scientific advice related to:

*Stock assessment for Pacific ocean perch (*Sebastes alutus*) in Queen Charlotte Sound, British Columbia.*

Your expertise related to this assessment would greatly aid in this scientific peer review process.

The RAP will be held Wednesday, November 24, 2010 in the Seminar Room (2nd floor) of the Pacific Biological Station (PBS) in Nanaimo. The meeting will commence at 9:00 a.m. and run no later than 4:30 p.m. An option to participate via Internet-based webinar will be available for those unable to attend in person.

Please let me know whether or not you plan to participate in this review by emailing (CSAP@dfo-mpo.gc.ca) or phoning 250-756-7208 by **Wednesday, November 10, 2010**. Please indicate if you will attend in person or via the Internet, so instructions can be provided in advance.

It is important to confirm your intention to participate, as drafts of the confidential working papers and further meeting logistics will be transmitted **only** to those who have confirmed their intention to participate.

For additional information about this RAP, see the attached terms of reference.

The Center for Science Advice Pacific is guided by the policies and procedures established by DFO's Canadian Science Advisory Secretariat (CSAS). For further information on participation in the peer review process, see the following internet site: http://www.dfo-mpo.gc.ca/csas/csas/Process-Processus/ExtPart-PartExt/Ext-Part-RAP_e.htm

APPENDIX 3: LIST OF PARTICIPANTS

List of invited and attending participants at the November 24, 2010 CSAP Science Advisory Process review of Pacific ocean perch in Queen Charlotte Sound, British Columbia.

Last Name	First Name	Affiliation	E-mail Address	Attended
Acheson	Schon	Science, Groundfish Section	Schon.Acheson@dfo-mpo.gc.ca	√
Ackerman	Barry	FAM, Groundfish Management	barry.ackerman@dfo-mpo.gc.ca	√
Anderson	Kris	Science, Groundfish Section	Kristina.Anderson@dfo-mpo.gc.ca	√
Brown	Laura	MEAD	Laura.L.Brown@dfo-mpo.gc.ca	√
Edwards	Andrew	Science, Groundfish Section	andrew.edwards@dfo-mpo.gc.ca	√
Flemming	Rob	Science, Groundfish Section	Rob.Flemming@dfo-mpo.gc.ca	√
Forrest	Robyn	Science, Groundfish Section	Robyn.Forrest@dfo-mpo.gc.ca	√
Haigh	Rowan	Science, Groundfish Section	Rowan.Haigh@dfo-mpo.gc.ca	√
Holt	Kendra	Science, Groundfish Section	Kendra.Holt@dfo-mpo.gc.ca	√
Houston	Kim	Science, NHQ	Kimberly.A.Houston@dfo-mpo.gc.ca	√
Joyce	Marilyn	Science, CSAP	marilyn.joyce@dfo-mpo.gc.ca	√
Kronlund	Allen	Science, Groundfish Section	allen.kronlund@dfo-mpo.gc.ca	√
Mawani	Tamee	FAM, Groundfish Management	tameezan.mawani@dfo-mpo.gc.ca	
McPhie	Romney	Science, Groundfish Section	romney.McPhie@dfo-mpo.gc.ca	
Ou	Wan Li	FAM, Groundfish Management	wan-li.ou@dfo-mpo.gc.ca	
Rutherford	Kate	Science, Groundfish Section	kate.rutherford@dfo-mpo.gc.ca	√
Schnute	Jon	Science (Retired)	jon.schnute@dfo-mpo.gc.ca	√
Stanley	Rick	Science, Groundfish Section	rick.stanley@dfo-mpo.gc.ca	√
Taylor	Nathan	Science, Groundfish Section	Nathan.Taylor@dfo-mpo.gc.ca	√
Workman	Greg	Science, Groundfish Section	greg.workman@dfo-mpo.gc.ca	√
Wyeth	Malcolm	Science, Groundfish Section	Malcolm.Wyeth@dfo-mpo.gc.ca	√
External				
Chalmers	Dennis	Province of British Columbia	Dennis.Chalmers@gov.bc.ca	
Koolman	John	Commercial Industry Caucus, Rockfish Outside	koolmanent@shaw.ca	√
Martell	Steve	University of British Columbia	martell.steve@gmail.com	√
Mose	Brian	Commercial Industry Caucus, Trawl	bmose@nanaimo.ark.com	√
Starr	Paul	Canadian Groundfish Research and Conservation Society	paul@starrfish.net	√
Turris	Bruce	Canadian Groundfish Research and Conservation Society	bruce_turris@telus.net	√
Wallace	Scott	David Suzuki Foundation	swallace@davidsuzuki.org	

APPENDIX 4: DRAFT AGENDA FOR THE MEETING.

Agenda

**Center for Science Advice Pacific (CSAP)
Groundfish Standing Committee
Regional Advisory Meeting**

**November 24th, 2010
Seminar room, Pacific Biological Station, Nanaimo, BC
Chairperson: Greg Workman**

Convene – Review Agenda Introductions Review terms of reference	09:00
Presentation: Stock assessment for Pacific ocean perch (<i>Sebastes alutus</i>) in Queen Charlotte Sound, British Columbia. Andrew Edwards, Paul Starr and Rowan Haigh	09:15
Coffee	10:15
Reviews: <ul style="list-style-type: none">• Steve Martell, UBC• Nathan Taylor, Groundfish Section, PBS• Jon Schnute, Groundfish Section, PBS (Retired) Committee discussion	10:30
Lunch	12:00
Committee discussion Address review questions. <ul style="list-style-type: none">• Is the purpose of the working paper (Advice) clearly stated?• Are the data and methods adequate to support the conclusions?• Are the data and methods explained in sufficient detail to properly evaluate the conclusions?• Are the recommendations provided in a form useful to a fisheries manager?• Does the advice reflect the uncertainty in the data, analysis or process?• Can you suggest additional areas of research that are needed to improve our assessment abilities?	12:45
Coffee	14:30
Acceptance of working paper Formulate recommendations <ul style="list-style-type: none">• to FAM• to Authors Discussion of next steps – formulation of SAR	14:45 16:30