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Regional Science Advisory Process on Management procedures for the multi-gear sablefish (*Anoplopoma fimbria*) fishery in British Columbia

Processus de consultation scientifique régional sur les procédures de gestion de la pêche à la morue charbonnière (*Anoplopoma fimbria*) à l'aide de divers engins en Colombie-Britannique

January 17, 2011
Pacific Biological Station
Nanaimo, British Columbia

17 Janvier 2011
Station biologique du Pacifique
Nanaimo, Colombie-Britannique

Meeting Co-Chairpersons
Greg Workman
Marilyn Joyce

Président de réunion
Greg Workman
Marilyn Joyce

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November 2011 | **Novembre 2011**

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 January 17, 2011 in Nanaimo (BC) to conduct a science peer review of the status of sablefish (*Anoplopoma fimbria*) in British Columbia. The science review was conducted in response to a request from DFO Fisheries and Aquaculture Management (FAM) for advice regarding the development of fishery reference points based on biomass at maximum sustained yield (MSY) and a harvest control role in compliance with Sustainable Fisheries Framework (SFF) policy. Advice was requested on whether mortality associated with at-sea releases compromises the achievement of fishery objectives. A request to evaluate the requirement to continue two fishery-independent trap gear surveys used in the development of harvest advice was put forward by science and the sablefish fishing industry and was included in the FAM request. Participants at the review included science staff from the DFO Pacific region, personnel from DFO FAM, and representatives from fishing industry associations, recreational fishing associations, and First Nations. Limit reference and upper stock reference points, and a target reference point that used spawning biomass at maximum sustained yield, were developed following SFF policy. The analytical approach used closed-loop simulation methods to test candidate management procedures against a suite of stock scenarios. Stock scenarios were developed using historical data to reflect uncertainty in the stock and recruitment relationship, fish growth, future recruitment patterns, and included a low productivity scenario for robustness testing. Management procedures differed in their utilization of survey data, assessment model assumptions, and harvest control rule configuration. Results were summarized in a science advisory report. A research document is expected in support of the science advisory report.

SOMMAIRE

Une réunion du processus de consultation scientifique régional a eu lieu le 17 janvier 2011, à Nanaimo (C.-B.), afin que soit effectué un examen scientifique par des pairs de l'état des stocks de morue charbonnière (*Anoplopoma fimbria*) en Colombie-Britannique. L'examen scientifique a fait suite à une demande d'avis de Gestion des pêches et de l'aquaculture du MPO relatif à l'élaboration de points de référence pour la pêche reposant sur une biomasse au rendement maximal soutenu (RMS) et d'une règle de contrôle de la pêche, en conformité avec la politique du Cadre pour la pêche durable. On a également demandé qu'un avis soit formulé sur la question de savoir si la mortalité associée aux rejets en mer compromet l'atteinte des objectifs de la pêche. Les Sciences et l'industrie de la pêche à la morue charbonnière ont demandé que soit évaluée la nécessité de poursuivre deux relevés au piège indépendants de la pêche qui sont utilisés pour l'élaboration d'avis sur les prélèvements; cette demande a été incluse dans celle formulée par Gestion des pêches et de l'aquaculture. Parmi les participants à l'examen, mentionnons des scientifiques de la Région du Pacifique et du personnel de la Gestion des pêches et de l'aquaculture du MPO ainsi que des représentants des associations de l'industrie de la pêche, des associations de la pêche récréative et des Premières nations. On a élaboré des points de référence limites et supérieurs ainsi qu'un point de référence cible établi selon la biomasse de reproducteurs au rendement maximal soutenu, conformément à la politique du Cadre pour la pêche durable. L'approche analytique adoptée comprend des méthodes de simulation en boucle fermée utilisées pour mettre à l'essai des procédures de gestion potentielles par rapport à une série de scénarios relatifs aux stocks. Ces scénarios ont été élaborés à l'aide de données historiques afin qu'ils reflètent l'incertitude entourant la relation stock-recrutement, la croissance des poissons et les futurs profils de recrutement. Ils comprennent également un scénario de faible productivité permettant de vérifier la robustesse des procédures. Les méthodes de gestion sont différentes sur les plans de l'utilisation des données dérivées de relevés, des hypothèses de modèle d'évaluation et des caractéristiques de la règle de contrôle de la pêche. Les résultats sont résumés dans un avis scientifique. On prévoit qu'un document de recherche sera publié à l'appui de cet avis scientifique.

INTRODUCTION

A Pacific region science advisory process peer review of sablefish (*Anoplopoma fimbria*) in British Columbia was conducted in Nanaimo (BC) on January 17, 2011. The terms of reference for the science review were developed by the CSAP office, Pacific region (Appendix 1). Notifications of the science review and conditions for participation were sent to identified industry associations, recreational fishing associations, and First Nations organizations with an interest in the sablefish resource of British Columbia on December 21, 2010 (Appendix 2, 3).

A working paper was prepared and made available for review by meeting participants on December 23, 2011:

Management procedures for the multi-gear sablefish (*Anoplopoma fimbria*) fishery in British Columbia, Canada, by S.P. Cox, A.R. Kronlund and Lisa Lacko. CSAP Working Paper 2010/P05.

The meeting began at 9:00 AM, Monday, January 17, 2011. Co-chair G. Workman welcomed participants, explained room arrangements and reviewed the agenda (Appendix 4) for the meeting. The chair asked meeting participants, including those participating by webinar, 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 A. Edwards (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 Committee. 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, participants from outside the DFO are invited to take part in the Committee's activities. Proceedings also focus on recommendations made by the meeting participants.

CONTEXT

Directed longline trap, longline hook, and trawl commercial fisheries exist for sablefish off Canada's Pacific coast. However, sablefish are also intercepted by non-directed groundfish longline hook fisheries including halibut, rockfish, lingcod and dogfish fisheries. Sablefish are released by regulation when measuring less than 55 cm fork length.

In 2008, a Management Strategy Evaluation (MSE) approach was developed for sablefish assessment and management in British Columbia and was reviewed through a Canadian Science Advisory process. Fisheries and Aquaculture Management has requested advice from Science to inform planning for the 2011/12 fishing year that incorporates the consequences of release mortality on the sablefish stock. A requirement of the advice is to update the MSE approach to reflect new fishery objectives introduced by the "*DFO Sustainable Fisheries Framework*" (SFF) policy and "*A fishery decision-making framework incorporating the Precautionary Approach*" (PA) policy.

WORKING PAPER PRESENTATION

The working paper was presented by S.P. Cox. The presentation was organized into seven sections:

- Issues for sablefish management;
- Description of the management strategy evaluation approach;
- Fishery objectives;
- Management procedures tested by closed-loop simulation;
- Operating model used to develop stock and fishery scenarios;
- Relative performance of the candidate management procedures, and;
- Limitations and further research.

The introduction of the presentation reviewed current issues in sablefish management related to (*i*) revised fishery objectives due to the introduction of the Sustainable Fisheries Framework, (*ii*) industry criticism of the catch performance of previously proposed management procedures, (*iii*) uncertainty regarding available resources for future survey effort, and (*iv*) the effects of post-release mortality of sub-legal (< 55 cm fork length) sablefish on achievement of fishery objectives. Reference points were developed using the limit and upper stock reference points of 0.4 and 0.8 of spawning biomass at maximum sustained yield, B_{MSY}, respectively. The target biomass of B_{MSY} was adopted for the analysis. These choices are drawn from the defaults identified in the DFO (2009) policy "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). The presentation included a description of how stock trajectory and acceptable probability of decline considerations outlined in Table 1 of the DFO (2009) policy document were implemented. Fishery objectives related to avoidance of the limit reference point over 2 generations with high probability, maintaining an acceptable probability of stock decline over 10-years, ensuring the stock fluctuated around the target biomass over 2 generations, and maximizing average annual catch over 10 years.

The authors described the general approach of management strategy evaluation as the systematic determination of the expected performance of a management plan against a set of objectives. In this process, an operating model that incorporates historical data is used to specify plausible stock scenarios and to simulate future fishery and survey data. Candidate management procedures are tested using data generated by the operating model in closed-loop feedback simulations. Management procedures varied by the choice of survey data (i.e., standardized or stratified random surveys), priors used in the production model assessment method, and the shape of the harvest control rule. The authors pointed out that the harvest control rule could be decoupled from the fishery objectives, which are based on zones defined by the DFO default reference points of $0.4B_{MSY}$ and $0.8B_{MSY}$. For example, management procedures were evaluated that used a precautionary reduction in the harvest rate when estimated biomass was less than $0.6B_{MSY}$ to reduce catch variability, instead of $0.8B_{MSY}$. However, the status of the stock relative to DFO default reference points is simulated in the operating model and conservation performance is summarized based on the operating model state.

Management procedures that mimicked the implementation of avoidance and retention management options were explained. The former "avoid" option could be achieved through gear modification, spatial and seasonal closures, and increased communication among fishing masters in support of avoiding concentrations of sub-legal sablefish. The "retain" option

mimicked removal of the current 55 cm size limit in favor of full retention of all sablefish regardless of size. A perfect information procedure designed to serve as a performance benchmark was also described; this procedure used the "true" simulated legal harvest rate and spawning biomass at MSY, and spawning biomass.

The age-structured, pooled-sex operating model used to construct stock scenarios and generate data for closed-loop feedback simulations was described. The model included Beverton-Holt stock recruitment function, multiple growth groups, gear-dependent release rates based on fish length and gear-dependent post-release mortality. Four base stock scenarios were constructed by varying assumptions about natural mortality and growth rate. Additional scenarios intended for robustness-testing were developed by assuming auto-correlation in future recruitment and by selecting a “low productivity” case selected from the posterior distribution of one of the four base scenarios.

Base scenarios and their derivatives (Table 7 of the working paper) were reviewed and the range of stock status suggested by the base scenarios was described. The four base scenarios suggest that the stock is currently below B_{MSY} but that the harvest rate of legal sablefish is close to the harvest rate at maximum sustained yield, U_{MSY}, largely due to a series of quota reductions from 4,600 t to 2,300 t that was initiated in 2007. Sub-legal harvest rates were projected to be low, typically less than 3%. Average projected catches were expected to be lower than the historical average for all procedures, but reasonably good catch stability (annual average changes of less than 10%) could be expected for procedures that used relatively precise priors on leading parameters and did not include the standardized survey in projections. The probability of breaching the limit reference point was expected to be low (<5%) over two sablefish generations (~36 years) regardless of the procedure.

The authors reviewed performance outcomes of the simulation testing, explaining that the purpose of the MSE analysis was to select a management procedure that performed adequately over a range of plausible stock scenarios designed to capture uncertainty about stock status, rather than to determine and select a best model fit and forecast. Performance differences between avoid and retain management options were reported as being small (~20-30 t difference in annual average catch over 10 years). However, the authors believed that the effects of sub-legal releases were underestimated in the current analysis due to the assumption of time-invariant selectivity for each gear type. The operating model fit to longline trap and longline hook releases was shown to be reasonably good, but trawl releases were underestimated from 1996 to the early 2000s. The authors suggested that this assumption was likely to be violated for the trawl sector, citing (*i*) low recent recruitment of sub-legal sablefish to the fishery, and (*ii*) changes in selectivity over time as a result of improved trawl catch monitoring beginning in 1996, groundfish integration beginning in 2006, gear modifications, and increased communication among fishing masters for the purposes of avoiding sablefish.

Results suggest that the less precise standardized survey could be discontinued in favor of the stratified random survey without compromising stock assessment capability, and was shown to increase catch variability when utilized in a management procedure.

Clarification was provided by the authors and participants during the course of the presentation. In particular, the large amount of sablefish released by hook and line gear in 2006 was discussed. These releases were attributed primarily to the halibut sector which was accountable for releases from the start of the 2006 fishing year but was not required to be responsible for obtaining quota until June 1, 2006. Therefore there was no incentive to avoid legal sablefish by the halibut sector until June 1. The lack of fit to trawl releases from 1996 to the mid-2000s was

attributed by the authors to change in selectivity over time that was not modeled. A Science participant commented that the introduction of the individual quota system and 100% at-sea observer coverage to the trawl sector in 1996 applied pressure to change fishing practices with respect to legal size sablefish but not for sub-legal sablefish, which must be released by regulation. Both industry and Science participants concurred and commented that there had been relatively fewer recruits to the fishery after the 2000 year class, increased sub-legal avoidance behavior, and possibly effects due to changes in the amount of fishing effort targeting thornyheads (*Sebastolobus* sp.) where sablefish co-occur in the catch.

Implications of various 2010 stratified random survey outcomes were discussed; in particular why Figure 12 of the working paper implied a 30% increase in the 2010 survey relative to 2009 would be required to maintain the quota at the current level of 2,300 t. An industry participant questioned why the legal catch resulting from application of a management procedure would decline if the survey increase was less than 30%. The authors responded that the relative "insensitivity" of the legal catch output from a procedure arises because one new data point is being added to a relatively short index time series where the recent stock trend is a decline. Legal catch and the survey index are not linearly related because the data are used in conjunction with a production model and harvest control rule in the procedures. A log-normal error assumption means that the influence of the most recent survey point declines as the observed value gets more extreme. The authors suggested that the procedure should in fact be robust to a single observation. The authors pointed out that the relationship between the survey value and the legal catch is asymmetric because more conservative catches are produced as the estimated stock status gets positioned on the declining ramp of the harvest control rule, i.e., this behavior is a product of the interaction of the assessment method and harvest control rule. In response to a question from a FAM participant, the authors responded that 2010 stratified survey result, which was not available during preparation of the working paper, increased approximately 15% relative to 2009. Inspection of Figure 12 in the working paper implied a legal catch of ~2,250 t from a management procedure based on the stratified random survey, a production model with relatively precise priors on the leading parameters, and a harvest control rule with bounds at 0.4 and 0.6 of the estimated B_{MSY}. The authors agreed to revise the working paper to expand discussion of these issues.

DISCUSSION OF REVIEWS

The Committee considered reviews by N. Taylor and D. Hanselman (*in absentia*, written review discussed by Committee) following the presentation of the working paper.

N. Taylor reported that he was able to reproduce some of the assessment results using an age-structured model he had developed and had found no gross differences from the results obtained by the authors. The reviewer conducted additional analysis that (*i*) used simulation-estimation testing to conclude that the data were sufficient to estimate leading model parameters, and (*ii*) confirmed the author's conclusion that existing data are not that informative about sablefish production relationships. The reviewer also noted that in his model he found that bias in parameter estimation could lead to overestimation of MSY and U_{MSY} which he recommended the authors should evaluate in future work for their specific model.

The reviewer stated that the apparent better performance of procedures that used relatively precise prior distributions on leading parameters needed discussion. He suggested that choosing $0.6B_{MSY}$ as a control rule bound performs better because the assessment method in the procedure is a Shaefer production model and that this choice would be aggressive if an age-

structured model were used in the management procedure. The authors responded that this was an issue related to the control rule, not to prior distributions on parameters and that they would not characterize the bound as aggressive. If an age-structured were used then the authors agreed that the reviewer would be correct, but in that situation tuning of the management procedure would involve testing alternative multipliers for the control rule bounds to assess performance relative to conservation objectives. The authors agreed to revise the working paper to more fully explain this point.

The reviewer stated his view that the performance of the procedures with relatively imprecise priors on the leading parameters could be more typical of what might be realized in practice. The authors responded that the results obtained with any of the procedures are predicated on the scenarios used for simulation testing and that the results reflect expected performance over the projection period. If future stock conditions and data characteristics are outside the range of the scope of the simulation then different performance could be expected. They stated that the MSE approach is no more unfair than conducting a data-fitting assessment and selecting a preferred model, in which case results are predicated on that one model being correct.

The authors asked the reviewer for commentary on his view that it seems inevitable that mixed-stock effects with Alaska will need examination, and they suggested that mixed-stock effects with the west coast United States should also be included in such efforts. The reviewer responded that the very simplest approach possible should be attempted and that performance will depend on the degree to which immigration enters BC from Alaska. In particular he noted that economic performance will depend on policy in Alaska as it dominates the North American catch of sablefish. An industry participant confirmed that Canadian prices could be influenced by Alaskan supply.

The Committee considered the major points identified in the written review submitted by D. Hanselman (*in absentia*) which opened with the reviewer's comments on harvest policy. The reviewer stated that the policy used to establish the Cautious Zone (e.g., the use of B_{MSY} as a target reference point, with limit and upper stock reference points at 0.4 and 0.8 of B_{MSY}, respectively) appeared to be aggressive relative to similar policy applied to the Gulf of Alaska sablefish stock which uses B_{MSY}, or a suitable proxy, as the target reference point. The authors noted their agreement that the limit reference point for U.S. policy appears more conservative and noted that the limit reference point of $0.4B_{MSY}$ corresponds to approximately 10% to 15% of unfished equilibrium biomass for B.C. sablefish. They further noted that similar results would likely be achieved for other long-lived species. The authors also noted that the U.S. often uses a proxy for B_{MSY} that may be more or less conservative than the true B_{MSY} so it is difficult to compare the two policies in different analyses.

The reviewer commented on the problems of model fit noted by the authors in their presentation (e.g., ~1996 to early 2000s trawl release data indicates lack of fit). The authors stated that planned work to implement a form of time-dependent selectivity should help to improve the historical fit to the release data and age composition data, although they noted it was more problematic to simulate plausible selectivity patterns in projections. This issue was related to the problem of anticipating realistic changes to selectivity that will arise from the evolution of the Integrated Groundfish management program. The authors pointed out that assessment model uncertainties in the current analysis attributed to poor estimation of the production relationship appears to dominate differences among specific fits for the base scenarios.
The reviewer objected to the use of a normally-distributed prior on MSY since the distribution can admit negative values of MSY and instead suggested a log-normal prior. The authors commented that a log-normal prior is asymmetric and actually adds information to the prior

whereas a normal prior implies (*i*) the least information, and (*ii*) equally likely higher or lower values than the prior mean. In any case the data were sufficient to eliminate negative MSY values based on the posterior distribution. The authors suggested that the text of the working paper be revised to address and clarify this issue.

The authors agreed with the reviewer's comments on sex-specific growth and commented that when a model is split into males and females the estimated productivity tends to decrease which results in corresponding changes to estimated fishery reference points. The authors have pointed out the risks of imposing higher mortality on females and reported that members of the fishing industry have similarly expressed concerns about size-selective effects imposed by trap gear fishing with escape rings, which should tend to select for (larger) females. Trap fishing on spawning aggregations could then impose a high effective fishing mortality on female fish. The authors agreed that this issue should be assessed in the near future, noting that the Alaskan assessment had adopted a split-sex model formulation in 2006. An industry participant asked what the current sex ratio was in the stock. No estimates were available for the meeting, however, the authors did report that the sex ratio is spatially variable and that estimates would reflect the capture gear, e.g. trap gear is suspected to capture the fastest growing fish at age and likely retains proportionately more females than either longline hook or trawl gear.

With respect to the growth analysis the authors suggested that further development of the analysis could allocate more effort to assessing different formulations of growth although any selective gear effects would be challenging to resolve, as noted in the working paper. Finally the authors expressed the view that differences in growth parameters have a smaller effect on production relationships compared to leading parameter uncertainties (e.g., natural mortality, M, unfished equilibrium spawning biomass, B_0, and stock-recruitment steepness, h) and noted that a log-normal error assumption is used for the growth formulation as suggested by the reviewer.

The reviewer expressed the view that as M is increased in an age-structured model the stock is interpreted as being more productive and the maximum permissible fishing mortality also increases. The authors pointed out that if M is fixed at a value higher than the true value when fitting the operating model to data that (*i*) the stock biomass will tend to be over-estimated and the exploitation under-estimated, and (*ii*) that the observed production relationships are consistent with Clark's (1999) observation cited by the reviewer. The authors agreed to revise the text to clarify their discussion on this issue.

The reviewer stated that both conservation and economic performance could be improved by improved stock assessment models. The authors pointed out that conservation performance of the production model would be difficult to improve as shown by small difference in rebuilding rates relative to the perfect information procedure. The authors suggested this result is mainly because the production model assessments tend to under-estimate stock size, but suggested it would make an interesting debate as to the value of assessment models for conservation and that there is probably a minimal model that would suffice.

The reviewer questioned whether release mortality for hook and line gear should be twice that of trap gear, citing experience with tagging studies in Alaska. The authors agreed that survival from both hook and trap capture must be reasonably high given observed tag return rates but pointed out that research caught fish are captured and released under processing and handling conditions that are most favorable to survival relative to commercial fishing (e.g., cold water, limited deck-time, careful handling, individual release, and at least in the case of B.C. surveys protocols to avoid post-release predation by marine mammals). The authors maintained their

view that the current analysis uses release mortality rates that probably underestimate post-release mortality.

The reviewer commented that with enough age data assessment performance should improve markedly and that it should be possible to estimate recruitments and *M*. The authors stated that if there are no ageing data from the period when the stock was lightly exploited (as is the case for BC sablefish) then accurate estimation of *M* is unlikely and they chose to fit the operating model with fixed and estimated *M*. They pointed out that they do not claim that the estimate of *M* is correct but the scenarios were included to incorporate this possibly irresolvable uncertainty. The authors explained that they did simulate ageing data and apply catch-age models in a procedure for the previous 2008 analysis. These procedures had good performance because the simulated age data were well-behaved (i.e., no bias which is unlikely for this difficult to age species and modest ageing errors). Pending understanding and information on the error structure of the age classification, the authors expressed the view that simulation of realistic ageing data is difficult to achieve.

The reviewer questioned why estimating autocorrelation in historical recruitments should produce estimates that are biased high. The authors stated that the relatively high ageing imprecision of sablefish suggests that smearing of age classes implies artificially higher autocorrelation in recruitments. The hypothesis arose because even though the model assumes independent log-normal errors in annual recruitment, there is a clear autocorrelation signal in years where it should not exist (e.g., the 1977 year class appears to be smeared over several years due to sampling or ageing errors). The authors stated that such errors are known to inflate recruitment autocorrelation estimates and they chose to pick an arbitrary value for recruitment autocorrelation and test the effect on management procedure performance.

GENERAL DISCUSSION

Co-chair M. Joyce assumed the duties of chairperson for discussion of the working paper and reviews, and the development of Committee recommendations. The Chair reviewed the requirements of the working paper identified in the terms of reference (Appendix 1) and opened general discussion to the Committee.

A FAM participant pointed out that the terms of reference should note that the trawl sector is part of the directed fishery with 8.75% of the quota allocation.

A Science participant commented that a useful aspect of closed-loop simulations was testing of the value of data inputs (e.g., the utility of the standardized survey). However, the participant suggested that the metric used to judge the standardized survey was unfair; if both surveys are unbiased then the standardized survey could be viewed as "a second opinion" to cross-check the trajectory indicated by the stratified random survey. The authors agreed that while it appeared qualitatively better to have a second survey to corroborate the results of the first survey, catch variability was substantially increased by inclusion of the standardized survey. A frequent effect of the interaction of a noisy survey with the harvest control rule was to place the estimated stock status on the declining ramp of the control rule because of variability, rather than due to a true decline in stock status. Also, the control rule is a tactic to convert assessment results into harvest and should not be confused with the achievement of objectives determined by the status of the operating model. The authors noted that if a constant harvest rate policy was used one might realize a benefit due to the inclusion of noisy, but unbiased, surveys. This was not tested because the DFO (2009) policy requires a precautionary adjustment to the

removal rate as estimated stock status declines. The Science participant suggested that the noisy survey should not have equal weight in assessment method of the procedure and therefore the interaction with the harvest control rule. The authors confirmed that higher variability in an index implied less influence in the likelihood function of both the operating model and assessment method used in the procedure.

The authors pointed out that there are good *a priori* reasons to suggest that the standardized survey may not be representative of the offshore sablefish population. The survey was purposively designed to visit nine localities spaced such the south to north extent of the offshore area of B.C. could be spanned in about 30 days of survey time. The localities selected were generally sablefish commercial fishing areas. The response of the survey suggests it is sensitive to recruitment to the fishery and has undergone fluctuations inconsistent with the population dynamics of sablefish. The Science participant commented that he did not question the recommendation to discontinue the standardized survey but wanted to anticipate the broader issue of assessments that incorporate multiple stock indices and how (*i*) indices should be ranked from best to worst, and (*ii*) what set of indices should be included in the assessment method to create output for the harvest control rule as opposed to those include in the characterization of stock status. The authors noted that the problem was similar to a multiple regression problem where inclusion of many covariates reduces the residual error of the fit but weakens the predictive utility of the model. An industry participant commented that the randomized survey was always intended to replace the standardized survey.

A Science participant pointed out that the International Pacific Halibut Commission longline hook survey could be considered as potential source of an additional stock index for sablefish. The authors agreed and commented that the multi-species trawl surveys, inshore rockfish surveys, and shrimp surveys had also not been included in the current work as each survey source has different spatio-temporal coverage and creates additional requirements to estimated survey-specific selectivity and catchability. However, the authors agreed to review halibut survey results and determine whether their inclusion in future analyses strengthens the sablefish assessment.

A FAM participant asked for confirmation of the conclusion that post-release mortality does not compromise the achievement of conservation objectives, but that management measures to mitigate post-release mortality of sablefish would provide for more timely achievement of fishery objectives. The authors agreed that the conclusion was consistent with results reported in the working paper, which indicated small differences in outcomes among the current 55 cm size limit, avoid and retain management options. However, the differences were in the expected direction of increased conservation and catch performance for avoid and retain options. The authors re-iterated their view that the effects of release mortality were underestimated primarily due to the current specification of selectivity and less so to the uncertainty around the release function and post-release mortality rates. However, they recommended more systematic evaluation of the influence of these parameters when selectivity modeling is improved. They also re-iterated (*i*) the need for analyses that estimate the costs of specific measures that could be implemented relative to the expected gains, and (*ii*) the need to consider other economic performance measures in addition to the simple approach of using average catch performance over a 10 year time horizon as done in the current analysis.

The Chair asked where data on post-release mortality were obtained. The authors responded that post-release mortality was fixed based on (*i*) review of the literature and (*ii*) their view that release mortality rates currently applied to legal releases in the Integrated Fisheries Management Plan were low in comparison to rates reported in the literature. The Chair asked

about the magnitude of impacts if release mortality were incorrectly specified. The authors responded that they believe the current analysis underestimate the effect of release mortality but not due to mis-specification of release mortality alone (i.e., effects of time-varying selectivity not being modeled) and that it was likely that catch benefits to avoid or retain options would be larger. The authors noted that if the fit to releases can be improved then estimates of leading model parameters will also change as the operating model rescales to explain the increased mortality (i.e., productivity must increase to explain the higher removals). In response to the a suggestion that more data would be required to improve the modeling of releases, the author's agreed that there were relatively few data (e.g., release data prior to 1996 for trawl and prior to 2006 for other sectors are not credible) but stated that structural changes to selectivity in the model could be developed and tested in the short-term without having to wait for the accumulation of substantially more release data.

Participants requested clarification on the magnitude of catch benefits due to avoid or retain options, which the authors had characterized as being small. The authors responded that both conservation and catch performance tended to improve but were limited to less than 5% for average annual catch over the first 10 years of the projection in the current analysis. The authors also clarified that those differences were thought to be underestimated due to problems with selectivity already discussed and pointed out that differences reflected (*i*) avoid vs. retain options, and (*ii*) comparison of avoid/retain with the existing management measure of a 55 cm size limit. They noted that results indicate the expected performance if the procedures were actually followed in the future over the periods summarized by the statistics.

The authors commented that a reviewer (N. Taylor) had raised a pertinent point about elevating catch variability to the level of an objective since discrimination among the performance of procedures was often assisted by average variability statistics and the expected minimum and maximum average catches under each procedure over 10 years.

A Science participant suggested that the selection of a procedure would have to account for the worst case scenarios, i.e., the low productivity scenario based on a draw from the posterior parameter distribution corresponding to the 10^{th} percentile of MSY. The authors and a reviewer responded that the suggestion was unreasonable since it bases the choice of a procedure solely on a scenario which is far less plausible than all other scenarios considered. The authors clarified that the choice of the low productivity stock scenario was intended to insure that the procedure is sensitive to a challenging productivity scenario and that the objective of maintaining the stock above the limit reference point in 95% of the years over two generations is likely to be achieved even in low productivity conditions.

It was pointed out by a Science participant that another procedure option is to test the standardized and stratified random surveys in conjunction with relatively precise priors in the production model. The authors responded that they attempted to limit the number of simulations which increases multiplicatively with the addition of either scenarios or procedures and that expected reductions in funding suggested it is unlikely that both surveys could be continued indefinitely so that particular management procedure combination was not tested.

A Science participant suggested that the choice of a procedure should be based only on conservation objectives, rather than catch performance. The authors responded that that choice would not be consistent with consideration of economic performance under the Sustainable Fisheries Framework and that the tradeoffs between conservation and catch could not be evaluated without explicit measurement of expected catch performance. Furthermore, it was

important to understand the trade-off between conservation and catch performance that would be required to increase the stock to the B_{MSY} level.

The Chair reminded the Committee that the management choice for this analysis was the selection of a procedure that adequately meets fishery objectives across scenarios, in contrast to the situation where a single baseline model and corresponding forecast harvest is selected. The scenarios represented a range of stock conditions that increased in the degree to which procedures would be challenged to meet objectives based on assumptions about productivity, growth, and recruitment autocorrelation.

The Committee considered priorities for future development of the sablefish analysis in addition to those issues identified by the reviewers. The authors suggested that work was required on determining how best to transition to management by a procedure in cases when the procedure outputs diverged significant from previous decision making. A FAM participant suggested that guidance on the "shelf-life" of a procedure would be required, i.e., to identify what criteria are used to determine that a change in procedure is required. The authors suggested that future funding availability for stock assessment data and analyses will be a large factor in such determination as management procedures are dependent on the future availability of the data being used to develop and test the procedure. A Science participant recommended that other potential stock indices (e.g. DFO multi-species trawl surveys, IPHC survey) be evaluated for potential use in the development of alternative management procedures to provide contingency options.

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 Committee discussion is provided below.

1. Advice for sablefish that uses MSY-based fishery reference points and a harvest control rule in compliance with the Sustainable Fisheries Framework (DFO 2009).

The advice is based on the Sustainable Fisheries Framework default limit and upper stock reference points at 0.4 and 0.8 of B_{MSY}, respectively, and a target biomass of B_{MSY}. The authors confirmed that the working paper contains a table that summarizes stock status for each scenario relative to the reference points (Table 7 of the working paper which contains four base scenarios four scenarios derived from the base scenarios). The base scenarios suggest that (*i*) the stock is currently below B_{MSY}, (*ii*) the current spawning stock biomass is in the mid to upper Cautious Zone and for one scenario the stock is in the low Healthy Zone, and (*iii*) the harvest rate of legal sablefish is close to the harvest rate at maximum sustained yield, U_{MSY}, largely due to a series of quota reductions from 4,600 t to 2,300 t that was initiated in 2007. Sub-legal harvest rates were projected to be low, typically less than 3%. Closed-loop simulation projections indicate the probability of breaching the limit reference point is expected to be low (<5%) over two sablefish generations (~36 years) regardless of the management procedure. The Committee recommended that a table summarizing the relative performance of the management procedures be accepted as the advice (Table 8 of the working paper).

A FAM participant asked about the stock trajectory for each scenario. The authors responded that the trend depends on the time frame over which the decline is characterized. The stock has declined over the most recent 5 years as the 2000 year class declines, but a stable trend exists

over 10 years, albeit at a relatively low biomass level. When the time frame is expanded to a generation (~18 years) the stock trend is in decline for all scenarios. The trajectory of the stock during simulation projections was required to meet the objective of being stable or increasing over 10 years with a probability that exceeded a specified value. This value, the acceptable probability of decline, was determined by linear scaling of the probability of stock decline between 0.05 at the limit reference point and 0.5 at the target biomass and was proposed by the authors as an implementation of guidelines contained in Table 1 of the DFO (2009) policy document.

The Chair asked for confirmation that selection of a procedure requires making a choice related to survey configurations, choice of priors in the production, and harvest control rule configuration based on conservation and catch outcomes. The authors responded that once conservation objectives were adequately met, the differences in catch variability among procedures that can be implemented for 2011/12 were only appreciable when comparing outcomes for procedures that used more or less precise priors for production model parameters.

2. Consideration of all sources of removals including releases.

The Committee concluded that the current analysis was an improvement over previous efforts to incorporate at-sea releases and release mortality for sablefish and was adequate for meeting this requirement of the terms of reference.

3. Evaluation of whether mortality attributable to at-sea releases across all fishery sectors compromises the achievement of fishery objectives.

The Committee accepted the author's view that release mortality impacts were small when comparing avoid and retain management options, and that these effects were likely underestimated in the current analysis. Results reported in the working paper suggest that conservation objectives could be met under the current 55 cm size limit management regulation, but the benefits of alternative avoid and retain options could not be fully assessed pending further model development.

4. Evaluation of the impacts of potential future management measures such as full retention or avoidance.

The Committee accepted the author's view that small differences in performance attributable to avoid and retain management options were likely underestimated in the current analysis. Because the avoid and retain procedures mimicked the implementation of specific management measures (e.g., gear modification or spatial closures) which had not been evaluated, the Committee also accepted the author's view that practical considerations limited the choice of management procedures to those based on the current 55 cm size limit management tactic for the 2011/12 fishing year. The Committee recommended (*i*) re-assessment of the expected impacts and a cost-benefit analysis of specific measures if modeling of selectivity can be improved to reduce the lack of fit to trawl release data, and (*ii*) systematic evaluation of the interaction of effects of release rates and release mortality.

5. Recommendations on the requirement to continue two fishery-independent trap gear surveys for the purposes of providing harvest advice.

The Committee concurred with the conclusion that the standardized survey could be discontinued in favor of the stratified random survey without adversely affecting stock assessment advice in support of management decisions.

It was recommended that the working paper be revised and published as a research document. The Chair closed the meeting at 2:30PM, January 17, 2011.

APPENDIX 1: TERMS OF REFERENCE

Terms of Reference

Management procedures for the multi-gear sablefish (*Anoplopoma fimbria*) fishery in British Columbia

Pacific Regional Science Advisory Process
January 17, 2011
Nanaimo, British Columbia

Chairperson: Greg Workman

Context

A directed longline trap and longline hook commercial fishery exists for sablefish (*Anoplopoma fimbria*) off Canada's Pacific coast. However, sablefish are also intercepted by non-directed groundfish fisheries including other longline hook and trawl fisheries. Sablefish enter the commercial fisheries at a few years of age, but are released by regulation when measuring less than 55cm fork length. There is a need to evaluate the potential impacts of post-release mortality on the achievement of fishery objectives when developing an action plan for the 2011/12 season.

In 2008, a Management Strategy Evaluation (MSE) approach was developed for sablefish assessment and management in British Columbia and was reviewed through a Canadian Science Advisory process. MSE outputs can be used to (*i*) inform decisions about a long-term harvest strategy, (*ii*) evaluate the likely trade-offs among conservation, yield and inter-annual variability in yield, and (*iii*) provide a consistent procedure for determining annual harvest advice.
Fisheries and Aquaculture Management has requested advice from Science to inform planning for the 2011/12 fishing year that incorporates the consequences of release mortality on the sablefish stock. The advice should update the MSE approach to reflect new fishery policy objectives that were not considered in the previous analysis. This evaluation should consider the effects of a full retention option for sablefish, i.e., removal of the current size limit. It is expected that advice will be compliant with both the "*DFO Sustainable Fisheries Framework"* (SFF) policy and "*A fishery decision-making framework incorporating the Precautionary Approach*" (PA) policy.

Objectives

This Regional Advisory Process (RAP) will review the following working paper:

Cox, S.P., Kronlund,A.R., and Lacko, L. Management procedures for the multi-gear sablefish (Anoplopoma fimbria) fishery in British Columbia, Canada. CSAP Working Paper P2010-05.

The advice is expected to include:

1. Advice for sablefish that uses MSY-based fishery reference points and a harvest control rule in compliance with the Sustainable Fisheries Framework (DFO 2009);
2. Consideration of all sources of removals including releases;
3. Evaluation of whether mortality attributable to at-sea releases across all fishery sectors compromises the achievement of fishery objectives;
4. Evaluation of the impacts of potential future management measures such as full retention or avoidance, and
5. Recommendations on the requirement to continue two fishery-independent trap gear surveys for the purposes of providing harvest advice.

Expected Publications

CSAS Science Advisory Report (1)
CSAS Research Document (1)
CSAS Proceedings

Participation

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

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

References Cited

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.

APPENDIX 2: ATTENDEES

The symbol "W" denotes attendance via webinar.

Last Name	First Name	Affiliation	Attended
DFO PARTICIPANTS			
Acheson	Schon	Science, Groundfish Section	√
Ackerman	Barry	FAM, Groundfish Management	√
Brown	Laura	MEAD	√
Edwards	Andrew	Science, Groundfish Section	√
Holt	Kendra	Science, Groundfish Section	√
Joyce	Marilyn	Science, CSAP	√
Keightley	Stephanie	PBS Coop Student	√
Keizer	Adam	FAM, Groundfish Management	√
Kronlund	Allen	Science, Groundfish Section	√
Lacko	Lisa	Science, Groundfish Section	√
Mawani	Tamee	FAM, Groundfish Management	√
Rutherford	Kate	Science, Groundfish Section	√
Stanley	Rick	Science, Groundfish Section	√
Taylor	Nathan	Science, Groundfish Section	√
Workman	Greg	Science, Groundfish Section	√
Wyeth	Malcolm	Science, Groundfish Section	√
Yamanaka	Lynne	Science, Groundfish Section	√
EXTERNAL PARTICIPANTS			
Acheson	Chris	Canadian Sablefish Association	√
Ashcroft	Chuck	Sports Fish Advisory Board	√, W
Budden	Leslie	Canadian Sablefish Association	√, W
Cox	Sean	Simon Fraser University	√
Koolman	John	Commercial Industry Caucus, Rockfish Outside	√
Mose	Brian	Commercial Industry Caucus,	√
Thompson	Jason	Council of the Haida Nation (Haida Oceans Technical	√, W
Turris	Bruce	Canadian Groundfish Research and Conservation Society	√

APPENDIX 3: AGENDA

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

January 17, 2011
Seminar room, Pacific Biological Station, Nanaimo, BC

Chairperson: Greg Workman

Convene – Review Agenda Introductions Review terms of reference	09:00
Presentation: Management procedures for the multi-gear sablefish (*Anoplopoma fimbria*) fishery in British Columbia, Canada. S.P. Cox, A.R. Kronlund, and Lisa Lacko	09:15
Coffee	10:15
Reviews: • Nathan Taylor, Groundfish, PBS • Dana Hanselman, National Marine Fisheries Service, Alaska Fisheries Science Center, Juneau, AK USA • Committee discussion	10:30
Lunch	12:00
Committee discussion Address review questions. • 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 • to FAM • to Authors Discussion of next steps – formulation of SAR	14:45 16:30