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March 12–14, 2013
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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may 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.

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SUMMARY

In June 2012, the Government of Canada introduced amendments to the *Fisheries Act*. While many of these amendments are not yet in force, the Fisheries Protection Provisions (FPP) made substantive changes to the protection of Canadian fishes and fish habitat. Scientific advice and support are needed to inform implementation of the FPP. Specifically, the FPP includes an explicit purpose for decision-making to provide for the sustainability and ongoing productivity of commercial, recreational and Aboriginal (CRA) fisheries (Section 6.1), and a need to consider the contribution to CRA fisheries productivity when making decisions related to serious harm to fish and permanent alteration to fish habitat (section 6 of the *Fisheries Act*).

Previous science advice (DFO 2012) has been provided, including biological interpretations of the terms productivity and contribution, and a framework to guide how the contribution of the relevant fish to the ongoing productivity of CRA fisheries should be evaluated. The contribution framework considers how the productivity of CRA fishery species will be affected by changing the state of species or habitats likely to be affected by human activities. The framework allows consideration of both the direct impacts of a project on productivity of CRA fisheries and the potential cumulative impacts when new or increased stressors (e.g., change of flow regime, addition of nutrients, or sedimentation) are introduced. Such new or increased stressors may initially have no measurable impact on productivity, but alter the state of affected species or habitats in ways that interact with other stressors to decrease productivity.

To implement this framework, an expectation of how productivity will respond to state changes in specific aspects of fish habitat is required. The Pathways of Effect (PoE) can be used to link human activities to state changes in habitat features. Productivity-state response curves then form the link from changes in state of habitat features to changes in productivity. In this SAR a number of PoE endpoints are assessed and operational advice and guidance is provided on these productivity-state relationships.

SOMMAIRE

En juin 2012, le gouvernement du Canada a présenté des modifications à la *Loi sur les pêches*. Tandis que bon nombre de ces modifications ne sont pas encore en vigueur, les dispositions relatives à la protection des pêches entraînent des modifications significatives à la protection des poissons et de leur habitat au Canada. Les responsables compétents ont besoin d'avis et de soutien scientifiques pour éclairer la mise en œuvre de ces dispositions. En particulier, les dispositions sur la protection des pêches ont pour but explicite de faire en sorte que la prise de décisions se traduise par la durabilité et la productivité continue des pêches commerciale, récréative et autochtone (CRA) (article 6.1) et ont pour exigence de considérer la contribution de la productivité de ces pêches lorsque vient le temps de prendre des décisions à propos de dommages sérieux au poisson et d'altérations permanentes à son habitat (article 6 de la *Loi sur les pêches*).

Un avis scientifique présenté en 2012 (MPO 2012) comprend les interprétations biologiques des termes productivité et contribution et établit un cadre pour l'évaluation de l'importance des espèces visées pour la productivité continue des pêches CRA. Le cadre de contribution aborde la question de savoir de quelle manière la productivité des espèces visées par les pêches CRA sera affectée par des modifications de l'état des espèces ou de leurs habitats susceptibles d'être touchés par les activités anthropiques. Le cadre permet de prendre en considération tant les impacts directs d'un projet sur la productivité des pêches CRA que les impacts cumulatifs potentiels de l'augmentation des agents de stress, actuels ou nouveaux (p. ex. des modifications du débit, l'ajout d'éléments nutritifs ou la sédimentation). Ces nouveaux agents de stress ou leur augmentation peuvent, à l'origine, ne pas avoir d'impact mesurable sur la productivité; toutefois, ils peuvent modifier l'état d'une espèce ou d'un habitat d'une manière qui interagit avec d'autres agents de stress pour diminuer la productivité.

Si nous voulons mettre en œuvre ce cadre, nous devons nous figurer de quelle manière la productivité dépendra des modifications de l'état de certains aspects particuliers de l'habitat du poisson. Nous pouvons utiliser la séquence des effets (SE) pour relier les activités anthropiques à des modifications d'état des composantes de l'habitat. Ensuite, les courbes de réponse productivité-état (P-E) forment le lien entre les modifications de l'état des composantes de l'habitat et les changements de la productivité. Dans le présent avis scientifique, un certain nombre d'indicateurs de résultat associés à la séquence des effets sont évalués, et un avis opérationnel et des orientations sont fournis concernant cette relation productivité-état (P-E).

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS) National Peer Review meeting was held on March 12 - 14, 2013, in Ottawa, ON to provide advice that will inform the implementation of section 35 of the amended *Fisheries Act*. Canada's Fisheries Act, amended via Bill C-38 (last amended June 29, 2012) refers to the "ongoing productivity of commercial, recreational and Aboriginal fisheries". DFO Program Policy Sector requested scientific advice regarding the operational measures of fisheries productivity and the operational tools to assess potential impacts on fisheries productivity.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to this request for advice from DFO Program Policy Sector. The following working papers (WP) were prepared and made available to meeting participants prior to the meeting:

- Science-based guidance for choosing surrogate measures of fisheries productivity
- A Review of Scientific Evidence Supporting Generic Productivity-State Response Curves

WELCOME AND OPENING REMARKS

The Chairs of the meeting, Jake Rice and Roger Wysocki, welcomed everyone and thanked them for coming to this Peer Review meeting. Participants introduced themselves (Appendix B). The Chairs explained the purpose of the three day meeting, which was to provide a thorough scientific review of the information presented in the two working papers, with the intent of using this information and the expertise in the room to provide science advice on the operational measures of fisheries productivity and the operational tools to assess potential impacts on fisheries productivity. Participants were encouraged to participate actively in the discussion. The Terms of Reference and agenda were reviewed.

PRESENTATIONS AND DISCUSSIONS

PRESENTATION 1: A FRAMEWORK FOR ASSESSING FISHERIES PRODUCTIVITY FOR THE FISHERIES PROTECTION PROGRAM

Presented by Mike Bradford

Regulatory decisions made by the Minister of Fisheries and Oceans about projects, works, or activities that have the potential to affect fish or fish habitat may need to consider the effects on the productivity of fish that are part of commercial, recreational or Aboriginal fisheries. Assessment of productivity changes will inform the four considerations listed in section 6 of the *Fisheries Act* (2012). A framework for assessing changes in fisheries productivity resulting from projects is described. This framework uses components of productivity, which are the vital rates and life processes needed for fish to complete their life cycle. The impacts of a project on fish habitat or the mortality of fish are identified using existing Pathways of Effects (POEs). For projects that affect the quantity or quality of habitat (or cause the death of fish) in the project vicinity, components of fisheries productivity are analyzed using a life cycle approach (reproduction, growth, survival, migration). Qualitative and quantitative metrics for each component of productivity are tabulated. For projects considered likely to result in ecosystem transformations, productivity assessments are conducted at the population or ecosystem scale. Density-dependent processes can be incorporated into productivity assessments, but detailed information on the biology of the species and a population model will be required. Examples are provided to illustrate how the approach can vary depending on the scale of the project, the fisheries resources that are affected and the information available for the assessment.

Discussion

This working paper was accepted as a CSAS research document (DFO 2013). Please refer to the research document for more details on the topic. The following were the major points of discussion on this working paper.

- Metrics
  - One participant commented on the way the author had drawn distinction between the terms measurements, metrics and indicators and wondered about their degree of overlap. In response the author stated that some indicators could be very general but a metric would be more quantitative than qualitative.
  - There was a discussion about the use of metrics and whether or not the scale of the impact is clear.
  - There was a comment that many activities have multiple impacts and multiple pathways. Different pathways may be handled differently if they are scored on different metrics.
  - The chair noted that the working paper states that the focus was kept on using a single axis and a single component.
- Pathways of Effects (POEs) – there was considerable discussion of the validity of using already existing POEs and how to do that most effectively
  - It was noted that both working papers used the POE endpoints that were developed under the earlier provisions of the *Fisheries* Act with a harmful alteration, disruption or destruction (HADD) of fish habitat. Participants discussed whether those endpoints still applied as well under the new focus of the *Fisheries Act*?
  - The second working paper (see Presentation 2) converts the endpoints into metrics of productivity. The original PoE diagrams came from a productivity viewpoint and were developed to fit the Habitat program needs.
  - The Chair confirmed with participants that the conclusions drawn at the CSAS meeting in August 2012 (DFO 2012) should be used as the foundation for this advice, including using the POE framework as a starting point. The endpoints of the POEs map onto the components of productivity and become measurements of the shape of the relationship. Endpoints that are not linked to productivity won't be used.
  - The Chair asked the participants whether all of the existing POEs need to be reviewed and if there are endpoints not identified that should be included in a review. The review could also be at a later date. One participant felt that a review to validate the POEs was unnecessary, and if anything there is a need to consolidate what exists. Another noted that there are subsequent endpoints from more recent processes.
  - One participant felt that it would be helpful to look at the POEs and see if they can be used in a similar way under the new regime. Under the old regime residuals could be plotted to see if a HADD was likely but now the POE will be used to see what the risk of productivity impact is. It is the same POE but the endpoints are being used in a different way.
  - The chair noted that the POEs have not changed at all but that the way that they are used has changed.
- Types of Projects – projects that reduce habitat quantity, projects that affect habitat quality and projects that result in ecosystem transformation
  - A participant wondered if it would be easier to define the expectations for each category of project if they were considered with the serious harm definition in mind.
  - A participant questioned whether the differences between qualitative and quantitative changes are only a matter of duration.

- There was a lot of discussion about the value of three categories: qualitative, quantitative and transformational. While there was some concern that the difference between qualitative and quantitative was more of the duration of an incremental change, the consensus was that the categories would be valuable for evaluating a project. It was felt that the difference was in the metrics used in the assessment of impact. The rules are the same but the metrics likely to be used will depend on what category.
- A participant was concerned that the impacts of small projects could get lost. The chair noted that the smaller the impact the less one would need to assess it compared to projects with a big impact. The issue would then be what do we mean by something that is big enough that indirect surrogates are no longer sufficient? Would that be solely a policy decision? It was decided to leave this question for another advisory meeting.
- A participant noted that although there is a tendency to associate changes in carrying capacity and density dependence with habitat quantity and not quality, a change in habitat quality leads to more changes in density independent productivity.
- A participant asked about how transformation fits into the regulatory overview. What scale is the transformation? There needs to be a range where a higher level of scrutiny is initiated (a small stream versus a large river). The importance of providing guidance around the methods and metrics to assess productivity changes was noted.
- How much change is needed in a system for it to become a transformation? If nutrients are being added to a system, at some point the entire organism make up with change completely. At some point it goes from small scale change to a transformation.
- One participant's interpretation of transformation is the transformation of biota. Other participants agreed with this.
- Another participant noted that the degradation of habitat quality becomes a change in the community structure.
- One participant suggested that among the features that tell us we're close to the transformational line is that there are not just decreases in life history components but that there are decreases in some species and some formerly rare species are becoming more dominant. That may not be the only diagnostic but it is a symptom of transformation.
- One proponent was concerned that transformation would be much easier to identify after the fact and wondered if there would there be enough information to guide the proponent before the project.
- The chair summarized that from a science perspective, measuring the biota and local biodiversity is more tractable that measuring some other possible metrics. He suggested it could possibly be developed into a condition for saying that transformation is likely.
- The author suggested the possibility of using more concrete examples of each type of project.

- Density dependence – if a vital rate changes with population abundance or density it is referred to as a density-dependent process
  - A participant wondered whether using the endpoints of the POEs as the primary pathway into the assessment process, would there be any mapping of density dependence or independence? And if not, does it matter for the POE endpoints and for the assessment?
  - A participant was concerned that if there is serious harm at a life stage or function that precedes a density dependent stage, it may not be apparent if there is a bottleneck. This would require a fair bit of knowledge about the system – more than many proponents would have.
  - Another participant was concerned that some proponents will try to use density dependence to avoid assigning serious harm or avoid mitigation.

- There was a question about whether density dependent effects need to be explicitly included or excluded. Another participant noted that density dependence can only be used when there is a lot of information known about the fishery.
- There was discussion of a Pacific salmon example in the North Pacific. Two to four percent of salmon will survive and return from the North Pacific but that does not mean that a proponent can use those losses to avoid offsetting a freshwater project.
- The chair thought that the Pacific salmon was a good example. The fisheries are at sea but the project may be in fresh water. If there is an effect on the ongoing productivity of the fisheries, there is a geographic displacement from the activity. The Science Advice has to acknowledge that density dependence can be observed in both quantitative and qualitative habitat changes. How does the determination of serious harm depend on permanent alteration of habitat and the death of fish?
- One participant noted that it is a challenge to develop a model that can handle the large number of different types of lifecycles. A model that is general to a wider range of life histories.
- Chair – it seems like the place we've landed is that we will expect the assessment to use the POE endpoints and acknowledging that there may be density dependence issues.

- Fishery management objectives
  - The chair noted that it would be helpful to have fishery management objectives for smolt production. That could help to avoid some of the issues with density dependence.
  - There was agreement that upon for the larger projects, that fisheries productivity is needed. It is less clear for small projects even though some small projects could have a large impact on a fishery.
- Other topics
  - A participant noted that both impact prediction and monitoring are important and that this advice could be an opportunity to explain why. A logical argument about what is needed for monitoring and how the monitoring ties back to the tables is important.
  - One participant noted his concerns about cumulative impacts.
- Science advisory report
  - It was decided to write one SAR to cover the material in this research document.
  - To keep the SAR shorter and more concise there will be a hyperlink from the SAR to the appendices in the research document.

PRESENTATION 2: PRODUCTIVITY-STATE RESPONSE CURVES

Presented by Marten Koops

Case studies were conducted to develop productivity-state response curves. This working paper was split into an overview of the paper and then presentations of each individual response curve. Each discussion is recorded separately. Please refer to the SAR 2013-067 for more details about each of the response curves. The individual curves are discussed below.

Change in Habitat Cover and Structure

The POE endpoint of concern is the change in structural heterogeneity resulting from projects that involve habitat simplification, or in less frequent cases, that increase structural habitat complexity. It is the second most common endpoint appearing on 17 individual PoEs and is a factor to consider under most impact types of concern including infilling/footprint, deposition of

non-deleterious substances, changes in flows and water levels, dredging/excavating, fish disturbance and riparian alteration.

Discussion

- The chair noted that the POEs were designed for a different regulatory framework. They may need to be reviewed in light of the new context that they will be used.
- One of the authors noted that peer reviewed literature was used to support the shapes of the curves wherever possible and the supporting references were listed.
- The chair recommended each curve include more detail about local specificity, what variable changes and how it does. He also suggested that the author explicitly indict the one or two important modifiers and their direction of change to the curve.
- One of the authors noted that there can sometimes be regional variants for some modifiers and it can be helpful to have some basis for making choices.
- Another participant noted the struggle to take the meta-analysis and apply it to the local environment.
- The chair noted that although the problem could be made too complex to solve, it would be more helpful to assume more resilience in the system.
- A participant noted the challenge in avoiding over simplifying the system. The productivity of some species may increase even though the species being managed decreases.
- The chair agreed that there would have to be care to avoid oversimplifying while simplifying the biology enough to create functional advice.
- The author noted that some response curve shapes could potentially provide a rationale to add stress to the ecosystem. He recommended that when there is a dome shape, that it should be treated as a plateau.
- There was a question on how to use the curves operationally.
- There was discussion on what physical layout of the curves would make it more intuitive for readers. There was also discussion about how detailed or complex the curves needed to be and whether there would be regional specific information.
- It was noted that the meeting is to try to design a system that can be unambiguously implemented. As well, it is likely impossible to use a strongly quantitative mechanism to place oneself on the curve.
- The chair noted that very large scale projects would be dealt with individually by DFO.
- The chair noted that the hard case is when there are activities where there is a plateau in the response curve. A case by case assessment cannot be done for each activity and one cannot assume that people with expert knowledge will deal with it. If there is a response curve with a plateau, what advice can be given that allows a proponent to know whether they are on the plateau.
- The chair again wondered how one would know where on the curve they were. A participant noted that the advice should say that we don't know where we are on the curve and the question will have to be addressed through experiments; however, the chair did not find that answer satisfactory.
- The chair commented on the problem being solved. Would the decision be any different at two places on the plateau/hump? If the decision wouldn't be any different then it doesn't

need to be considered. If, for example, a habitat subsidy situation never happens, then we don't have to solve it. If a proponent wants to do thinning as a compensation, then they need to do the calculations themselves. Is there any generic guidance to allow a proponent to make the case for whether they are to the left or right of the slope?

- There was discussion about using values on the *x*-axis. The chair stated that we do not need the number on the *x* axis; we need the description that the biological property would have so that the proponent knows what to look for.
- A participant asked how to handle the trade-off between different species?
- It was agreed that it would be done through fisheries management objectives. There would still be detrimental impacts. The assessment will be based on CRA fisheries.
- One option for quantitatively combining multiple stressors would be to use a weighted suitable area approach, although this requires more information than will be available for most small to medium sized projects (c.f. Productivity SAR). Another quantitative option would be to use the estimated loss of productivity for the stressor with the greatest impact on productivity. Neither approach may be precautionary, however, because both assume all effects are at most additive, and do not take into account interactions among stressors.

Change in Access to Habitat

An alteration in water depth, flow, and/or substrate size causing a disruption in access to fish habitats essential for various life processes within given fish populations such as spawning and rearing.

Discussion

- The chair commented that the message seems to be that you get fragmentation but the smaller populations are normal. A few fragments can be compensated for but once it gets past a critical point it goes downhill quickly.
- It was noted that if the effect is fragmentation but the pieces are large enough to contain functioning ecosystems within each reach then the plateau curve would apply. If it is a barrier that excludes access to particular areas then loss of habitat is also loss of productivity.
- Another participant thought that if the fragments are large enough one could assume that it is on the plateau part of the curve. What can indicate that a barrier is okay and not a barrier to productivity.
- The chair noted that the most consistent advice is that with reaches of 100km or more there isn't very much impact.
- One participant noted that species specificity needs to be mentioned. As well, a barrier near the mouth of the river would have more impact.
- The chair noted that if the barrier simply divides a system into two functioning ecosystems, it is different than if a barrier blocks a key part of the ecosystem. In that instance it's not a barrier, it is removing habitat. If a barrier divides the size of the ecosystem into pieces of complete habitats then the size of the pieces matters. The question becomes if you have a response curve with a plateau, what advice will allow a proponent to know if they are on a plateau or not?
- The participants agreed that for habitat fragmentation those cases when we are on the plateau will be large enough projects that they will be dealt with on a case by case basis.

- The chair noted two important questions:
    - In practice when these are applied on a case by case basis, is there any guidance that can be given for all curves?
    - How do we know whether we are still on the plateau or are past it?
- In response participants commented that:
    - Unless it is a pristine system the plateau is long gone, regardless of activity.
    - It's important to consider how much fragmentation is viable.
    - It will be rare when one knows, on a case by case basis, the minimal viable size and where the population abundance is, at least for freshwater fish.

Loss of Wetted Area

Works, undertakings and activities that result in reduction in wetted area (habitat quantity) have an impact on fisheries productivity because of the loss in population carrying capacity. Carrying capacity is the maximum sustainable population size (unfished equilibrium). Loss of wetted area reduces carrying capacity because of the decrease in living space (m_2) and structural habitat lost to the footprint. Population carrying capacity and fishing yield are directly related to habitat area.

Discussion

- An author noted that some of the response curves still need to add to the working paper why modifiers matter and how they impact relationships to the working paper. It was agreed that if the curve does depend on things like headwaters, coastal location or other factors, it has to include in which way it depends.
- The author noted that it would be hard to quantify the information although some descriptors could be stated. The chair agreed that it may only be possible to be relative. Do we expect the plateau to be wider or narrower? Every time it depends on something, it needs to indicate what directions it depends on.
- The chair noted that it would be the same for all response curves. There are two assessment processes:
    a. Whether or not there is serious harm
    b. If there is serious harm is the assessment sufficient to document the death of fish or that habitat related to productivity will be altered on time scales relative to the life history of the species

The guidance that will need to be provided in order for the first assessment to be made doesn't require the width of the plateau or the steepness of the decline. If that assessment indicates serious harm then the next assessment will be done. There will be higher level of engagement from the Department and one can expect a higher level of information. It has to be clear exactly what that information is.

- A participant noted that the curves will be very helpful to justify how much offsetting is required.
- The chair noted that the productivity is the basis for concluding whether there is serious harm and the response curves will be used when it has been decided that the activity will cause serious harm.
- A participant noted that it would be useful to define infilling.

- The author noted that in terms of habitat supply and type of habitat being lost there can be some differences in the curve. In one scenario there could be a project on the north shore of Lake Ontario. There is no coastal wetland and a large expanse of exposed shoreline with some infilling. What impact will it have on the fisheries in Lake Ontario? There would be a threshold, and the slope would be gradual. Conversely there could be a project on the east side of Lake Ontario and it impacts the Bay of Quinte. It's not exposed, there are wetlands, habitat is unique and fish aggregate there. In that case with an infill project there is maybe not even a threshold and the slope would be much steeper. If a project were in the headwaters with a residual brook trout population and a fishery, you would be very hesitant to infill. Loss of habitat in that area would have a dramatic effect.
- The chair commented that the less alternative habitat there is, the less likely it is that there is a plateau of resilience. Losing 10% of a common habitat will have a different impact than losing 10% of a rare habitat.
- A participant noted that one thing that isn't in the text is that the greatest support is for the curvilinear response curve. We could then list the modifiers if the linear should be chosen instead.

Change in Temperature

A change in water temperature or thermal structure can arise from different activity pathways that either modify temperatures directly or indirectly.

Discussion

- A participant liked that the *x* axis was without directionality and wondered how it would be different if one figure was used instead of two. The chair responded that for the thermal tolerance of a given species there are a range of temperatures where temperature does not matter that much. The slope for cold temperatures is shallower than the slope for hot temperature and once you get beyond the warm tolerance the slope is much steeper. The asymmetry is important and shouldn't be lost in a single graph.
- A participant noted that the asymmetry changes with life stages. In general it becomes more asymmetric in adults.
- The chair asked if there are always some species that are tolerant in whatever the temperature is and some that are not, at least until it gets pathologically hot and the water loses oxygen.
- A participant responded that it would have to be assessed species by species and compared back to fisheries management objectives.
- It was noted that a simple ecosystem with limited species may not be able to replace one species with another at different temperature ranges.
- A participant noted that it would be useful to indicate that there are situations where the slopped decline is more like a sharp drop off. The author noted that salmonids can be like that and that it should be captured.
- A participant asked about the temperature refuge effects of warm water in some habitats. It is important to protect the refuge habitat elements.
- Participants noted several aspects of temperature – it's layered and complex and can be tied to a particular place. It needs to be clear how to handle it.

- A participant noted that it can be difficult to deal with temperature changes. When it is a deposit, it is considered a deleterious substance and is Environment Canada's responsibility and when it is a biological impact of a project it is DFO's responsibility.
- A participant felt there should be more discussion of impacts of changes in temperature regime.
- It was decided to have one curve for temperature increase and one for temperature decrease from ambient.
- The chair noted that for a given system it has to be done by picking the species of concern. Temperature tolerance is very species specific. It's important to highlight that it's a quality element.

Change in Dissolved Oxygen

A change in dissolved oxygen level or saturation can arise from different activity pathways that either modify oxygen levels in water directly or indirectly.

Discussion

- A couple participants questioned on what curve a sensitive species would found and whether the slope would be different for less sensitive species.
- The chair noted that many fish that are part of CRA fisheries are often the ones that are particularly sensitive to loss of oxygen. Fishing management objectives are typically set for species that are less resilient.
- One participant noted that if you mange for more sensitive species then you also manage for the more resilient ones.
- A participant asked whether the fact that temperature increases oxygen demand was captured.
- A participant asked whether invertebrates and marine organisms were considered in the curves.
- The chair responded that this meeting was exclusively dealing with freshwater.
- A participant noted that there are detrimental effects to benthic communities when there are lower levels of oxygen. Some organisms will not be able to move away from the low oxygen area.
- The chair suggested providing references to review articles and taking what generalizations that can be made into the advice. He also suggested including any known critical time durations for low dissolved oxygen exposure.

Direct Mortality

Direct mortality refers to the killing of fish that are part of a fishery or support a fishery by any human induced mechanism other than fishing. Direct mortality can occur within any life stage and subsequently removes the individuals affected from the fisheries yield. Fish kills can have a wide range of effects on productivity ranging from relatively small increases in mortality to significantly reducing population size

Discussion

- There was discussion about serious harm:

    - A participant asked if offsetting would be a matter of policy if there was mortality. The author thought that it would be.
    - Another participant noted that offsetting is for serious harm.
    - The chair wanted to know the circumstances under which compensation would not be required.
    - A participant question how much sustainability would be impacted if there were only a few fish killed.
    - The chair agreed that there has to be enough fish killed to mean something before it is called serious harm.
- A participant question how much sustainability would be impacted if there were only a few fish killed.
- The chair agreed that there has to be enough fish killed to mean something before it is called serious harm.
- The author noted that, in a lot of situations, the level of direct mortality can be difficult to predict before it happens. For example, there are entrainment issues in almost every hydro project but the specific issues are only known after it is in place.
- A participant noted that there are difficulties with direct mortality under the existing act as well.
- A participant noted that there is a difference between chronic and acute direct mortality: a one time direct mortality event versus regular, often smaller, direct mortality events. Dam turbines were used as a chronic example.
- The chair asked if there was any biological basis to guide how many dead fish are enough to say there is serious harm? Is a single dead fish enough?
- A participant asked how to relate a large number of dead juvenile fish to productivity.
- Another participant thought that threshold values would be helpful.
- The chair noted that there needs to be a biological basis for any advice given.
- A participant asked to bring the discussion back to the fisheries management objectives again because there are some species where it can be very important if a very small number are killed.
- Another participant was concerned that there would be more uncertainty for proponents when using fisheries management objectives.
- A participant suggested using an official assessment when one is available. A single approach may not work well.
- Another participant was concerned that the only consideration here was density dependence.
- Another participant replied that the most risk adverse is assuming density independence.
- A participant noted that it will be hard to have a one size fits all rule.
- The chair noted that it will be unlikely to have fishery management objectives for each river and each lake. What is the fishery management objective that would give the guidance needed for populations that are not depleted?
- A participant noted that there would be a need for a tool that can be used immediately.

- A participant suggested finding a couple sentences of extra guidance around which types of population systems show more sensitivity and which show more resilience.
- A participant noted that there is some information that sensitivity to mortality is related to body size. That doesn't help with identifying the threshold though.
- One participant felt that it is possible to characterize the population biology of different fish. One could then look at mortality impacts. Emergent properties may be identifiable from that.
- The chair commented that something doesn't have to be done for each lake. One of the ideas that has come up is that it is the impact of the project on the species and its current population state. Population impact is dependant on both the population biology for the species and on mortality factors at different life history stages.
- The chair commented that if a stock is otherwise healthy, we wouldn't consider one or two dead fish to be serious harm. At some point there will be a place where it becomes serious harm. This should be a place where science can help so that the decision isn't totally arbitrary.
- A participant noted that there are fisheries where the upper stock reference point has not been identified.
- Another participant agreed that the reference points would be missing for many stocks.
- The chair noted that it will have the properties that guide setting the reference point. It's meant to follow the science properties.
- The chair commented that the focus is on a CRA fishery. We're not taking fish away from the fishery and giving it to the habitat. It's the incremental impact of the habitat use along with the fishery.
- A participant asked if proponents will need to demonstrate that they are on the plateau.
- A participant commented that he was comfortable pointing to the PA framework.
- A participant wondered what would happen if multiple species are impacted. In response another participant noted that it would depend on which species is chosen to test the mortality with.
- A participant felt the advice should have more details about when mortality should be avoided.
- The chair noted that if a population is part of a CRA fishery then that fishery is already using the compensation that is there. We acknowledge that there may be some surplus in unexploited fish but the CRA fishery could be using it. Any further impact may decrease the productivity of the CRA fishery. If we can't be confident that it has the properties that put it in the healthy zone, there will be a need for offsetting.
- The chair summarized that in choosing a population to measure direct mortality the following should be considered:
    a. Is it part of a CRA fishery?
    b. Does it have life history properties that are more vulnerable?
    c. Is the fishery already fished or healthy? If we add this extra mortality, are we still confident that it still has the list of properties?

- The chair commented that if there is possibility that the fishery will move out of the healthy zone, we will ask for a level of offsetting that will bring it back.
- A participant suggested to note in the preamble to the SAR that there are some logical links between the healthy zone of the PA framework and the serious harm boundary.

Change in Baseflow and Hydrodynamics

These endpoints are specific changes in flow attributes.

Discussion

- A participant noted that the presentation didn't include putting a structure in water. The author responded that he avoided it in order to stay as close to flow modifications as possible. Turbines go into unique locations and likely need to be individually assessed.
- A participant asked if it included coastal processes. The author responded that it only includes rivers. The chair clarified that coastal and offshore weren't intended to be covered at this meeting. Another participant suggested that research document acknowledge that there is application in marine.
- A participant asked if the tools would work as well for incremental withdrawal as for a significant withdrawal.

Change in Noise and Vibration

The PoE endpoint of concern is change in noise and vibration resulting from Works, Undertakings, and Activities (WUA) such as seismic surveys, pile driving, increased vessel traffic, low-frequency sonar equipment, underwater dredging and drilling activities, and construction noise. Some land-based activities like excavation and drilling work may also generate sound and vibration, which subsequently enters adjacent waterbodies like lakes and rivers.

Discussion

- A participant asked if these curves are consistent with earlier CSAS advice dealing with seismic impacts.
- The chair noted that to be consistent with the past science advice the initial decline would be slow and the impact on productivity will be small.
- A participant noted that there are no authorizations required for seismic but there are for large explosions.
- The chair asked about which part was the biggest issue – the sound from the detonation or the actual detonation.
- A participant noted that one reason seismic isn't considered to be an issue is because it's a short duration which is very different from long term noise.
- Another participant noted that the effect of an explosion is dead fish.
- A participant suggested having more than one graph.
- The chair noted that there is evidence of impacts on marine mammals at lower sound levels.
- A participant noted that to meet the definition of serious harm there needs to be fish mortality. Behavioural changes would not be a trigger for serious harm. It isn't until there is a

mortality impact that you can look at changes in productivity. The other possible link is in the alteration to habitat.

- A participant noted that it would be more important around chronic noise.
- The chair noted that when there is direct mortality due to noise, it would be way off the end of the curve. Serious harm can be a doorway to action if there is a change in the habitat that can last long enough to change behaviour. The sound levels of seismic that could induce behavioural changes don't last long enough for serious harm. There may be some chronic noise sources that last long enough that you would exclude animals from their breeding habitat.
- A participant asked about the situation when fisheries yield is affected by seismic.
- The chair noted that there isn't an obligation to sustain yield.
- The chair summarized that the only way that sound qualifies as serious harm is if it is high enough to cause direct mortality or if the impacts are on behaviour and the parts of behaviour linked to productivity. The sound has to be long enough lasting that it disrupts the completion of parts of the life cycle. There are still a lot of other tools to regulate sound.

Change in Light

The PoE endpoint of concern is **change in light** resulting from WUAs such as offshore oil platforms and renewable energy installations (wind, tidal and wave power, and in-river hydrokinetic turbines), lighthouses, and vessels.

Discussion

- Several participants suggested dropping this section from the advice. Although loss of light can have an impact on productivity, it was felt that something that would change a light profile enough to cause serious harm would have other impacts that are already identified in the advice. No one could identify a situation where changes to the light would be the major change.
- There was discussion about the need to include changes to light in freshwater environments in the science advice for the meeting. It was decided that the changes in light levels are not a primary pressure for freshwater. It will be revisited when the curves for the marine environment are done.

Change in Electromagnetic Field

The PoE endpoint of concern is change in the electromagnetic field (EMF) due to the increasing number of underwater electric cables from renewable energy sources such as offshore wind power, wave and tidal power, and in-river hydrokinetic turbines.

Discussion

- A participant asked if this would be a problem in freshwater systems. Another participant gave the example of the Great Lakes offshore wind energies.
- A participant noted that most electromagnetic fields (EMF) generated by electric cables would be strong compared to the EMF induced by organisms.
- A participant asked why the response curve had a threshold higher than zero.
- The chair stated all of the response curves will go to zero. EMF is not on the scale of loss of productivity as temperature. The chair noted that all of the figures would be in the same

document and will look the same to any reasonable reader. There are some habitat alterations, like temperature, for which zero matters. It won't be meaningful if the other graphs look the same but without the same serious implication. The preamble of the SAR will explain how to interpret the axes.

- A participant asked if the curves would be based on the literature or based on theory.
- The chair responded that they would be based on literature when possible and strongly supported by theory when necessary.
- A participant asked if the *x*-axis would be expressed as a measurement.
- The chair responded that it wouldn't be. Each curve would have additional factors that could require different parameters. Some would be much harder to express as a measurement than others.
- A participant suggested that a statement could be added to indicate the types of values that could populate the *x*-axis.
- A participant noted that he would like the preamble to make it clear that the advice covers the range of impacts that seem to be reasonable.
- There was discussion on how to appropriately demonstrate comparable productivity on the different curves.

Change in Sediment Concentration

A change in sediment concentration can result from increases in either suspended sediment in the water column or fine material in in the streambed. This endpoint appears in most of the current PoEs from both land-based and in-water activities.

Discussion

- A participant asked whether the curves can accommodate natural sediment load in a system. The author replied that one would expect it would have less of an impact.
- Another participant noted that the Canadian Council of Ministers of the Environment has extensive guidelines on this.
- The chair noted that this curve is one where what is put as the starting point matters.
- The author noted that the pristine condition has a natural sediment load. The species in those systems are different than in a mountain stream with minimal sediment load.
- The chair asked if there is a certain amount of incremental load coming from farming would change the river a lot. A participant responded that for some systems we don't know where we've moved it along the curve, for example the Red River may have been quite clear with limited sediment.
- A participant noted that there is a difference between suspended sediment and sediment that drops into the river bed. In the working paper there is only one curve for two different types of processes. The author responded that the *y*-axis would be different. Things like egg survival would be about sediment dropping out and suspended sediment would cause avoidance behaviour. In terms of the shape of the curve you'd still expect that the curves would be similar.
- The chair noted that this is a curve that should go to zero since it could eliminate productivity.

- A participant suggested that a modifier could be used to account for different geological conditions.
- Another participant noted that the sediment type would be the modifier including particle size distribution. The author agreed to add that to the information but didn't have supporting literature.
- The chair noted that modifiers would be captured in the prologue to the change in sedimentation section. In it, there is an acknowledgement that different watersheds will have different inherent loads. In each case the curve may be the same but the evaluation should be done to the community adapted to each configuration. The evaluation is done relative to a different background.

Change in Nutrient Concentration

Decreasing nutrient concentrations will not always result in an immediate reversal of the effects of increased nutrient concentration (Schindler 2012). The result of decreased nutrient concentrations will depend on which nutrient is limiting and can be slowed by nutrient pools in sediments and if species have been lost from the ecosystem. This P-S response curve will not deal with reversing the effects of eutrophication since the activities leading to this endpoint of the pathways of effects are associated with increased nutrient concentrations, such as removing riparian or aquatic vegetation, organic debris management, dredging, livestock grazing, and wastewater management.

Discussion

- A participant asked what kinds of projects will be reviewed with this as an output.
- Another participant didn't think that DFO would be managing direct nutrients per se.
- Another participant agreed that DFO doesn't manage it but wanted to know how to take it into account.
- A participant thought that supplementing a lake would fall under this. Another participant agreed that the changes to nutrient regimes can be important in mining projects.
- A participant felt that there would be a turbidity gradient that should be captured in the modifiers.
- The chair reiterated the sequence of events for a project:
    a. Determining whether there is serious harm. Will the change in the habitat feature persist long enough?
    c. If there is serious harm, is the serious harm going to harm productivity that will require some kind of compensation?
    d. If that is true, how is the compensation calculated.
- The author noted that this curve would be just for lakes.
- A participant noted that Environment Canada would be responsible for contaminants through the regulation of deleterious substances.

Change in Food Supply

In the current PoEs, changes in food supply are associated with activities that affect riparian or aquatic vegetation, structures in water, flows, dredging, or the placement of aquaculture facilities.

Discussion

- The author noted that food quality modifiers still need to be added.
- A participant asked if the overlap with fish that support a CRA fishery needs to be acknowledged. The chair didn't feel that was necessary.
- Another participant felt that fish that support a CRA fishery should be excluded.

ADVISORY REPORTS AND MEETING PRODUCTS

It was agreed that two SARs would be produced from this meeting:

- A Science-based Framework for Assessing the Response of Fisheries Productivity to State of Species or Habitats (SAR 2013/067);
- A Science-based Framework for Assessing Changes in Productivity, within the Context of the Amended Fisheries Act (SAR 2013/071).

Both SARs were completed after the meeting was concluded.

The two working papers were accepted as research documents.

MEETING ADJOURNED

The chairs thanked the meeting participants for their contributions. The chairs noted that there would be a CSAS meeting in June, 2013, that would provide Science advice on Fisheries Protection Policy regarding offsetting. Any issues remaining from the current meeting would be dealt with at that time.

REFERENCES

DFO. 2012. Science Advice to Support Development of a Fisheries Protection Policy for Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/063

DFO. 2013. A framework for assessing fisheries productivity for the Fisheries Protection Program. DFO Can. Sci. Advis. Sec. Sci. Res. Doc. 2013/67.

APPENDIX A: TERMS OF REFERENCE

Additional Science Guidance for Fisheries Protection Policy: Science-based Operational tools for Implementation

National Peer Review, National Capital Region

March 12-14, 2013
Ottawa, Ontario

Chairperson: Dr. Jake Rice

Context

In August 2012, DFO Science produced Science Advice to Support Development of a Fisheries Protection Policy for Canada (DFO 2013). This report provides advice to policy and management primarily regarding scientifically significant terms in the amended *Fisheries Act* (2012).

To enable implementation of S.35 of the amended *Fisheries Act*, science advice is required regarding:

1. operational measures of fisheries productivity, and
2. operational tools to assess potential impacts on fisheries productivity.

Objectives

The objectives of this meeting are to:

1. Peer review two supporting research documents:
    1. "Science-based guidance for choosing surrogate measures of fisheries productivity" (working title); and
    2. "A Review of Scientific Evidence Supporting Generic Productivity-State Response Curves" (working title);
2. Review and finalize templates for the evaluation of impacts to productivity from priority development activities via pre-established Pathways of Effects (POEs).
3. Provide advice on the operational use of
    1. measures of fisheries productivity; and
    2. the associated response curve templates.
4. Define necessary follow-up actions and next steps.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Documents (2)

Participation

- DFO Science
- DFO Fisheries Protection staff

References

DFO. 2013. Science Advice to Support Development of a Fisheries Protection Policy for Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/063.

APPENDIX B: MEETING PARTICIPANTS

Rice, Jake	DFO (Co-chair)
Wysocki, Roger	DFO (Co-chair)
Thorleifson, Erika	DFO (Editor)
Dahl, Julie	DFO
Smedbol, Kent	DFO
Winfield, Nicholas	DFO
Phelps, Anne	DFO
Keatley, Bronwyn	DFO
Hwang, Jason	DFO
Bradford, Mike	DFO
Curtis, Janelle	DFO
Dunham, Anya	DFO
Comeau, Luc	DFO
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Enders, Eva	DFO
Smokorowski, Karen	DFO
Clarke, Keith	DFO
Watkinson, Doug	DFO
Robichaud, Guy	DFO
Roberge, Michelle	DFO
Guitard, Alain	DFO
Thomas, Jennifer	DFO
Nardini, Michel	DFO
Hopky, Glen	DFO

APPENDIX C: MEETING AGENDA

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat (CSAS)
National Science Advisory Workshop

Additional Science Guidance for Fisheries Protection Policy: Science-based Operational tools for Implementation

Venue : Lord Elgin Hotel
www.lordelginhotel.ca
100 Elgin St, Ottawa, ON K1P 5K8

March 12-14, 2013

Chairpersons: Dr. Jake Rice and Roger Wysocki

Draft agenda. All times tentative and subject to change depending on discussions.

Tuesday March 12, 2013

Time	Topic
09:00 – 10:00	o Start at 0900h o Welcome and Context (15 min.) o Introduction of participants (5 min.) o Review Terms of Reference (5 min.) o Overview Presentation: Update on new developments on Fisheries Protection Program, including decision framework (Nick Winfield. 15 min. presentation; 15 minutes questions) **Approx. = 60 minutes**
10:30 – 10:45	Break
10:15 – 12:00	o **Review and Discussion of Productivity 2 Working Paper (M. Bradford to present)** o Presentation o Peer Review and Discussion o Draft key points for Science advisory report (SAR) **Approx. = 90 minutes**
12:00 – 1:00	Lunch Break (on your own)

Time	Topic
1:00 – 2:30	o **Review and Discussion of Response Curves Working Paper (Marten Koops to present)** o Presentation on general principals. o Demonstrate via presentation of 2-3 response curves. o Peer Review and Discussion o Draft key points for Science advisory report (SAR) **Approx. = 90 minutes**
2:30 – 2:45	Break
2:45 – 4:30	o Review progress from morning. o Presentation of response curves (times tentative, various presenters, TBD) • Loss of Wetted Area • Change in Sediment Concentration • Change in Habitat Cover and Structure **Approx. = 90 minutes**

Wednesday March 13, 2013

Time	Topic
8:30 – 10:30	o Re-cap of day 1 (review progress) including discussion (30 minutes). o Presentation of response curves (times tentative, various presenters, TBD) • Change in Nutrient Concentration • Change in Food Supply • Direct Mortality • Change in Temperature **Approx. = 90 minutes**
10:30 – 10:45	Break
10:45 – 12:00	o Presentation of response curves (times tentative, various presenters, TBD) • Change in Nutrient Concentration • Change in Food Supply • Direct Mortality • Change in Temperature **Approx. = 90 minutes**
12:00 – 1:00	Lunch Break (on your own)

Time	Topic
1:00 – 2:30	o Presentation of response curves (times tentative, various presenters, TBD) • Change in Noise and Vibration • Change in Light • Change in Electromagnetic Field **Approx. = 90 minutes**
2:30 – 2:45	Break
2:45 – 4:30	o Presentation of response curves (times tentative, various presenters, TBD) • Change in Access to Habitat • Change in Dissolved Oxygen • Change in Baseflow and Hydrodynamics **Approx. = 90 minutes**

Thursday, March 14, 2013

Time	Topic
8:30 – 10:30	o Re-cap of days 1 and 2 o Review of objectives for provision of advice to managers. o Drafting of Science Advisory Report (SAR) **Approx. = 90 minutes**
10:30 – 10:45	Break
10:45 – 12:00	o Drafting of Science Advisory Report (SAR) and guidance to managers. **Approx. = 90 minutes**
12:00 – 1:00	Lunch (on your own)
1:00 – 3:00 pm	o Finalize drafting of Science Advisory Report (SAR) o Review and endorse summary bullets of SAR **Approx. = 90 minutes**
3:00 pm. (approx)	Conclusion (time approximate)