Fisheries and Oceans Canada / Pêches et Océans Canada
Science / Sciences

C S A S | ***S C C S***

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Proceedings Series 2012/045 | **Compte rendu 2012/045**

Pacific Region | **Région du Pacifique**

Review of Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory

June 20-21, 2011
Vancouver, British Columbia

Meeting Chair:
Bruce Clark

Examen du Protocole de surveillance à long terme des projets hydroélectriques nouveaux et mis à niveau en Colombie-Britannique et au Yukon

Les 20 et 21 juin 2012
Vancouver, Colombie-Britannique

Président de réunion :
Bruce Clark

Fisheries and Oceans Canada / Pêches et Océans Canada
Science Branch / Secteur des Science
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

November 2012 | **Novembre 2012**

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 contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée 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.

ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/

CSAS-SCCS@DFO-MPO.GC.CA

Correct citation for this publication:

DFO. 2012. Review of Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory; June 20-21, 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/045.

TABLE OF CONTENTS

SUMMARY v
SOMMAIRE v
INTRODUCTION 1
REVIEWS 2
DISCUSSION 7
CONCLUSIONS & Recommendations 16
REFERENCES 18
APPENDIX A: AGENDA 19
APPENDIX B: ATTENDEES 21
APPENDIX C: TERMS OF REFERENCE 22

SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process (RAP) of 20-21 June 2011, at the Morris J Wosk Centre for Dialogue in Vancouver, British Columbia. The purpose of this meeting was to peer review a working paper outlining a protocol for the long-term monitoring of hydroelectric projects.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science and Ecosystem Management Branch, First Nations, hydroelectric industry, environmental consultants, academia and environmental non-governmental organizations.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Reports providing advice to EMB to inform *the development of monitoring programs for hydroelectric projects.*

The Science Advisory Report and supporting Research Document will be made publicly available on the CSAS Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm

SOMMAIRE

Le présent compte rendu résume l'essentiel des discussions et conclusions de la réunion relative au processus de consultation régionale de Pêches et Océans Canada (MPO) et du Secrétariat canadien de consultation scientifique (SCCS) qui a eu lieu les 20 et 21 juin 2011, au Morris J Wosk Centre for Dialogue à Vancouver, en Colombie-Britannique. Le but de la réunion était de procéder à un examen par les pairs d'un document de travail présentant un protocole de surveillance à long terme des projets hydroélectriques.

Au nombre des participants qui ont assisté à la réunion en personne ou par conférence Web, il y avait des représentants de la Direction des sciences et de la Direction de la gestion des écosystèmes (DGE) du MPO, des Premières Nations, de l'industrie hydroélectrique, du milieu universitaire et d'organisations non gouvernementales vouées à l'environnement, ainsi que des experts-conseils en environnement.

Les conclusions et avis découlant de cet examen seront présentés à la DGE sous forme d'avis scientifique afin d'éclairer *l'établissement de programmes de surveillance des projets hydroélectriques.*

L'avis scientifique et le document de recherche à l'appui seront rendus publics dans le calendrier des avis scientifiques du SCCS à l'adresse suivante : http://www.dfo-mpo.gc.ca/csas-sccs/index-fra.htm.

INTRODUCTION

A Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process (RAP) was held 20-21 June 2011 at the Morris J Wosk Centre for Dialogue in Vancouver, British Columbia, to review one working paper (*Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory*).

The Chair Bruce Clark welcomed everyone and reviewed the agenda with the meeting participants. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions so they could be heard by those online.

The Terms of Reference for the RAP (Appendix C) were reviewed, highlighting the objectives the review. It was explained that the Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from DFO, Ecosystem Management Branch (EMB). Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from Industry, consulting professionals and academia.

Marilyn Joyce Head of Centre for Science Advice Pacific (CSAP), gave a presentation on Canadian Science Advisory Secretariat (CSAS) reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair discussed the role of participants, the purpose of the various RAP publications (Science Advisory Report, Proceedings and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, working papers, and draft SARs.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 33 people participated in the RAP (Appendix B).

Participants were informed that Dr. Keith Clarke, (Section Head, Ecological Sciences Section, Science Branch, Fisheries and Oceans Canada) and Dr. Mike Bradford (Research Scientist, Salmon and Freshwater Ecosystems Section, Ecosystem Management Branch, Fisheries and Oceans Canada) had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

The authors gave a presentation to summarize the paper and then the reviewers presented their comments to the meeting group

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting (summaries provided in Appendix B):

> *Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory* by Lewis, A. and Harwood, A. (CSAP WP2011-P37)

The conclusions and advice resulting from this review will be provided in the form of Science Advisory Reports to Fisheries and Aquaculture management to inform salmon fishery planning for the above-noted stocks. The four Science Advisory Reports and two supporting Research Documents will be made publicly available on the CSAS Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm

REVIEWS

DR. KEITH CLARKE

Dr. Clarke thanked everyone for the opportunity for involvement in this process. He noted that his review of the paper was not for detailed methodologies, but rather for key points that would generate discussion at this meeting. Dr. Clarke briefly mentioned DFO's ongoing interests in moving towards national consistency in light of the current review of the Habitat Policy. He noted that his final comment would speak to some of the challenges in developing national standards for habitat assessments for effects monitoring and compensation monitoring, and provide a suggestion for the working paper to possibly achieve those ends.

Dr. Clarke commended the amount of work and effort put into the paper to date. He commented on the utility of having a standardized methodology for monitoring (would make the job easier for habitat practitioners, monitoring staff, and industry alike), in addition to supporting future scientific analyses.

Dr. Clarke felt it important to emphasize that methodologies should not be put in stone when they are created. He noted that, even though the intent is not to put them into stone, it's difficult to change government-approved protocol or guideline documents once they are in use; for example, the guidelines that come out of the protocols in this paper could be in place for 10 years before updates are made, and it could be five years before the next review occurred. Several examples of this were provided, including the metal mining effluent guidelines. Dr. Clarke mentioned the tendency for protocols and guidelines to be used in a prescriptive fashion, thus the importance of the contents in being well thought out. He also inserted a caveat that, despite these comments, it is important to make sure that the paper's objectives and purpose are focused on doing what needs to be done for the Fisheries Management Program.

The authors agreed that the paper should be balanced between being prescriptive and flexible for projects, but noted that it was necessary to provide some minimum requirements so that the monitoring work that proponents do is useful. They suggested that they could add some text around prescription/flexibility, as well as more text describing the paper's objective and purpose.

Dr. Clarke felt there was some confusion regarding the purpose of the paper, as the context of the paper was small run-of-river hydro projects (the number of hydro project referrals in DFO's workload is increasing) but storage hydro projects were also included in the paper. He noted that the storage aspect was not addressed as strongly as the run-of-river component of the paper. He also noted that the paper's application to large hydro projects was unclear, and remarked that the monitoring program section would need some changes to apply to large hydro projects. Concerns with a BACI design at the watershed scale were mentioned, and reference sites or before/after studies were suggested as alternatives. Given that not all of the monitoring parameters would be appropriate for large hydro projects, Dr. Clarke recommended that the application for large hydro projects (or lack of application) be made more explicit in the paper.

The authors acknowledged that the paper is focused on the predominant project type that industry and practitioners encounter, which is the smaller run-of-river project. The authors commented that larger projects have unique monitoring programs with methodologies that may be developed over time, and agreed that this should be mentioned in the paper. They did, however, want to identify some minimum monitoring guidelines that could be applied to larger projects as well as the smaller projects. The authors felt the inclusion of storage projects in the paper is critical, as these kinds of projects will be developed over the next few years and DFO practitioners will have to deal with them, but agreed that this section of the paper could be improved by adding more storage project-specific detail. The authors agreed with Dr. Clarke's comments around applying the BACI design on the watershed scale, and acknowledged that

monitoring sometimes begins later than planned or there isn't a reference site. They explained that the selection of the BACI design for the paper was driven in part by the history of project reviews as well as Provincial standards.

Dr. Clarke brought up the problematic nature of collecting baseline monitoring data for any environmental effects monitoring program. He commented on the tendency of hydro projects to change the rivers with which they are associated, and noted that it is thus difficult to compare the pre- and post-project impacts. Dr. Clarke noted that a lot of the baseline monitoring parameters are linked in to the EIA process, which translates to a two-year monitoring program. He did not feel that two years was long enough to come up with an accurate estimate of the natural variation within certain metrics, however, such as fish abundance. He suggested that an extra monitoring period during the years pre-construction (but post-EAI process) would be helpful, and also noted that this is not always easy for proponents. Dr. Clarke observed that fish are poor monitoring indicators because they move, adapt, and are difficult to sample, and commented that the metrics used for monitoring fish are not always easy to interpret in the context of effects monitoring.

The authors concurred that two years of data collection might not be sufficient. They observed that industry has a lot at stake with any of these projects, and noted that the two years of baseline monitoring came out of the Provincial process that DFO is involved in. The authors iterated that two years of monitoring is meant to be the minimum, and affirmed that there is a weakness here.

Dr. Clarke expressed his impression that the sampling methods developed for lakes did not seem to be as well developed as those for streams within the paper. He provided several examples, including: collecting one invertebrate sample at the deepest point in the lake once a year (may not adequately describe the lake populations because of lake turnover times; invertebrate growth cycles; and development stages, particularly with regard to identifying the zooplankton samples post-collection); no primary production sampling for the lakes; no body burden for mercury sampling (mercury monitoring).

The authors agreed that there are weaknesses in the lake sampling methods section of the paper. They understood the concerns around the zooplankton sampling, and suggested that they could consider water quality aspects in the paper as well.

Dr. Clarke suggested the mark-recapture methods section be expanded to better address reservoirs. He noted the difficulty of conducting abundance studies in larger reservoirs with gillnets or minnow traps. Dr. Clarke put forward pelagic species monitoring (e.g. hydroacoustic monitoring) in addition to the littoral species monitoring as another means of adding 'lake flavour' to the paper.

The authors commented that the mark recapture section of the paper applies to smaller reservoirs with single stocks, and that this section would need more work to be applicable to larger storage systems.

Dr. Clarke brought up the issue of dealing with cumulative effects. He questioned whether cumulative effects should be addressed in the document, and suggested acknowledging the issue in the paper whether they are spoken to there or not.

The authors stated that cumulative effects were intentionally not addressed in the paper. They commented that some of the protocols could be used to help assess cumulative effects, however, and some text could be developed around this.

Dr. Clarke felt that the rational behind the paper should be more clearly stated. He suggested the paper include a few paragraphs on adaptive management programs as one means of addressing the uncertainty associated with this kind of data and monitoring.

The authors agreed that there could be additional text added. It was noted that, while adaptive management is currently being used in monitoring programs, there is no global support for it, so it would have to be determined whether it would be acceptable and how it could be used to include it in the paper.

Dr. Clarke's last comment was related to DFO's interest in developing national consistency standards for habitat assessments for both effects and compensation monitoring. He suggested that standardizing the metrics rather than the methods for fish habitat monitoring would make achieving consistency possible, as implementing standard methodologies across the country may be difficult, but collecting data to standard metrics could be feasible. Dr. Clarke remarked that one goal is to be able to show the public that the productive capacity of fish habitat is being maintained. Dr. Clarke commented that he had shared his idea that standardizing monitoring methods could be secondary to standardizing monitoring metrics with the goal of generating discussion during the meeting. Dr. Clarke also brought up the issue of considering no net loss and productive capacity in an ecosystem perspective. He noted an expectation of having to answer questions such as "What's the form and function of this habitat, and how does it fit into the overall ecosystem?" in the future.

The authors agreed that the metrics are the focus in the paper. It was suggested that, since the metrics are already specified in the document and methods are provided, the tone could be clearer to better reflect this. The authors agreed with Dr. Clarke that the metrics are better detailed in the table in the Appendix than in the body of the paper.

The authors thanked Dr. Clarke for his comments, and generally agreed that the comments could be used to improve the document. The Chair summarized Dr. Clarke's comments on the paper for the group.

The group was brought up to speed on the evolution of the document prior to the second review: the document was initially written as monitoring guidelines for DFO, but is now being reviewed as a scientific working paper. Consequently, some edits to the paper are needed to reflect the new purpose (including revisions to the title and body of the text, e.g. changing the word "guidelines" to "protocols.") The purpose of the peer review meeting is to determine whether the paper contains the correct protocols, as well as the rationale for them as the correct protocols. Once the protocols are finalized, DFO Habitat Management Program can decide to put out a guidelines paper based on the protocols; the discussions during this meeting are meant to be around the correctness of the protocols, as these protocols will provide the background support for subsequent guidelines.

The Chair reminded the participants to think about whether the paper is sufficiently and scientifically supported, as they will have to agree that it is or make recommendations on how to make it so at the end of this peer review process.

DR. MIKE BRADFORD

Dr. Bradford began by commending the authors on the document, and noted that the authors' experience, particularly with small hydro projects, was evident throughout. He presented the major points of his review to the group, and referred to his written review for more minor points and topics already presented by Dr. Clarke.

The authors thanked Dr. Bradford for his review. They noted the constructive criticism and food for thought, and did not disagree with the review comments.

Dr. Bradford suggested that it would be helpful to clarify in the paper why the monitoring is being done, as the monitoring results have implications on how DFO manages its programs. He commented that knowing who will use the results and how they will be used should be included in the paper, and noted that the reporting out requirements for DFO's national Habitat Monitoring Program might be different from the reporting requirements presented in the paper.

The authors agreed to include more text about the reasons for monitoring in the paper.

Dr. Bradford observed that time and spatial controls are typical challenges for monitoring programs. He referenced the ambiguous results of an Electricité de France program (Sabaton et al. 2008 RRA 24:476) as well as one of his own flow experiments (Bradford et al. 2011, Freshwater Biol. In press) to highlight the difficulties associated with monitoring the responses of fish populations. Dr. Bradford pointed out that although fish habitat often serves as a proxy for fish populations in monitoring (because it is simpler and easier to monitor), it is important to keep the objectives of the monitoring in mind when designing the monitoring program. In other words, has the monitoring program been designed in such a way as to yield results that are useful for decision making?

Dr. Bradford questioned whether the power to capture a 50% decline in fish populations is adequate, and what "adequate" actually means in this case, as it is not the intent to advocate that a 50% reduction in a fish population is acceptable. This links back to the usefulness of the monitoring results if a 50% decline is the highest resolution yielded by the monitoring program.

The authors agreed that Dr. Bradford had a good question about the 50% fish population decline monitoring resolution. They noted that the question was raised during the Provincial review process as well, and commented on the challenges of designing a monitoring program that meets the desire to detect small changes and the related implications for those actually doing the monitoring. From a fisheries perspective it might be argued that no decline is acceptable. The authors clarified that the level of monitoring effort identified in the paper's protocols are meant to be a minimum rather than a standard, however, and there is flexibility to increase the sampling depending on the relevant fisheries resources pressures etc. The authors requested this topic be further discussed with the group later in the meeting.

The authors also commented on collaboration and alternative research programs, and briefly highlighted the opportunity to collect data for meta-analysis over time. One possible use for meta-data is larger trend analysis from the bigger data set. The authors acknowledged the challenges of striking a balance between how much monitoring is needed to yield useful information and how much monitoring effort industry is expected to provide.

Dr. Bradford raised some concerns about control site selection. He noted that it is not necessarily known what is being 'controlled for' when using an upstream reach as the control site, and in some situations using a control stream creates more noise in the data. Dr. Bradford remarked that the degree of spatial correlation in freshwater systems is quite low, and that fish populations in the project area can have a variety of external factors working on them (e.g. ocean events, where the fish come from), which adds further difficulties to the sampling.

The authors acknowledged that selecting control sites can be problematic. They noted that some programs use before/after designs, while others use reference conditions. The authors suggested mentioning in the paper that alternatives to the BACI design are available.

The authors also agreed that the multiple control sites idea was good. It was proposed that, over time, proponents could assemble the 'larger picture' when multiple projects are occurring in the same area, and a set of reference conditions could possibly be created from the data. As every single project will be monitored, in time there will be some useful finds along with the possibility to compile the data into a larger body of information that could be analyzed.

With regard to ramping Dr. Bradford noted that, while flows change a lot naturally in the project streams, hydro operations can create even more fluctuations. He commented that the 2.5cm/hr rate that is used as the fish-safe ramping standard by DFO has somewhat uncertain origins and the accuracy of the rate is not well-supported; recent research shows that it is hard to protect fish from stranding regardless of the ramping rate used. Other factors may be considered for protecting fish from stranding, including the time of day for the ramping. Dr. Bradford agreed

that it is possible to reduce mortality related to flow factors, but felt that the suggestion in the report that a particular ramping rate is safe for fish may not exactly be the case. He suggested that it may be possible to develop ramping rates for different classes of streams in future research.

The authors agreed that it was not the intention to imply that ramping protection would result in zero mortality; it is known that even slow ramping incurs mortality. They agreed to reword this part.

Dr. Bradford brought up the sample design outlined in the paper, and recommended that some thought be given to the kinds of information that would be used in the decision-making processes for projects to ensure that the parameters being sampled are appropriate (i.e. meaningful monitoring leading to meaningful results). For example, invertebrate sampling can be done but the reliability and usefulness of the data should be considered given the ambiguity of other invertebrate/flow change study results.

The authors noted that invertebrates are highly variable and present challenges when monitoring. For this reason, they were made a secondary parameter; invertebrate sampling may not be necessary for every stream, but the data may be valuable in certain conditions.

Adam Lewis also responded to several comments from Dr. Bradford that were available in the written comment sheet but not presented orally to the group (Dr. Bradford left them to be covered during the general discussion later in the session). The comments are as follows:

Regarding the absence of guidance on how monitoring program will be assembled, the authors agree that monitoring certain components on certain streams wouldn't make sense. It might be possible to put together standards for which parameters to monitor on which types of streams. Lots of customization would be needed, but could be useful. The authors agreed that they could add more guidance, but not enough to design all of the details of the monitoring programs.

The authors adopted the BACI design for the paper because of the precedent in the literature. They agreed that there are shortfalls with using classical statistics, but noted that it's the standard in science right now.

The authors commented that relating the monitoring program significance to the fisheries resources seems reasonable; however, DFO's primary consideration whether or not there is a HADD (practitioners do not necessarily take the state of the fisheries resource into account first).

Regarding the ramping rates section of the paper, the authors considered the results of available studies. They agree that there is a lot of variation in the study results, however. The approach taken was to try to focus on the most sensitive periods to eliminate some of the other 'noise' in the data. The authors suggested that research from the last couple of years might help improve the ramping information section. They commented that ramping studies would also speak to the hydro peaking issues.

The authors acknowledged the concerns around the fish community sampling issue and the need for using high quality habitat sites. They agreed that more discussion is needed in this section of the paper. The tradeoff between performing high quality sampling and the associated increase in effort was noted.

As far as the other methods identified as possibilities for fish sampling are concerned, the authors recognized that a variety of newer methods are being developed and proven currently. Historically, electro-fishing was used a lot (e.g. it is a standard in forestry sampling), but it is clear now that that some of the standard methods are not always as effective, and sometimes electro-fishing is prohibited. The authors remarked that other sampling methods are on the table, and commented that the document could emphasize this.

With regard to Dr. Bradford's comment that on the water quality, the authors noted that it would depend on where the water coming in, but agreed that most projects would not require specialized (micronutrient) analysis and monitoring. The authors also highlighted that water quality is identified as a secondary sampling metric in the document. This also applies to water temperature.

The authors agreed with Dr. Bradford that the lakes and reservoirs parts of the paper needs additional explanation.

The authors thanked Dr. Bradford for his input. The Chair summarized Dr. Bradford's comments for the group before the floor was opened for general discussion.

DISCUSSION

The Chair opened the floor for comments and discussion by all RAP participants. The following represents the nature of the discussion, organized by topic.

Monitoring

This document could be used as guidance provided to proponents or included in a *Fisheries Act* authorization early in the review process. The chair asked the following question: *Is the reference list in the document sufficient and suitable, or is it missing anything in particular?*

Adding more references to the document was brought up multiple times during the discussion. Specific topics suggested for further referencing include: using snorkeling as an assessment technique; DFO positions on the DFO policy points present in the paper (e.g. DFO's position on the interbasin transfer policy), as this topic comes up regularly in DFO reviews; geomorphology and the link to fisheries resources; channel pattern; and channel morphology. A complete list of additional reference suggestions was to be provided to the authors. Generally, it was felt that the scientific rational for the paper could use more support. After some discussion, the group also agreed that a USA water licensing reference (page 13) was not appropriate and should be removed.

Intended use of the document

There was a discussion around the likelihood of the document resulting in setting policy on some of the issues raised by the reviewers and other meeting participants. It was questioned whether policy would be developed for issues that presently lack formal DFO policy (e.g. policy stating that tailraces should be designed to exclude fish). The intended use of the document was discussed at length, and identified as an important component for inclusion in the paper by the group.

Monitoring Program Design

It was felt that there was a gap in the document in providing guidance on designing the monitoring program. This point was raised several times. Industry's interest in clarity and certainty of process was mentioned; specifically, what was the rational for developing a monitoring program, and what are the objectives and specific elements of the monitoring program? While the document contains a good list of what could or should be monitored, it could benefit from more discussion on why and how to monitor the elements identified. Adding a reference on research design was suggested, and the authors suggested that they could emphasize the precursor documents in the text instead, as this paper relies heavily on those documents for rationale and research design methods. With regard to specific monitoring objectives, it was requested that the possible kinds of decisions that could result from the information obtained be identified in the paper. It was also requested that the specific endpoints of the monitoring program be defined. Further to this idea, the group had a discussion about the

kinds of issues that could come up in a monitoring program, and thought that these should be included in the document before the section on specific methods.

Related to the design of the monitoring program is the rational for the monitoring parameters to be included in the monitoring program. The authors agreed to include more of the rational for the parameters in the document (in addition to the rational already provided by the reference documents, including the Hatfield document). They also noted the high amount of variability between projects, and agreed that some guidance for dealing with specific differences on a case-by-case basis could be useful. Geomorphology-related monitoring was presented as an example where more monitoring than was listed in the document was likely needed to be adequate.

Detecting changes through the monitoring program

The question of how to develop a monitoring program that can detect small changes was raised and discussed, given the often small effects that are being monitoring in these run of river projects. More monitoring isn't necessarily the answer to this question, but rather 'smart' monitoring.

Tailraces as Compensation

The suitability of using tailraces as an example of compensation in the paper was brought up. While some Areas within DFO have accepted tailraces as compensation in the past, the results have generally been disappointing or have even negatively impacted fish because of the poor quality of the flow. It was suggested that this example be removed from the paper, and noted that the document should be written in the context of long term effectiveness monitoring rather than compensatory monitoring.

Response Monitoring Program

There were some questions about how the document speaks to response monitoring. The basic design for the response monitoring has been provided in the document in the form of a BACI design. This design was selected intentionally by the authors, but may not be ideal for every situation so it was suggested that alternatives should be allowed to be considered by DFO assessors if accompanied by appropriate rational. The SAR report could include additional guidance and rational rather than adding it to the paper.

The question of what would be done with the monitoring data collected was brought up multiple times, along with the reasons for monitoring. What is the hypothesis that is being tested by doing all of this monitoring? This would be useful to include in the paper. It was suggested that the document make reference to Habitat's Pathways of Effects (POEs), as some would fit well (e.g. flow management, fish passage) to help show why the hypotheses are reasonable. The POEs also tie in with the assessment process: they are predictions of the effects, and the monitoring confirms and evaluates the appropriateness of those predictions. It was requested that the process be more clearly laid out in the document, as it was felt that this would help proponents to set up a reasonable monitoring program. The authors commented that the tables at the end of the report already sought to lay out the monitoring program and provide some of the rational (i.e. it's not just a list of monitoring methods), but agreed that bolding specific text in the document could help emphasize the "why" part of the monitoring program.

An editorial suggestion was made to review the language in the document for prescriptive words (e.g. "must do") that may not be appropriate. While there is a minimum monitoring requirement provided in the document, monitoring for all projects will not necessarily be exactly the same and in atypical situations some things may change; the text of the document should reflect this.

Fish Passage

The group discussed the need for better guidance in the document regarding assessment of fish migration through fishways in a project (where fishways are supposed to mitigate impacts of the project). It was felt that the protocols around establishing fish passage before (baseline information) and after the project's construction were not fleshed out well for specific locations (e.g. intake or weir locations), and the text in the document around out-migration was not specific enough for different locations (e.g. weir intakes). It was suggested that some text be added around intake weir locations and adult fish passage obstructions. The authors commented that the monitoring should show the effectiveness of the fish passage structure, and expected that it would be of interest to all involved parties to evaluate whether the fishways were working or not.

Electrofishing

Electrofishing was raised as a concerning sampling methodology, particularly in anadromous fish-bearing waters. The authors agreed to include alternatives to electrofishing in the document, and it was suggested that the issue also be included in the SAR.

Benthic Invertebrates

A concern that benthic invertebrates were not adequately addressed compared to fish in the ramping section of the paper was brought forward. A Canadian Ecological Flow Index document (Armanini et al. 2011) was provided as a potential reference for invertebrates, and the authors agreed that they could reference this document. Invertebrates and the effects of river ramping on them were discussed in the context of a variety of studies. A comment that three years of pre-construction baseline data is not sufficient to understand what the effects are post-construction came out of the discussion, in light of the conclusions of the invertebrate-ramping studies discussed (i.e. even a well-designed and rigorous study has yielded data that is proving difficult to interpret). There was some discussion on what constitutes an adverse change in the invertebrate community structure, as well as discussion on drift and benthic invertebrates. The group agreed that effects on invertebrates from river ramping in an emerging field, and there is still a lot of uncertainty in the science. The authors noted that invertebrates were been identified as a parameter that can be monitored in the paper; they are a potential study component but not a monitoring requirement. At this point they did not feel that they could come up with a reasonable protocol that could be applied across a wide variety of projects, and did not feel that it was appropriate to include a standard protocol for evaluating invertebrates as per ramping rates at this time. It was suggested that the paper could mention monitoring of invertebrates as an ecosystem health indicator, since DFO is moving in the direction of considering an ecosystem approach to management. It was also felt that it would be worthwhile to have a recommendation from Science on options to consider for ecosystem indicators (even if they are high level or qualitative). In conclusion, the group agreed that the invertebrate sampling issue should be more thoroughly addressed in the SAR, but the document is sufficient in terms of invertebrate sampling.

Climate Change

It was mentioned that the climate change reference in the paper from 2002 (BC MWLAP 2002) was dated, and could be updated. The authors agreed that updating the reference was a good idea. A discussion on cumulative effects followed, and it was questioned whether the paper adequately addresses cumulative effects. The group agreed that cumulative effects should be addressed in the SAR. It was mentioned that paragraph 1 of the paper's conclusion states that the monitoring protocols are applicable to comprehensive study and panel processes (where cumulative effects assessment is a requirement). It was suggested there may be need to explain why the paper's protocols are not sufficient to consider cumulative effects (given the statement in the paper's conclusion).

Definitions

The group discussed large reservoirs and the document's applicability to such water bodies. The authors felt that lakes and large reservoirs were part of the original scope of the document, but noted that the large reservoir definition was somewhere arbitrary (it was meant to be conservative while ensuring that the really small reservoirs function more like pools are not monitored the same way as lakes are monitored).

The definition of "upgrade" (as in, "upgraded facility") was raised for clarification. Examples of "upgrades" include: a facility that has increased its capacity to withdraw water from the system, retrofitting the monitoring program after a new turbine is installed, a change to power capacity, and significant upgrades and changes to the facility that require an authorization. In sum, it can be assumed that an "upgrade" involves some kind of change that has biological implications, and the *Fisheries Act* would be in play. The authors noted that they had included "new" and "upgraded" in the title so that existing projects would not be subject to the protocols, but suggested that they could change the title and put the details in the foreword to the document. It was suggested that the authors could add some standards on minimum project size for which the protocols would apply, and this generated a lengthy discussion. The group consensus was to keep the title as it, but to add some extra text into the paper's foreword and possibly the SAR around the definitions of upgraded (and other terms that need defining).

A glossary was suggested for when the protocol paper becomes a guidelines document, as several terms were highlighted for defining during the meeting. The authors agreed that a glossary would be appropriate and useful in the guidelines document.

Hydro Peaking, Ramping, and Natural Rate Changes

The terms "hydro peaking" and "ramping rate monitoring" were raised as needing further defining. The authors clarified that "monitoring ramping rates" in the document applies to the operations continuously in addition to start up and shut down, but does not hold proponents to maintaining natural stage change rates at all times (this could be a term in Authorizations). They noted that the issue is too poorly defined to be considered research at this point, even though proponents are installing the equipment for monitoring flow changes. It was raised that some proponents are doing ramping studies in advance of projects to establish sensitive sites, and comments made regarding the regulating end of ramping. A comment was made that there seems to be some confusion between the *Fisheries Act* requirements and then other responsibilities that DFO must take into consideration related to environmental assessments; it was suggested that Science protocols would be better suited to focus solely on the effects of hydro dams on fish and fish habitat, but the terms of reference [for the document] includes CEAA process so the whole issue becomes less clear.

Industry would like to know how they will be regulated and what the goals will be, as there are challenges to work through, such as communicating the desired ramping standards to the turbine makers to ensure that the equipment can actually do perform as needed. A technical ramping discussion followed, including topics such as state changes, turbine specifications, and participants' experience in either project operations or regulatory work. To conclude the discussion, it was suggested that the paper qualify the fact that ramping information is evolving by adding some more text to section 3.1.1.2, and making reference to the Hunter paper. The group was in consensus with the suggestion. The SAR was also suggested as a place for clarification around ramping rates and natural stage change data.

A comment was made highlighting concerns that the contents of the document may be perceived as "set in stone" despite the evolving nature of ramping science and research; it is therefore important to word the contents of the document carefully and correctly around issues that may be subject to change as more is learned in the future.

There was a question raised about natural rate changes and project impacts. It was suggested that a sentence be added to the paper around the timing of when the sensitive sites are identified (prior to the ramping tests) to avoid inconclusive results.

North of 60 degrees

The difficulties of monitoring icing issues was raised and discussed. Several questions were asked, including whether hydro-regulated systems create more ice, and if they cause more shoreline scouring (including in redd areas for salmon)? “frazil” ice and anchor ice were mentioned as potential concerns. It was noted that literature is available on icing from both Norway and Canada. There are two strains of icing research: from an engineering perspective, and from a biological perspective. The authors commented that the research and the “frazil” ice issue had been acknowledged in the document, and noted that while monitoring is required there are not a lot of icing-related monitoring protocols in the document. This is because of timing (the protocols that could be referenced are not yet finished being reviewed). Since this meeting was not the time to add anything substantive to the document, the group agreed to include the icing issue in the SAR as something that needs to be addressed and considered making reference to the protocols that are available but not yet defended. A discussion around icing and whether higher flows are better or worse followed. There is some direction provided in the document, but it was noted that it may not be the correct direction. The authors noted that there are some basic requirements for monitoring “frazil” ice provided in the paper, but agreed that the statement regarding flows as a mitigative measure might not read well and could be improved. After more discussion on “frazil” ice and the effect of “frazil” ice on modifying fish habitat, buildup of “frazil” ice in fish habitats, effects on channel flows and velocities, the group agreed that the authors should add more “frazil” ice references to the document (because there are many available), and note in the document why it’s an issue in terms of the fisheries resource and fish habitat. “frazil” ice should be identified as a concern, and monitoring recommended, but there should be no specific advice provided.

Title of paper

The title of the document was brought up for discussion, as the paper mentions larger hydro projects and reservoirs in addition to small hydro projects, albeit the lake/reservoirs are not covered as thoroughly. Small hydro projects were the focus of earlier versions of the paper, which were initiated by the IPP Working Group. The discussion segued into a discussion about the applicability of the document to projects other than small hydro projects.

Scope of paper

The group discussed how the paper applies to projects of different sizes, including projects that affect larger river systems. It was noted that the lake sections of the paper were less detailed, and there was a comment that it seemed unlikely that someone could pick up the paper and use it to come up with a monitoring project for larger projects. It was suggested that larger projects should be dealt with on a case by case basis because of the connections within the watershed. The group discussed adding some standards around the size of the projects that the document is applicable to, and the authors noted that there is some text in the document already regarding seasonal projects and their associated monitoring. It was mentioned that mega projects (e.g. BC Hydro’s Site C) have separate monitoring plans, and that this document was not meant for those mega projects. However, the authors noted that the protocols could be still be used on larger hydro projects (because they already are being used on such projects). The group agreed that the report (and possibly the SAR) should state that the protocols do not apply to mega projects, also recognize that the protocols could be used to inform some of the monitoring program designing for mega projects.

A question was asked about the necessary to talk about panel process in the paper. Since the Environmental Assessment covers all environmental effects, and the monitoring in the paper

specific to *Fisheries Act* regulatory requirements for fisheries outcomes, it was felt that the monitoring protocol should be complimentary to a broader process (and the scope kept specifically to the *Fisheries Act* where possible).

Experimental Design

The rigor of the overall experimental design was brought forth for discussion. Is the design rigorous enough to come to conclusions, or should there be thought put towards other options for experimental design? This issue is nested within the larger question of why monitoring is being done at all. An assumption was presented: an Environmental Assessment will be done and an authorization will follow for these projects; consequently, the amount of habitat change in question should be fairly small (or otherwise it would not have been authorized). The idea of reference conditions was subsequently brought up (i.e. what does a typical stream have in it, and after a project has been constructed and operating for a while at a particular stream, does that stream still have the typical representation of what it should contain?). As reference conditions are key components of experimental design, they are expected to affect how the monitoring program is designed (to ensure that the desired outputs for the monitoring program can be met). The authors agreed with the majority of the comments, except for the idea that these projects are permitted with No Net Loss (NNL) being maintained. They felt that the projects are frequently permitted by the Province with the idea of making the most use of the water as possible (economic benefits), which does not necessarily mean that the NNL objective is always met. They commented on the high amount of variability in watercourse habitat and productivity (this comment supported by several studies); consequently, until there is confidence that issuing water licenses means that NNL is being maintained, there is a need for monitoring. The BACI experimental design was proposed for the paper because others have found it to be the most powerful way to recognize effects and changes. There are other designs, however, and they may be more appropriate in certain situations. This last point has been recognized within the document.

Flow Rates

It was noted that these smaller hydro projects often come down to flow rates, and the question of “how little is too little?” was raised. It was suggested that some support for those flow numbers would be helpful for the paper. The group had a discussion about flow rates, and there were several comments made linking flow rates to biological threshold. For example, a particular decrease in flow may lead to a certain decrease in wetted habitat for a given fish life stage, which could lead to a decrease in said fish species population numbers. The authors noted that they are trying to collect more data to show the effects of flow on fish abundance, and made reference to the Bradford study that shows drastic variability. Predictions of responses from Environmental Assessments were also mentioned; and the question of “what if a loss is predicted?” posed. It was noted that if there’s a prediction made, the monitoring program should be designed to try to address the predictions. It is anticipated that there will be a large increase in knowledge available over the next five years as monitoring results start to come in, and the authors commented that they may be able to revise some more concerns in the document at that time. Given that there is information lacking right now, however, the document was written to provide some guidance.

Issues brought forward from Industry

On behalf of Clean Energy BC, Summit Environmental Consultants reviewed the document and came up with a 15 page paper that outlines how they expect Clean Energy BC would take the requirements contained in the paper. The paper was submitted to the group, and several key technical issues were raised for discussion. The Summit paper speaks to editorial issues as well as technical issues, and it was agreed that anything not raised during the meeting would be handled through the general paper revisions and/or in the SAR.

One concern raised was the idea that the protocols in the paper will turn into guidelines, which will then be applied to projects without much room for case-by-case considerations. It was explained that the purpose of the paper is to tell managers how to measure the things they need to measure to get the information they want or need to make their management decisions.

Another editorial concern was the use of the word “must” in the paper; it was requested that they be removed if the paper is to be a protocol. The authors noted that the Province insisted on the ‘musts’ (based on past experiences rather than science, perhaps). The group was reminded that the document will be revised as needed to make it a protocol document rather than a guideline document, and that the document is not ‘cast in stone.’

It was suggested that the document could be improved by making it clear that the particular monitoring program that is adopted in each case should be driven by expectations based on site-specific information, rather than determined a priori; and that the monitoring program be agreed to formally between proponent and regulator see section 1.1 2nd paragraph and last paragraph and 1st sentence of section 1.5 for example). The Environmental Impact Assessment and associated regulatory processes should be the starting point for the monitoring plan.

It was also requested that additional references and justification for the six primary parameters and three secondary parameters be included in the document. A comment was made that a science-based paper would not outline the monitoring parameters up front, but rather determine the parameters to be monitored on a case by case basis. The authors disagreed that there was not opportunity for case by case review already included in the paper. For example, professionals can put their stamp as Registered Professional Biologists that they don’t feel parameter X makes sense to monitor for a certain project. However, they agreed to edit the wording in the document to make it more clear that there is room for professional judgment. The authors commented that not all proponents are as willing to monitor as others, and could benefit from the extra structure provided by stating the parameters up front. Several people commented on the need for backing up the parameters with references, and felt that some stronger acknowledgment of alternative monitoring approaches on a case by case basis would be appropriate.

The lack of detail and support for storage and lake hydro projects compared to run of river projects was raised again.

Reporting Timelines

An issue about specifying timelines as part of a reporting requirements piece in the document was raised. It was felt that reporting requirements do not have a place in a science-based document; reporting requirements belong in a guidelines piece. It was recommended that that if there scientific grounds for a particular reporting timeline they be included and justified in the document, but otherwise DFO Habitat staff are responsible for defining the timelines in their relevant policies and practices (so it would not belong in the report). Legal requirements around reporting timelines would also be appropriate to include in the document.

Response Parameters

It was felt that the response parameters (in the tables in the back of the document) were not well justified, and that the objectives were not well stated in all cases. It was requested that the objectives be clearly defined and it be clear how the response parameters are linked to adaptive actions.

Data analysis

The possibility of doing meta-analysis in the future with the monitoring data collected was discussed. It was clarified that the document just states that some meta-analysis could be done with the data, not that meta-analysis would have to be done as a result of the monitoring. It was recognized that meta-analysis needs to be supported by the document although it is not a requirement for monitoring, and the authors agreed to add some more text regarding meta-analysis to the document. A discussion around research-level monitoring and studies followed, including the pros and cons of monitoring a select set of streams versus doing basic monitoring on all streams, and the methods used for the monitoring versus the power of the studies (with "power" meaning the number of studies).

Minimum data requirements to enter into meta-analysis were also discussed, and the authors asked the group explicitly about the five sample suggestion put forth in the paper. Questions were raised about whether five samples would show the desired resolution of change, and the authors noted that the literature cites five sites as yielding 50% change accuracy. A suggestion was made to focus on the metrics of the monitoring and leave the sampling methods up to the professionals (i.e. leave out the details about the sample occurs, sample numbers, and sampling location). The group discussed this idea, and it was noted that if a minimum sampling number could not be identified, [DFO] managers would appreciate some guidance on how to determine the minimum number of samples needed to get the desired information. The group agreed that information to give to managers could be captured in the SAR, along with adding some wording around trend analysis (to the report and/or the SAR).

Hydrologic variability

With regard to hydrologic variability, it was asked why the paper states a three year requirement for capturing the data. A suggestion was made to remove this time frame, or change it to one year, under the rational that three years is too long to expect proponents to monitor for and still may not capture enough information to get a good idea of hydrologic variability. It was felt that a variety of sources and timescales was necessary to obtain the necessary data. The authors noted that the three year time frame was put into the paper de facto; however, the data usually already exists because of the way the process runs. Three reasons were given: three years of data improves the correlation in the analysis, the collection of the data is not onerous, and the Province already specifies two years rather than one.

It was suggested that this timeframe should be a guideline and not a minimum standard. It was pointed out that a hydrologist can derive estimates of hydrologic characteristics at any site with no data whatsoever from the site itself. Some data is better than none, 2 years is better than one, 3 years is better than 2, 4 years is better than 3, etc., but additional years of site-specific data only reduce the width of the error bars. It was also pointed out that there is never enough information contained in a 2 or 3 year record at a site to allow one to use only that data to describe the hydrology at a site. Other regional information to describe site hydrology (unless you have many years or even decades of site data) is required to provide the best assessment.

The group discussed the validity of the three years and a text change was suggested, along the lines of "typically there will be two years of data available…". It was noted that the paper will need to reference the science and literature to back up whichever standard is selected. A discussion about using onsite gauging versus near-site gauging followed, and in conclusion the

authors agreed that two years is a generally valid period and they could make this change to the paper.

Geomorphology and slope stability

It was asked whether the document speaks to geomorphology and slope stability issues at all, as they are important considerations for steep sites with changing water levels. In the absence of any in the document, it was suggested that baseline monitoring for slope stability, sedimentation, plant communities, etc was needed, as they are all issues for larger reservoirs with changing water levels that can have disastrous results without proper monitoring. These issues can also be present for smaller projects, particularly sedimentation. The authors agreed that adding some text around slope stability to section 3.2.1 would make it complete. Recruitment and monitoring of large wood debris (LWD) was also highlighted as lacking in the document.

Riparian assessment

Concerns about the quality of the riparian assessment in section 3.1.3 (as part of the footprint baseline data requirements) were raised. The document says to assign low, med high riparian classes, and the concern was that, it would be difficult for any of the projects to ever receive a "high" value because most of them are located in logged areas. The statement about the riparian value class influencing the compensation plan was also highlighted as a concern; it was requested that, if not removed (if it does not inform the protocol, since the compensation decision is not part of the science advice), it be changed to "may influence" rather than "will influence." The group discussed riparian habitat quality, site potential, DFO policy considerations/ and interpretations, and the Riparian Areas Regulations (RAR) before agreeing to change the text in this section and add some more references.

Lake Sampling

The group has a lengthy conversation about lake sampling. A variety of location and sample replicate number suggestions were tabled and discussed. The authors described the intention of the lake sampling in the paper, and multiple topics or concerns were discussed including: zooplankton in reservoirs and lake systems (and their including generation time); lake turnover time and mixing periods; and the purpose of lake sampling (fish food availability versus zooplankton community dynamics, etc). The authors suggested that the sampling outlined in the paper (i.e. one sample location) be designated as the "minimum" requirement to leave room for professional judgment in circumstances where sampling at more than one location would be appropriate. They also agreed that some qualifiers should be included in the SAR for when more sampling would be appropriate (e.g. when there is more than one basin), or when zooplankton sampling could be useful.

CONCLUSIONS & RECOMMENDATIONS

The group agreed that the working paper, with the changes identified in these proceedings and agreed by the authors and participants, was acceptable for publication as a CSAS Research Document, and sufficient on which to base Science Advisory Report, resulting from this review. It was agreed that a small editorial board would be established to review the draft Research Document after the authors make the revisions to ensure that the agreed upon changes were addressed. The review board will consist of: Brian Guy, Dave Carter, Mike Bradford, and the authors.

The following provides a comprehensive list of conclusions, recommendations, editorial changes and key advice arising from this review and discussion of the development of the Science Advisory Report. The group discussed which ones were to be reflected in the Science Advisory Report, by working though draft bullets for the SAR.

Specific Editorial Changes

- The scope of application - use a threshold of megawatts and or reservoir size rather than Canadian Environmental Assessment Act (CEAA) Comprehensive Study Regulation.
- A 5-10 year period because there will be a number pf projects with 5 years' worth of data submitted then, and it'll take some time to do the analysis.
- Measuring the effects on fish – want to make sure that the issue of how hard it is to detect effects is captured, without implying that better methods could be used than those proposed in the paper, because the group agrees on the methods to be used, it's just that the changes to be measured may be quite small, or there might be a lot of underlying natural variability might be large and obscure the results considerably. Avoid using 'statistically significant' phrase as it's not the correct application. It's better to speak to the challenges associated with detecting the 50% level.
- Species of management concern – to encapsulate Species at Risk, listed species, non-listed species that are of management concern in terms of fisheries resource etc.

Limitations

- Climate change effects – discussion around how to monitor with regard to climate change. Perhaps it is noted that this monitoring can't differentiate between climate effects and natural variability. What about cumulative effects and climate change?
- Does electrofishing need to be dealt with in the SAR? Is it adequately covered in the document? Concern is that anadromous fish are too much at risk to risk mortality from electrofishing (especially Coho)… in contrast with the idea that the data is worth the risk of the relatively small mortality risk associated with electrofishing. Need to be able to give advice to proponents. In the doc it says that permits will be required for electrofishing; maybe it should be qualified in the document noting that it's not an acceptable method for all circumstances and proponents should seek advice before doing it. Is this high level enough that Habitat needs to consider this further and come to some conclusions? It's broader than just Habitat—could need some Science advice on the issue. Want to leave it in as an option to protect the power of select future sample designs.
- Ramping/hydro peaking – very little known about this to date… still in the scoping stages of this issue. Also a need for a glossary entry for this in the document. The monitoring protocol for ramping is appropriate for base load, as opposed to peaking… some hesitations on publishing the doc with a prescriptive ramping section when there's new information being learned about ramping every week… still learning and understanding

more about the ramping on the local systems. The protocols in the doc are not appropriate for monitoring hydro peaking operations. How do you determine which effects of ramping are attributed to project operations compared to the effects of natural variability? The compliance part of the question is simple in that proponents can ramp at a specified rate, but the effects may not be obvious when natural system changes are applied too. Lots of work to be done still on this topic (could make for a good master's project).

Invertebrates

- lots of emerging research/science with regard to inverts, including the utility of monitoring inverts with response to flow measurements (e.g. north vs. south because of climate change – regime changes, flow changes)
- invert sampling has historically been used in the context of water quality
- not widely used in the northern sites yet
- the protocols provide only limited direction on appropriate protocols to be used for invert sampling and monitoring

Icing

- "frazil" ice, anchor ice
- the protocols don't evaluate the effects of icing (that's not to say that the rest of the protocols aren't applicable)

Lack of hydrology data

- not just in Yukon (although it's most of Yukon outside of the Yukon river)
- steep slopes also lack data
- in the doc the min is 2 years; may often get three or more but in certain situations less might also be applicable (systems with proxy info)

Lakes and reservoirs

- partially settled by limiting the size of the projects in the scope of the doc
- further assessment by qualified experts required to make this section more accurate
- the protocols only provide minimal monitoring directions; the situations should be covered off on a case by case basis in terms of monitoring design.

Climate change and cumulative effects

- what about other land use considerations (e.g. logging)?

**Big note that there are three companion documents that are to accompany the protocol document since it relies on them for a lot of background information.

Future Areas of Research & Follow-up

- several of the above topics identify future research needs
- Meta analysis – monitoring data that could feed into meaningful meta analysis. Would like to do meta analysis in the future
- Need/desire to have reports available. Not all info is available, so it's useful to have other information available.

- Going to work with Dave and Derek to come up with some statement around collecting/reporting on data (in a standardized fashion so it's useful and cost effective)
- some discussions around databases and PATH reporting

REFERENCES

Armanini, D.G., Horrigan, N., Monk, W.A., Peters, D.L. and Baird, D.J. 2011. Development of a benthic macroinvertebrate flow sensitivity index for Canadian rivers. River Research and Applications, 27: 723-737.

BC MWLAP (British Columbia Ministry of Water, Land and Air Protection). 2002. Indicators of Climate Change for British Columbia 2002. Published by the BC Ministry of Water, Land and Air Protection, Victoria, B.C. Available online at http://www.env.gov.bc.ca/air/climate/indicat/index.html.

APPENDIX A: AGENDA

Regional Advisory Process (RAP)
Centre for Science Advice Pacific

AGENDA

Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory
Pacific Regional Science Advisory Process

June 20-21, 2011

Morris J Wosk Centre for Dialogue
SFU Vancouver Campus
ICBC Salon B, Lower Concourse
580 West Hastings St.
Vancouver, British Columbia

Chairperson: Bruce Clark

Day 1 – Monday June 20th

9:30	Welcome & Introductions Marilyn Joyce
9:45	Review Agenda & Housekeeping Bruce Clark
10:00	CSAS Overview & Meeting Procedures Marilyn Joyce
10:15	Review of Terms of Reference Bruce Clark
10:30	Presentation of Working Paper Adam Lewis
11:10	***Break***
11:30	Reviewer Presentation & Author Response Keith Clarke
12:15	***Lunch Break***
1:30	Reviewer Presentation & Author Response Mike Bradford
2:15	Group Discussion to identify issues and topics needing further discussion
RAP	Participants
2:45	***Break***
3:00	Discussion and resolution - Issues & Topics RAP Participants
4:30	***Adjournment***

Day 2 – Tuesday June 21st

9:30	Introductions & Housekeeping Bruce Clark
9:40	Day 1 Review & Confirm Agenda for the day Bruce Clark
9:50	Discussion and resolution - Issues & Topics RAP Participants
10:30	***Break***
11:00	Discussion and resolution - Issues & Topics RAP Participants
12:00	***Lunch Break***
1:15	Science Advisory Report: Develop Consensus on:

- Key findings & conclusions
- Uncertainties
- Ecosystem Considerations
- Advice for Management / application of
- protocols
- Recommendations for future work
- Other
- RAP Participants

4:30 *ADJOURNMENT*

APPENDIX B: ATTENDEES

Name	Organization
Babakaiff, Scott	Ministry of the Environment
Beattie, Alasdair	DFO
Bradford, Mike	DFO
Busto, Vince	DFO
Carter, Dave	DFO
Casey, James	World Wildlife Federation - Freshwater
Clark, Bruce	DFO
Clarke, Keith	DFO
Closs, Natalie	Innergex Renewable Energy
Deguise, Isabelle	Clean Energy BC & Cloudworks Energy
Ferguson, Brian	DFO
Fisher, Neil	DFO
Guy, Brian	Summit Environmental Consultants
Harwood, Andrew	Ecofish Research Ltd.
Hillier, Joy	DFO
Joseph-Bruce, Maxine	Mount Currie Band - Lil'wat Nation
Joyce, Marilyn	DFO
Kennedy, Matt	Cloudworks Engery
Knight, Francesca	DFO
Lebel, Mathieu	World Wildlife Federation
Lewis, Adam	Ecofish Research Ltd.
Major, Stephanie	DFO
Mossop, Brent	B.C. Hydro
Nishimura, Derek	DFO
Rempel, Laura	DFO
Schubert, Neil	DFO
Smith,Rob	DFO
Smokorowski, Karen	DFO
Wagner, Glenn	Environmental Dynamics Inc.
Watts, Dean	DFO
Wilkins, Susan	Pottinger Gaherty Environmental Consultants
Woods, Monica	DFO
Wysocki, Roger	DFO

APPENDIX C: TERMS OF REFERENCE

TERMS OF REFERENCE

Long-term Monitoring Protocols for New and Upgraded Hydroelectric Projects in British Columbia and Yukon Territory

Pacific Regional Science Advisory Process

June 20-21, 2011
Vancouver, British Columbia
Chairperson: Bruce Clark

Context

Small hydro development proposals represent the largest number of referrals by sector to the Habitat Management Program in Pacific Region (British Columbia and Yukon Territory). Standardized monitoring methodologies are required for consistency and for comparing data across many projects. This is aligned with the National Habitat Management Program, whereby monitoring results are to be used to evaluate, modify and improve Program delivery. The adoption of standardized methods for both departmental monitoring and proponent monitoring will allow the development of more robust data sets that can be used to evaluate environmental effects and program success. The development of scientifically defensible monitoring methodologies will directly support the departmental priority of performance measurement and quality of service to Canadians.

The DFO Ecosystem Management Branch - Habitat Management Program, Pacific Region (DFO-HMP) has requested science advice in the form of peer review of the proposed standardized habitat monitoring protocols for new and upgraded Hydro-electric projects in British Columbia and Yukon Territory. The purpose of the monitoring protocols is to establish the parameters and types of monitoring necessary for the effective long-term monitoring of new hydroelectric projects, as well as those undergoing significant upgrades. They are intended to apply to small (<50 MW) and large (>50 MW) run-of-river hydroelectric projects involving streams or lakes, as well as projects that involve the creation of a storage reservoir. The monitoring protocols are to be used by proponents and/or Qualified Environmental Professionals (QEPs), both prior to submission of the development plan and Environmental Assessment (EA) application (to assist in the collection of the necessary baseline data) and during project operation, for the development of suitable effects monitoring programs. This protocol document is intended to serve as a companion piece to existing hydro project guidelines (Lewis et al, 2004; Hatfield et al, 2007); the emphasis of this document is on project operation, while the existing guidance documents emphasize baseline data collection in support of the project application.

Objectives

The following working paper prepared under contract to DFO will be reviewed:

Lewis, F.J.A., A.J. Harwood, and T. Hatfield. 2011 Long-Term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects. (CSAP Working Paper 2011-P37)

Specifically, this review will consider the following protocol elements and, using expert opinion and peer reviewed published literature as a basis for evaluation, provide advice as to their suitability for identifying and evaluating the environmental effects:

- baseline inventory requirements
- monitoring methodologies
- reporting requirements

Elements of this working paper pertaining to legislation, environmental assessment and regulatory permitting are provided for context and will not be considered in this review.

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

Participation
DFO Science Branch
DFO Ecosystem Management Branch – Habitat Management Program
Technical Representatives from the Hydroelectric industry
First Nations organizations
Non-government organizations
Academia
Province of BC

References Cited

Lewis, A., T. Hatfield, B. Chilibeck and C. Roberts. 2004. Assessment methods for aquatic habitat and instream flow characteristics in support of applications to dam, divert, or extract water from streams in British Columbia. Report prepared for the Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management. Available online at: http://www.env.gov.bc.ca/wld/documents/bmp/assessment_methods_instreamflow_in_bc.pdf

Hatfield, T., A. Lewis, D. Ohlson, and M. Bradford. 2003. British Columbia Instream Flow Standards for Fish, Phase II: Development of instream flow thresholds as guidelines for reviewing proposed water uses. Developed for the BC Ministry of Sustainable Resource Management and the BC Ministry of Water, Land and Air Protection. March 2003. http://www.env.gov.bc.ca/wld/documents/bmp/guidelinesIFRv5_2.pdf

Hatfield, T., A.F. Lewis, and S. Babakaiff. 2007. Guidelines for the collection and analysis of fish and fish habitat data for the purpose of assessing impacts from small hydropower projects in British Columbia. Prepared by Solander Ecological Research Ltd. and Ecofish Research Ltd. for the BC Ministry of Environment, Surrey BC. http://www.env.gov.bc.ca/wld/documents/bmp/guidelinesIFRv5_2.pdf