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Results of a Peer Review Workshop on the Draft Report "Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake, and Estuarine Habitat Indicators"

Résultats d'un atelier d'examen par des pairs sur le rapport provisoire intitulé *La politique du Canada pour la conservation du saumon sauvage du Pacifique : indicateurs proposés pour les habitats des cours d'eau, des lacs et des estuaires*

15-16 January 2009

15 et 16 janvier 2009

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Canada

Foreword

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

Avant-propos

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

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SUMMARY

A workshop to allow peer review discussion of DFO's draft report "Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake, and Estuarine Habitat Indicators" was held in Vancouver, BC, on January 15-16, 2009. Strategy 2 of the Wild Salmon Policy (WSP) requires assessment of habitat conditions within salmon Conservation Units (CUs), based on appropriate habitat indicators with associated metrics and benchmarks. The main goals for the workshop were: 1) to assess the efficacy of the report's proposed habitat indicators in meeting Strategy 2 objectives, 2) make recommendations for improving the efficacy of these proposed indicators to meet Strategy 2 objectives in view of available resources, and 3) continue dialogue on Strategy 2 habitat indicators. Workshop participants included representatives from DFO, BC Ministry of Environment, Washington State Conservation Commission, Pacific Fisheries Resource Conservation Council, Salmon Enhancement and Habitat Advisory Board, Upper Fraser Conservation Alliance, Pacific Salmon Foundation, Watershed Watch Salmon Society, Streamkeepers, Skeena Wild Conservation Trust, Skeena Fisheries, and Simon Fraser University. The workshop included formal reviews of the report by invited experts as well as informal discussion by workshop participants over the course of two days.

Formal reviews and comments from workshop participants suggested that the suite of proposed habitat indicators presented in the report was acceptable for moving forward on Strategy 2 of the WSP, with an expectation that continued refinement of indicators will be an iterative process. General opinion was that the report will provide a strong foundation for a Strategy 2 habitat indicators monitoring program. However, it was suggested that the report would benefit from some restructuring to improve reader understanding of the habitat indicator selection process employed by DFO and the rationales used for selection of associated indicator benchmarks/thresholds. This document summarizes the formal reviews and discussions at the workshop and presents recommended next steps to improve the structure and content of the "Proposed Stream, Lake, and Estuarine Habitat Indicators" report.

SOMMAIRE

À Vancouver, C.-B., a eu lieu du 15 au 16 janvier 2009 un atelier d'examen par des pairs du rapport provisoire du MPO intitulé *La Politique du Canada pour la conservation du saumon sauvage du Pacifique : indicateurs proposés pour les habitats des cours d'eau, des lacs et des estuaire*s. La stratégie 2 de la Politique concernant le saumon sauvage (PSS) prescrit l'évaluation des conditions de l'habitat dans les unités de conservation du saumon (UC) à l'aide d'indicateurs de l'habitat appropriés, assortis de paramètres et de valeurs de base. Les principaux buts de l'atelier étaient : 1) d'évaluer l'efficacité des indicateurs de l'habitat proposés dans le rapport à l'égard de l'atteinte des objectifs de la stratégie 2; 2) de formuler des recommandations afin d'améliorer l'efficacité des indicateurs en question de manière à permettre l'atteinte des objectifs de la stratégie 2, avec les ressources disponibles; 3) de poursuivre le dialogue sur les indicateurs de l'habitat de la stratégie 2. Parmi les personnes qui ont participé à l'atelier, mentionnons des représentants du MPO, du ministère de l'Environnement de la C.-B., de la Washington State Conservation Commission, du Conseil pour la conservation des ressources halieutiques du Pacifique, du Conseil consultatif sur l'habitat et écloseries du saumon, de la Upper Fraser Conservation Alliance, de la Fondation du saumon du Pacifique, de la Watershed Watch Salmon Society, des Streamkeepers, du Skeena Wild Conservation Trust et de l'université Simon Fraser. Cet atelier de deux jours a permis aux scientifiques invités d'effectuer un examen officiel du rapport et aux participants, de discuter de façon officieuse sur le sujet.

Les examens officiels et les commentaires des participants laissent sous-entendre que la série d'indicateurs de l'habitat proposés dans le rapport sont acceptables pour la mise en œuvre de la stratégie 2 du SSP, dans l'expectative que le raffinement continu des indicateurs soit un processus itératif. L'opinion générale est que le rapport est un fondement solide pour l'élaboration d'un programme de surveillances des indicateurs de l'habitat de la stratégie 2. Cependant, on a indiqué qu'une restructuration du rapport améliorerait la compréhension du lecteur à propos du processus de sélection des indicateurs de l'habitat utilisé par le MPO et des motifs utilisés pour la sélection des valeurs de référence et des seuils associés aux indicateurs. Le présent document comporte un résumé des examens officiels et des discussions qui ont eu lieu au cours de l'atelier et indique les prochaines étapes qui sont recommandées pour améliorer la structure et le contenu du rapport sur les indicateurs de l'habitat proposés pour les cours d'eau, les lacs et les estuaires.

INTRODUCTION

The overall goal of Canada's Wild Salmon Policy (WSP) is to restore and maintain healthy and diverse salmon populations and their habitats (DFO 2005). There are six strategies to implement the policy and each strategy has specific action steps. Strategy 2 (assessment of habitat status) has four action steps:

2.1 document habitat characteristics within Conservation Units;

2.2 select indicators and develop benchmarks for habitat assessment;

2.3 monitor and assess habitat status; and

2.4 establish linkages to develop an integrated data system for watershed management (DFO 2005).

To implement the first two action steps (2.1 and 2.2) for Strategy 2 of the WSP, a Habitat Working Group (HWG) was formed and comprised of DFO staff from the Oceans and Habitat Enhancement (OHEB) and Science branches. The HWG reviewed existing literature on habitat indicators, commissioned new reports specific to information needs of the WSP, and consulted agency staff that had previously developed and used habitat indicators.

Based on their appraisal the HWG developed a recommended reporting structure for describing the quantity and quality of habitats in salmon CUs. They also identified suitable habitat indicators (with associated metrics and benchmarks) that could be used to track the status and trends of specific habitats (both limiting and highly productive) within CUs, while gaining insight into the overall habitat status. This provisional suite of indicators was further evaluated by the HWG based on their potential costs and the feasibility of their eventual implementation within a broad monitoring framework (to be developed ultimately in Strategy 2 action steps 2.3 and 2.4). The HWG's work on developing habitat indicators for Strategy 2 of the WSP was summarized in a draft report by Stalberg et al. (2009). A workshop was subsequently convened by DFO on Jan 15-16, 2009 in Vancouver to undertake peer review of the draft report to ensure both scientific credibility and transparency within the Strategy 2 process. The objectives of the workshop were to review the draft HWG report to:

1. assess the efficacy of the proposed indicators in meeting the Strategy 2 objectives;

2. make recommendations for improving the efficacy of these proposed indicators to meet the Strategy 2 objectives in view of available resources; and

3. continue dialogue on Strategy 2 habitat indicators.

Peer review was provided through two rounds of written reviews and workshop discussion. The first round of written review was provided by two DFO scientists on a previous draft of the document prior to the workshop. These reviews were not presented at the workshop or explicitly discussed but copies of these reviews were provided at the workshop and are included in Appendix 3. The draft was subsequently revised but because of timing only some of the review comments were addressed in the draft discussed at the workshop. Those which were not addressed are included in the report in a Supplementary Review Comments section.

The second round of written reviews consisted of three reviews of the current draft report provided by experts identified as Key Reviewers at the workshop. Key Reviewers were from DFO and the Washington State Conservation Commission, and represented management, monitoring and science domains. Comments from the Key Reviewers were presented at the

workshop and contributed to shaping the workshop discussion. Key Reviewers were asked to address five questions in relation to the HWG report:

1. Are the objectives of the work clearly stated?

2. Are information sources adequate to support the summary conclusions?

3. Are information sources and methods explained in sufficient detail to properly evaluate the summary conclusions?

4. Do summary conclusions reflect uncertainty in the information, analysis or methodology?

5. Can you suggest additional steps or actions required to improve this work?

The January 15-16, 2009 workshop was structured in three phases:

1. Introductory presentations[1] on WSP strategies 1-3 and the draft HWG report itself.

2. Presentations by the Key Reviewers, which used the following process:

    a. comments from a Key Reviewer
    b. questions on clarity (if any) to a Key Reviewer
    c. authors' response to a Key Reviewer's comments

3. Overall plenary discussion of:

    - recommendations for changes to the report structure;

    - improvements to the suite of indicators; and

    - additional steps or actions required to improve this work.

The original intent for the workshop was that it be constrained to not include discussions aimed at:

    - reaching consensus on the ideal suite of habitat indicators;

    - convincing other participants of a particular suite of indicators; and

    - discussing DFO capacity and resources for implementation.

This original agenda indicated that there would be no attempt to reach group consensus on the proposed suite of habitat indicators. However, based on a suggestion from some workshop participants the agenda was restructured on the 2nd day to allow broader plenary discussion of the perceived importance, applicability and feasibility of the suggested indicators, as well as discussion of the potential capacity/resources available within DFO or supporting agencies for undertaking monitoring of these indicators. As such, there was a directed effort to determine if there was general agreement among workshop participants as to whether the proposed habitat indicators would be suitable for Strategy 2 monitoring.

The workshop agenda is contained in Appendix 1, workshop participants are listed in Appendix 2, and the written reviews are contained in Appendix 3. Appendix 3 is separated into 2 sets of reviews: 1) Key Reviewer comments on the draft report discussed at the workshop, and 2) reviews of the earlier pre-workshop draft. References for relevant papers/reports discussed by reviewers or workshop participants and noted in the text are listed in Appendix 4.

WORKSHOP PRESENTATIONS

Introduction to WSP Strategy 2: Assessment of Habitat Status *(Heather Stalberg, DFO)*

- Strategy 2 of the WSP focuses on assessment of the status of salmon habitat and consists of four Action Steps (2.1 - 2.4).

- Action Step 2.1 requires reporting on the overall habitat health of Conservation Units (CUs) with a focus on identifying limiting and highly productive habitats (with rationale based on numerous related references within the WSP policy (DFO 2005)).

- This information will be used to identify initial priorities for protection, rehabilitation, and restoration.

- Action Step 2.2 requires selection of habitat indicators and associated benchmarks for habitat assessment (and is the focus of the draft report being reviewed at this workshop).

- For Strategy 2 single benchmarks per indicator are considered sufficient as greater number than this was not emphasized in the WSP (unlike Policy Strategy 1, 3).

- Action Step 2.3 requires ongoing monitoring of selected habitat indicators to assess change in habitat status.

- Action Step 2.4 requires establishment of linkages with other partners to develop an integrated data system for watershed management that will increase access to information on fish habitat status.

- Action Steps for Strategy 2 will be costly and represent major change for DFO's Habitat Management Program (HMP) as HMP does not currently collect and monitor habitat status information.

- Pilots have been undertaken in various CUs throughout the province to develop the habitat status reporting structure that will be used consistently in the future.

Introduction to the draft report "Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake and Estuarine Habitat Indicators" *(Heather Stalberg, DFO)*

- The objectives of the draft report were to:
  - Document the process by which DFO identified proposed habitat indicators, metrics, and benchmarks under WSP Strategy 2, Action Step 2.2.
  - Identify linkages among these indicators, metrics, and benchmarks, the indicator objectives and key inputs to guide habitat management, and
  - Provide a basis for scientific review.

- Selected habitat indicators are intended to track the status and trends of limiting and productive habitats and gain insight into overall habitat status of CUs.

- Monitoring of habitat indicators will provide key inputs to guide habitat management to protect or enhance salmon productivity.

- Selection of indicators, metric, and benchmarks involved a stepped process of information accretion through directed reports, workshops, and consultation with experts.

- ESSA Technologies developed an associated Indicator Practical Assessment report that clarified cause-effect pathways on salmon life-stages and assessed the initially proposed indicators in relation to a suite of criteria relating to data availability, cost, scientific relevance, spatial and temporal scale.

- The outcome of the process was adoption of a Pressure-State monitoring model and selection of a provisional suite of indicators/metrics for monitoring.

- The key criteria for the proposed metrics selected were:
  - Availability and costs of acquiring data to measure the metric
  - Existence of published relationships between the metric and fish habitat condition or productivity, and
  - Availability of appropriate benchmarks for the metric.
- Proposed benchmarks chosen for each pressure and state metric were chosen to be consistent with a Pressure-State model and were set to:
  - reflect known risk of adverse effect (based on the published literature), or
  - allow comparisons of relative changes in habitat conditions over time or space where specific benchmarks could not be determined

Canada's Wild Salmon Policy Strategies 1 and 3 Update *(Jim Irvine, DFO)*

- WSP Strategy 1 defines CUs as groups of wild salmon living in an area sufficiently isolated from other groups, that if extirpated, that area is very unlikely to be recolonized naturally within an acceptable time frame.
- Strategy 1 has three actions steps required for standardized monitoring of wild salmon status:
  - Identify CUs
  - Develop criteria to assess CUs and identify benchmarks to represent biological status
  - Monitor and assess status of CUs.
- Assessment of CUs requires development of benchmarks that can identify where varied metrics of biological production status of a CU have changed significantly.
- These benchmarks can be used to establish zones of concern (e.g., red, amber, green status) that can determine the need and extent of management intervention.
- WSP Strategy 3 is currently focused on identifying high level objectives for ecosystem status and relating these (unpacking) to sector-specific operational objectives (i.e., fishing, habitat, enhancement, aquaculture).
- Once operational objectives are clearly defined then related indicators can be developed.
- The relationship and separation between WSP Strategy 2 (Habitat) and Strategy 3 (Ecosystem) is sometimes confusing as habitat is an integral part of an ecosystem.
- Proposes that Habitat and Ecosystem under the WSP could be differentiated by restricting habitat indicators to physical and chemical parameters, while ecosystem indicators would include habitat attributes PLUS biological parameters.

REVIEW COMMENTS ON REPORT

Review comments relating to the Habitat Indicators report were organized around three general topic themes: 1) Overall Report Structure and Content, 2) Indicators, and 3) Next Steps. For the sake of brevity and clarity we have chosen to separately synthesize all of the comments made in written reviews, as distinct from those raised in workshop discussions. Some topics were not covered in the written reviews, but were raised during the workshop discussion. Where appropriate, we've simply indicated this under each heading.

1. Overall Report Structure and Content

General Opinion of the Report

Written Reviews:

- This useful report is a significant contribution to the implementation of WSP Strategy 2. However, it needs to be acknowledged that the identification of habitat indicators and benchmarks is an iterative process, and those identified here cannot be considered final. This is particularly true without a thorough description and understanding of the purpose of measuring the various proposed indicators, and an accepted scientifically defensible habitat assessment framework.
- This work is very encouraging and a significant advancement towards improving our management efforts.
- This work should be helpful in addressing a long standing information void and should help considerably with directing future priorities.
- The report is well written, has undergone extensive review, and is technically sound.
- The comprehensive preparation work for this report will aid in having a robust program that is efficient and effective in guiding wild salmon habitat actions under very challenging times.
- This report did a very good job of compiling relevant information sources and summarizing results in a manner that supports the monitoring needs of the WSP.
- This is one of the most thoughtful monitoring programs developed for salmon habitat, and when implemented will be one of the leading monitoring programs in the region.

Workshop Discussion:

- Reorganize the report so that it is easier to follow the logic of indicator selection.
- Simplify the report. Put detailed information into appendices. Use more graphs, figures and charts.

Overall Scope

Written Reviews:

- The comprehensive nature of the review process is one of the positive attributes of the work, but it is a double-edged sword, as it does make it difficult to explain to an outside reader. Suggest adding a flow chart that illustrates the name of the review or process and a description of the result of that review or process.

- More up-front time needs to be spent on some of the broader issues such as program objectives that will define indicator selection.
- Eliminating particular indicators (for various rationales) should not be done within this report. This should represent a next step in development of the Assessment Framework.

Workshop Discussion:

- Objective was clearly stated in the report abstract: 'development of the proposed suite of habitat indicators, metrics and their benchmarks'. Based on this it was felt the report should have focused solely on identifying indicators best suited to inform WSP Strategy 2. Instead the report has drifted into deciding what is currently affordable.
- Identifying the cost of different habitat monitoring options and perceived data gaps should not be part of the approach and should be removed from the report.
- There is no discussion of potential climate change impacts on fish habitat within the report; this is a weakness that should be addressed.
- The HWG should also consider a preliminary scoping out process where habitat indicators and pressures are: 1st step - rated using professional judgment for most of the watersheds; 2nd step - run a more in-depth habitat assessment in the high priority CUs; 3rd step - examine the high priority CUs that have "professionally identified" high habitat pressure and/or poor habitat condition – downward trend. Then apply the detailed habitat pressure/habitat status analyses as described in Stalberg et al. (2009). This will then lead to a "limiting factors" analysis & recovery plan.

Objectives

Written Reviews:

- Include a specific definition of habitat status in the report. This is necessary to help understand the utility of the indicators in terms of how they are expected to be applied for future analysis.
- The objectives of the policy and of this report were clearly stated and in particular, Figure 1 of the report was very helpful in defining the goal, objectives, and strategies to achieve these.

Workshop Discussion:

- Provide a clear hierarchical table outlining objectives and nested sub-objectives linked to indicators.
- Objectives and sub-objectives need to not only consider habitat management objectives, but also CU status (in terms of habitat diversity) as well as other linkages to WSP Strategy's 1 and 3.
- Provide clarity on the objectives and the decisions to be made that will flow from these objectives.
- Show better linkages between objectives and the associated indicators/benchmarks.
- Show how this work connects with CU priorities.

Format/Structure/Methods

Written Reviews:

- It was unusual to read a description of the objectives for the habitat indicators in the discussion when one would expect a clear description of the problem and objectives before the detailed description of the indictors.
- There is a standard series of steps that are usually undertaken for decision problems that has not been followed here. This process begins with problem bounding, including the frame of reference, the development of the objectives, and the types of decisions that are being made. Only then are the indicators needed to support decision-making identified.
- The HWG should develop an objectives hierarchy for Strategy 2. This should involve a clear definition of the frame, objectives, and potential linkages between sub- (or means) objectives and indicators.

Workshop Discussion:

- Provide an overview summary explaining how the assembled information will be used.
- Provide a more detailed but concise methods description with less narrative; replace narrative with a better description of the criteria used to evaluate indicators.
- Use tables or text boxes to highlight key definitions, decisions, principles, etc.
- Provide a glossary with definitions such as: state vs. status; habitat quantity, benchmark, indicators, risk, etc.
- Provide maps/figures illustrating what final design might look like.
- Table 1 needs to be improved with better documentation of sources (e.g., primary literature or other sections in report that provide more details).

Relationships Among WSP Strategies

Written Reviews:

This was not discussed directly within the written reviews.

Workshop Discussion:

- Clarify the process for integrating habitat indicators with WSP strategies 1 and 3.
- Add a flow chart that shows where this reports "fits" with other Strategy 2 actions.
- Define more clearly the separate processes that will be followed for Actions Steps 2.1 (Document habitat characteristics within CUs) and 2.2 (Select indicators and develop benchmarks for habitat assessment).

Key Habitats

Written Reviews:

- Explain the connection between the habitat indicator work and the work from action step 2.1 (document habitat characteristics within CUs).

- Although it seems important to monitor key habitats, the report wasn't very clear about how the results will be used.
- Better define what question(s) is answered by assessing key habitats and whether these habitats need to be monitored over time.
- Describe what actions would be triggered with the results of the key habitat assessments.

Workshop Discussion:

- Clarify what exactly will be done in Action Step 2.1 (Document habitat characteristics within CUs).
- Define characteristics of good habitat, this will influence indicator choice.
- Clarify how key habitats will be identified and monitored, and how this information will be used to inform decisions.
- Discuss the need to identify both highly productive habitats and degraded habitats with high potential.
- Synthesize DFO or other agency/community data that already exists (e.g., SHIM mapping) that could be used to determine the locations and extent of "key" habitats.
- Use expert opinion, local knowledge and First Nations knowledge to assess CU status quickly.

2. Indicators

Breadth and Depth of Indicators

Written Reviews:

- The existence of published relationships between the metric and some measures of fish habitat condition as the primary criteria for selecting metrics may limit the ability to use other types of indicators that could have valid, but as yet unpublished relationships.
- Identify where work is needed to improve understanding of key limiting factors. This would help inform future refinement of indicators and highlight where effort/resources should be focused. Otherwise there could be reliance on indicators that may not be the most relevant to the needs of fish.
- The strategy of relying on existing information in selecting the current indicators may leave important gaps in the indicator suite. If there are important data that are not currently available but that could provide high value indicators, these should be highlighted so they can be considered by the department and others for future work.
- Provide explanation as to whether indicators chosen were focused on factors related to human development, or whether they were intended to capture all habitat risks and constraints, whether natural or human induced.
- Provide an explanation for why marine indicators were not included.
- The report states that the status indicators can clearly be linked to the key factors enhancing or limiting wild salmon production. It may be worth clarifying that these indicators are not necessarily specific with regard to cause/effect relationships to wild salmon production.

- It would be more useful to monitor one useful indicator (such as land cover vegetation) in a high quality manner rather than use multiple indicators that have either more variability or less applicability.

Workshop Discussion:

- Summary of indicators is good enough to start with. These can be adapted over time and tweaked for particular CUs with experience and practice.

- The list of indicators developed will assist in overall review/assessment of CUs but may or may not be able to help protect habitat. More work is needed to fill in some blanks and address cumulative effects.

- There is considerable information available on indicators, but the HWG have been able to capture the essence and in tablular form describe what should be monitored where/when/why.

- Some people can look at a stream and simply "know" it's good, for others this report outlines the necessary evaluation steps to go through so others can understand.

- It is important to document all indicators that have been considered and then either accepted or discarded.

- Use of both biotic and abiotic indicators as summarized in Table 1 within the report is inconsistent with other WSP strategies.

- This is the right amount of information on indicators for this report. Those implementing Strategy 2 will need to delve further to know which sampling methods to employ. For example within the Streamkeepers program certain modules are put forward for evaluation and inclusion. This provides "us" the green light to promote more use. Others should learn more about the habitat monitoring protocols housed in the Streamkeepers manual.

- Uncertain as to whether these identified indicator choices will address habitat conditions enough to allow monitoring of really important changes.

Feasibility of Indicators

Written Reviews:

- Include with each indicator what the next steps are to fully develop the indicator and to implement or action the indicator.

Workshop Discussion:

- Indicators chosen are reasonable but need to ensure they will be feasible in their implementation i.e., consider a cost effective triage, limiting monitoring to areas of very high value or else areas of concern.

- Indicators seem reasonable, but would be best to limit them to a small number and monitor these well.

- Define the capacity/resources required to undertake the full suite of monitoring proposed.

- Determine how to optimize the monitoring over varied spatial/temporal scales.

Scale of Indicators

Written Reviews:

- Strategy 2 of the WSP is based on species-specific CUs, but at times this appears to be confused in the report with watershed-based frames. The HWG should consider how to organize the indicators by species (instead of watersheds or regions) and what approaches will be used when more than one salmon species occupies a watershed.

Workshop Discussion:

- Clarify how habitat indicators measured at the watershed scale will be rolled up to the scale of CUs (which will vary in size dependent on species).

- Need to identify the scale at which the decisions will be made, this will have repercussions to the coverage required for their indicators (i.e., some indicators monitored in all CUs, other indicators monitored only within CUs that are the most important from a stock concern perspective).

- Provide better links between habitat indicators and CUs, demonstrating the ability to capture variation in species and life history diversity.

Linkages between Indicators (Pressure-Status)

Written Reviews:

- The proposed methodology of using pressure/driver indicators to trigger status/response indicators is an excellent approach.

- Clearly identify linkages between pressure indicator thresholds and the specific status indicators that will be measured if a threshold is exceeded.

- The Pressure-State approach needs to be clearly defined in the report. "State", appears to be defined as metrics related to the instream habitat related to salmon production. "Pressures" are landscape level indicators of human activities that can affect instream habitat conditions (i.e., state).

- Explain the distinction between "state" and "status". State is determined from the indicators or metrics (an example would be streamflow or temperature), but status is evaluated by comparing the state to the so-called benchmarks. Follow a nomenclature consistent with other WSP strategies in this report.

- If costs become a factor, reduce the number of required pressure indicators by instead developing a very good data layer on actual land cover. This negates the problem that the same land use (agriculture, forestry, etc.) has many different kinds and levels of impacts. A land vegetation cover layer could also substitute for several pressure indicators.

- In addition to pressure/stressor indicators identified by the HWG that were restricted to human impacts it is important to recognize that there are a host of natural pressures and stressors that have ongoing impacts on habitat in addition to man-made ones.

Workshop Discussion:

- Table 1 in the report that describes pressure/status model is good but needs better clarity re: overview vs. local status.

- Link or nest the pressure and status indicators.
- Identify the particular status indicators which will be triggered by particular pressure indicators (chain of events).
- Narrow down the relevant pressure indicators by relating more clearly to management questions.

Indicator Benchmarks

Written Reviews:

- Define, with reference to the literature, what is meant by indicators, benchmarks, and metrics.
- The report's recommendation to have complimentary assessments per region instead of different benchmarks is a good one, as if you have a core set of indicators in common, you'll be able to compare across regions. This may prove to be very helpful as you consider ecoregion and/or land use differences.
- The HWG should clearly identify the principles that underlie the benchmarks to be used to evaluate habitat status. These might be specific in terms of habitat quality (for salmon production), the degree of human alteration, or in terms of the regulatory actions that would result from the status determination. Benchmarks for rates of change in habitat are needed to inform Action step 2.3.

Workshop Discussion:

- Resolve and describe the approach used for developing benchmarks.
- Will the thresholds be used for demarcating between red (poor quality habitat), amber (monitor for changes) and green (good quality habitat) or something else?
- In Table 1 are there one or two benchmarks? Uncertain as to what they mean or where they came from.
- Do not identify benchmarks in the report until they have been better defined (purpose, etc.). May be something better left until a next stage.
- Highlight the importance of integrating habitat indicators with benchmark development and ecosystem indicator development (Strategies 2 and 3).
- Clarify whether we are trying to define specific thresholds or just tracking changing trends (to general points where you get worried).

Indicator Baselines

Written Reviews:

- The absence of baseline quantity measures for significant habitat units may be a significant limitation with regard to ongoing habitat status assessment. It may be useful to consider establishing a baseline for habitat quantity as a related product to the habitat condition indicators.

Workshop Discussion:

- Establish the difference between the current status of habitat and what it should be (potential) by using local knowledge and observable alterations from the historical condition e.g., First Nations, aerial photos (e.g., from the 1940's), NuSeds, Stewardship groups.

Information Sources / Indicator Rationales

Written Reviews:

- Provide better indication of where within the report substantiating information is provided.
- Provide more extensive supplemental information and better documentation describing linkages among indicators, metrics and benchmarks.
- The HWG should be commended for their efforts to date. It's clear that the information sources serving as the foundation for this paper are very extensive and the authors plus the associated HWG have worked hard to take them into account.

Workshop Discussion:

- Link the proposed indicators to species and objective, and provide more consistent citations to literature.
- Reference other assessment framework work currently underway i.e., Barkley Sound pilot.

Pro-active Anticipatory Indicators

Written Reviews:

- The indicator approach seems primarily oriented around habitats that are already damaged or impacted. It would also be valuable to understand how this work would be used to inform future priorities related to managing and protecting pristine productive areas vs. damaged or impacted areas.

Workshop Discussion:

- Should be more focus on a longer term proactive approach to habitat protection considering the impact of climate change on the ecosystem and cumulative impacts.
- Add another category of indicator to recognize current or imminent development pressure or the expected rate of change. This would inform more pro-active responses to current/anticipated conditions.
- Need a process within Strategy 2 which assesses potential impacts to wild salmon/critical habitat when developments are proposed for specific areas. It is often too late to mitigate damages if you simply monitor afterwards.

Use of Expert Opinion to Inform Indicator Status

Written Reviews:

This was not discussed directly within the written reviews.

Workshop Discussion:

- Incorporate professional judgment review/screening of indicators to streamline process.
- Expert opinion should be incorporated as soon as possible. While in-house experts are still relatively cheap, projected retirements will increase over the next 5 years within DFO; consulting costs to access this expertise will subsequently cost more over time.

- Assessment of potential indicators should be flexible i.e., leave room for local indicators, professional / expert opinion, historical narrative capture.

Comments on Specific Indicators

Written Reviews:

- Refer to Appendix 3 for reviewer comments on specific indicators.

Workshop Discussion:

- Water extraction indicator: report proposed using water licenses as an indicator of water extractor. Licenses provide an approved volume of water that can be extracted but don't usually designate a maximum daily rate. Also most licensed users are not monitored and may use more water than allocated.
- Water extraction indicator: report proposed using volume licensed for consumption. This may be misleading, as not all licensed water may actually be used for a watershed.
- Clarify the role of modeled vs. measured indicators e.g., discharge.
- Temperature criteria suggested for rearing salmon – some confusion in Table 1 as to whether this would be applied only for coho or for pink salmon as well.
- Table 1: needs some tweaking as there is no indicator (s) relating to habitat diversity.
- Stream flow indicator: 20% of mean annual discharge considered an optimum. Need to develop other thresholds e.g., 1, 5, 7, 10, 15 %. Can use Hatfield and Bruce (2000) flow meta-analysis of North American streams to help determine these thresholds.
- Land use indicator: land conversion may instead represent a better metric. Want to look at what land type would exist naturally (i.e., pine forest) vs. what it has become (i.e., grassland) vs. changes by/within land use sector. Land uses, even within a land use sector (i.e., agriculture), are not equivalent and will have different impacts on fish habitat.
- Permitted discharges indicator: uncertain as to what is being discharged and how this would relate to changes in habitat quality.
- Sediment indicator: should include turbidity thresholds as summarized by Birtwell (1999).
- Stream discharge indicator: associated metric is presented as m3. This needs instead to be presented as % of MAD or quartiles of monthly discharge range. Uncertain whether flow data to inform this will be readily available, feasible to extract or cost effective.
- Road density: might be better to use or include a professional evaluation on road impacts e.g., off channel habitat cut-off, run off problems, level of associated slides, water quality impacts, etc.
- Temperature flow relationships: 30% loss of surface flow at higher temperatures due to water viscosity; this needs to accounted for.

3. Additional Recommendations for Implementation

Assessment Framework

Written Reviews:

- Clarify the difference between this report and the Assessment Framework. Include a graphic to illustrate this relationship.
- Develop a classification system to rate the health of the CU. This would be an extremely valuable component for this report, or as a piece of subsequent work. A simple system like red/yellow/green or endangered/threatened/special concern is the kind of simple categorized output that would be valuable.
- Provide more specific discussion about next steps, timelines for various tasks, and the relative urgency of the various work.
- Prioritize the next steps for implementing the assessment framework. Current report structure does not generate any sense of urgency to undertaking or advancing this work. Add some context as to the current status of habitat in this Region and the risks/costs of not advancing this kind of work.
- Implementation seems to be the biggest limitation encountered in this kind of work. It will be important to see this work followed through.
- To assure continuing policy support, it will be important to ascertain that management questions are answered and guided by the results of this program.
- Continued adaptive management to review indicator usefulness is recommended.
- Consider how the metrics and indicators will be combined or otherwise used to estimate the state of habitats at the CU scale, and to evaluate status relative to benchmarks.
- Determining how to subsample a large CU, collecting data that can be used by all CUs that use the habitat, and rolling everything up into a single assessment of status for each CU will be a significant challenge.
- Describe how habitat indicators identified in the report will inform us about the status and trends of limiting or highly productive habitats for local populations or the population aggregates that make up CUs.

Workshop Discussion:

- Demonstrate how accumulative impacts will be accounted for and addressed.
- Determine how the suite of indicators will be (or won't be) combined into a WSP habitat index. See p.41 of Stalberg et al. (2009) re: "health."
- Pursue a "traffic light" (green, yellow, red) approach to categorizing habitat to assist with simplifying management decisions.
- Provide clarity on how many 'failed' benchmarks are required to move a CU from a green zone (good) to a red (bad) zone, or vice versa.
- Explain the anticipated linkage between the results of monitoring habitat indicators and the associated management actions.

- Is it possible to define how many indicators will likely be sufficient to 'indicate' the health of the ecosystem e.g., riparian = 7 indicators?
- Provide specifics of implementation plan for Strategy 2 (e.g., timing, scope, budget requirements, etc.)
- Will need to develop and implement the Assessment Framework as quickly as possible. The implementation step often fails in many proposed monitoring programs, so critical to move forward to viable action.

High Level Analysis/Reporting

Written Reviews:

- Provide suggestions for the required assembly and storage of data related to habitat indicators.
- Provide suggestions for the communication of assembled habitat information/data with interested stakeholders and the public.
- Brief mention is made in the report of the potential for DFO to track the losses and gains of various types of habitat, and this is linked to the ability to identify habitat status and trends. This is currently almost non-existent within DFO, and it may be useful to more specifically discuss the needs in this regard and develop recommendations for this issue. Not addressing this key point may result in a significant limitation to the success of our ability to monitor habitat status and achieve Wild Salmon Policy objectives.
- Discuss the extent to which DFO personnel will be expected to generate habitat indicator data, analyze and report on it, archive and manage it, and use it as a basis for resource management decisions.

Workshop Discussion:

- Highlight the need for additional cooperation among agencies to improve data sharing; encourage monitoring and evaluation synergies.
- Develop a communication plan to highlight and explain Strategy 2 monitoring to DFO and external partners.
- Consider developing a high level reporting process, analogous to Washington's "State of the Salmon" report in support of habitat indicators monitoring. We need something to motivate political and public interest into making commitments to invest and act on fish habitat. The urgency for this work needs to be emphasized in the report.
- Clarify what pilot projects will be undertaken in regard to refining the habitat indicators and when these pilots would occur.

4. Supplementary Review Comments

(Key comments still to be addressed from previous reviews of a pre-workshop draft of the Habitat Indicators report)

- Overall, the report is difficult to evaluate. This is primarily because much of the report is a narrative of the HWG's activities. This description could be relegated to a supporting appendix so that the methods contain only a concise description of what was done to reach the indicator list.

- The objectives of the paper are clearly stated at the most general level. However, there are a host of subordinate objectives, often implied by questions or designation of indicators that arise throughout the remainder of the text, that should be compiled into a more complete list.

- Given that review of results and recommendations from reports, letters and workshops is part of the "methods," the HWG authors need to identify who did this review.

- The general method used in the report was to generate and then look for confirmation of the utility of a suite of habitat indicators through a repetitive "expert opinion" panel process. The methods section of the text is currently far too long and repetitious with respect to identifying this as the principal approach.

- The current report structure is too focused on "process information" (i.e., the historic sequence of what was done) that is not essential, rather than an integrated treatment of the methodology used to do it.

- The narrative structure used to deal with diverse information sources, methods and results in the current paper are difficult to follow or review. This could be solved by integrating the HWG work and that done by Nelitz et al. (2007a, b) into each of the paper's sections such that a core set of concepts, a unified methodology and an integrated set of results would inform the conclusions and recommendations.

- The structure and contents could be improved greatly by restructuring the introduction, methods, results, discussion, conclusions, recommendations, references, and appendices to better integrate the various sources of information serving as the foundation for recommendations regarding a defensible suite of habitat indicators.

- The methodology for selecting indicators remains highly subjective and virtually impossible to withstand a defensible peer review process.

- The current results represent only the final outputs rather than all the intermediate summaries and cross-referenced material that they are based on. Inclusion of the latter in a unified results section is necessary in order to be able to subject the report to peer review.

- Provide a brief narrative describing logical associations among WSP Strategies 1-5. A concise explanation of linkages among the overarching WSP goal, its objectives, strategies and guiding principles would be beneficial and help smooth what is currently an abrupt transition to the presentation of the specific action steps required under Strategy 2.

- Explain what is meant by "limiting and productive habitat" and justify why emphasis was placed here instead of, for instance, habitat diversity.

- Explain better how highly productive and limiting habitats (of wild salmon) will be identified or ranked.

- The lists of pressure and status indicators, as well as of key habitat attributes against which they are ranked, are limited relative to the large number of possible entries under any of these categories. The report needs to explain better the selection criteria and how these were then used to either include or exclude an indicator within the ranking exercise.

- The HWG recommend developing various habitat "quantity indicators" for which there are currently limited data. There is no discussion in the report to explain when, where, how or why they might be essential. In the absence of this type of information there is a risk of excluding other indicators that might be a higher priority.

- Difficult to understand how cost can be evaluated without knowing the sampling design. For instance, measuring primary production in lakes might be deemed to be too expensive. But what if one can do this through remote sensing for little cost?
- If the framework to be adopted is the pressure-state-response framework there is a substantial literature on its origins and use that should be summarized.
- The list of human-associated pressure/stressor indicators identified in the report is rather incomplete.
- There's more work to do in identifying the key indicators that should be considered for inclusion in the suite of recommended habitat indicators.
- Need to provide better clarity on why particular indicator benchmarks were chosen and by whom.
- WSP policy is quite clear in describing 3 benchmarks for CU biological status. Is the HWG intending to follow the same approach? If so, one would expect multiple habitat benchmarks for each indicator. If the HWG is not following the 3 benchmark approach then a rational should be provided.
- Clarify what quantity indicators are and the rules for consistently distinguishing between those that require ranking and those included in the core set without ranking.
- The rationale for the habitat indicators chosen is clear, but unclear why other indicators were excluded.
- Provide rationale for why the particular quantity indicators were chosen, as compared to other potential quantity indicators.
- Various criteria such as accessibility and cost have been identified as a basis for weighting the selection of the subset of indicators recommended but this process seems to have been largely subjective and quite vulnerable to challenge.
- The absence of methodological details in the document for how various expert panels treated indicators is an unqualified source of uncertainty that remains problematic. Consequently, there is no formal assessment provided for how certain or uncertain various indicators might be.
- Estuaries should be dealt with in the same fashion as streams and lakes in the report; that is by omitting aquatic biota categories that will instead be considered as part of the Strategy 3 ecosystem indicators exercise.
- Because assembly of indicator information and ranking in the report was based on "expert opinion", it is only possible to provide commentary on specific indicators that a given reviewer might have specific experience with.

AUTHORS' RESPONSE TO REVIEWERS

- The approach used by the HWG was to create a pool of indicators that would be evaluated as needed dependent on species/CU. Not all indicators are intended to be used at all times, in all CUs. Pressure indicators could be applied more broadly, while status indicators might only be evaluated in areas where pressure indicators suggest a problem. If the pool of proposed indicators is inadequate in some cases, then watershed specific indicators would be developed as needed for those situations.
- The approach used by the HWG for defining benchmarks was to determine thresholds at which detrimental effects are likely to begin to occur (proactive), not those necessarily expected to trigger immediate action.

- Habitat indicators selected by the HWG focused on evaluating anthropogenic impacts. Although natural sensitivity could be captured in Action step 2.1 the direction in Action Step 2.2 has been to identify habitat indicators that managers could track and ultimately control/influence.

- While some potentially useful habitat indicators and quantity indicators were not selected by the HWG there was a process for justifying final inclusion/exclusion of indicators. This is described currently in the report Appendices and more of this explanation will be brought forward into the main body of the report.

- The HWG considered different baseline starting points for evaluating indicators, which will vary by specific indicator depending on when data became available for comparisons (e.g., existence of satellite imagery with sufficient resolution). It will likely be necessary to set up rule sets for defining baselines used for indicators within different CUs (may relate to level of human disturbance for example).

- It was suggested that it would be useful to indicate in the report how all the WSP strategies would come together, however, that is not possible at this time. The Barkley Sound pilot is testing out how to combine all 3 WSP strategies, but an overall, consistent approach to this is still in development.

SYNTHESIS

- Based on the formal reviews and comments from workshop participants it was determined that the Habitat Indicators report and the initial suite of proposed habitat indicators will be suitable for moving forward with for Strategy 2, requiring only minor revisions to the draft report.

- Reviewers and workshop participants all suggested that the report should be revised to reduce the narrative element in the description of the indicator filtering process, improve the rationale for indicators chosen, and provide clearer linkages in the main report body to supporting appendices.

- Consistent throughout the very thoughtful formal reviews and comments from workshop participants a key theme emerged that will need to be more clearly articulated within the report: **what are the management decisions that these habitat indicators will inform?** Capturing that decision framework is necessary to rationalize the hierarchy of associated objectives that ultimately filter down to the specific proposed habitat indicators, metrics and benchmarks to be monitored for Strategy 2.

- Using TEK, professional judgment, etc. for further insight into pressure/status indicators would be good to develop/test as a future pilot. It would be informative to see how well this supplemental information could inform senior management decision needs around Strategy 2.

- Ultimately, effective monitoring and evaluation of habitat for Strategy 2 will require improved integration with partner agency datasets and analyses

- Consensus was that the Habitat Indicators report should be considered as a catalogue providing the foundation for the next steps in Strategy 2 (i.e., a supporting Assessment Framework should be something developed in later stages).

- However it was also suggested that it is important to work as quickly as possible towards implementation of an Assessment Framework (as often this next step fails in many programs), concurrent with finalizing the Habitat Indicators report.

- Designing a pilot for indicator monitoring would be a useful next step in the overall Strategy 2 process, forcing a move to the operational aspects of the WSP program.

- Joint adaptive zones with anadromous salmon that have recently been designated provincially (each zone containing at least one CU) could provide a consistent spatial basis for linking/nesting Strategy 2 CU-based monitoring with habitat monitoring being undertaken concurrently by provincial agencies

NEXT STEPS

- Reviews/discussion from the Habitat Indicators workshop were summarized as feedback for revisions to the draft Habitat Indicators report, and are included in this stand-alone Proceedings document

- The authors agreed that revisions are necessary to improve report structure and content, and the report will be modified accordingly with consideration to the recommendations provided by formal reviewers and workshop participants

- Other workshop comments will be addressed in later reports that explore further elements of Strategy 2 (i.e., are beyond the scope of the current Habitat Indicators report).

APPENDIX 1 – Agenda

Peer review workshop of draft report:
"Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake,
and Estuarine Habitat Indicators"

Date: 15-16 January 2009

Location: British Columbia Institute of Technology, 555 Seymour St., Vancouver, B.C.

Workshop Objectives:

Review the draft report entitled "Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake and Estuarine Habitat Indicators" to:

- assess the efficacy of the proposed indicators in meeting the Strategy 2 objectives,
- make recommendations for improving the efficacy of these proposed indicators to meet the Strategy 2 objectives in view of available resources, and
- continue dialogue on Strategy 2 habitat indicators.

AGENDA

Thursday, 15 January 2009

8:30-9:00   Participant introductions and review of workshop objectives and agenda **(Dave Marmorek, ESSA)**

9:00-10:00   Overview Presentations (2 presentations (each 15 min., with 15 min. for questions):

1. Introduction to WSP Strategy 2: Assessment of Habitat Status (**Heather Stalberg, DFO**)
2. Introduction to the draft report "Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake and Estuarine Habitat Indicators" (**Heather Stalberg**, **DFO)**

10:00   Coffee Break

10:15-12:00 First Key Reviewer (**Jason Hwang**, **DFO)**
             Response Process[1]

12:00-1:00 Lunch

1:00 pm   Second Key Reviewer (**Carol Smith**, **WSCC**)
             Response Process

2:30-2:45   Coffee Break

2:45-4:00   Third Key Reviewer **(Mike Bradford, DFO)**
             Response Process

4:00-4:30   Summary of Key messages from Day 1 (**Dave Marmorek, ESSA**)

Friday, 16 January 2009

8:30-8:45   Day 2 Introductory comments (**David Marmorek, ESSA**)

8:45-10:00   Plenary discussion of report, focused on 3 themes (overall report structure, indicators, next steps)

10:00-10:15 Coffee Break

10:15-11:00 Plenary discussion of report (cont.), identify highest priorities, areas of agreement or disagreement

11:00-11:30 Canada's Wild Salmon Policy Strategies 1 and 3 Update (**Jim Irvine, DFO**)

11:30-12:00 Summary of key messages from Day 2 and review of Next Steps (**Dave Marmorek, ESSA**)

End of Meeting

[1]**Questions for Key Reviewers and the Response Process:**

Questions for Key Reviewers

1. Are the objectives of the work or paper clearly stated?
2. Are information sources adequate to support the summary conclusions?
3. Are information sources and methods explained in sufficient detail to properly evaluate the summary conclusions?
4. Do summary conclusions reflect uncertainty in the information, analysis or methodology?
5. Can you suggest additional steps or actions required to improve this work?

Response Process

1. Response from a Key Reviewer (20 minutes)
2. Questions on clarity (if any) to a Key Reviewer (20 minutes)
3. Authors' response to a Key Reviewer's response (35 minutes)
4. Repeat steps 1-4 for each Key Reviewer

APPENDIX 2 – List of participants

Participants –
Peer review workshop of draft report: Canada's Policy for Conservation of Wild Pacific Salmon: Proposed Stream, Lake, and Estuarine Habitat Indicators

Name / Nom	Affiliation / Affiliation	Email / Addresse électronique
Carol Smith	WSCC	casm461@ECY.WA.GOV
Jason Hwang	DFO	HwangJ@pac.dfo-mpo.gc.ca
Mike Bradford	DFO	mbradford@sfu.ca
Zo Ann Morten	PSKF	pskf@direct.ca
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Dave Marmorek	ESSA	dmarmorek@essa.com
Marc Porter	ESSA	mporter@essa.com

WSCC – Washington State Conservation Council
DFO – Fisheries and Oceans Canada
PSKF – Pacific Streamkeepers Federation
SEHAB – Salmon Enhancement and Habitat Advisory Board
PFRCC – Pacific Fisheries Resource Conservation Council
BC MOE – British Columbia Ministry of Environment
UFCA – Upper Fraser Conservation Alliance
SFC – Skeena Fisheries Commission
SWCT – Skeena Wild Conservation Trust
WWSS – Watershed Watch Salmon Society
SFU – Simon Fraser University
PSF – Pacific Salmon Foundation
ESSA – Ecological and Social Systems Analysts Ltd.

1) Key Reviewer Comments

Jason Hwang
Area Manager, BC Interior
Fisheries and Oceans Canada
Oceans, Habitat and Enhancement Branch

(expertise in fisheries habitat management)

Review of "Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake, and Estuarine Habitat Indicators"
(H.C. Stalberg, R.B. Lauzier, and E.A. MacIsaac)

10 January 2009

I appreciate the opportunity to review and provide in put on this paper. My perspective is significantly oriented around the operational programs that are delivered by the program I work within which involve the evaluation of potential habitat impacts, the restoration of damaged habitat, community involvement, and stock enhancement. I have attempted to become familiar with as much of the background reference material as possible, but I have not been able to review it all in detail. As such, I apologize if any of the comments I provide are a result of not being fully apprised of the full body of existing work. I have provided the comments in summary form which will hopefully be suitable.

General Comments

- On page 13 it is noted that one of the criteria for selecting metrics for each indicator was the existence of published relationships between the metric and some measures of fish habitat condition. This may limit the ability to use other types of indicators that could have valid, but as yet unpublished relationships. For example, indicators like human population, and land value while not necessarily directly linked to fish habitat condition, would be relatively easy to gather and would provide potentially useful pressure indicators.

- Page 42 suggests that the primary focus of monitoring should initially be tracking the status and trends of highly productive and limiting habitats. There seems to be very little assessment information available that is able to inform what those key habitats are. It may be beneficial to identify the need for ongoing work to improve our understanding of key limiting factors. This could help inform and refine the indicators for the future and where effort and resources should be focused. Otherwise we may be relying on indicators that are not the most relevant to the needs of the fish.

- Related to the previous point, the strategy of relying on existing information and data in selecting the current indicators may leave important gaps in the indicator suite. If there are important data that are not currently available, but would provide high value indicators if available, it may be useful to highlight these so they can be considered by

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[1] Jason Hwang, Carol Smith, and Mike Bradford reviewed the draft of the Habitat Indicators report that was discussed formally by participants at the workshop. Kim Hyatt and Jim Irvine reviewed an earlier draft of the Habitat Indicators report and their comments were not formally discussed at the Habitat Indicators Workshop.

the department and others for future work. We should make sure we are aware of the "known unknowns".

- It may be beyond the scope of this report, but it seems that the indicator approach is primarily oriented around habitats that are already damaged or impacted. In terms of how the outcomes of this work are put to use, it would be valuable to understand how this work would be used to inform future priorities, in particular whether this provides insight to questions like the relative priority of managing and protecting pristine productive areas vs. damaged or impacted areas.

5 questions

1. Are the objectives of the work or paper clearly stated?

- I was unable to find a specific definition of habitat status in the report. There were references to habitat condition, references to quality and quantity, and some comments about highly productive and limiting habitat. I believe it would be useful to include this as it would help to understand the utility of the indicators in terms of how they are expected to be applied for future analysis.

- There seems to be limited discussion about attributes that are naturally sensitive, vs. those that have become sensitive due to human activity. It may be useful to include some comment as to whether the indicators that were chosen were focused on factors related to human development, or whether they were intended to capture all habitat risks and constraints, whether natural or human induced. This is tied somewhat to how habitat status is defined—how would we define the habitat status of a pristine stream that naturally experiences unsuitable temperatures.

2. Are information sources adequate to support the summary conclusions?

- It is not clear why the particular quantity indicators were chosen as compared to other potential quantity indicators. Some indication as to why these were selected over others may be useful.

- Some of the indicators seem like they require some base point that they will be compared against—especially the quantity indicators. Some discussion as to how these are expected to be applied may be useful.

- It is not clear how circumstances where there has been significant development to where the habitat is now eliminated is considered. For example, much of the Fraser estuary has been dyked and developed and is completely inaccessible to salmon. Would this be captured in the estuary quantity indicator? How would the lost streams of greater Vancouver be factored in?

- I did not see an explanation for not including marine indicators. As an example, perhaps an indicator like the density of fish farms in juvenile migratory corridors would be useful.

3. Are information sources and methods explained in sufficient detail to properly evaluate the summary conclusions?

- The rationale for the indicators that were chosen is clear, but it is not clear what the rationale was for why some of the indicators were dropped. For example, it is not explained why an indicator listed in appendix H (% stream length channelization) is not considered in the subsequent evaluation steps).

- I had some difficulty following the connection between the indicator work and the work from action step 2.1 (document habitat characteristics within CUs) described in this

report. I'm not sure that I am clear on how the information from these steps is to be used together.

4. **Do summary conclusions reflect uncertainty in the information, analysis or methodology?**

   - In the summary, the second section on the Pressure-State model is a bit brief and a bit more explanation may reinforce the key ideas on these points for a reader.

   - In the summary, it is stated that the status indicators can clearly be linked to the key factors enhancing or limiting wild salmon production… It may be worth clarifying that these indicators are not necessarily specific with regard to cause/effect relationships to wild salmon production.

   - The last paragraph on page 44 leaves me a bit uncertain as to where the habitat status work is being left at the conclusion of this report. I'm not sure what the specific works related to the highly productive and limiting habitats within the CUs is referencing, and I'm not sure what the absence of this work means to the work on developing and assessing the indicators.

5. **Can you suggest additional steps or actions required to improve this work?**

   - The absence of baseline quantity measures for significant habitat units may be a significant limitation with regard to ongoing habitat status assessment. It may be useful to consider establishing a baseline for habitat quantity as a related product to the indicators. It is difficult to convince decision makers that there is a need for action unless we are able to demonstrate specific and direct measures of the problems.

   - On page 40 a brief mention is made of the potential for DFO to track the losses and gains of various types of habitat, and this is linked to the ability to identify status and trends. This is currently almost non-existent within DFO, and it may useful to more specifically discuss the needs in this regard and develop recommendations for this issue. I am concerned that not addressing this key point may result in a significant limitation to the success of our ability to monitor habitat status and achieve Wild Salmon Policy objectives.

   - On page 41 developing a classification system to rate the health of the individual CUs is discussed. In my view, this is would be an extremely valuable subject worth discussing in more detail either in this paper, or as a piece of subsequent work. Without this, I think we will struggle to be able to implement meaningful strategies to analyze, interpret and respond to the information gathered via the indicators. A simple system like red/yellow/green or endangered/threatened/special concern is the kind of simple categorized output that I could see being valuable.

   - Some more specific discussion about next steps, timelines for various tasks, and the relative urgency of the various work would be valuable. I note that one of the background reports said that indicator selection had been completed in other jurisdictions on a number of occasions, but implementation has not been very successful.

   - It may be beyond the intended scope of this paper, but it might be useful to include with each indicator what the next steps are. What is required to fully develop the indicator? What would be required to implement or action the indicator?

   - Related to the above point, the Next Steps section (5.2) notes that the list of resources needs to be prioritized and tackled as resources and opportunities permit. It would be useful if possible to prioritize the next steps as part of this report. The way this is

currently presented does not really create an impression that there is a particular urgency to undertaking or advancing any of this work. It may be valuable to add some context as to the current status of habitat in this Region and the risks/costs of not advancing this kind of work.

Specific Comments on the indicators

- One circumstance that does not seem to be captured by the current indicators is where there is a significant alteration to the natural flow regime. Storage and flow manipulation for hydro-electric generation and storage for irrigation are examples. Did the HWG contemplate this? Has this been addressed by other jurisdictions?

- Was peak flow or stream hydrograph variability considered? This may complement the total land cover alteration indicator and/or the water extraction indicator. If stream flows are going to be measured as part of future monitoring (seems to be indicated for water extraction, sediment, temperature), this may be a useful, low cost add on.

- Riparian disturbance does not specifically discuss instream changes (such as bank armouring). Is this intended to be captured as part of the riparian disturbance indicator?

- Sediment as an indicator seems somewhat challenging. How do we define a background on a watershed scale when it is likely naturally variable? How do we establish measuring points that would be effective at showing departures from background? This seems to be an indicator that is best suited for site specific situations where point source issues are identified, and would likely be difficult to establish as a broad scale indicator.

- Stream temperature – coho rearing; how is annual variation factored in to the benchmark? Also, in some circumstances this is probably quite sensitive to micro-site conditions.

- Stream temperature – migration and spawning; how is the annual variability considered in the benchmark?

- Stream discharge; how is annual variability factored in to the benchmark? How is variability along the length of a stream considered?

- Accessible stream length barriers; are these man-made barriers only or does this include natural barriers?

- Lake total land cover alteration; what is the scope of this measure - is this just within a certain distance of the lake HWM, is it catchment area including inflow streams, etc.?

- Lake coldwater refuge; is there a need to also factor in maximum surface temperature using similar logic to the stream temperature indicator?

Summary

From my position working day to day dealing managing and protecting fish habitat, I find this work to be very encouraging and a significant advancement towards improving our management efforts. This work should be helpful in addressing a long standing information void and should help considerably with directing future priorities. As noted in some of the background reference material, implementation seems to be the biggest limitation encountered in this kind of work. It will be important to see this work followed through.

Thank you for the opportunity to review and comment on this report.

_____

Carol Smith
CREP, Habitat, & Monitoring Coordinator
Washington Conservation Commission

(expertise in development of indicator monitoring programs)

Review of "Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake, and
Estuarine Habitat Indicators"
(H.C. Stalberg, R.B. Lauzier, and E.A. MacIsaac)

8 January 2009

General Impressions:

I was very impressed with the quality of work this document represents! It is well written, has
undergone extensive review, and is technically sound. The comprehensive preparation work will
aid in having a robust program that is efficient and effective in guiding wild salmon habitat
actions under very challenging times. Even more impressive is the apparent policy support
towards monitoring habitat indicators. To assure continuing policy support, it will be important to
ascertain that management questions are answered and guided by the results of this program.
Continued adaptive management to review indicator usefulness is recommended. However,
I've never seen such inclusive and comprehensive preparatory work, and congratulate you and
staff on a job well done.

Objectives of the Paper:

The objectives of the policy and of this report were clearly stated and in particular, Figure 1 was
very helpful in defining the goal, objectives, and strategies to achieve these. I did get lost a few
times in the background discussion, mostly because it was a protracted process. The
comprehensive nature of the review process is one of the positive attributes of your work, but it
is a double-edged sword, as it does make it difficult to explain to an outside reader. I suggest
adding a flow chart that illustrates 1) the name of the review or process and 2) one sentence to
describe result of that review of process.

From a technical perspective, Table 1 would be better served if the metric and benchmarks
columns referred to Appendix S as the location with more details. As a scientist, I had many
questions about your metrics and benchmarks, and finally found the answers to those questions
upon discovering that appendix. I wouldn't alter the content in Table 1 as it is very useful; just
make sure the reader can easily access the details to each of the columns by referencing the
appropriate appendix.

I support the recommendation to have complimentary assessments per region instead of
different benchmarks, as if you have a core set of indicators in common, you'll be able to
compare across regions. This may prove to be very helpful as you consider ecoregion and/or
land use differences.

Information Sources and Conclusions:

This report did a very good job of compiling relevant information sources and summarizing their
results in a manner that supports the monitoring needs of the WSP. My comments below are
mostly directed towards choices of indicators and next steps.

Ultimately, an indicator is only good if it can answer management/policy questions or guide management actions. For this reason, indicators must be able to show change, not only change from functional to degraded conditions, but also change to a restored or improved condition. A good indicator should also be able to show this change within a reasonable timeframe. For example, using large woody debris as an indicator would likely be a poor choice because actions to improve conditions, such as restoration of riparian forests, take decades to yield a measurable change in instream wood. However, using riparian conditions makes more sense as recovery can be measured in steps, such as young conifer as an interim improved condition.

Indicators should also be broadly applicable to overall habitat health, and the closer they are to watershed process drivers, the better because drivers are more likely to be linked to the causes of differing conditions. For example, stream flow is very broadly applicable and therefore of high relevance to salmon habitat, while measuring one particular toxin would be much less valuable. Drivers such as land cover/land use (including riparian) and stream flow are extremely valuable for another reason, its close link to causes. This adds to the usefulness because one of the first questions management asks after hearing that an indicator is poor, is "why?" If the indicator is a response variable, such as pools, you will not know why they are in poor supply or condition without measuring other indicators. Thus, it is very important to concentrate on the pressure/driver indicators, which you have done, and having a mix of drivers and response indicators is the ideal situation. Your methodology of using pressure/driver indicators to trigger status/response indicators is a great way to incorporate both types.

With these ideas in mind, I've reviewed your indicators and have the following comments. If costs become a factor, I suggest that you could reduce the number of pressure indicators by developing a very good data layer on actual land cover. Your category of land cover alterations is what we would call land use, and as you noted in the report, can have much variations within one land cover alteration category. Instead, it might be more useful to measure actual land cover, such as the type and extent of vegetation or hydrologic maturity and the extent of impervious surfaces, as these get around the problem that the same land use (agriculture, forestry, etc.) has many different kinds and levels of impacts. Then link your benchmark of degradation to certain status indicators that would then be measured if a degraded pressure indicator is detected. For example, a large percentage of impervious surfaces would trigger status monitoring of water quality and stream flow because these are the typical impaired responses to high levels of impervious surfaces. A loss of forest cover on steep slopes would trigger an analysis of sediment, flow, and macroinvertebrates, etc. You can also overlay the key salmon areas on top of potential problem areas to prioritize where subsequent funds, actions, and monitoring will occur.

The report mentions that road data will be costly to obtain. If you have a good data set on actual land vegetation cover (not land use, although you might want to be able to overlay a land use layer on top of the land cover for later questions), then you might want to skip the roads indicator. Roads are usually hand-in hand with land vegetation cover changes. Another alternative is to prioritize roads by type and only look for those that are particularly damaging such as floodplain roads, unpaved roads, poorly-drained roads (would use age as a predictor), and roads on steep slopes.

A good land vegetation cover layer could also substitute for a few other pressure indicators such as marine vessel traffic, permitted discharges, and crown tenures. Instead of monitoring these (and road densities), a superior overall land vegetation/impervious surfaces layer could be a better trigger for further status monitoring. LIDAR could complement the land cover layer to focus on key areas, such as important estuarine habitat to determine quantities of marsh, scrub-shrub, riverine tidal, and channel habitat. In other words, I'd recommend to do one useful

thing like land cover vegetation in a high quality manner rather than four total indicators that have either more variability or less applicability.

Although it seems important to monitor key habitats, the report wasn't very clear about how the results will be used. Do you plan to do habitat status measurements within these, such as water quality or substrate quality? One of the future next steps would be to better define 1) what question is answered by assessing these key habitats, 2) will these habitats need to be monitored over time 3) which triggers are appropriate to cause a change in management or further assessment actions for key habitats, and 4) what sort of further assessment actions would be triggered?

Summary Conclusions and Next Steps:

This is the one section of the report that could be strengthened. Linkages need to be clearly identified between thresholds in the pressure benchmarks to specific status indicators that will be measured if a threshold is exceeded. Also as mentioned above, the assessment of key habitats should be better developed with an assessment that will answer management questions and definition of actions that would be triggered with the results of the key habitat assessment.

However, these are relatively minor suggestions compared to the huge body of work that has already been completed to develop your program to-date. I commend you on this effort as I believe that it is one of the most thoughtful monitoring programs I've seen for salmon habitat, and I believe that when it is implemented, it will be one of the leading monitoring programs in the region.

_____

Mike Bradford
Research Scientist
Fisheries and Oceans Canada
Cooperative Resource Management Institute

(expertise in indicator development)

Review of "Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake, and
Estuarine Habitat Indicators"
(H.C. Stalberg, R.B. Lauzier, and E.A. MacIsaac)

9 January 2009

Overview

Strategy 2 of the Wild Salmon Policy (WSP) has a goal of identifying, quantifying and tracking
changes to salmon habitat in the Pacific Region. Part of that process is the development of
indicators and metrics for salmon habitat. Stalberg et al. documents the process used by the
Habitat Working Group (HWG) for the indicator work.

Overall, I found Stalberg et al. difficult to evaluate. I think this is primarily because a lot of the
report is a documentation or narrative of the HWG's activities. This description could be
relegated to a supporting appendix so that the methods contain a concise description of what
was done to reach the indicator list. The report of Nelitz et al. (2007b) would be a good starting
point.

Any discussion of monitoring programs and indicators that I have been involved in usually turns
into the creation of long lists of metrics that could be used to measure attributes of the system
in question. This list usually grows with each review or consultation with technical specialists,
and there is a corresponding decline in affordability and feasibility. I am of the view that far
more up-front time needs to be spent on some of the broader issues such as program
objectives that will define indicator selection. That certainly seems to be the case here as only
vague guidance is provided by the WSP itself.

<u>**Specific comments**</u>

Section 2. Background

The material in this section seems to be taken from the WSP and thus provides guidance for
the remainder of the document. However, when reading the text statements such as "it was
decided that…." make it very unclear whether the material is from the WSP or was generated
by the HWG. I would suggest that this section start by stating its purpose (a summary of
guidance from Strategy 2 of the WSP), and quote liberally from the WSP in setting the stage for
the subsequent sections. The section can be organized by the Strategy 2 action items.

Missing Next Section:

It was unusual to read a description of the objectives for the habitat indicators in the discussion
when one would expect a clear description of the problem and objectives before the detailed
description of the indictors. Strategy 2 has many similarities to other decision problems, and

there is a standard series of steps that are usually undertaken for the analysis. This process begins with problem bounding, including the frame of reference, the development of the objectives, and the types of decisions that are being made. Only then are the indicators needed to support decision-making identified.

Problem bounding in the current context should identify the spatial area, the species, and some discussion of the term "wild". For example are *Oncorhynchus* in the Great Lakes or the MacKenzie River included? What about the marine environment?

Related to problem bounding is the question of the *frame of reference*. The Policy appears to define the frame for Strategy 2 as CUs, but at times this appears to be confused with watershed-based frames. CUs are species-based and a single watershed can both contain CUs and only small portions of others. There is a need to define the appropriate frame and be mindful of it during the consideration of indicators. Based on the title of this report and much on the content the reference frame used by the HWG was habitat types (streams, lakes, estuaries). This difference needs to be reconciled with the WSP which uses species-specific CUs as a reference frame.

A careful consideration of the *objectives* is required. This begins with fundamental objectives, which can then be subdivided into sub-objectives or means objectives. Attributes are then developed from the means objectives (attributes are also known as performance measures or indicators). All of these can be arranged in a hierarchy and the proposed indicators can then be attached to one or more means objectives as a way of identifying how they will contribute to meeting the fundamental objectives.

The fundamental objective for Strategy 2 is defined on page 12 of the WSP as "Maintain habitat and ecosystem integrity".

Some of the sub-objectives for this can be inferred from action steps 2.2 and 2.3-
1) An evaluation of the amount of habitat for each CU (a spatial analysis)
2) Estimate trends in habitat state (a temporal analysis)

These 2 sub-objectives will only partly succeed in meeting the fundamental objective as they are only concerned with habitat monitoring. Other objectives or activities are needed to fully achieve the fundamental objective- presumably these will be dealt with elsewhere.

Each of these sub-objectives can be further subdivided. For example, sub-objective (1) clearly has quantity and quality as subcomponents. These could be regarded as "means objectives" as there will be indicators and metrics that could be defined and attached to each.

It is not difficult to imagine that there are indicators for sub-objective 1 will not be useful for sub-objective 2. For example, stream length or lake area is a useful predictor of habitat quantity, but those measurements are unlikely to change over time as required by sub-objective 2. Conversely, land-use patterns are unlikely to provide information for objective (1) but might be a useful proxy measure for objective (2). The point of this exercise is to enable organized thinking about how and why the indicators will assist in achieving the overall objectives.

Recommendation: The HWG should develop an objectives hierarchy for Strategy 2. This should involve a clear definition of the frame, objectives, and potential linkages between sub- (or means) objectives and indicators.

The recent draft document for Strategy 1 (Holt et al., 2009) makes the distinction between "state" and "status". State is determined from the indicators or metrics (an example would be

streamflow or temperature), but status is evaluated by comparing the state to the so-called benchmarks. I recommend that a similar nomenclature be followed in this document.

The WSP provides some clear guidance for the benchmarks for Strategy 1 as embodied by the red-amber-green continuum in Figure 3 and supporting text. Those benchmarks permit the definition of the biological status of the CU (by comparing abundance to a predefined level), and suggest management actions that would be indicated based on the status determination.

Benchmarks are less well-defined for Strategy 2, both in terms of their number (2 or 3?) and what they delineate. Some thought is required to identify the purposes of the benchmarks. It should be recognized that there is significant variation among pristine habitats in their attributes and capacity to produce salmon, and this variability forms the backdrop for evaluating anthropomorphic impacts on habitat. There is a suggestion that the benchmarks are also trigger points for habitat management actions, but few details provided in the WSP.

Recommendation: the HWG should clearly identify the principles that underlie the benchmarks to be used to evaluate habitat status. These might be specific in terms of habitat quality (for salmon production), the degree of human alteration, or in terms of the regulatory actions that would result from the status determination. Benchmarks for rates of change in habitat are needed for Action step 2.3.

The Pressure-State approach needs to be clearly defined. "State", appears to be defined as metrics related to the instream habitat related to salmon production. One needs to be careful not to confuse state with status here. "Pressures" are landscape level indicators of human activities that can affect instream habitat conditions (i.e., state). This model is relevant to identifying and assessing anthropomorphic impacts on land (or water) to salmon habitat over time and space. The model is not useful for evaluating spatial variation in state within and among CUs that are unrelated to human activities.

CUs are species-specific groupings of populations that show little genetic or life history variation. The species have widely varying life histories and habitat requirements within freshwater and coastal ecosystems. The current organization of indicators and metrics does not account for the species-based definition of CUs, but rather appears to be oriented to watersheds and regions within the landscape. Consideration should be given to organizing the indicators and benchmarks in a way that can best report on species-specific habitat factors that affect CU productivity (and human impacts on that productivity). For example, for a pink salmon CU the habitat indicators of greatest importance might be those related to substrate quality and winter flow stability. A different and probably longer list of indicators might be appropriate for coho salmon. In most areas more than one species is present, so a different suite of indicators might be used for the same stream, depending on the CU (i.e., the species) being considered.

Recommendation: Strategy 2 of the WSP is based on species-specific CUs. The HWG should consider how to organize the indicators by species and what approaches will be used when more than one salmon species occupies a watershed.

Section 4. The title of this section "Stream Indicators" immediately suggests that the reference frame used in the development of this work may be different from Strategy 2 of the WSP. This section could be (and perhaps should be) organized on the basis of species and CUs rather than habitat types. Based on species-specific life history differences, and the implied scale of the CUs (single lakes vs. large regions of the coast), candidate lists of indicators can be developed. The indicators should also be organized by the means objective that they link to (i.e., habitat quality vs. trend etc.).

Specific comments on Table 1.

General: Based on the guidance provided by the WSP, the entries into the cells should be expressed in terms of CUs, not watersheds. The number of benchmarks and their definition needs to be established in the text. At the moment the definition of the benchmarks is inconsistent. Ideally the benchmarks should also be independent of the current state of habitat.

Did the HWG consider a holistic expert-driven approach? Bradford and Irvine (2000) showed how a qualitative scoring scheme was as useful a predictor of salmon declines as quantitative GIS-based rules. If the objective is to classify CU habitat into three broad categories (such as a stop-light scheme used for Strategy 1), a structured expert elicitation approach may be the most efficient way to arrive at a CU level assessment.

Total land cover: metric is unclear. Benchmark should be identifiable from existing literature. A 10-year sampling rate is probably optimistic.

Road development: Benchmark- if 0.4 is the point where "effects are evident" are road densities >0.4 "higher risk"? More clarity is needed.

Water extraction: This indicator might be better entitled "flow alteration" as there are more impacts than just abstraction. One metric is the proportion of water used, especially during the late summer. A benchmark (20% MAD for small streams) is mentioned in the text but a different one is used in the table.

Riparian disturbance: Is this relevant for large rivers? There appears to be a variety of benchmarks in the Nelitz et al. (2007b) report, why is 5% chosen?

Sediment: Habitat quality will not be measured as TSS over "background"- that measure is more suitable for point source effluents. Habitat will be affected by the total sediment. Human impacts will be "over background" but unless there are point sources it will be difficult to separate human impacts from background. It is possible to translate the CCME guidelines into a definition for a benchmark using Newcombe and Jensen's model.

Temperature: why identify a specific species/life stage? Temperature (low or high, or altered) will have impacts on all species. There should be a single indicator with a variety of metrics depending on the species and season. There are a variety of benchmarks for temperature that can be employed here.

Stream Discharge: The proposed metric and benchmark relate to low flows in late summer only. Some further analysis to justify the benchmark is needed (along with a definition). The text also mentions a recurrence frequency for those flows.

Invertebrates: More specific detail is needed on the metric and benchmarks. There is a need to ensure that the reference condition approach is providing information relevant to salmon production.

Stream quantity: Models are available for coho and Chinook that estimate salmon abundance as a function of stream length or watershed area. Gradient and pool frequency have been used as modifiers. Spawning areas should probably be reported as area rather than length (consider the case of the Harrison River Chinook CU).

Lake land use: Is there any evidence that lakes will be significantly negatively affected by land use practices? Similarly, is there support for riparian impacts on lake-based salmon production?

Lake productive capacity. The metric might be predicted pelagic biomass based on the PR model or phosphorus. If P is used there are accepted standards for trophic status that could be used as independent benchmarks.

Estuary, marine traffic. There doesn't appear to be much scientific support for this one. Marine traffic will be a function of size, population density and latitude and so will likely be confounded with other factors.

Estuary, disturbance. The description of the metric (a rate of change of licences) differs from riparian and land use metrics and appears inconsistent.

Estuary, others. The remainder of these seem underdeveloped.

Discussion comments:

It is unfortunate that the HWG did not have the time to consider how the metrics and indicators will be combined or otherwise used to estimate the state of habitats at the CU scale, and to evaluate status relative to benchmarks. There are likely to be over 400 CUs, varying in size from single coastal lakes to large regions of the coast or interior watersheds. A single stream could part of 5 or more CUs. Based on Table 1, each lake or stream could potentially have 5 or more scores from the various indicators. Determining how to subsample a large CU, collecting data that can be used by all CUs that use the habitat, and rolling everything up into a single assessment of status for each CU is a significant challenge.

2) Review Comments on Earlier Draft of Report

Jim Irvine
Research Scientist
Fisheries and Oceans Canada
Division Management

Review of "Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake, and Estuarine Habitat Indicators"
(H.C. Stalberg, R.B. Lauzier, and E.A. MacIsaac)

10 Dec 2008

Pg i You should indicate this is a DRAFT report

Pg ii I am impressed you have a report number already, but it will have a 2009 date

Pg ii Ray's address needs updating

Pg ii You may want to give the correct title for the WSP in the title of the report and indicate that these are "Proposed" indicators?

Pg vi Is there a Table 3?

Pg vii Abstract – these are normally 1 paragraph

- First sentence, suggest you expand to read "….habitats associated with Conservation Units within the Pacific Region"
- Explain what is meant by a "research and expert-orientated strategy"?
- Indicators, benchmarks, and metrics are identified as components, but the abstract only describes indicators. How come?

Pg 1 and elsewhere - quotes from the WSP should be in quotation marks.

Pg 2 Explain, with reference to the literature, what is meant by indicators, benchmarks, and metrics. Also, referencing to the DPSIR (Driver->Pressure->State->Impact->Response->) literature would seem to be needed.

Pg 2 It is good to see the objectives explicitly stated. But the discussion should link back to each of these. Did the report successfully achieve each of these objectives?

Pg 2 I suggest you have an appendix identifying all those who participated on the HWG and each of the chairs. This will lend credibility to the report and also help to give credit where it is due.

Various pages – be careful with the use of the term CU. CUs are groups of fish, not geographic areas. We screwed up on this in the policy in various places as well.

Pg 2 Explain what is meant by "limiting and productive habitat" and justify why emphasis was place here instead of, for instance, habitat diversity. (I notice a problem with the final sentence in that "is" should be "are – report needs more thorough proof reading)

Pg 3 (and elsewhere) presumptuously refers to the "final" list of indicators. Consider deleting "final".

Pg 8 Biotic stream indicators were not scored or apparently considered further. I see this as a major limitation to this report that needs much more discussion. For instance, there is a huge body of literature (e.g., instream flow methodology) that should be referenced. Fish and sometimes invertebrate abundance (there are lots of relevant publications other than CABIN) and growth patterns are arguably the best indicators of habitat carrying capacity. It is true that it is challenging to use these types of data; for e.g., when salmon are below carrying capacity. However, fish data can still be informative in identifying key habitat units, and information on non-salmon that are not regulated by marine factors can often provide information on the status of "salmon" habitat.

Pg 10 I do not understand how one could evaluate cost without knowing the sampling design. For instance, measuring primary production in lakes might be deemed to be too expensive. But what if one can do this through remote sensing for little cost?

Pg 16+ Table 1. This is an extremely important and useful table. I suggest you expand the table caption (or add appropriate footnotes) to indicate where in the report substantiating information is provided. For instance, you justify many of the benchmarks in Sections 4.1-4.3). These latter sections are very informative, but additional details are often needed. For instance, on pg 23 you state "A reference point of 0.4 km/km^2 was selected as a general benchmark delineating low and high risk levels of road density." Who chose this benchmark, and why? In Table 1, what is meant by lower/higher risk? Similarly, it is not clear (at least to me) how you determined the sampling rates for these various indicators. This implies that you have a detailed habitat assessment sampling design worked out. If so, what is it, and where is it described?

There are other issues that deserve discussion. For instance, the policy is quite clear in describing 3 benchmarks for CU biological status. Are you following the same approach; if so, one would expect 2 habitat benchmarks for each indicator. If not, why not?

Pg 33-34 (Juvenile Salmonid Densities). As stated earlier, I believe that salmon are the best indicators of salmon habitat, and when the ecosystem is below carrying capacity, other biotic and biotic-related indicators are still useful (non salmon densities, salmon growth and mortality estimates, concentrations of harmful chemicals, etc.)

Pg 34 (Groundwater extraction). It might be appropriate to describe the recent legislation as it is relevant. What are irrigation circles?

Pg 35. As mentioned earlier, this section needs extensive revision or should be deleted. WRT Table 2, I had hoped to see a discussion of linkages between proposed habitat indicators and objectives in the report as part of Strategy 2. Earlier I made some suggestions for the content of Table 2. If the table is to be included in the report, it needs to be described and referred to in the text.

Pg 36 + Discussion. There is quite a bit of information here that is relevant to Table 1 that I suggest should have been provided earlier in the report.

Pg 36 + In addition to describing the 4 key inputs to habitat management (are these

referenced?) perhaps you should have subheadings related to each of the objectives stated in the Introduction.

Pg 36 + Do you discuss how the WSP pertains to the "new habitat policy"?

Pg 36 + I personally would have been interested to hear if any of the "lessons learned" described in a recent paper were relevant to the identification habitat indicators, benchmarks, and metrics.

Pg 36+ Any comments/discussion about data assembly and storage? How about the communication of information/data with interested stakeholders and the public?

Pg 47 There is no Stock Assessment Branch

Of the 4 objectives for the report stated on pg 2:
- "document the process by which DFO identified provisional habitat indicators, metrics, and benchmarks under WSP Strategy 2, Action Step 2.2;
- identify linkages among these indicators, metrics and benchmarks and key inputs to guide habitat management;
- identify linkages with the habitat indicators and Strategy 3, Ecosystems; and
- provide a basis for scientific review."

it would appear that the first objective has been achieved, in particular with respect to provisional indicators. The addition of supplemental information and documentation is recommended to better describe linkages among indicators, metrics and benchmarks. Linkages with Strategy 3 are not well described and I suggest this objective be deleted. The report provides a basis for scientific review, but to do this properly, knowledgeable reviewers need to be identified with the time to go through the document in detail (I ran out of time).

In summary, this useful report is a significant contribution to the implementation of WSP Strategy 2. However, it needs to be acknowledged that the identification of habitat indicators and benchmarks is an iterative process, and those identified here cannot be considered final. This is particularly true without a thorough description and understanding of the purpose of measuring the various proposed indicators, and an accepted scientifically defensible habitat assessment framework. This is not meant to downgrade the significance of the findings in the report, but rather to suggest that the development of an assessment monitoring framework should be a major next step, and it is at this point that final decisions can be made as to the appropriateness of the various proposed indicators.

Kim Hyatt
Ecosystems Research Scientist
Fisheries and Oceans Canada
Salmon Assessment

Review of "Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake, and
Estuarine Habitat Indicators"
(H.C. Stalberg, R.B. Lauzier, and E.A. MacIsaac)

14 December 2008

I have read the above noted paper carefully and provide a range of both general and specific
comments below. However, before attending to these, the authors should have brief responses
to the "standard questions" addressed in a peer review as follows:

(a.) **Are the objectives of the work or paper clearly stated**? The objectives of the paper are
clearly stated at the most general level. However, there are a host of subordinate
objectives, often implied by questions or designation of indicators, which arise throughout
the remainder of the text. Some of these are specific but many are simply implied. It would
be helpful to compile these into a more complete list that either is summarized in a table or
alternately such that key objectives/questions associated with particular sections appear at
the first of each section.

(b.) **Are information sources adequate to support the conclusions**? First, the authors and
the Habitat Working Group (HWG) should be commended for their efforts to date. It's clear
that the information sources serving as the foundation for this paper are very extensive and
the authors plus the associated Habitat Working Group have worked hard to take them into
account. Although the current paper allows readers some appreciation of just how broad the
information sources are, it does not represent an adequate synthesis or treatment of these
sources. The problem is largely one of too little attention to ensuring there are linkages to
the specifics of the information sources used. For example, most tables in the appendices
do not provide explicit linkages to source documentation for indicators, benchmarks, etc.
even when it's clear that these exist. Similarly, inclusion of large tabular summaries of
information from various reports such as Nelitz et al (2007a), preclude peer review because
the methods and information used to justify them are part of a different report rather than
this one. However, that report and its contents appears to be serving as a major source of
information for the recommendations arrived at here suggesting that the Nelitz et al
(2007a,b) reports should be included as part of the current review?

(c.) **Are information sources and methods explained in sufficient detail to properly
evaluate conclusions**? Information sources and especially methods are not explained in
sufficient detail to permit peer review. The general method has been to generate and then
look for confirmation of the utility of a suite of habitat indicators through a repetitive "expert
opinion" panel process. The methods section of the text is currently far too long and
repetitious with respect to identifying this as the principal approach. By contrast, it's far too
short or silent on the details of exactly how extensive information sources were used or
what criteria were used for the process of indicator review and selection.

(d.) **Are recommendations provided in a form useful to resource managers**? The paper
does make an attempt to do this by suggesting information gaps for additional work on the

utility of indicators as well as by suggesting data and information sources that may support indicator assembly. However, these commentaries could be expanded or more systematically treated in an actual discussion of the feasibility for generation, assembly, analysis, archiving and management of data/information by DFO or others. At present, the text tells us that various criteria such as accessibility and cost were identified as a basis for weighting the selection of the subset of indicators recommended but this process seems to have been largely subjective and quite vulnerable to challenge.

(e.) **Do conclusions or advice reflect uncertainty in the information, analysis or methodology**? The paper wrestles with the issue of uncertainty from a limited perspective. The absence of methodological details in the document for how various expert panels treated indicators is an unqualified source of uncertainty that remains problematic. Consequently, there is no formal assessment provided for how certain or uncertain various indicators might be. Expert opinion has been used to subjectively qualify some indicators as to their utility but the requirement to do this in a more systematic way remains. One option would be to assign indicators a verification weighting-index based on the number of published studies that have confirmed a statistically significant relationship between a given habitat indicator and some attribute of either salmon or of aquatic biota clearly linked to salmon.

Its currently difficult to differentiate among indicators that are:

- well supported by empirical research (i.e., greater than 3 published sources confirming significant associations),
- those with moderate support (i.e., 2-3 citable sources for significant association),
- those with nominal empirical support (1 citable source for significant association) and
- those having no statistically meaningful support but still thought to be relevant (i.e., logic model of cause and effect suggests there should be a link).

(f.) **Are there additional steps or actions required to improve the work**? This question is dealt with under various detailed comment sections below. The brief answer is that the work of the HWG plus that of ESSA and perhaps Winsby and Associates would benefit greatly from investment of additional integration and synthesis efforts from an expanded list of authors. In its current form, this report is too fragmented or vague with respect to introductory context, concepts, definitions, methodology, results and discussion to serve as a peer reviewed foundation document to satisfy Strategy-2 objectives (detailed comments provided below).

General Comments:
This working paper represents the culmination of many months of effort by DFO's Habitat Working Group to develop a suite of indicators to inform managers about changes in status and trends of habitats supporting wild salmon conservation units (CUs) in the Pacific Region. I have examined the paper and its appendices thoroughly and I have little doubt of the likely existence of many relationships between the developed suite of indicators and wild salmon productivity. Unfortunately, much of the evidence of whether this is the case, and a subject for peer review, originates with Nelitz et al (2007b, Appendix Q). Observations from that source have been inserted into the current report as the basis for metrics and benchmark recommendations even though the Nelitz et al. (2007b) report is not the subject of our peer review. It's simply impossible to import the mass of appendicized information here from some other report without the supporting documentation and then expect that such material may be subjected to meaningful peer review. The result is that most recommendations in the current report rest on the premise that repeated rounds of application of expert opinion are a sufficient basis for DFO

to embark on an ambitious program of monitoring and evaluation of habitat indicators.

I'd be far more comfortable with the current paper and its recommendations if the extensive materials from Nelitz et al. (2007a, b) and other reports had been considered systematically here, but the current report does not constitute a serious effort to integrate and synthesize these various sources of information. In particular, I found the narrative structure used to deal with diverse information sources, methods and results in the current paper difficult to follow or review. This could be solved by integrating the HWG work and that done by ESSA into each of the paper's sections such that a core set of concepts, a unified methodology and an integrated set of results would inform the conclusions and recommendations. The current structure stretches these out over too many narrative sections with contents focused on too much "process information" (i.e., the historic sequence of what was done rather than an integrated treatment of the methodology used to do it) that is not essential to the outcome. In my view, the paper falls short of providing a really solid foundation on which DFO may build a habitat indicators information system.

Consequently, my major conclusion is that the structure and contents of the current paper could be improved greatly by restructuring the introduction, methods, results, discussion, conclusions, recommendations, references, and appendices to better integrate the various sources of information serving as the foundation for recommendations regarding a defensible suite of habitat indicators.

Regardless of whether this recommendation is followed by the authors, the other general comment is that even the current version of the paper would benefit from a thorough round of editing to reduce repetitious text, grammatical errors and to improve overall clarity and coherence.

Specific Comments by Section:

Abstract: The abstract needs to be refined for greater clarity. Examples: (1) The strategy used in this study did not involve a "research" approach as no new research was conducted. It did involve the creation of a panel of "expert practitioners" drawn principally from habitat management as opposed to habitat science backgrounds (I can't really say who these folks were from the report because they are not identified). This expert panel then engaged in a series of meetings during which they systematically discussed/reviewed their knowledge and experience with use of various pressure or state indicators to track spatial and/or temporal trends in the status of habitats used by wild salmon in B.C. and the Yukon. (2) The pressure-state framework does not describe "human stressors" (i.e., stressors of humans) but does describe man-made stressors that affect either habitat or wild salmon. (3) Road development, land cover alteration water extraction are not "habitat indicators" rather they are habitat indicator categories or classes within which many specific indicators may be identified (e.g., length of roads per km, % land converted from forest to grassland, etc.).

Introduction:
The introduction needs to set the overall context for the development of habitat indicators and so should provide a brief narrative describing logical associations among WSP Strategies 1-5. As currently presented, the overall context is largely left to readers to sort out through examination of the contents of Figure 1. A concise explanation of linkages among the overarching WSP goal, its objectives, strategies and guiding principles would be beneficial and help smooth what is currently an abrupt transition to the presentation of the specific action steps required under Strategy-2.

Although the introduction jumps right in to identify that the objectives of the report involve the identification of indicators, metrics and benchmarks there is no definition of any of these terms. Readers should not have to sort out what these are and how they might be used i.e., what's the difference between an indicator, a metric and a benchmark? Are all indicators the same or are there different classes? The introduction should include a short section that refers to some general literature on the definition and development of indicators to remedy this.

The text outlining the objectives of the paper is vague on a number of issues. First, it is not clear whether the objective of documenting the "process" through which habitat indicators were identified also includes or is the same as documenting the methodology used to identify habitat indicators. By this, I'm asking whether the objectives include identification of the specific methods, their rationale and steps used in their application to identify indicators. These items need to be included in order to "provide a basis for scientific review".

The objectives list also includes "identify linkages among indicators, metrics, benchmarks and key inputs to guide habitat management" but provides no real clues about what types of linkages are to be considered. For example, the linkages may be restricted to explanations of associations among general classes of indicators, specific indicators expressed as a metric within a given class and then benchmarks which may be used to draw conclusions about habitat status and trends in space and time. Alternately, linkages may envisage explanations of linkages among habitat indicators and benchmarks relative to these same categories for CUs and Ecosystems. My guess is the document should lean towards the latter where such linkages will constitute "key inputs to guide habitat management" i.e., one of the major premises behind the intent of the WSP and Strategy-4 is that CUs, their habitat and broader ecosystems will be managed in an integrated fashion. Even in the absence of a well-developed document on Strategy-4, it is important to identify the value of this overarching integration objective and what it implies about how the "business of habitat management" will change from past or even current practice.

Background: Suggests a two-tier reporting structure for reporting on the quantity and quality of habitat supporting CU populations. This includes (1) overview reports on important habitat (i.e., highly productive and limiting) and habitat issues and (2) detailed habitat status reports that relate habitat status to life history requirements for a given CU.

Bottom of Page 2. The second bullet at the bottom of page 2 as worded is not a separate objective but rather the outcome of the first bullet i.e., "track the status and trends of limiting and highly productive habitats to gain insight into the overall habitat status of a given CU". The second bullet would be a separate objective if it were altered to say "identify associations between habitat status-and-trend information versus CU status-and-trend information".

Top of Page 3. Indicator benchmarks are to be set "to protect and restore habitat" for prevention of population abundance declines in response to degraded habitat. This material describes an objective of the WSP and would be better included under the section (page 2) documenting the objectives of the report.

Methods:

Page 3. Section 3.1. The heading, "Review Wild Salmon Policy Guidance Reports" should be changed to "Review Results and Recommendations from Wild Salmon Policy Guidance Letters, Reports and Selected Workshops" since the section does not deal with just reports.

Given that review of results and recommendations from reports, letters and workshops is part of

the "methods", the authors need to identify who did this review. Was the review undertaken by the HWG and reflected in their "expert discussions" about the process and products to be produced as part of the habitat-indicators work? Was the review undertaken by the authors of the current document and, if so, where did this fit into the process?

Page 4. Section 3.2 This section tells me that the report by Diewart (2007) is important as a "guide for defining highly productive and limiting habitats within a CU or watershed" and then "for the selection of relevant habitat indicators". However, aside from saying that the report is important, the authors do not tell me specifically how the information was used by the HWG members or the authors to identify highly productive or limiting habitats for CUs much less what habitat indicators to select. Similarly, the current text highlights the Diewart report's identification of 10 life history strategies which leads one to think these also played some role in the HWGs method but fails to tell me how because the methodology is not described.

Note that simply telling me that reports were read, that meetings were held and numerous discussions completed does not constitute sufficient information for a reader to provide peer review of the methodological basis for identifying habitat indicators. As a reader, I'm left wondering who read the Diewart report (e.g., all HWG members, just the authors of the current report), how its contents were used by the HWG and to what end? A more complete description of the materials used and how they were used is required as part of the methods section. If the Diewart life history categories were important to identifying productive and limiting habitat, then the onus is on the authors to tell me how they were used. They might also comment on why excluding other life history categories (e.g., early-run chum, late-run chum, summer Chinook, fall Chinook, age 1.0 sockeye, age 2.0 sockeye strategies) did not matter.

Page 5. "An initial list of 26 habitat performance indicators was developed by the HWG and provided for review and comparison within existing habitat productivity models."

I can't be certain from the text description whether work and steps described are executed by Lewis and Ganshorn or the HWG. First, it looks like Lewis and Ganshorn (2007) identified habitat productivity models by reviewing the contents of 113 reports on this subject. As part of their review, they considered habitat pressure indicators (needs a definition) and habitat status indicators (needs a definition). These authors grouped habitat status indicators into six general categories including: stream flow, etc. Next, the text says that the HWG developed the list of 26 habitat performance indicators (they really mean classes of habitat performance indicators) for review and comparison with habitat productivity models summarized in Appendix C. However, Appendix C. contains a list of 24 (not 26 as far as I can see) "classes" of performance indicators and there is no specific reference to productivity models in Appendix C.

Questions remain as to what methodology was used to create Appendix C. If this is simply taken from Lewis and Ganshorn (2007), just say so. By contrast, if the HWG reviewed Lewis and Ganshorn (2007) and then developed the table on the basis of specific criteria, the authors will need to spell out what these criteria were. Even if it's the latter, readers will still want some explanation of how various criteria were used by the HWG to include or exclude indicators from this list.

Page 5. 3rd Paragraph: "The literature review found strong relationships between indicators and fish abundance/production for those habitat status indicators with a longer history of evaluation and those with direct experimental evidence." At this stage I'm not certain whether this is part of the HWG's method or part of the results from applying their method and it really depends on whether or how these observations were used by the HWG to identify indicators. The text needs to clarify this.

Page 5. 4th Paragraph: "The challenge of uncertainty related to co-variance between habitat status and fish production <u>was explored</u>" and then used "to <u>inform the scientific criteria</u> evaluated as part of the next steps in the indicator selection process". At this stage it's not clear exactly what this means. The meaning could range from:

(1) all HWG members consulted a summary table indicating the frequency of statistically significant associations between fish production variations and a given class of indicators (i.e., objective basis for scoring), to

(2) all HWG members have read lots of papers or the Lewis and Ganshorn (2007) report which then formed a basis for their "expert opinions" about what they thought the strengths of associations likely were between fish production variations and a particular class of indicator (i.e., subjective basis for scoring).

Page 5. Section 3.3 Two technical workshops were held with scientists who are considered experts on habitat and salmon associations. Some conclusions from these discussions are identified in the main body of the text and others are found only in the Appendices. The pattern that I see emerging from the way the text has been assembled thus far is that the "methodology" for developing the habitat indicators was based on "expert opinion" summarized in literature reviews, workshops and repeated discussions among members of the Habitat Working Group. The process by which these "expert opinions" were obtained is identified and clearly involved a significant amount of work. However, aside from soliciting repeated rounds of expert opinion, the methodology for selecting indicators remains highly subjective and virtually impossible to withstand a defensible peer review process. If the report remains in its current form, the upcoming workshop will only constitute yet another independent panel of "experts" offering another set of opinions about whether they agree or disagree with recommendations or findings of other experts.

Section 3.4 The information reported in this section largely deals with reporting on the scope and costs of habitat monitoring systems in other jurisdictions. It identifies several factors (cost, statistical power to detect change given natural variability, time lags between causes and effects) that might be used in weighting or prioritizing a short list of pressure and status indicators. One alternative to consider is to create a summary table that identifies the various review criteria (for assessing or weighting habitat indicators) that the HWG applied to indicator selection, the rationale or supporting information and their origin (e.g., U.S. E-Map Program, K. Krueger pers. comm., or Smith 2005, etc.).

The text suggests the meetings, associated background reports and correspondence obtained, all "assisted" next steps in the indicator selection process. Thus far, the text does not specify where, when or how this was accomplished. What does "assisted" mean?

Page 7., Section 3.5 Define Framework (and criteria ???) to Assess Habitat Status:
If the framework to be adopted is the pressure-state-response framework there is a substantial literature on its origins and use that should be briefly summarized. One might expect a framework to take into account spatial and temporal issues that are created not only by differences in life history elements of wild salmon CUs but also by differences in the scale at which processes that shape habitat occur. As currently described, the authors and the HWG's insight into this framework appears once again to depend on a superficial summary limited to identifying a few elements (e.g., pressure indicators, state indicators, exceedance-benchmarks) based on word-of-mouth descriptions from various practitioners. Coverage does not have to be encyclopedic but inclusion of key references and some indication they have been read are appropriate. Reference to this literature would quickly dispel the apparent notion that pressure indicator information will be derived entirely from the use of "remote sensed data". Sources of information on pressure indicators are more varied than this (e.g., size of the bottom trawling fleet and number of trips by area will not come from satellite data, volume of water withdrawals

from a given region or sub-region, etc.).

In locations where "benchmarks" are being exceeded. The authors so far have not defined what a benchmark is in general or whether there are different types of benchmarks leaving the reader to guess about the specifics of what they mean by exceeding benchmarks.

Page 8., Section 3.6 Rank Candidate Habitat Indicators:
The lists of pressure and status indicators as well as of key habitat attributes against which they are ranked are limited relative to the large number of possible entries under any of these categories i.e., "the HWG recognizes these lists were not exhaustive." What were the criteria and how were they used to either include or exclude a row or column category for the ranking exercise? How were these categories selected or defined? For example, hydroelectric or irrigation dams would be considered both a pressure/stressor indicator as well as a status/impact indicator which would rank a 1.0 or 0.5 for influence on virtually all of the habitat attribute categories both upstream and downstream of a given dam (a type of barrier?). However, this important habitat pressure and status indicator does not appear to be reflected anywhere in Appendix F. Similarly, I could argue that the % of time during the year for which air or water temperatures exceeded the temperature optimum of 15 degrees or that precipitation pH falls below 7.0 are pressure/stressor indicators of climate change impacts, so why are they not considered here? Clearly there are geographic regions/watersheds in BC that are vulnerable to changes in both of these indicators of environmental conditions under human influence (i.e., various geographic regions have different background values for these habitat indicators in space and time and departures from baseline averages or value ranges may be influenced by anthropogenic effects).

It would also be useful to know where and how particular habitat attributes and "objectives" which appear to be thresholds for Pacific Salmon well-being were derived. As an expert I can recognize why water temp. is important to wild salmon, but I'm not certain why the single objective is to maintain water temp < 15 degrees as other temps are also important e.g., water temp < 12 degrees (for spawning), > 0 degrees (for overwinter survival), etc. Similar comments apply to other habitat attributes and one has to query whether changing these "threshold values" would influence their ranking.

Page 8, Paragraph 4: Quantity indicators (QIs) are introduced as a term that has still not been identified although several specific examples such as accessible stream length, area of spawning habitat, etc. were cited earlier. One assumes QIs are quantitative measures of the spatial or temporal extent of salmon habitat (i.e., indicators measured in various spatial and temporal units) associated with a CU-habitat combination. In addition, the authors suggest that QIs are essential status indicators and so are included by definition in the core set of status/impact indicators without the need to rank them. However, in the tables various area-based QIs are treated as subjects that are ranked so this inconsistency needs further explanation i.e., clarify what quantity indicators are and the rules for consistently distinguishing between those that require ranking and those included in the core set without ranking. As a more general level comment, the current paper is focused on little else other than indicators but it has no general section on definitions of what indicators are, how many types there are or how they are used. Consequently too much of this is left for readers to figure out for themselves. The authors should remedy this early on in the paper.

Page 8, Paragraph 4: The various reasons given in the text for excluding most, but not all, biotic pressure/stressor indicators (i.e., periphyton, invertebrates, fish are excluded but forest cover is included) are inherently inconsistent. Further, although the text suggest most biotic indicators are excluded, this appears to be restricted to treatments of streams and lakes and then ignored in the tables that summarize the treatment of estuaries where biotic entities are

more heavily represented. These inconsistencies suggest the absence of clearly articulated methodological rules for how to achieve consistency in what to include or exclude. This may be remedied by further consideration of the relationships between habitat and ecosystems along with associations among pressure/stressor, status/impact indicators and attributes of both habitat and ecosystems.

Habitat versus Ecosystem: Habitat, as treated by the HWG is largely defined by attributes associated with either physical or chemical but not biological structure (as treated in the text and most of the work but see comments below). By contrast, ecosystems are defined by all of the physical and chemical attributes associated with habitat <u>in addition to</u> a multitude of sensitive attributes (distribution, abundance, growth rates, survival, biomass, production, etc.) of the biota associated with habitat. If adopted, this classification of attributes delineates a readily definable difference between habitat and ecosystems where the former consists of a sub-set of the latter i.e., ecosystem attributes include all attributes identified as habitat attributes plus an extended set associated with the biota that characterize ecosystems. The separation of habitat and ecosystem entities is generally maintained in the HWG tables associated with streams and lakes (Table 1 dealing with the final suite of habitat indicators as well as various tables in Appendix F). However, it is largely abandoned in the HWG consideration of estuaries which use extent of eel grass, flux of detrital and organic matter, aquatic invertebrates, periphyton and plankton as habitat status/impact indicators rather than treating them as ecosystem attributes. My advice would be to deal with estuaries in the same fashion as streams and lakes by omitting aquatic biota categories that will be considered under attributes of ecosystems as part of the Strategy-3 exercise. Whether this change is made or not, <u>the current text does not describe a consistent set of rules or definitions supporting the assembly of the tables in Appendix F, so this needs to be attended to.</u>

Pressure/Stressor or Status/Impact Indicators: It is clear from examination of Table 6 (Appendix F) that pressure/stressor indicators considered by the HWG were intended to be restricted to entities directly stemming from human activities but not natural variations or changes. However, it is important to recognize that there are a host of natural pressures and stressors that have ongoing impacts on habitat in addition to man-made ones. In spite of the fact that these are sometimes difficult to disentangle, the human-associated pressure/stressor indicators considered here are rather incomplete.

Example 1: Harvest of fish is clearly a human associated activity that can reduce the abundance of fish in the same fashion and even to the same degree (when expressed as % of biomass removed per unit time) that harvest of forests does. Total catch of salmon by area or time appears to have been omitted from the pressure/stressor list indicators because the HWG did not recognize any connections with habitat attributes. However, returning salmon clearly influence riffle substrate compositions (i.e., % fines) and water chemistry (N and P concentrations) as salmon abundance is altered by harvest. Thus, the rationale for including salmon harvest measures as a pressure/stressor indicator will be the same as that used for including forest cover alterations due to logging. Perhaps even more importantly, DFO has full authority and responsibility to control this human induced disturbance to avoid harm. The only reason to exclude it would be if it had no impact on what the HWG regards as habitat attributes.

Example 2: The fact that some aspects of invasive species may be treated as an ecosystem attribute under Strategy-3 work should not preclude consideration of human mediated introductions of invasive species as a pressure/stressor or status/impact indicator under habitat. This is because invasive species may be considered both an attribute of ecosystems but also as a pressure/stressor of habitat or as ecosystem attributes given that human-mediated introductions of invasive species of plants and animals may affect both. For example, introductions of aquatic milfoil into lakes affect littoral substrate quality, diel levels of dissolved

oxygen, patterns of near-shore water circulation and shoreline erosion so there is clearly a specific category of indicator under the general heading of invasive species that affect habitat as well as ecosystem attributes. Thus, the number of invasive species originating from human activities can be considered both a pressure/stressor indicator for habitat and ecosystems as well as an ecosystem attribute to be managed.

I could go on here with more examples but these two should serve to identify there's more work to do in identifying key indicators for consideration as part of the suite of habitat indicators.

Page 9, Section 3.8, Assess Practicality of Applying Habitat Indicators: This section describes review of the HWG efforts by ESSA and an attempt by ESSA to add additional methodological (as opposed to process) elements (e.g., linkage diagrams for habitat indicators and salmon) to the HWG work. I agree these steps are necessary but suggest the structure and contents of the current paper could be improved greatly by restructuring each of the report sections to integrate the various sources of work rather than as a sequential narrative that is difficult to follow or review. If this suggestion is followed, then both the HWG work and that done by ESSA would be integrated into each of the paper's sections such that a core set of concepts, a unified methodology and an integrated set of results would inform the discussion, conclusions and recommendations. The current structure stretches these out over too many narrative sections with contents focused on process information (i.e., the historic sequence of what was done rather than an integrated treatment) that is not essential to the outcome.

Page 10, last paragraph. Reporting that the workshop outcomes included a list of miscellaneous recommendations about data sources is fine but the current paper should aspire to more than simply reporting on workshop outcomes i.e., the authors have an opportunity to comment on whether or how particular recommendations might be acted on. For example, the workshop "recommended use of water chemistry data for sockeye lakes in B.C. as collected and archived by the DFO Cultus Lake lab. Nothing wrong with the recommendation, but it hints at a broader need for water chemistry data for aquatic habitats used by wild salmon. Consequently, the paper could go further by identifying the range of groups that assess water chemistry variables and maintain databases for same (i.e., Environment Canada, B.C. MOE, various groups within DFO that include but are not limited to just the Cultus Lake lab). Appendices M and N do contain this type of information but the current text makes little use of it.

Page 11, second paragraph. The ESSA procedure is simply covering the same ground in a slightly different fashion than the HWG did as described in earlier sections of the paper to arrive at yet another ranking scheme. Same point as noted above re: the potential value of restructuring the paper to integrate the ESSA and HWG work.

Page 11, 3rd paragraph. ESSA options for developing habitat indicators are summarized in considerable detail in Tables 21-25 of Appendices P and Q. Nelitz et al. (2007b)) exerted much effort to read the literature, review experts, and synthesize information to identify, and prioritize, a suite of potential habitat indicators to track status and trends in salmon habitat. This raises the issue of which report we should be reviewing. The current report refers to the ESSA work and, most importantly, leans heavily on their work to select a "final suite of habitat indicators". The problem with this approach is that we are attempting to use the current report, rather than the Nelitz et al. (2007b) report, as the basis for peer review of whether the objectives, data sources, methods, and "analysis" conducted by the HWG are a sound basis for accepting the "final suite of indicators". Although the current report contains a lot of information about the process of getting to this point, it fails to identify the method for arriving at this point. We are reminded that repeated applications of "expert opinion reviews" were completed as part of the method but these are by no means a sufficient treatment of its elements to be considered

authoritative. The remedy for this is to use the Nelitz et al. (2007b) report as the basis for the methodology and subject it to peer review, or alternately, merge the HWG work-and-methods with the ESSA work- and-methods into a single document that may be peer reviewed and then serve as a more authoritative basis for recommendations about a "final suite of indicators".

Page 12, Item 3. The authors recommend developing various habitat "quantity indicators" for which there are currently limited data. Although I can readily guess at how these quantity indicators might be used, there is no discussion in the paper to inform non-experts about the when, where, how or why they might be essential. In the absence of this type of thinking the authors run the risk of excluding items that might be a higher priority. For example, lake cold water refugia are identified as a desirable habitat quantity indicator (implicitly for sockeye salmon since they are the main salmon species that make use of lakes). However, no mention is made of river and stream groundwater water refugia (i.e., groundwater fed side-channels or springs that are cool in summer and warm in winter) that are at least as important for Chinook and coho salmon. Groundwater-fed refugia in streams are likely at much greater risk of damage within many B.C. watersheds from water extraction pressures than coldwater refuges in lakes. In my view, mapping the location and importance of these is a higher priority than the sockeye lakes although the latter are much easier to complete.

Page 12, last paragraph. If the Nelitz et al. work (2007b, Appendix Q) is the basis for metrics and benchmark recommendations, then it's clear that the Nelitz et al. (2007b) report will need to be part of the peer review. It's simply impossible to import a mass of information included here as appendices from some other report without the supporting documentation and then expect such material to receive meaningful peer review. Further, although the sections I've examined thus far are included under the methods section, the attachment and reference to appendices is really tantamount to pulling much of what should be results into the methods section. The current results (Section 4 below) represent only the final outputs rather than all the intermediate summaries and cross-referenced material that they are based on. Inclusion of the latter in a unified results section is necessary in order to be able to subject it to peer review.

Page 13. Section 4. Results: This section starts out with a paragraph focused on restatement of what appears to be the overarching methodological approach which is all sorts of expert panels were convened to express opinions about what should be included in Table 1. The methods section above repeatedly states this as the basis for information assembly and derivation of the habitat indicators so restating it here is not necessary. However, what is necessary, is to provide a more detailed and coherent presentation of exactly how the HWG or ESSA either jointly or collectively arrived at their short lists as this constitutes the methodology that the current document is largely silent about.

Table 1 provides a list of what are intended to be the "short-listed" suite of habitat indicators. However, readers will know only in a very general sense whether these are largely based on "expert opinion", authoritative review, analysis and synthesis of previous work or combinations of both. Although some of material that establishes this is included in the appendices most of the background material is contained in other reports, the details of which are not available here. For example, there are no source references or identification of linkages to these with respect to metrics, benchmarks or sampling methods columns in Table 1.

Because assembly of Table 1. was based on "expert opinion", its not easy to review other than to provide commentary on parts that a given reviewer might have specific experience with. Even at this level there are some questions. **Examples**: (1) Contrary to the "measured" designation in Table 1, water extraction to my knowledge is not measured. This pressure indicator is nominally "indexed" through water licenses that specify the maximum that may be extracted. However, actual amounts extracted, with notable exceptions, are not generally

measured so there are few direct measures of quantities extracted. One can use hydrological models to roughly estimate the sum of uses plus evaporative and groundwater recharge losses but this is a modeled rather than measured estimate. (2) The cold-water refuge zone is more likely a habitat quantity indicator than a status indicator other than for the assignment of a risk classification to it. (3) Length of shore spawning for sockeye in lakes is not entirely workable because the extent of depth intervals used varies from lake to lake meaning beach area (km^2) would be a more sensitive metric. For example, sockeye in Meziadin, Kennedy and Henderson lakes all spawn within the top 3-5 m depth intervals but sockeye in Sproat and Great Central lakes use depths from surface down to 50 m or more. The column currently labelled "Sampling Methodology" is not restricted to just information about methods but also contains stuff such as where the data should be stored. (4) Its not at all clear to me why chemistry variables for streams <u>are not included</u> as status and trend indicators but then <u>are used this way</u> for both lakes and estuaries.

Paragraph three of Section-4 primarily contains commentary that should be part of the methods (i.e., how observations were treated or defined) rather than results.

Section 4.1: The narratives contained in this part of the report may be regarded as part of the results or background material required to justify the various indicators summarized in Table 1. Accordingly, the presentation of these narratives should precede Table 1 in the results although this still does not take the authors "off the hook" to do a better job of integrating and synthesizing the HWG work with that done by Nelitz et al (2007b). If the results section has been largely extracted from Nelitz et al. (2007b), then the convention is that Nelitz and others should be included as co-authors of the current report.

Section 4.1.0. The narrative on stream indicators contains no authoritative references as a foundation for the selected indicators although this type of material is provided in **Section 4.1.1** regarding land cover alteration.

Section 4.1.2. The reference point of 0.4 km/km^2 as a benchmark is of unknown origin so anchor it to a reference.

Section 4.1.3. I've already commented that real observations of water extraction are not generally available as opposed to hypothetical levels of water extraction recorded with water licenses.

Section 4.1.4. The benchmark of 5 % was informed by Steve Gotch's expert opinion which is not subject to peer review until Steve writes a report on this work.

4.1.5 Suspended sediment is highly variable over time (seasons, years) and is not extensively measured so perhaps other "related indicators or metrics" would be better. For example, concentration of fines deposited in salmon spawning areas might be a more feasible way to go i.e., would likely only have to be measured at a fixed number of sites a couple of time per year and could be immediately related to salmon egg and alevin survival.

Section 4.1.6. Water quality observations for estuaries are no better than for streams in terms of space and time availability plus it's an important habitat parameter for tracking status and trends of changes to habitat productivity for salmon in streams. Nothing in the narrative would seem to support its exclusion from Table 1. Similarly, what about easily measured variables such as pH and the known effects of acidification as a risk factor for streams (and lakes) throughout BC and the Yukon.

Section 4.1.7. Link the temperature indicators and metrics to their specific source literature (I don't think pointing to the Nelitz report (2007b) here is sufficient). I can also make a case that temperature indicators and metrics should be spread across more life history stages because adult spawning, egg/alevin incubation and fry rearing all have different requirements. The uneven treatment of these rationales may be remedied by linking indicator narratives to authoritative references on indicators where such material exists.

Section 4.1.8. Anchor various statements to specific references that are currently missing. Examples: (1) The carrying capacity and sustainability by species and life-stage of salmon streams is directly related to aspects of the mean annual discharge (MAD). (2) Changes to the natural hydrograph can adversely affect primary and secondary productivity. (3) The benchmark for stream discharge is when the 1 in 2 year 30-day duration summer minimum flow is less than 20% of MAD. The rationale is that this discharge appropriately maximizes riffle width while optimizing depth and velocity. This is, in turn, based upon extensive empirical observations of Ron Ptolemy (BC-MOE). (4) Flows less than 20 % MAD in the winter can decrease productivity due to increased potential for icing events and mortality of biota.

The problem with these types of statements is that they require not only a key reference that is accessible to review but also that the reference needs to provide evidence that claims are generally true (i.e., not just supported by a single instance in which this was observed under extreme conditions). I appreciate that Ron Ptolemy is regarded as an expert, but the bottom line is that, to my knowledge, these observations and associated relationships have not been thoroughly reviewed or published, and so remain empirically unverified as a basis for the HWG's short list of indicators. Ron's "expert information" may be regarded as a hypothesized but as yet untested basis for the water quantity indicators (e.g., read Bradford and Heinonen 2008).

Section 4.1.9. The rationale here seems weak at best given the limited extent of these data. Jim Karr has developed effective Indices of Biotic Integrity employing benthic invertebrates as indicators so this literature would need to be consulted specifically to strengthen the rationale presented here.

Section 4.1.10. If Nelitz et al (2007b) is the source for this, then use the rationale that Nelitz et al. provided.

Section 4.1.11. Key spawning area is defined as "those areas of spawning habitat used foremost annually regardless of escapement." Although I personally agree with the probable importance or utility of this indicator, you have not provided any case history observations that confirm its actual utility.

Section 4.2.4 Lake productive capacity is strictly speaking not a specific indicator but rather an indicator category within which several specific status and trend indicators might be identified (e.g., total P concentration, TDS, photosynthetic rate index of Hume et al. 1996, etc.). The statement about factors limiting production of smolts is ambiguously worded. Smolt production can be limited by the quantity or quality of lake rearing habitat, by the quantity or quality of the egg and alevin incubation environment, or by fry recruitment variations that depend on variations in adult returns.

Section 4.2.5. It's still not clear whether this is a so called "quantity indicator" or an "impact status indicator", although I expect the difference simply lies in how it's used. The coldwater refuge zone is defined as the width of the zone of water below the depth of the bottom of the thermocline but above the depth of the 50% oxygen saturation (Ruggerone 2000). Several other habitat indicators may be based on temperature and oxygen metrics and it's not yet clear

which ones might be most sensitive to predicting impacts on salmon. This raises the issue that the level of certainty associated with the utility of indicators needs to be qualified in a more rigorous way than currently dealt with in this paper. It's clear that indicators may be purely speculative and lacking empirical evidence but based on a hypothesized cause and effect relation, indicators may have some actual supporting evidence that is still equivocal, or that indicators may have a sound and well understood cause and effect association, etc.

Section 4.2.6. I've already commented earlier about this indicator and the possible need to consider depth as well as shoreline length.

Section 4.3. I've already commented above on estuary indicators and some problems with how they have been reviewed and presented. In general it will be important to harmonize the treatment of estuary habitat indicators with the structure applied to stream and lake indicators. The literature on both chemical contaminants and dissolved oxygen effects in estuaries is not well reviewed here. Moreover, data holdings at Environment Canada and originally Ocean Sciences within DFO are more extensive with respect to dissolved oxygen that the HWG appears to appreciate.

Section 4.5.1. Juvenile salmonid densities appears to be the only fish indicator considered among dozens of possibilities associated with life-stage-specific abundance, survival, growth, production, behaviour, etc. Moreover, the rationale for excluding salmonid abundance (or densities) as an indicator because it may be confounded by complex associations is weak because there are many instances where we understand how to control for the influence of confounding variables as part of data analysis. A more general reason to exclude the use of aquatic biota as the basis for most, but not all, habitat indicators is that the treatment given to habitat is largely reflective of physical and chemical variables. By contrast, biotic variables, including salmonid densities, may be considered part of the suite of entities to be considered in association with ecosystems rather than habitat (refer to definition for habitat versus ecosystem elements provided above).

Section 4.5.2. Although continuous spatial and temporal measures of groundwater quantity are scarce, its clear that groundwater availability and its role in the creation of summer thermal refuges for salmonids in rivers and streams is generally considered (again expert opinion) to be important. Rather than wait for decades for groundwater inventories from wells and aquifers to become available, it would likely be more useful to use thermal, infrared, imaging systems (deployed from the air) to spatially map the locations of groundwater refuges. These would include cool, groundwater-fed refuges in summer, and warm, groundwater-fed refuges in winter in various regions where such refuges are likely to play a large role in controlling salmon production.

Section 4.5.5. I've noted above that invasive species are both a useful habitat pressure/stressor indicator that influences key habitat attributes as well as an ecosystem stressor/pressure indicator or even ecosystem attribute depending on how it is used.

Section 4.6. I've already explained the links between habitat and ecosystem indicators in comments above so there won't be a lot more to say on this subject until a draft of the WSP ecosystem paper is completed.

Section 5. Discussion:
The discussion raises some important issues that will need to be dealt with in any future version of the report. In particular, I'd like to see a specific treatment of how habitat indicators identified in the current document will inform us about the status and trends of limiting or highly productive habitats for local populations or the population aggregates that make up CUs. I also

think the issue regarding exactly how highly productive and limiting habitats (of wild salmon) will be identified or ranked requires more consideration than was given to this topic in the introduction of the report.

In general, I think the discussion might consider the extent to which DFO personnel will be expected to generate habitat indicator data, analyze and report on it, archive and manage it, use it as a basis for resource management decisions. What are DFO's capacity limits when these issues are considered and where should we invest budget and effort in bolstering this capacity versus depending on others? Do we envisage DFO developing, maintaining expertise in satellite and remote sensor data acquisition, analysis, management, etc.?

I won't make additional comments on the contents of the discussion now as I expect the organization and possibly even topics for discussion will change if my principal recommendation that the paper be put through a significant revision (to clarify methods, data sources, concepts, etc.) is adopted.

APPENDIX 4 - References

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