Pacific Fisheries Resource Conservation Council

Advisory: Implementing the Habitat and Ecosystem Components of DFO's Wild Salmon Policy

Report to the Minister of Fisheries and Oceans Canada

Report to the Minister of Environment for British Columbia

Report to the Canadian Public

October 2006

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Pacific Fisheries Resource Conservation Council

For further information about this document and about the Pacific Fisheries Resource Conservation Council (PFRCC), contact:
Pacific Fisheries Resource Conservation Council
800 Burrard Street, Suite 590
Vancouver, BC, Canada V6Z 2G7
Telephone 604 775 5621
Fax 604 775 5622
www.fish.bc.ca
info@fish.bc.ca

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Pacific Fisheries Resource Conservation Council
Conseil pour la conservation des ressources halieutiques du pacifique

29 September 2006

The Hon. Loyola Hearn
Minister of Fisheries and Oceans
Government of Canada
Parliament Buildings
Ottawa

The Hon. Barry Penner
Minister of Environment
Province of British Columbia
Legislative Building
Victoria

Dear Ministers,

We hereby submit to you our advisory on Implementing the Habitat and Ecosystem Components of DFO's Wild Salmon Policy (WSP).

Over the past two years, the Pacific Fisheries Conservation Council has encouraged the Department of Fisheries and Oceans to finalize the Wild Salmon Policy, an initiative which promises to improve the management of wild salmon stocks and establish a firm scientific and practical basis for their use and conservation.

Last year the Council published an in-depth review of potential indicators for assessing the status of salmon stocks and their habitat. We also convened a workshop with experts to develop recommended categories and indicators, and held further and broader public meetings on the subject. A parallel study, providing further background to this advisory, addressed the issue of ecosystem values associated with wild salmon.

Gathering information on habitat and ecosystem parameters is of course essential. However, we emphasize that the challenge for the Minister in developing an appropriate habitat and ecosystem monitoring strategy for the WSP is not in identifying the potential long suite of indicators. Rather, the challenge is in developing a cost-effective, user-accessible, up-to-date monitoring program that focuses on the most relevant and important indicators while ensuring that the monitoring program is integrally linked to management actions to achieve the habitat objectives of the WSP.

The Council's recommendations for the development of a framework for characterizing salmon habitat status are particularly topical given the stated positions of some groups suggesting that the Fisheries Act as it now stands is an impediment to economic development. The Council is of the view that more, not less, protection of wild salmon habitat is required, based on a smooth collaboration of federal and provincial agencies. We suggest that habitat protection may be improved through the adoption of a system based on quantitative indicators and reference levels for management action. Our advisory outlines how to establish such a program.

We hope that our advisory will help lead the way to a new and more effective system of habitat protection within the general framework of the Wild Salmon Policy.

Paul LeBlond
Chair

Mark Angelo
Vice Chair

590 - 800 Burrard Street
Vancouver, British Columbia
Canada V6Z 2G7

Tel/Tel: (604) 775-5621
Fax/Tele: (604) 775-5622
E-mail: info@ fish.bc.ca
Web Site/Site Web: www.fish.bc.ca

590 - 800 rue Burrard
Vancouver. Colombie-Britannique
Canada V6Z 2G7

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29 septembre 2006

L'honorable Loyola Hearn
Ministre des Pêches et des Océans
Gouvernement du Canada
Édifices du Parlement
Ottawa

L'honorable Barry Penner
Ministre de l'Environnement
Province de la Colombie-Britannique
Édifice de l'Assemblée législative
Victoria

Chers ministres,

Par la présente, nous avons le plaisir de vous présenter notre avis concernant la mise en œuvre des composantes de la Politique concernant le saumon sauvage (PSS) axées sur l'habitat et les écosystèmes.

Au cours des deux dernières années, le Conseil pour la conservation des ressources halieutiques du Pacifique a encouragé le ministère des Pêches et des Océans à finaliser la Politique concernant le saumon sauvage, une initiative visant à améliorer la gestion des stocks de saumons sauvages et à établir une base scientifique et pratique solide pour leur exploitation et leur conservation.

L'année dernière, le Conseil a publié un examen approfondi des indicateurs potentiels qui permettraient d'évaluer le statut des stocks de saumons et de leurs habitats. Nous avons également organisé un atelier rassemblant des experts pour définir des catégories et des indicateurs et nous avons organisé des réunions publiques plus générales sur le sujet. Une étude parallèle, mettant en lumière le contexte de cet enjeu, a permis d'aborder la question des valeurs écosystémiques associées au saumon.

Il est bien sûr essentiel de recueillir des informations sur les paramètres concernant l'habitat et les écosystèmes. Nous tenons cependant à faire remarquer que le défi du ministre dans le cadre de l'élaboration d'une stratégie appropriée pour la surveillance des habitats et des écosystèmes ne consiste pas à inventorier une longue série d'indicateurs potentiels. Le défi se situe plutôt au niveau de l'élaboration d'un programme de surveillance économique, convivial et à jour, qui sera axé sur les indicateurs les plus pertinents et les plus importants. Le défi du ministre consistera également à faire en sorte que ce programme de surveillance soit lié de manière intégrée à des mesures de gestion visant à réaliser les objectifs de la PSS en matière d'habitat.

Les recommandations du Conseil, pour ce qui est de l'élaboration d'un cadre de travail pour la caractérisation du statut des habitats des saumons, sont particulièrement pertinentes compte tenu de la position déclarée de certains groupes qui soutiennent que la Loi sur les pêches, dans son état actuel, est un obstacle au développement économique. Le Conseil est d'avis qu'il est nécessaire d'accorder une protection accrue, et non pas moindre, aux habitats des saumons sauvages en s'appuyant sur une collaboration harmonieuse entre les organismes fédéraux et provinciaux. Nous suggérons d'améliorer la protection des habitats en adoptant un système basé sur des indicateurs quantitatifs et des niveaux de référence pour fonder les décisions de gestion. Notre avis décrit de manière générale comme mettre en place un tel programme.

Nous espérons que notre avis contribuera à la mise en place d'un nouveau système plus efficace pour la protection des habitats du saumon dans le cadre de travail général de la Politique concernant le saumon sauvage.

Paul LeBlond
Président

Mark Angelo
Vice-président

590 - 800 Burrard Street
Vancouver, British Columbia
Canada V6Z 2G7

Tel/Tel: (604) 775-5621
Fax/Tele: (604) 775-5622
E-mail: info@ fish.bc.ca
Web Site/Site Web: www.fish.bc.ca

590 - 800 rue Burrard
Vancouver. Colombie-Britannique
Canada V6Z 2G7

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1. INTRODUCTION

This advisory is intended to assist the Department of Fisheries and Oceans and their implementation partners in executing the habitat and ecosystem components of the Wild Salmon Policy. **The challenge for the Minister in developing an appropriate habitat and ecosystem monitoring strategy for the Wild Salmon Policy is not in identifying the potential long suite of indicators. Rather, the challenge is in developing a cost-effective, user-accessible, up-to-date monitoring program that focuses on the most relevant and important indicators while ensuring that the monitoring program is integrally linked to management actions to achieve the habitat objectives of the WSP.**

This advisory is consistent with the strategies of the WSP while providing clarity on how to identify benchmarks necessary to implement Strategies 2 and 3. This advisory provides critical additional advice on the need to link monitoring to management actions so that habitat and ecosystem integrity can be maintained. Specifically, this advisory:

1. Describes a logical and unique eight step framework for implementation of the habitat and ecosystem management components outlined in the WSP;
2. Provides clarity on the rationale and how each WSP step could be implemented;
3. Recommends broad spatial mapping of salmon distributions and of high value habitat for CU's. Emphasis is on a cost-effective program that is updated at intervals;
4. Describes the prioritization of CUs and watersheds using broad-scale indicators of threats;
5. Recommends detailed monitoring of habitat with high values;
6. Recommends the development of up-front key indicators and standards for identifying threats to habitat along with associated data requirements;
7. Recommends the inclusion of ecosystem components at the outset;
8. Recommends management actions be undertaken to reduce if not eliminate habitat threats identified. More effort should be expended where values and risks are high but all habitat needs protection and management; and
9. Identifies opportunities for partnering with other governments, First Nations and local stewardship groups.

In February of 2005, the Pacific Fisheries Resource Conservation Council (PFRCC) provided comments on the draft WSP. With respect to salmon habitat and the salmon ecosystem, the Council recommended strengthening Strategies 2 and 3 of the draft by including a number of schemes (approaches) to address salmon habitat and salmon ecosystems (PFRCC 2005), including approaches to designation of habitat and ecosystem status, monitoring of habitat and ecosystem status, inclusion of management actions, reporting of information, and establishing meaningful partnerships. The final WSP remains quite vague in these areas, particularly with respect to salmon ecosystems.

Supporting this advisory was unpublished advice from LGL Limited Environmental Research Associates, specifically Robert Bocking and Marc Gaboury. LGL reviewed the WSP and provided information to Council on an applicable management system that would maintain habitat and ecosystem integrity.

Packman & Associates and Winsby Environmental Services provided an in-depth review of potential indicators to measure the habitat status of wild Pacific Salmon for Council (Packman and Winsby

2006). They reviewed other work, primarily for Washington and Oregon, identifying potential indicators, and convened a workshop with experts to develop recommended categories and indicators. In 1999, 2WE Associates completed a similar review for Fisheries and Oceans Canada to develop a catalogue of indicators of marine health in the Strait of Georgia (2WE 1999a, 2WE 1999b). The indicators referred to in this advisory are a subset of those listed by Packman and Winsby (2006) and 2WE (1999b).

The Council has also prepared a report on managing Pacific salmon for ecosystem values (Nelitz et al. 2006). In this report a suite of potential ecosystem indicators was identified to address two main issues or questions: 1) How salmon influence the ecosystem, and 2) How the ecosystem influences salmon.

Wild Salmon Policy Objectives

The Wild Salmon Policy (WSP) has three overarching objectives (WSP p.9) with Objective 2 being the primary focus of this advisory:

1. Safeguard the genetic diversity of wild Pacific salmon;
2. Maintain habitat and ecosystem integrity; and
3. Manage fisheries for sustainable benefits.

The WSP is a higher-level policy with respect to management of Pacific Salmon. It is not a regulatory document and the achievement of the stated objectives requires further development of clear management objectives and appropriate management actions, as well as potentially new jurisdictional arrangements. The policy does not specify what these management objectives or approaches might be. Rather, much of the document is focused around defining benchmarks or thresholds for abundance and establishing indicators of change through a series of action steps.

WSP Strategies 4 and 5 speak to integrated strategic planning and annual program delivery but the linkages between Assessment and Monitoring (Strategies 1, 2 and 3) and planning and delivery are not well described in the policy.

The policy as written has a significant focus on assessing status of wild salmon (abundance, habitat and ecosystems) through time. However, as has been stated by many parties that reviewed the WSP, to be successful at meeting its objectives, the policy must clearly embrace improved habitat protection and management. To do so will require a concerted effort to work cooperatively with other government agencies, First Nations, industry, and local stewards of salmon.

The Wild Salmon Policy addresses habitat protection and restoration because habitat is essential to wild salmonid production. However, habitat protection and restoration crosses public and governmental lines and requires coordination at the fundamental level of habitat needs for salmonids. To be successful habitat protection and restoration must occur through a combination of locally-based watershed planning and strategic policy objectives that have the flexibility to implement management actions in light of local conditions.

The lack of clear implementation schemes, guidelines, measurable objectives, and other planning tools was troubling to some reviewers of the WSP including the Council (PFRCC 2005). This advisory addresses this concern by describing an eight step adaptive framework for assessing threats to habitat, monitoring the status of salmon habitat, invoking management actions to deal with threats to salmon habitat, and monitoring the effectiveness of those actions. The process emphasizes the need to priorize monitoring and management action effort based on habitat value and risk. High value habitat needs focused attention but all habitat impacts need to be addressed if salmon are to thrive. We support the intent of DFO to streamline protection of less valuable habitat but stress the need to ensure guidelines

and standards established to do this are sound and effective. We also stress that in recommending this priorized approach to habitat management that the PFRCC is not recommending budget cuts – the Council considers the habitat program to be underfunded and such an approach will simply be a step in the right direction towards more efficient use of resources. The Council in its comments to the Minister on the WSP noted the need for more resources to implement the policy and the Council continues to take that view. The eight steps are, for the most part, consistent with strategy steps described in the WSP.

Protection and restoration of wild salmonid habitat is fundamental to meeting the overall Wild Salmon Policy goal. This will require identification and provision for the habitat needs of wild salmonids, identification of threats to habitat, and implementation of management goals and actions that will maintain or increase the quality and quantity of habitat necessary to sustain and restore salmonid populations. Habitat goals, performance measures, and actions should apply to all salmonid habitats, regardless of land use and regardless of ownership.

Protection of wild salmonid habitat will require a high degree of specificity and guidance about "what fish need". Implementation of Strategy 2 must include defining narrative and numeric performance measures that reflect the best available science to evaluate biological and physical processes for salmonids. The performance measures will be used to direct adaptive management actions, ensure compliance and accountability including enforcement when needed, and measure adequacy of implementation. Accordingly, achievement of WSP objective #2 will require top-down strategic planning and bottom up delivery of management actions.

During the public consultations following release of the first draft of the WSP, the need to incorporate ecosystem values was clearly conveyed to DFO. This directive is not adequately dealt with in the final policy and this should be dealt with early during implementation. The WSP states that it is DFO's intent to progressively consider ecosystem 'values' in salmon management, but acknowledges a limited ability to do so at the present time. The Council considers salmon habitat as a primary component of the salmon ecosystem and that many of the indicators specific to salmon habitat status will also address salmon ecosystems so that development of these indicators should take this into account. In particular, the monitoring of physical and chemical components of salmon habitat such as ocean temperature, freshwater water quality, and riparian condition also serve to monitor salmon ecosystems. Additional indicators will ultimately be required to fulfill the commitments of WSP Strategy 3 and these should primarily focus on the monitoring of additional non-salmon biological components of salmon ecosystems or ecosystem pathways.

To develop a rational monitoring program that fully addresses WSP objective #2, there must be clear articulation of the specific objectives for maintaining the integrity of salmon ecosystems and for management goals and this must precede the identification of additional indicators specific to ecosystem status. This advisory provides some initial direction in this regard.

Management Goals

WSP Strategy 4 describes how the WSP will be implemented in a strategic manner. It identifies the need to establish management actions to protect or restore Pacific salmon, their habitats and ecosystems in order to achieve biological targets for each CU. Proponents of salmon conservation view this as the ultimate step of the Wild Salmon Policy and this step will require significant commitment from government and local interests. Success of the policy lies not with the establishment of monitoring programs and indicators, but with specific actions to arrest the decline of wild Pacific salmon in British Columbia and the Yukon.

Successful achievement of WSP Objective 2 will require maintenance of the basic components of fish habitat. Watershed hydrological processes need to be maintained so that physical processes affecting the quality and quantity of fish habitat continue to function. Water extraction and use is an increasing threat and water use needs to occur within the context of providing adequate stream flows for salmon. Water itself and stream sediments are essential for the maintenance of healthy and productive wild salmonid populations and water quality needs to be managed with salmon in mind. Stream, wetland and riparian habitat, lake and reservoir habitat and estuarine and marine habitat are also key components of fish habitat. Free and unobstructed fish access among habitat types is also essential for most wild salmonids at all life stages. Clear articulation of these goals with specific targets and timeframes for achievement are required. These five goals are based upon work within Washington State (WFWC 1997) and more detail is provided in Appendix B.

Strategic Planning and Prioritization

WSP Strategy 4 states that the WSP will be implemented in a strategic manner with established timeframes and priorities. This will be a critical step to ensure that the highest valued and most at risk salmon habitats are maintained and management actions to ensure this are put in place as soon as possible. In WSP Strategy 5, the DFO commits to a proactive habitat management strategy to protect, maintain and restore habitats that are essential to achieving the overall goals of the WSP. The Council contends that all salmon habitats are important but supports priorized attention to the most valuable habitat with streamlined and effective attention to other habitats. Coarse filters should be applied to develop priorities for assessment and monitoring of salmonid habitats within the Pacific Region.

Data Requirements and Data Management

The amount of data that could be used to monitor and assess salmon habitat for each CU can be extensive. It will be critical to focus on data that support the eight steps of the implementation framework and ensure that these are matched to the five specific management goals summarized above and described fully in Appendix B. Much data already exists on salmon habitat in British Columbia, but in many cases is outdated or not readily accessible. Extensive habitat assessments and inventories were conducted between 1995 and 2002 under the auspices of Forest Renewal BC. Less detailed information exists for salmon habitat in the Yukon.

The spatial/temporal framework for collecting these data is also an important consideration. Both broad-scale (landscape level) and fine scale (reach or site level) indicators will be required as per the implementation framework. Broad-scale data are useful for prioritizing CUs based on landscape level threats while fine scale data will be required to define management actions to correct disturbances to high-value salmon habitat.

Data management and user access to data must be supported and it will be important to coordinate with existing Canada, BC and Yukon agencies and utilize work that has already been completed (e.g., BC Integrated Land Management Branch, BC Fisheries Data Inventory, Environment Canada).

Partnerships

For DFO to successfully achieve the habitat objectives of the WSP will require extensive partnering with other agencies (BC and Yukon Governments), Environment Canada, Natural Resource Canada, First Nations, Municipal governments, industry and stewardship groups. Implementation of the habitat components of the policy should incorporate a high level of public involvement and collaboration with those that have a high interest or stake in the outcome of actions guided by the policy. Substantial involvement at the local level will be necessary and DFO should place a high priority on public

involvement to collaboratively communicate, educate, analyze, plan, implement, and evaluate the habitat component of the WSP.

In BC the province is the main holder of broad-based data sets and we recommend establishment of effective and formal partnerships to ensure data are accessible. Otherwise access to critical information could vary year-by-year depending upon informal co-operation that may or may not be present. We encourage the Ministers to utilize the Pacific Council of Fisheries and Aquaculture Ministers to establish a formal data sharing partnership so that the monitoring components of the WSP can be effectively and cost-effectively assured.

At the broad-scale planning level (Ecoprovince, Ecoregions, and CU), governments of the province of BC and the Yukon will need to play an important role as they are the holder of much of the landscape level information necessary for the identification of threats to salmon habitat and have existing programs that could contribute to the process. The PFRCC stresses that the only way for the WSP to be successful is through access or utilization of other agencies data bases. Further, through its regulation of industry and other resources that could threaten fish habitat the province has the opportunity to avoid damage in their licensing process.

Non-profit organizations such as the Pacific Salmon Foundation, Fraser Basin Council, Nature Conservancy of Canada and EcoTrust have the capacity to engage at a provincial and territorial level to support broad-scale planning. Finally, First Nations, stewardship groups, and round tables are well poised to play a major role in implementation at the watershed level. Municipal governments should also be approached and encouraged to play an active role in implementation. Where needed, DFO should assist in the development of new regional, multi-party, salmonid management planning groups to assist in defining management strategies.

Implementation Framework

The Council recommends an eight step framework for implementing the habitat component of the Wild Salmon Policy (Figure 1). This new framework that the Council has devised adheres most closely to the Pressure-State-Impact-Response (PSIR) framework described in Whitman and Hagan (2003) and adopted in Oregon Plan for monitoring salmon and watersheds (Dent et al. 2005). This model explicitly acknowledges that to be effective, indicators must be quantifiable, relevant, responsive, understandable, reliable and accessible. The proposed hierarchical framework also links indicators directly to values and management goals.

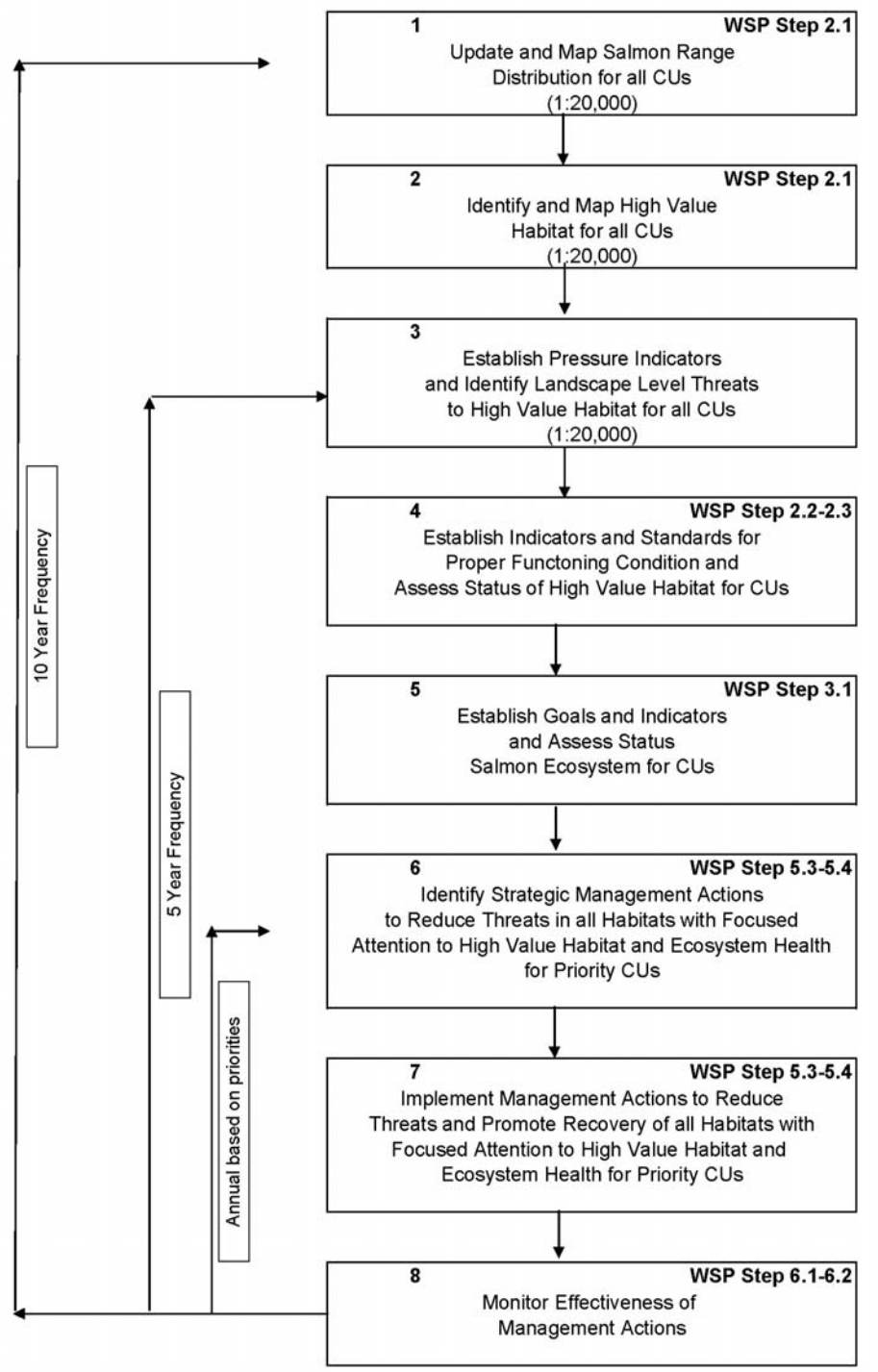
The framework begins with the comprehensive identification and mapping of the habitat range (both freshwater and marine) and high-value habitat (habitats limiting productivity) for each CU.

The framework then employs broad-scale indicators of threat (both natural and anthropogenic) to identify priority Ecoregions or CUs that should receive initial management attention. It then employs finer-scale indicators of habitat condition to support the identification of management strategies to address threats to high-value habitat within those high priority CUs. Lower priority CUs and habitats still need protection for salmon to thrive. Cumulative impacts are real and a concern and while less valuable habitats may not require the same degree of effort there needs to be effective, even if streamlined, management actions to reduce threats. Identification of key ecosystem components important to salmon is included as a step in the framework. Monitoring of the effectiveness of management actions and the taking of enforcement actions where necessary to assure achievement of goals for maintenance of habitat and ecosystem integrity is the final step in the framework.

Each step of the framework is described in sufficient detail here and in Appendix A to enable the Minister's staff and other delivery partners to further develop the framework over the next few months. For each step, we identify the strategy or component of the Wild Salmon Policy that is being

addressed and provide a rationale for inclusion in the implementation framework, the goal and the general approach. The recommended spatial and temporal frames are discussed as well as limited discussion of current and potential data sources. Finally, potential implementation partnerships are discussed for each step.

Figure 1. Flow chart for implementing the habitat and ecosystem components of the Wild Salmon Policy.



2. CONCLUDING REMARKS

The Wild Salmon Policy as it stands provides guiding principles for the achievement of the three primary goals:

- Safeguard the genetic diversity of wild Pacific salmon;
- Maintain habitat and ecosystem integrity; and
- Manage fisheries for sustainable benefits.

However, the successful implementation of the policy requires considerably more work on the part of those faced with implementing it. The eight step framework is a new cost-effective approach to implementing the habitat and ecosystem components of the WSP. The approach stresses that to be effective, indicators must be quantifiable, relevant, responsive, understandable, reliable and accessible. The proposed hierarchical framework also links indicators directly to values and management goals.

It is the hope of the Council that DFO staff and other practitioners of salmon habitat management will find the framework useful for undertaking immediate and long term tasks associated with implementing the habitat components of the Wild Salmon Policy. However, it is emphasized that a good monitoring program in itself will not achieve the goals of habitat and ecosystem components of the Wild Salmon Policy. It will be important to ensure that monitoring and management actions are linked.

In many places, current approaches are making progress in meeting the habitat performance measures and management goals discussed in this advisory. In other places implementation will take much longer, requiring time, effort, and resources to answer the difficulties that some salmon CUs currently face under neglect. A number of success stories already exist such as the Pacific Salmon Foundation recovery plans for the Englishman River, Coldwater River, Nimpkish River, and Salmon River. Numerous other small community projects continue to protect and recover salmon habitat. While many projects have been successful, much more is needed to achieve the goals of the WSP. The recently announced Living Rivers Fund promises more good work in this regard.

3. RECOMMENDATIONS

- The WSP strategies for habitat and ecosystems should be implemented together, recognizing there are overlaps between the two strategies and also recognizing that additional indicators will ultimately be required to fully address the ecosystem strategy of the WSP.
- Managing fish habitat the best way possible should be the goal of any program. Elements must include monitoring to provide necessary information and making the best management decisions based upon that information. Monitoring and management actions must be linked. Simply said you need good information for good management.
- The eight step implementation framework outlined in this advisory has been designed to be a cost-effective and practical means to meet the objectives of the WSP. A summary of some of the key elements follows:
    - Establish a repeatable monitoring program that focuses on the most relevant and important indicators. The monitoring program initially needs to be broad scaled. More detailed monitoring is only required if high valued habitats are under threat. To assure DFO access to critical broad-based data sets the federal Minister of Fisheries and Oceans and the provincial Minister of Environment should utilize the Pacific Council of Fisheries and Aquaculture Ministers to establish a formal agreement on data access and sharing.
    - Ensure that the monitoring program is integrally linked to management actions to achieve the habitat objectives of the WSP. Those management actions could include watershed planning, referral review and the use of appropriate guidelines and regulations (along the lines of DFO's emerging Environmental Process Modernization Plan (EPMP). There also needs to be monitoring for compliance and enforcement where necessary.
    - Priorized monitoring and management attention needs to be placed on the most valued habitats but all habitats need some degree of management attention to ensure DFO's working principle of No Net Loss of the productive capacity of habitat is met.
    - Quantifiable, relevant and reliable indicators of proper functioning habitat need to be established and communicated to ensure consistent habitat management.
    - To assure success of the habitat and ecosystem components of the WSP there will be a need for a concerted effort to work cooperatively with other government agencies, First Nations, industry, and local stewards of salmon.
    - The Council stresses that in recommending this approach to habitat and ecosystem monitoring and management that the PFRCC is not recommending budget cuts – the Council considers the habitat program to be underfunded. Components of our recommendations such as the priorization of assessment efforts will simply be a step in the right direction towards more efficient use of the currently insufficient resources. The Council in its comments to the Minister on the WSP noted the need for more resources to implement the WSP and the Council continues to take that view noting that the commitment to habitat and ecosystem monitoring is a new activity that requires adequate resourcing.

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APPENDIX A. DETAILS OF IMPLEMENTATION FRAMEWORK

Step 1: Update and map salmon range distribution for all CUs

WSP Step: Strategy 2, Step 2.1 (WSP p. 20)

Rationale: Accurate documentation of marine and freshwater salmon range is an essential first step to protection of essential salmon habitat (DiCosimo 1999). The current FISS database is over a decade old and is attached to the BC 1:50,000 Watershed Atlas. A more accurate representation of available salmon range should be provided at the 1:20,000 TRIM scale. In addition, salmon range in the marine environment should be updated.

Modeling species distributions is an increasingly important tool that can aid in the protection of species habitats and biodiversity and the planning of conservation actions. The distribution of salmon CUs can be modeled using broad-based geomorphic and topographic criteria that are related to species needs and preferences and water connectivity. Barriers or impediments to historical access to these spawning or rearing areas should be identified (documentation of barriers is incomplete in the present Fish Information Summary System). These broad-based criteria could include such variables as stream gradient and stream order as well as water quality and quantity. For example, low gradient channels of <4% gradient are preferentially selected by Chinook for spawning (Montgomery and Buffington 1997). The distribution of species within watersheds and CUs can then be mapped by modeling using these broad geomorphic and topographic criteria.

Goal: Document the natural range in distribution for each species in marine and freshwater environments. Habitats above man-made barriers (e.g., dams, culverts) should be included and identified as such. Habitats above natural barriers to migration should not be included as part of the 'natural' range for salmon but are recognized as being integrally linked to downstream salmon habitat for inclusion of habitat protection and restoration actions.

Approach: Model salmon range using gross features (gradient, stream order, barriers, known water quality and quantity) and validate with known fish distributions. Include watercourses truncated by man-made barriers or other anthropomorphic events. Use TRIM and ground truth with local knowledge. Include marine distributions.

The Fisheries Science Section of the Ecosystems Branch of the BC Ministry of Environment has completed a first cut of modeling the range of salmon in BC at a third order watershed level using the BC Watershed Atlas (1:50,000 scale). A major goal of this work is to predict, from habitat models, the expected occurrences of fish species. This product may provide a first cut at salmon distributions but needs further validation and ultimately should be presented on a 1:20,000 scale.

Outputs: Internet accessible GIS map of predicted and known salmon range for each CU at 1:20,000 scale. Subsequent updates will enable tracking of increasing or decreasing distributions.

Spatial frame: This step can be accomplished on a BC/Yukon scale. The entire province of BC has TRIM available. For scheduling purposes, the BC Ecoprovinces and Yukon Ecozones provide a suitable level of stratification for completing this step.

Time frame: Complete in 4 years / Update every 10 years. Analysis of pressures to salmon habitat to be completed in Step 3 will in all likelihood reveal that Georgia Depression, Southern Interior and Central Interior Ecoprovinces are highest priority. This, combined with the focus of the Living Rivers Strategy on these Ecoprovinces, suggest that these Ecoprovinces should be completed first.

Year 1 (Georgia Depression, Southern Interior, Central Interior Ecoprovinces)
Year 2 (Coast and Mountains Ecoprovince)
Year 3 (Sub Boreal Interior, Southern Interior Mountains)
Year 4 (Northern Boreal Mountains, Boreal Cordillera)

Data sources: Most of the required data are in readily available GIS forms with MOE or DFO. Watershed level habitat data at the 1:50,000 scale are available within the Watersheds BC Environmental Statistics database.

Partnerships: The province of BC has an interest in identifying sensitive watersheds for steelhead and other trout species. Integrated Land Management Bureau of BC is the custodian of much of the required data.

Step 2: Identify and map high-value salmon habitat for all CUs

WSP Step: Strategy 2, Step 2.1

Rationale: WSP requires that high-value habitat be identified, maintained and protected and degraded habitats be identified for restoration. Pressures on salmon habitat will continue and potentially intensify. Identification of these habitats is essential for the maintenance of salmon productivity and to achieve WSP goals. High-value salmon habitat can be defined as habitat, which if lost, would impair the CUs ability to meet production goals (i.e., remain in the red biological status zone for WSP Strategy 1).

Habitat for the various life stages of salmon is generally associated with four major components in freshwater: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration corridors; and 4) adult migration corridors; plus that of various components in estuaries and marine areas. High-value salmon habitat can be defined as such because of its rareness, productivity and sensitivity, in sustaining salmon populations. High-value habitat that is functioning at less than its potential capability or carrying capacity is often considered a limiting factor to salmon productivity. High-value spawning and rearing habitats are typically considered the most important habitat functions and, therefore, critical to sustaining fish populations. In addition, migration corridors that provide access to and connectivity between spawning and rearing habitat is often considered high-value and has, for some salmon populations (e.g., Fraser River sockeye en route mortalities due to high temperatures), been a limiting factor to their recent productivity.

Therefore, high-value habitats for each species should encompass those portions of the watershed that are preferentially selected by that species for spawning and rearing, and include migration corridor habitat where obstructions caused by water

quality conditions or physical barriers are evident. As such, the delineation and description of high-value habitat for each salmon species within watersheds and CUs should be based primarily on those physical and biological characteristics (i.e., indicators) that are requisites of properly functioning spawning, rearing and migration habitats (see Step 4).

Goal: Updated catalogue of valued salmon habitat including both freshwater and marine.

Approach: High-value habitat characteristics are comprised of habitat elements that can be measured at broad geographic and narrower field-based spatial scales. For example, preferred spawning habitat for Chinook would occur in mainstem rivers and tributaries with channel slopes of less than 4% (Montgomery and Buffington 1997), base flow of >50% of average annual daily flow, water velocities of about 0.2–1.15 m/s, and substrates 2–10.6 cm in diameter with <12% fines (Raleigh et al. 1986). Even though these primarily site level habitat variables could be used to evaluate spawning habitat condition, to deliver the WSP – Strategy 2 in a cost effective manner it will be necessary to identify the distribution of high-value habitats within watersheds and CUs on a broad geographic scale initially.

- The recommended categories of high-value habitat are:
- Spawning / incubation areas
- Rearing areas
- Adult and juvenile migration pathways
- Estuaries
- Marine habitats

Outputs: Internet accessible GIS maps of high-value salmon habitat for each CU at 1:5,000 scale. Subsequent updates will enable tracking of increasing or decreasing quantity of high-value habitat.

Spatial frame: This step will be completed at the scale of each CU. Because the CUs vary considerably in size, it may be necessary to use scales ranging from 1:5,000 to 1:20,000.

Time frame: Complete in 4 years / Update every 10 years. Analysis of pressures to salmon habitat to be completed in Step 3 will in all likelihood reveal that Georgia Depression, Southern Interior and Central Interior Ecoprovinces are highest priority. This, combined with the focus of the Living Rivers Strategy on these Ecoprovinces, suggest that these Ecoprovinces should be completed first.

Year 1 (Georgia Depression, Southern Interior, Central Interior Ecoprovinces)
Year 2 (Coast and Mountains Ecoprovince)
Year 3 (Sub Boreal Interior, Southern Interior Mountains)
Year 4 (Northern Boreal Mountains, Boreal Cordillera)

Data sources: The primary source for information on high-value fish habitat is the Fish Information Summary System (FISS) maintained by the province. Additional information on important fish habitat was obtained between 1995 and 2000 as part

of the Forest Renewal BC program. BC is endeavoring to capture much of the fish habitat assessment data in their data branch; however, this has not yet been completed. Considerable information still exists in the grey literature, as well as in previous DFO reports and studies. Finally, much local information exists on important fish habitat and this needs to be integrated over time.

Partnerships: The province of BC has an interest in identifying sensitive watersheds for steelhead and other trout species and has been modeling the range of salmon. Integrated Land Management Bureau of BC is the custodian of much of the required data. The Nature Conservancy of Canada has been developing an ecological aquatic classification system for Canada that may have some relevance.

Step 3: Establish pressure indicators and identify landscape level threats to high-value habitat for all CUs

WSP Step: Not specified in policy

Rationale: Ultimately, the WSP is about protecting habitat and ecosystem integrity. To be effective, the WSP requires a strategic approach to prioritizing and addressing threats to valued salmon habitat across CUs. This step will facilitate the prioritization of assessments and management actions on those CUs most threatened. CUs considered to be under a high level of threat would become the first priority for more detailed assessment of habitat condition and cause-effect analyses while CUs under a moderate level of threat would be considered as a second priority (Step 4). We recommend the use of broad-scale landscape level pressure indicators to identify CUs most at risk from threats to habitat. Population status indicators (Strategy 1) and socio-economic considerations will also play a role in setting priorities for action.

Goal: Identify which CUs are most seriously threatened to prioritize further assessment and management actions as well as track trends in pressures to salmon habitat over time.

Approach: To assess threats to high-value salmon habitat for each CU will require the compilation of spatial data on threats such as forestry, agriculture, urban and industrial development, surface water and groundwater extraction, dams and diversions, channelization, and climate change. Previous and current assessment procedures (e.g., Coastal Watershed Assessment Procedure, Sediment Source Assessment, Channel Condition Assessment, Fish Habitat Assessment Procedure, etc.) should also be used to identify threats.

CUs for which pressure indicators are determined as having a potentially high impact on high-value salmon habitat would be the highest priority for action, and could trigger: 1) further analysis to verify remote level assessments, 2) detailed and strategically focused field surveys to verify high-value habitat condition (Step 4) and identify ecosystem values at risk (Step 5), and 3) the development of management actions to reduce threats to high-value habitats (Step 6).

The first level of analysis would be at the Ecoprovince (and equivalent for the Yukon) level to identify areas of the province or territory where salmon habitat is

most threatened. Within each Ecoprovince, the highest priority CUs would be identified for habitat status reports (Step 4) and potential management actions (Step 6).

There are ten important pressure indicators that should be addressed in this step (Table 1). For each pressure indicator, there are several parameters (data) that need to be assembled. Some of these were previously discussed in Packman and Winsby (2006). Data metrics include number, area, length, density, or volume of impact.

Outputs: Current level of impact with ranking of low, medium, or high level of pressure (threat) for each indicator across all CUs will be identified and mapped. Low, medium and high ratings are:

Low = low pressure / low impact
Medium = moderate pressure / moderate impact
High = high pressure / high impact

Spatial frame: This step should be completed for each CU at 1:20,000 scale.

Time frame: Complete in 5 years / Update every 15 years. Analysis of pressures to salmon habitat to be completed in Step 3 will in all likelihood reveal that Georgia Depression, Southern Interior and Central Interior Ecoprovinces are highest priority. This, combined with the focus of the Living Rivers Strategy on these Ecoprovinces, suggest that these Ecoprovinces should be completed first.

Year 1(Georgia Depression, Southern Interior, Central Interior Ecoprovinces)
Year 2 (Coast and Mountains Ecoprovince)
Year 3 (Sub Boreal Interior, Southern Interior Mountains)
Year 4 (Northern Boreal Mountains, Boreal Cordillera)

Data sources: Many of the data required for this step already exist in provincial, territorial and federal databases (e.g., BC Integrated Land Management Bureau, Water Survey of Canada, BC Energy and Mines, BC Ministry of Forests). Current land cover information is obtainable from satellite imagery. There needs to be confirmation that these data bases are up-to-date, otherwise updating will be required.

Partnerships: Many government agencies at the federal, provincial/territory, and municipal level have existing programs to track land use and resource uses in their areas of jurisdiction. The Nature Conservancy of Canada is in the process of developing a decision support tool for sustainable management of freshwater biodiversity. Included in this is an analysis of threats to freshwater habitat. NCC proposes to rank watersheds by severity and scope of cumulative impacts.

Table 1. Suggested pressure indicators and data parameters.

Pressure Indicator	Activities That Create Pressure	Salmon Life Stages Most Affected	Key Parameters (examples) (#, area, length, density, volume)
Impervious Surfaces	Forestry, ranching urbanization, agriculture, roads	Spawning, rearing	• Roads • Urbanization
Riparian / Wetland Disturbance	Forestry, ranching urbanization, agriculture, roads, flood control, dredging, mining, exotic species	Spawning, rearing, migration	• Land use / land cover • Roads • Flood control structures • Dredge locations
Sediment Delivery	Forestry, ranching urbanization, agriculture, roads, mining	Spawning, rearing	• Land use / land cover • Roads • Placer mining locations
Bank Alteration	Forestry, ranching urbanization, agriculture, road crossings, pipeline, flood control, erosion control, bank development	Spawning, rearing	• Land use / land cover • Road crossings • Pipeline crossings • Flood control structures • Bank construction
Stream Habitat Alteration	Dredging, gravel removal, erosion control, flood control, road crossings, pipeline crossings, habitat restoration	Spawning, rearing	• Land use / land cover • Road crossings • Pipeline crossings • Major bank protections • Habitat restorations
Water Removal	Dams, irrigation, domestic water use, groundwater pumping	Spawning, rearing, migration	• Dams • Irrigation structures • Water intakes • Wells • Water licenses / use
Water Degradation	Industrial discharge, mining, forestry, agriculture, urbanization, vessel discharge, dredging, oil and gas, food waste	Spawning, rearing, migration	• Land use / land cover • Urbanization • Mine locations • Dredge locations • Oil / Gas development • Acid Rain
Barriers / Hazards to Migration	Dams, irrigation ditches, road crossings, pipeline crossings, gravel extraction	Spawning, rearing, migration	• Dams • Road crossings • Pipeline crossings • Gravel mining • Irrigation structures

Pressure Indicator	Activities That Create Pressure	Salmon Life Stages Most Affected	Key Parameters (examples) (#, area, length, density, volume)
Estuary Habitat Disturbance	Forestry, bank development, dredging, industrial discharge, pipeline, flood control, agriculture, vessel discharge, exotic species	Spawning, rearing, migration	• Land use / land cover • Road crossings • Pipeline crossings • Major bank development • Dredge locations • Vessel traffic
Ocean Disturbance/Change	Global warming, aquaculture, vessel discharge, oil and gas, industrial discharge, vessel discharge, exotic species	Migration, rearing	• Aquaculture tenures • Vessel traffic • Oil and Gas development • Pollution / discharge • Contaminant Closures

Step 4: Establish Indicators and standards for proper functioning condition and assess status of high-value habitat for CUs

WSP Step: Strategy 2, Step 2.2 and 2.3

Rationale: High-value habitat is often synonymous with the category of habitat that is considered to be limiting fish production. For salmon populations, spawning or rearing habitat is typically considered as an important limiting factor. For example, the amount of coho rearing habitat available in streams is generally considered to be the limiting factor in their natural production (Meehan and Bjornn 1991). On the other hand, the capacity of nursery lakes to rear juvenile sockeye has been considered a limiting factor in their productivity (Lister and Finnegan 1997). In recent years, there has also been increased recognition that conditions in the marine environment limit salmon survival and growth significantly. It is therefore important that both freshwater and marine habitats be considered in the assessment of the status of high-value habitats.

The habitat requirements for salmon spawning and rearing are usually described in terms of water flows/levels, temperature, substrate, space and food. Even though each salmon species has specific tolerances and preferences for these physical and biological parameters, there are some basic requirements for spawning and/or rearing that are common to all species and these parameters have been used as characteristics or measures of impact response to describe how well a watershed is functioning. The selection of indicators that characterize these high-value habitats, the identification of key parameter(s) that will be sensitive enough to measure change in each indicator, and the establishment of benchmarks or standards for each parameter are the fundamental steps leading to assessing the status of high-value habitats for CUs and watersheds. Alteration in land use / land cover, often measured as changes in equivalent clear cut area (ECA) can significantly alter both peak and minimum discharges from natural levels, thereby affecting salmon habitat. Characteristics (indicators) that define each category of high-value habitats for salmon species and the cause-effect linkages to changes in land and water use/development provide a means of assessing proper functioning condition of CUs and watersheds and monitoring changes in their status over time.

Goal: Assess status of high-value salmon habitat for priority CUs by comparing present condition to standards. This step establishes the benchmarks for management action.

Approach: Following the identification of landscape level threats to high-value habitat for CUs (Step 3), an assessment of the status of high-value habitat is required at successively finer geographic scales to focus down from individual CUs and identify the status of individual watersheds within CUs and, for highly or moderately threatened watersheds, at a reach level within these watersheds. Figure 2 illustrates details of the monitoring and decision-making layers that would be implemented in Step 4 relative to the overall framework.

The impact of threats on valued fish habitat for CUs and watersheds would be determined first by assessing changes in land use and land cover to determine potential changes in functional condition of high-value habitat supporting CUs (Step 3). Of highest priority is assessment of basin hydrology and analysis of the effects of water extraction on summer base flows. This analysis should be conducted for all watersheds supporting valued fish habitat for CUs that are considered to be under moderate or high levels of threat or for which the CU population is in the amber or red zone determined by WSP Strategy 1. CUs and watersheds considered to be under a high level of threat would be the first priority for more detailed assessment while a moderate level of threat would be considered as a second priority.

CUs and watersheds under a high level of threat would undergo field-based assessments at a reach level to quantify parameter values and to determine which parameters and habitat categories are being affected by checking habitat parameter values against standards. This activity would identify conditions / processes causing habitat impact. Protection / restoration management actions would then be implemented and monitored to restore preferred conditions and processes (see Steps 6–8). After the completion of all highly threatened watersheds, the procedure would be repeated for moderately threatened watersheds beginning with field assessments at a reach level.

The evaluation of threat level for CUs and watersheds, and the identification of habitat impairment at a reach level should be based on a set of indicators that characterizes the condition of high-value habitat. Population status of each CU is also an important first-cut indicator of potential habitat concerns. Packman and Winsby (2006) reviewed, for the Council, literature that had previously identified important indicators of Pacific salmon habitat condition. They concluded that while indicator selection had been exhaustively dealt with, implementation had not been very successful. Indicators had been identified at different geographic scales, including Ecoregions, broad scale, watershed, reach, site, and patch.

Based on the background information examined and expert opinion solicited through a workshop, Packman and Winsby (2006) recommended a suite of indicators. We suggest a further focusing of these indicators to match the important categories of high-value habitat for Pacific salmon described for Step 2 above and for which standards (benchmarks) of proper functioning condition can be employed. Examples of some of these potential indicators and standards are provided in Appendix A. Estuaries and critical nearshore marine habitats should also be included in the assessment of CUs. Larger ocean phenomenon will obviously be assessed at a broader ocean scale.

For each indicator, there may be single or multiple parameters included. For example, water quality might be an indicator with temperature and chemical water quality index being two parameters. Specific indicators and standards will also vary among species of salmon and the geographic scope of watershed assessments will also vary. For example, species that do not spend appreciable time in freshwater (pink, chum) may not require a full watershed approach.

The selection of relevant parameters must be governed by a clear and meaningful linkage to the management objectives described in the Wild Salmon Policy and understanding that the habitat indicators / parameters represent key characteristics of high-value habitat that can accurately measure levels of impact (Table 2).

Outputs: This step will provide the following Outputs:

1. Map at 1:20,000 scale with classification of all CUs as green, amber, or red:
    a) Green = sufficient quantity and/or quality of high-value habitat to meet production goals
    b) Yellow = sufficient quantity and/or quality of high-value habitat but under threat
    c) Red = insufficient quantity and/or quality of high-value habitat to meet production goals
2. Map at 1:20,000 scale with classification of all watersheds within moderately and highly threatened CUs; and
3. Database of key parameter values at a reach level for highly threatened watersheds.

Spatial frame: This step can be accomplished at a CU scale. The entire province of BC has TRIM available so CU and watershed assessments could be done at 1:20,000 scale but would need to be at 1:50,000 scale for Yukon. For high priority watersheds and reaches, the map base for assessments would be at a 1:10,000 or 1:5,000 scale.

Time frame: The status of high-value habitat in highly threatened CUs should be completed in 5 yrs followed by moderately threatened CUs over the next 5 years. Re-assessment of CUs should occur every 5 years when threats are re-assessed (Step 3). Analysis of pressures on salmon habitat to be completed in Step 3 will in all likelihood reveal that Georgia Depression, Southern Interior and Central Interior Ecoprovinces are highest priority. This, combined with the focus of the Living Rivers Strategy on these Ecoprovinces, suggest that these Ecoprovinces should be completed first.

Year 1–2 (Georgia Depression, Southern Interior, Central Interior Ecoprovinces)
Year 3 (Coast and Mountains Ecoprovince)
Year 4 (Sub Boreal Interior, Southern Interior Mountains)
Year 5 (Northern Boreal Mountains, Boreal Cordillera)

Data sources: This is the most data intensive step of the implementation framework and potentially the most costly to implement. Fortunately, many of the indicators suggested for this section are currently being collected as part of existing government programs. In some cases, the geographic extent of current collection coverage might need to be expanded to capture the high priority CUs and watersheds. In other cases

information needs updating. Some expansion (or rationalization) of current monitoring programs (e.g., Environment Canada's CABIN program, Water Survey of Canada Hydrometric Program) may be required to ensure appropriate coverage.

The WSC Hydrometric Monitoring Program is a simple example of how the WSP habitat monitoring needs might be accommodated by an existing program. Currently, there are 2938 active water level and stream flow stations being operated across Canada under the federal-provincial and federal-territorial cost-sharing agreements. Most of the stations are located in the southern half of the country where the population and economic pressures are greatest. As a result, the adequacy of the network to describe hydrologic characteristics, both spatially and temporally, decreases significantly to the north. The current network of hydrometric stations in British Columbia is close to providing adequate coverage across many CUs. However, expansion of this network should be considered as appropriate.

Data sources: Most of the required data resides in current government databases or reports. Data are typically collected at fine resolutions and through intensive field collections.

Partnerships: The province of BC has an interest in identifying sensitive watersheds for steelhead and other trout species. Integrated Land Management Bureau of BC is the custodian of much of the required data. The Nature Conservancy of Canada is developing an ecological classification for aquatic habitats in Canada. There are certainly commonalities to be shared amongst the parties.

Environment Canada has established a number of indicators to monitor the health of freshwater across Canada as part of the program called CABIN (www.cabin.cciw.ca). CABIN is a collaborative program developed and maintained by Environment Canada to establish a network of reference sites available to all users interested in assessing the biological health of freshwater in Canada with the ultimate purpose being the maintenance of biological integrity. The Minister of Fisheries and Oceans should work with the Minister of Environment to focus and expand CABIN to address monitoring the biological integrity of Pacific Salmon habitat.

Much of the on-the-ground collection of finer scale information should be conducted in partnership with DFO, BC Ministry of Environment, BC ministry of Forests, First Nations, and local stewardship groups, as well as industry.

Figure 2. Flow chart showing details of monitoring and decision-making layers for Step 4 within the overall implementation framework.

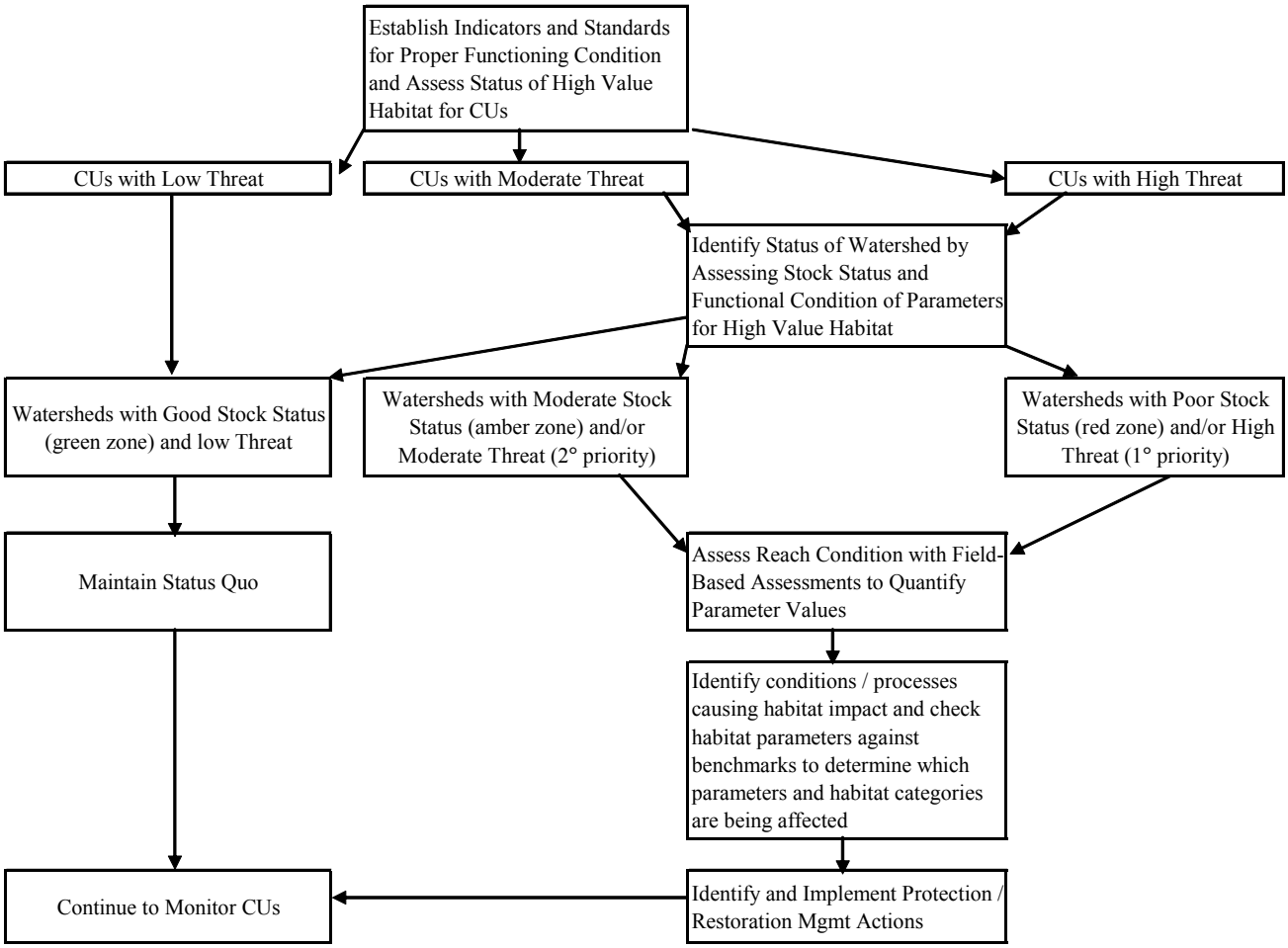

Table 2. Linkages between Wild Salmon Policy management objectives and habitat indicators to assess status.

Management Objective	Category of High Valued	Indicator	Scale of Assessment	Data Parameter	Applicable To	
					Species	Life
Maintenance of the physical processes affecting natural watershed hydrology	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Land Use/Land Cover	CU / Watershed	Change in land use/land cover; Road density; Impervious surface area; No. of stream crossings	All	All
		Water Quantity	Watershed	Instream flow; Flow hydrology	All	All
Management of water use in a manner that will optimize stream flows for salmonid spawning, incubation, rearing, adult residency, and migration as well as channel-formation	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Water Quantity	Watershed	Instream flow; Flow hydrology; Water extraction	All	All
Management of water quality (including temperature and sediments) that will optimize salmonid spawning, incubation, rearing, adult residency, and migration	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Water Quality	Watershed / Reach	Temperature; Chemical water quality index; Biological water quality index; Lake productivity	All	All
		Physical Habitat	Reach	Fines in spawning substrates	All	All
		Land Use/Land Cover	Watershed / Reach	No. of stream crossings; Road density; Riparian vegetation	All	All
Maintenance or restoration of stream habitats for salmonids	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Water Quantity	Watershed / Reach	Instream flow; Water extraction; Flow hydrology	All	All
		Water Quality	Watershed / Reach	Temperature; Chemical water quality index; Biological water quality index	All	All
		Physical Habitat	Watershed / Reach	Area of spawning habitat; Fines in spawning substrate; Channel width/depth; LWD	All	All
Maintenance or restoration of riparian and wetland habitats for salmonids	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Land Use/Land Cover	Watershed / Reach	Riparian vegetation	All	All
		Physical Habitat	Watershed / Reach	Off-channel and wetland area	All	All
Maintenance or restoration of lake and reservoir habitats for salmonids	Spawning and Incubation Areas; Rearing Areas; Migration Pathways	Water Quality	Watershed / Lake	Temperature; Chemical water quality index; Biological water quality index; Lake productivity	Sockeye; Coho	Adults; Juveniles
Maintenance of or restoration of nearshore marine, estuarine and tidal marine ecosystems for salmonid and ecosystem function	Rearing Areas; Migration Pathways	Land Use/Land Cover	Reach	Change in land use/land cover; Road density; Impervious surface area; Riparian	All	All
		Physical Habitat	Reach	Change in area, distribution, and types of tidal and submerged wetlands	All	All
		Water Quality	Reach	Temperature, oxygen, nutrients, toxins, pathogens	All	All
Maintenance of fish access to all useable wild salmon habitat	Migration Pathways	Physical Habitat	Watershed	Impediments to accessibility	All	All

Step 5: Establish goals and indicators and assess status of salmon ecosystems

WSP Step: Strategy 3, Step 3.1

Rationale: Salmon play an important role in freshwater, marine and terrestrial ecosystems. It is a complex biological system that is shared by many other species of plants and animals. Initially, the Wild Salmon Policy should focus on identifying components of the salmon ecosystem that can be influenced through management actions. As more comprehensive policies around ecosystem management (e.g., Canada's Integrated Oceans Management Strategy) are developed, the suite of indicators and standards can evolve.

Salmon play numerous different roles in influencing the ecosystem they inhabit: 1) as a source of nutrients, 2) as a source of food, 3) as predators, 4) as competitors, and 5) as manipulators of the stream bed. Similarly, other components of the salmon ecosystem can affect salmon populations including: 1) habitat alteration, 2) predators, and 3) introductions of other aquatic species.

The WSP commits to including ecosystem values in the monitoring framework. During the review of the WSP, numerous people commented that the ecosystem component of the policy needs to be addressed in concert with Strategy 1 and Strategy 2. This means ensuring that goals for the salmon ecosystem are included when establishing benchmarks for salmon abundance (escapement) and habitat.

In general, management goals and actions with respect to salmon should maintain the natural diversity of species, ecosystems, seral stages, and ecosystem functions including such biological legacies as bear dens, wildlife trees, snags, coarse woody debris, cultural plants, and cultural sites. Establishing ecosystem indicators and standards of success linked to these potential management goals and actions should be the focus of this step.

Goal: Assess the status of key salmon ecosystem components specific to stated ecosystem goals for priority CUs by comparing present condition to standards and monitoring trends. This step establishes the benchmarks for management actions to minimize threats to salmon ecosystems consistent with ecosystem goals.

Approach: The Council has prepared a report on managing Pacific salmon for ecosystem values (Nelitz et al. 2006). In this report a suite of potential ecosystem indicators were identified to address two main issues or questions: 1) How salmon influence the ecosystem, and 2) How the ecosystem influences salmon. Many of the indicators identified by Nelitz et al. (2006) also satisfy the requirements of Step 4 in this implementation framework (e.g., marine conditions, basin hydrology).

The Washington Fish and Wildlife Commission (WFWC 1997) identified four key goals and considerations for maintaining ecosystem integrity. We recommend that the Minister include these as the initial focus of Strategy 3 of Canada's Wild Salmon Policy. Further refinement can occur over time.

The first goal is the maintenance of wild salmon populations at abundance levels that naturally sustain ecosystem processes and diverse populations of indigenous species and their habitats. WSP Strategy 1 is the obvious place to address this, in part, through

the establishment of abundance-based benchmarks that, over time, will account for ecosystem needs (WSP, pp 17 side bar). The allowance of additional salmon carcasses to meet nutrient requirements within the ecosystem is an important consideration.

The second goal is to maintain healthy populations of indigenous plants and animal species within levels that sustain or promote wild salmon populations and their habitats. Maintenance of habitats of other species will require that any management actions taken to address threats to salmon habitat explicitly account for potential impacts to non-salmon habitat as well. This will require that the status of key ecosystem components be assessed and monitored with species diversity and habitat diversity being obvious candidate indicators.

The third goal is to avoid significant negative impacts on wild salmon through hatchery or other enhancement programs. The Council is currently preparing an advisory to the Minister on hatchery management.

The fourth goal is to control the numbers, varieties, habitat changes and distribution of non-indigenous species (exotics) that result in competition, predation, or displacement of wild salmon. This will require an initial assessment of the effects of current introductions on wild salmon and their habitats and the implementation of a comprehensive monitoring program to track changes in their distribution and habitats.

Table 3 provides a preliminary list of potential ecosystem indicators that are directly linked to the four ecosystem management goals listed above. Specific data requirements to support these indicators will require further scoping as well as the development of appropriate benchmarks. This will require additional strategic research to support existing science.

Spatial frame: This step is to be addressed at the CU or watershed level. The mapping components of this step can be accomplished at both an Ecoprovince scale and a CU scale and would include such things as distributions of invasive species. The entire province of BC has TRIM available so CU and watershed assessments could be done at 1:20,000 scale but would need to be at 1:50,000 scale for Yukon. For high priority watersheds and reaches, the map base for assessments would be at a 1:10,000 or 1:5,000 scale.

Time frame: It will take several years to establish appropriate indicators and standards for this step. However, establishing and monitoring the four proposed priority ecosystem goals can commence immediately with several pilot CUs.

Data sources: This is also potentially a very data intensive step of the implementation framework. Data for the numerous ecosystem components are less readily available and more challenging to collect. There are some CUs that currently have more ecosystem data available than others and these should be examined for pilot study.

Partnerships: Since this step will require collection of information at a CU or watershed level, partnerships with local groups are important. These groups, including First Nations, will be an excellent source of local knowledge on ecosystem components and available data. Information on broad scale phenomenon such as the distribution of exotics will require coordination with other agencies holding that information.

Table 3. Preliminary list of potential ecosystem indicators.

Ecosystem Management Goal	Linkage between Salmon and Ecosystem	Indicator
Sustain Ecosystem Processes and Species Diversity and Habitats	Salmon as Nutrient Source	• Salmon distribution • Salmon abundance • Macro invertebrate production • Lake primary and secondary productivity • Lake and stream nutrients
	Salmon as Food Source	• Sentinel predator distribution and relative abundance (terrestrial and marine mammals, birds, aquatic species)
	Salmon as Predators	• Distribution and relative abundance of major prey items in marine and freshwater
	Salmon as Competitors	• Distribution and abundance of major competitors • Identification of species overlaps
Maintenance of Healthy Ecosystem Components that Support Salmon	Ecosystem as Habitat for Salmon	Same indicators as for Step 4 of this framework PLUS • Ecosystem indicators listed above PLUS • Stream bed condition
Effects of Enhancement on Wild Salmon and Ecosystem	Salmon as Competitors	• Marine survival of hatchery versus wild salmon • Density-dependent effects in freshwater and marine (both inter-specific and intra-specific)
Control of Exotic Species	Exotics as Predators	• Distribution and abundance of key exotics and their habitats
	Exotics as Competitors	• Distribution and abundance of key exotics and their habitats

**Note: Some of the above listed ecosystem indicators such as those related to marine survival require further research before they can be used.*

Step 6: Identify strategic management actions to reduce threats and promote recovery of high-value habitat and ecosystem health for priority CUs

WSP Step: Strategy 5, Step 5.3 and 5.4

Rationale: A fundamental step to achieving the WSP Objective 2 of 'maintaining habitat and ecosystem function' is the development of management strategies or actions to reduce threats to high-value habitat and ecosystem health. The actions should be relevant to the eight habitat goals and objectives and be specific to salmon species, life stage and threatened high-value habitat, as well as watershed characteristics and key ecosystem components. The management actions should outline the specific habitat objectives and characteristics being addressed, land and/or water management activities proposed to reduce the threats, habitat indicators that will be monitored to assess strategy effectiveness, and anticipated measures of success (i.e., target benchmark values for habitat indicators).

Goals: Identify, through local planning initiatives, cost-effective management actions to reduce threats to high-value habitat and ecosystem health and promote recovery. Steps 6–8 are the most critical to achieving the overall goal of maintaining salmon habitat and ecosystem function and the overall goal of the WSP. Actions should be strategic and cost-effective.

Approach: The Washington Fish and Wildlife Commission's Policy concerning wild salmon details examples of specific action strategies that might be considered to address each of the eight management goals described in Section 1.3 of the advisory (WFWC 1997). The BC Watershed-based Fish Sustainability Planning Guidebook for Participants (BC and Canada 2001) also provides useful information on developing and implementing watershed plans.

Many of the recommended management actions required to address the eight management goals for maintaining salmon habitat and ecosystem function are actions already taken by federal, provincial, territorial and local government or by local stewardship groups, industry and land owners. Despite this, the loss of wild salmon habitat has continued.

To be effective, implementation of habitat management actions must be at the local level (e.g., watershed) and in partnership with local stakeholders. Several Salmon Watershed Recovery Plans have been successfully developed and implemented in BC (www.psf.ca) and a number of Watershed Management Planning tables are underway as well (e.g., Cowichan River Round Table, Nicola Round Table). A key ingredient of success is the all-inclusive membership in the planning process.

Spatial frame: Management actions must be implemented at a scale consistent with the threats to high-value salmon habitat and the relevant ecosystem components. Typically this will be at a watershed level but could also be at the CU level for CUs that are small in spatial scale. The advantage of the watershed scale is that multiple species that often share the same habitats can be addressed.

Time frame: Management actions will be developed in concert with the identification of CUs and watersheds under high or moderate threat. It is envisioned that watershed planning of management actions to address salmon habitat concerns will occur annually with new watersheds or CUs being addressed each year.

Data sources: Most of the data required for this step will have been collected in Steps 1–5.

Partnerships: All interested parties at the local level but particularly First Nations, government, industry and land owners. Several well-functioning 'round tables' exist within BC and these provide models for additional local implementation partners. The Living Rivers Strategy implementation partners will be critical to the success of the WSP implementation over the next 5 years.

Step 7: Implement strategic management actions to reduce threats and promote recovery of high-value habitat and ecosystem health for priority CUs

WSP Step: Strategy 5, Step 5.3 and 5.4

Rationale: Proponents of salmon conservation view this as the penultimate step of the Wild Salmon Policy and will require significant commitment from government and local interests. Success of the policy lies not with the establishment of monitoring programs and indicators, but with specific actions to arrest the decline of wild Pacific salmon in British Columbia and the Yukon.

Goal: To achieve the second objective of the Wild Salmon Policy: "Maintain Habitat and Ecosystem Integrity".

Approach: It will be important to follow a prioritized hierarchy for implementation of those management actions likely to yield the greatest initial benefit to wild salmon and their habitats. This will vary significantly among CUs and watersheds. The Watershed-based Fish Sustainability Guidelines and the Pacific Salmon Foundation's approach to Salmon Recovery Planning are good examples of how to prioritize management actions.

Spatial frame: Some management actions may be able to be implemented at a regional scale, although the majority will be implemented at the CU or watershed level (see Step 6).

Time frame: Implementing management actions and achieving the goal of maintenance of salmon habitat and ecosystem function is a long-term proposition, lasting decades.

Data sources: None required.

Partnerships: All interested parties at the local level but particularly First Nations, government, industry and land owners. Several well-functioning 'round tables' exist within BC and these provide models for additional local implementation partners. The Living Rivers Strategy implementation partners will be critical to the success of the WSP implementation over the next 5 years.

Step 8: Monitor effectiveness of management actions

WSP Step: Strategy 6, Step 6.1

Rationale: Implementation, monitoring and subsequent revisions or adjustments to the management actions should follow an adaptive management framework. Two key principles of monitoring that should be followed for this adaptive management framework are: 1) focus the monitoring on key performance measures, and 2) conduct detailed monitoring to compare the effectiveness of management actions (i.e., treatments) on their overall impact on fish habitat over a representative set of watersheds supporting a CU. The effectiveness of these management actions will be evaluated over time by monitoring key habitat indicators.

Goal: To monitor the success and failures of management actions undertaken in Step 7.

Approach: Due to the geographic breadth of CU coverage in BC and Yukon, monitoring for Strategy 2 of the WSP should use a low intensity approach that can be implemented at a relatively low cost. The approach to monitoring effectiveness should, in essence, mirror the approach in Step 4. Evaluation of broad based indicators for a CU or watershed that previously had a high level of habitat threat would be accomplished using remote sensing techniques that would evaluate the effectiveness that management actions had at reducing this level of threat. Site level and field-based indicators would be monitored at a more intensive level in a subset of high impact watersheds to provide further detail on effectiveness of management actions at improving habitat quality.

Spatial frame: As identified in Steps 6 and 7

Time frame: The frequency of monitoring will depend on the management actions taken. Some management actions such as riparian planting will require long-term monitoring but at a relatively infrequent step (every 5 years). Others such as water flow management will require annual monitoring.

Data sources: The suite of indicators established in Steps 4 and 5 will provide the basis for monitoring and assessing the success of management actions, provided as was previously stated, that established indicators are directly linked to threats and potential management actions (i.e., they are relevant and responsive; Dent et al. 2005).

Partnerships: Effectiveness monitoring should be done in partnership with the local partners responsible for the management actions taken.

APPENDIX B. MANAGEMENT GOALS

WSP Strategy 4 describes how the WSP will be implemented in a strategic manner. It identifies the need to establish management actions to protect or restore Pacific salmon, their habitats and ecosystems in order to achieve biological targets for each CU. Proponents of salmon conservation view this as the ultimate step of the Wild Salmon Policy and this step will require significant commitment from government and local interests. Success of the policy lies not with the establishment of monitoring programs and indicators, but with specific actions to arrest the decline of wild Pacific salmon in British Columbia and the Yukon.

Successful achievement of WSP Objective 2 will require achievement of the following five specific goals that are adapted from the Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes Concerning Wild Salmonids (WFWC 1997):

Clear articulation of the eight goals with specified targets and timeframes for achievement of each one is an important part of ensuring that salmon habitat is adequately conserved to meet WSP objectives.

Goal 1. Maintenance of Watershed Hydrology

The intent of this management goal is to maintain or restore the physical processes affecting natural basin hydrology. Salmon survival and reproduction are reflected in those flow regimes and basin hydrology. Salmon habitat requirements for basin hydrology should consist of flow patterns that reflect the natural hydrologic regime as closely as possible.

Goal 2. Management of Water Use

The intent of this management goal is to manage water use in a manner that optimizes stream flows for salmonid spawning, incubation, rearing, and adult migration, as well as address the need for channel-forming and channel-maintenance flows.

Goal 3. Management of Water Quality

Water and sediments within specific ranges of physical and chemical characteristics are essential for healthy and productive wild salmonid populations. For example, natural rates of sediment delivery and routing within streams and marine areas are essential to creating and maintaining salmonid habitat, but accelerated rates of sediment erosion/deposition are usually detrimental to salmonid habitat. There are well-established water quality thresholds (temperature, toxicity) for salmon that must be adhered to for survival and production of salmon.

Goal 4. Maintain Stream, Wetland and Riparian Habitat, Lake and Reservoir Habitat and Estuarine and Marine Habitat

Stream Habitat

Salmonids have evolved and adapted to streams that possess a variety of in-channel features important to spawning, rearing, and migration. These features include 1) frequency of pools and riffles, 2) substrate size and distribution, 3) sediment delivery and transport processes, 4) water depth and velocity, 5) undercut banks, 6) in-stream woody debris, and 7) a variety of side-channel and off-channel habitats. Natural stream characteristics and processes should be maintained and restored to ensure that these in-channel features are functioning properly.

Riparian and Wetland Habitat

Riparian areas are vitally important to wild salmonids for maintaining water quantity, water quality, food supply, and shelter, as well as accommodating migration needs and reproduction needs. Wetlands provide a variety of direct and indirect benefits to wild salmon including: reduction of flood peak-flows (including storm water runoff), maintenance of low flows, shoreline stabilization, groundwater recharge, water quality improvement, structural and species diversity components of habitat for plants

and animals, and habitat for numerous fish and wildlife species, including wild salmon and trout. Functional riparian habitat and associated wetlands should be protected and restored on all water bodies that support, or directly or indirectly impact, salmonids and their habitat.

Lake and Reservoir Habitat

Lakes and reservoirs provide rearing, adult residency, spawning habitat, and migratory pathways for many species of salmon. Access between lakes, and inlet or outlet streams, is high-value for reproduction of many lake dwelling species. Lake and reservoir habitats should be maintained and restored that are conducive to wild salmonid passage, rearing, and adult residency and spawning. Adequate flows through reservoirs should be maintained to ensure optimal and timely passage of out-migrant smolts.

Marine and Estuarine Habitat

Nearshore marine, estuarine and tidally influenced habitats are of vital importance to the survival of wild salmon. The functions and values of the following habitat types should be maintained or increased: eelgrass habitats, herring spawning habitats, intertidal forage fish spawning habitats, intertidal wetlands, intertidal mudflats, and safe and timely migratory pathways for salmonids in marine waters.

Goal 5. Maintain Fish Access

Free and unobstructed passage among habitat types is essential for most wild salmonids at all life stages. Natural barriers, such as waterfalls and cascades, are important features that contribute life history variation within species, and allow for species separation (i.e., anadromous/ resident). This management goal is to provide, restore, and maintain safe and timely pathways to all useable wild salmonid habitat in fresh and marine waters, for salmonids at all life stages. Natural fish passage barriers should be maintained where necessary, to maintain biodiversity among and within salmonid populations and other fish and wildlife.

APPENDIX C. POTENTIAL HABITAT INDICATORS AND STANDARDS (BENCHMARKS) FOR MONITORING HABITAT CONDITION

			Standards			
Category of High Valued Habitat	**Indicator**	**Parameter**	**High Quality Habitat (Green)**	**Moderate Quality Habitat (Amber)**	**Low Quality Habitat (Red)**	**Reference for Parameter and/or Standards**
Spawning, Incubation and Rearing Areas	Land Use/Land Cover	Change in land use/land cover (Equivalent Cleared Area - ECA)	<20% of subbasin area	20-35% of subbasin area	>35% of subbasin area	Modified after B.C. Ministry of Forests. 2001
		No. of stream crossings (sediment loading)	<0.8 / km^2	0.8-1.4 / km^2	>1.4 / km^2	B.C. Ministry of Forests. 2001
		Road density (peak flow & sediment loading)	<1.2 km/km^2	1.2-2.1 km/km^2	>2.1 km/km^2	B.C. Ministry of Forests. 2001
		Impervious Surface Area	<30% of subbasin area	30-60% of subbasin area	>60% of subbasin area	DFO Urban Stormwater Guidelines (draft) 2001; Schueler 1994
		Riparian vegetation	<20% of stream length impaired	20-35% of stream length impaired	>35% of stream length impaired	Modified after B.C. Ministry of Forests. 2001
	Water Quantity	Instream flow	>80% of accessible length	50-80% of accessible length	<50% of accessible length	Modified after Green Mountain Institute 1998; Tennant 1976
		Water Extraction	Extraction results in summer baseflows of >40% of MAD	Extraction results in summer baseflows of 30-40% of MAD	Exstraction results in summer baseflows of <30% of MAD	Modified after Tennant 1976
		Flow hydrology	<10% change in hydrology from historic	10-15% change in hydrology from historic	>15% change in hydrology from historic	Modified after Green Mountain Institute 1998
Spawning and Incubation Areas	Physical Habitat	Area of spawning habitat	Spawning area comprises >25% of wetted area	Spawning area comprises 10-25% of wetted area	Spawning area comprises <10% of wetted area	Modified after Johnston and Slaney 1996
		Fines in spawning substrate	≤15% fines (<2mm)	15-25% fines (<2mm)	≥25% fines (<2 mm)	Modified after Johnston and Slaney 1996
	Water Quality	Temperature	<14C	14-16C	>16C	Anonymous 1999
		Chemical Water Quality Index	Good-Excellent	Fair	Poor	Green Mountain Institute 1998; Dent et al. 2005

Potential Habitat Indicators and Standards (benchmarks) for Monitoring Habitat Condition (cont.)

			Standards			
Category of High Valued Habitat	**Indicator**	**Parameter**	**High Quality Habitat (Green)**	**Moderate Quality Habitat (Amber)**	**Low Quality Habitat (Red)**	**Reference for Parameter and/or Standards**
Rearing Areas	Physical Habitat	Channel width/depth	<15	15-30	>30	Oregon Watershed Enhancement Board 1999l; Newbury and Gaboury 1994
		Pool frequency	>50%	30 - 50%	<30%	Peterson et al. 1992
		LWD (for LWD controlled streams)	>2 pieces per meter of channel width	1-2 pieces per meter of channel width	<1 pieces per meter of channel width	Modified after Johnston and Slaney 1996
		Off-channel and wetland area	>2	1-2	<1	Modified after Johnston and Slaney 1996
	Water Quality	Temperature	≤14C[a]	15-20C[b]	>20C[b]	a-Bjornn and Reiser 1991; b-Green Mountain Institute 1998
		Chemical Water Quality Index	Good-Excellent	Fair	Poor	Green Mountain Institute 1998; Dent et al. 2005
		Lake productivity	No change in euphotic zone depth	Euphotic zone depth trending down	Trend shows significant decrease in euphotic zone depth	Light penetration
		Biological Water Quality Index	Good-Excellent	Fair	Poor	Green Mountain Institute 1998; Ward 1999; Dent et al. 2005; Tripp et al. 2005
Adult and Juvenile Migration Pathways	Physical Habitat	Reduction in range	<10% change in accessible length	10-20% change in accessible length	>20% change in accessible length	Bocking and Gaboury 2006
		Impediments to Passage	All anthropogenic structures meet passage requirements	Most anthropogenic structures meet passage requirements	Few anthropogenic structures meet passage requirements	Bates et al. 1999

Potential Habitat Indicators and Standards (benchmarks) for Monitoring Habitat Condition (cont.)

			Standards			
Category of High Valued Habitat	**Indicator**	**Parameter**	**High Quality Habitat (Green)**	**Moderate Quality Habitat (Amber)**	**Low Quality Habitat (Red)**	**Reference for Parameter and/or Standards**
Estuaries	Physical Habitat	Change in area, distribution, and types of tidal and submerged habitats, litter	% of estuary area modified			Scheltinga et al. 2004
	Sediments	Change to load, distribution/movement patterns, settlement/resuspension rates, grain size of suspended or settled sediments	Change in extent of mud flats, marshes, banks			Scheltinga et al. 2004
	Water Quality	Oxygen, bacteria, viruses, protozoans or fungi which cause disease, nutrients, toxins	Total bacterial, toxins entering the estuary, nutrient/oxygen levels			Scheltinga et al. 2004, Ohrel and Register 2000
	Freshwater Inputs	Salinity	Change in median freshwater input, Change in seasonality of freshwater input			Scheltinga et al. 2004, Ohrel and Register 2000
	Hydro-dynamics	Changes to local patterns of waves, currents or tidal exchange	Change in tidal exchange rates/residence			Scheltinga et al. 2004
Marine Habitats	Temperature (Ocean Condition)	Temperature Trends (various indices)	North Pacific sea temperatures favourable for salmon and stable	North Pacific sea temperatures favourable for salmon but trending down	North Pacific sea temperatures unfavourable for salmon or trending down	Hare and Mantua (2000); Bocking and Gaboury 2006
	Food Availability	Zooplankton and Ichthyoplankton Biomass and Species Composition	Normal to above normal	Normal to below normal	Below normal	Hare and Mantua (2000); Bocking and Gaboury 2006
	Water Quality	Organic and heavy metal contamination at index sites	No contaminated sites along migration route for CU	Few contaminated sites along migration route for CU	Several contaminated sites along migration route for CU	Hare and Mantua (2000); Bocking and Gaboury 2006

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590 – 800 Burrard Street
Vancouver, British Columbia
Canada V6Z 2G7
Telephone: (604) 775 – 5621
Facsimile: (604) 775 – 5622
E-mail: info@fish.bc.ca
www.fish.bc.ca