Northwest Power and Conservation Council

October 25, 2012

MEMORANDUM

TO: Fish and Wildlife Committee

FROM: Nancy Leonard, Fish Wildlife Ecosystem Monitoring and Evaluation Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist

SUBJECT: Discussion on Program objectives and research plan and ocean research

Attached are the staff overviews of the Program objectives and Research Plan tasks. These overviews consist of an introductory section, alternative actions for discussion, and background information. The updated draft Research Plan is also attached to this memo.

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PROGRAM OBJECTIVES

INTRODUCTION:

The 2009 Fish and Wildlife Program directed the Council to initiate a process with federal and state fish and wildlife agencies and tribes, Bonneville, and others to assess the value for the Program of quantitative biological objectives at the basinwide level, or at any level above the subbasin and population level. If determined to be useful in certain categories, the Council will work with these partners to develop a set of quantitative objectives for amendment into the Program.

Since 2010, staff has discussed with the Fish and Wildlife Committee how to best tackle this task, given past efforts and the challenges of deriving sound numerical Program biological objectives. The multitude of past efforts that encouraged and worked on the development of objectives pre-dates the 2000 Program amendment process and is described in the background section of this memo.

Staff seeks guidance from the Fish and Wildlife Committee on which of the 3 alternative actions described below should be taken to address this highly complex task.

ALTERNATIVE ACTIONS:

1) The Program amendment process should be used to seek input from federal and state fish and wildlife agencies and tribes on how the Program's biological objectives should be refined, if at all. This should be based on the 2009 Fish and Wildlife Program guidance detailed below:

    - Review whether the goals of increasing total salmon and steelhead abundance to 5 million fish by 2025 and the goal of achieving smolt-to-adult return rates in the 2-6-percent range for listed Snake River and upper Columbia salmon and steelhead should continue to be used as quantitative basinwide biological objectives for the Program.
    - Biological objectives should be science-based and should provide:
        - Benchmarks for measuring, evaluating, and reporting Fish and Wildlife Program performance;
        - Context for resource allocation decisions and broad policy decisions;
        - Guidance over time for necessary revisions of the Program's basinwide strategies and the Mainstem and subbasin plans.
    - Possible categories of biological objectives that fit the Program's framework include:
        - Population characteristics for focal species (such as adult abundance, population productivity, ratio of natural production to artificial production, life history diversity and population structure) expressed either in absolute numbers or in trends, probabilities, averages or ranges;
        - Species habitat potential (habitat productivity and capacity);
        - Environmental objectives (a small set of high level indicators such as increases in streamflow, improvements in water quality, improvements in channel structure and complexity, and removal of barriers);

- Escapement goals at particular points in the system.

2) The below changes would be shared with the region for their consideration during the 2014 Program amendment process:
    - The text describing the 2009 Fish and Wildlife Program's Biological Objectives will be kept the same; however, numerical references will be removed from the Program's Biological Objective section and either incorporated as part of the Program Vision or as part of the Mainstem Plan. If incorporated in the Mainstem Plan, these numerical objectives would require additional specificity to facilitate assessment. For example the point in the system from which SARs are to be calculated and specify which fish are to be included in the 5-million. These additional details would be solicited from managers and the region during the 2014 Program amendment process.

3) The existing 2009 Fish and Wildlife Program's Biological Objectives would be kept for the 2014 Program as stated in their current section. The Program language directing the region and the Council to assess the value of having and developing quantitative biological objectives would be removed from the 2014 Program.

BACKGROUND:

In 1**996** the Independent Scientific Group (ISG) produced the Return to the River publication (document 96-6, later replaced by the 2000 Return to the River report). This publication responded to a Council request for the (ISG) to develop a conceptual foundation for the Fish and Wildlife Program, and provide an overall set of scientific principles and assumptions on which the Program and fish and wildlife management activities basinwide could be based and against which they could be evaluated. In their report, the ISG stated that the Fish and Wildlife Program lacked a structure for *selecting or prioritizing measures based on a framework of overall goals and objectives. While the Council has identified general goals and priorities for the FWP, their level of generality is such that they provide little guidance or rationale for subsequent selection or prioritization of measures.* Thus the ISG recommended that the Fish and Wildlife Program incorporate *an integrated approach to ecosystem management that is based on an overall, scientifically credible conceptual foundation. This would lead to a rational structure of goals and objectives and provide a standard for evaluation of measures based on general properties of the salmon bearing ecosystem. It also would provide the Council with an objective, explicit structure around which to shape a scientifically based program.*

In **1997** the Council produced the document *An Integrated Framework for Fish and Wildlife Management in the Columbia River Basin* (document 97-2). This document describes the elements and structure of a common, scientifically based framework for regional fish and wildlife recovery in the Columbia River Basin. This framework included a description of ecological objectives needed to achieve goals that would be based on the scientific information in the conceptual foundation. These objectives *should relate to the organisms themselves (life history diversity, abundance, survival rate, productivity), associated physical conditions (temperatures, flow, sediment) and ecological conditions (habitat connectivity, species assemblages, ecological integrity). Ecological objectives can be arrayed on a time line to provide performance benchmarks. However, ecological objectives must go through the*

conceptual foundation to ensure a firm linkage to the goals and a scientific basis. It is important to distinguish goals from the ecological objectives. The goals drive the framework and are the sources from which other elements of the framework are derived. Objectives emerge from the conceptual foundation as a description of a needed ecological condition. Strategies are designed to achieve ecological objectives. A related concept is that of performance indicators. These are readily measurable indices of the ecological objectives. Parameters used as ecological objectives may be difficult to measure or respond slowly to strategies and actions. Performance indicators can be used to provide timely indications of change or to indicate problems. In any event, performance indicators relate directly to the ecological objectives.

The ***2000*** Fish and Wildlife Program established a broad framework for fish and wildlife mitigation and recovery within the Columbia River Basin. The framework included a vision for the Columbia River, which is intended to define the expected basin-wide outcomes of the Fish and Wildlife Program, and a scientific foundation, which is a set of scientific principles that are intended to broadly summarize current scientific knowledge concerning ecosystem attributes, processes, and functions that are applicable to fish and wildlife mitigation and recovery within the Basin. In order to achieve the vision, the Program called for the development of biological objectives that describe physical and biological changes needed to achieve the vision and that consist of two components:

(1) biological performance: describing population responses to habitat conditions; and
(2) environmental characteristics: describing the environmental changes that are needed to achieve the desired population responses

The basin-level biological objectives were developed and incorporated in the 2000 Fish and Wildlife Program. Biological objectives for the province and subbasin levels were intended to be developed subsequently, with subbasin-level biological objectives having been developed as part of the subbasin plans. Province-level biological objectives have yet to be developed.

The ***2001*** ISAB review (2001-6) of the biological objectives in the 2000 Program provided several suggestions for improving the basin-level biological objectives that warrant consideration as the Council works with the region to discuss further development of the Program's biological objectives. A subset of the ISAB suggestions consists of:

- Improving the linkage of the basin-level objectives with the Program's vision and scientific principles;
- Having a consistent level of specificity among the basin-level biological objectives; and,
- Modifying the biological objectives so that they are more similar in approach to the environmental characteristic biological objectives, as these were deemed to be more appropriate as basin-wide objectives than the biological performance biological objectives.

The **2002** version of A Multi-Species Framework Approach for the Columbia River Basin discusses how the Council can use the Ecosystem Diagnosis and Treatment (EDT)-model to evaluate subbasin plans for their contribution to the larger scale (province and basin) vision and biological objectives. Also, it can be used to inform development of the Council's biological objectives, because the EDT model describes the amount of environmental change needed within a province or subbasin to meet the overall vision. Subbasin plans would then detail the strategies and actions needed to make this amount of change across the province. In this approach, it is

suggested that biological objectives could be based on three characterizations of the environment: (1) the Current Potential condition, (2) the adopted resource management program, and (3) the Historic Potential condition. The Current and Historic Potential conditions are based on information gathered at the 6-HUC level. The characterization of the future conditions could be based on the increase in performance desired and the change in quantity and quality of attributes required to achieve the desired performance. The EDT model can be used to determine the amount of change from current conditions to achieve a desired condition. Thus, the EDT model can be used to help set the biological objectives for conditions in the basin by helping to determine what is possible. Biological objectives would be established for aquatic and terrestrial habitat and biological performance. Potential biological objectives could include the change needed in habitat, fish survival rates, fish productivity, life history diversity, abundance and other EDT-modeled parameters to achieve a desired outcome in the Columbia River basin.

In ***2005***, Council staff presented a plan for developing and adding biological objectives of this type to the Program. The plan proposes two phases for this work: 1) a period to organize and integrate recent information on populations and habitat conditions, and 2) a policy process to develop the objectives and amend them into the Program.

In ***2006***, building upon staff work from 2005, a proposal for adding Province-level objectives was developed (document 2006-15) for review by the ISAB and the region. These objectives aimed to express in quantitative terms the nature of the changes the Program seeks to achieve in key fish and wildlife populations and their habitats in the different ecological provinces of the Basin. Objectives of this type would add significantly to the Council's ability to guide Program expenditures in the most efficient direction and evaluate the success of the Program's activities over time.

In ***2007*** Council staff led a meeting with the region to discuss the Program objectives. During this meeting, representatives of public utilities, federal and state agencies, and tribes discussed the current 2000 Fish and Wildlife Program's biological objectives in terms of their limitation and their ideal future state. This meeting produced a subset of consensus topics, including:

- Collective Statements on the Ideal Future State of Objectives– what would appropriate biological objectives look like? (i) There would be regional agreement and the objectives would support the scope and goals of the Program; (ii) BPA's responsibilities would be clearly defined, the FCRPS priorities would be defined, we would have metrics measuring biological responses and progress could be measured; (iii) The Program would affect integrated progress, provide balance across the hydro, harvest, hatchery, habitat, and ESU obligations and changing nature are integrated; (iv) Strategies and measures would be biologically prioritized; and, (v) The Fish and Wildlife Program budget would reflect biological objectives that maximize biological value for every dollar spent
- Criteria for potential objectives: (i) Measureable and in real time; (ii) Currently measured; (iii) Have indicators that management actions can affect; (iv) Can demonstrate outcomes of projects relative to objectives; (v) Would guide decision making; (vi) Understandable to the general public; (vii) Can define FCRPS obligations; (viii) Can encourage partnerships with other ongoing actions; (ix) There is ownership; (x) They span hydro, harvest, hatchery, and habitat (the 4-Hs); (xi) Possible kinds of objectives include abundance (based on the 4 Hs), productivity of habitat and artificial production, performance indicators and chance in environmental parameters
- Next Steps may include:

    - Test conceptual objectives with some sample provinces
    - Expand description of conceptual objectives
    - Define some desired outcomes, such as using these for budget allocations, transparency in decision making, FCRPS responsibility, and how to measure progress over time
    - Describe application to resident fish and wildlife.

The ***2009*** Fish and Wildlife Program provides guidance for the further development of the biological objectives for the Program. This guidance consists of:

- Initiating a process to work with agencies and tribes to assess the value of the Program with quantitative biological objectives at the basinwide level, or at any level above the subbasin and population level. If determined to be useful in certain categories, the Council will work with these partners to develop a set of quantitative objectives for amendment into the Program.
- Describing characteristics for biological objectives, such as having benchmarks and informing revisions of the Program's basinwide strategies overtime.
- Suggesting potential categories of biological objectives, such as population characteristics and species habitat potential.

RESEARCH PLAN

INTRODUCTION:

The Northwest Power and Conservation Council (Council) recommends a range of research to pursue the objectives of the Columbia River Basin Fish and Wildlife Program (Program). Research is necessary to provide scientifically credible answers to questions addressing uncertainties pertinent to the Program and other management needs. As part of this endeavor the Council produced its first Columbia River Basin Research Plan (Research Plan) in 2006 which aims to *inform decision-making and management actions to conserve and recover fish and wildlife addressed in the Council's Fish and Wildlife Program by identifying and helping to resolve critical uncertainties.* The 2006 Research Plan was to be valid for 9-years with its research themes being revisited 3 times during that time-frame. The 2009 Program calls for updating the Research Plan.

Staff updated the 2006 Research Plan by first compiling into a database the research uncertainties in the 2009 Program, the Council's 2006 Research Plan, the draft research and monitoring implementation strategies (e.g., Anadromous Salmonid Monitoring Strategy, ASMS) and synthesis (e.g., ocean synthesis report) documents produced by managers, the Science-Policy Exchange materials, the recently adopted Bitterroot and Blackfoot subbasin plans, and uncertainties identified in the ISAB and ISRP documents produced since 2005. Some of the major summaries of research uncertainties pre-dating 2005 were also included, specifically the Return to the River (2000-12) and the Science Review Group's document on Critical Uncertainties in the Fish and Wildlife Program (SRG 93-3). These uncertainties were assigned to one of the 2006 Research Plan's 12 research themes. Linkages were made between the research themes and the Program's Biological Objectives and draft Program questions. The intent is to keep this database updated as new reports are produced, and to have the region review its content to identify missing uncertainties, those that have been resolved, and verify the linkages between these uncertainties and the 12 themes, Program's Biological Objectives, and the Council's draft Program questions.

Attached is an updated version of the 2006 Research Plan. This update includes new research questions within the existing 12 research themes to capture newly recognized uncertainties, and removal of obsolete text.

The track-changed, updated, Research Plan is attached to this memo. The database will be shown during the November Fish and Wildlife Committee meeting.

Staff seeks guidance from the Fish and Wildlife Committee as to which of the proposed alternative actions described below should be pursued.

ALTERNATIVE ACTIONS:

1) Post the updated Research Plan and supporting uncertainties database for a 3-month public comment period starting in November 2012. This comment period would provide feedback on the uncertainties compiled, and their linkages to program objectives, questions, and the 12 research themes. This comment period would also serve to identify additional newly recognized uncertainties and those that have been resolved. Once revised, the 2013 draft Research Plan would be posted to replace the 2006 Research Plan.

2) Include the updated Research Plan and its supporting database during the 2014 Fish and Wildlife Program amendment process. This process would provide recommendations on how to improve the updated version and its database. This option is based on the 2000 Fish and Wildlife Program which conveys the intent of adopting the Research Plan into the Program by stating that: *"The Council **will establish a basinwide research plan, similar to the subbasin plans,** which identifies key uncertainties for this program and its biological objectives and the steps needed to resolve them. The plan will identify major research topics, including ocean research, and establish priorities for research funding."*

3) A mixture of the above 2 options. Post the updated Research Plan and supporting database in November 2012 for a 3-month public comment period. Then have the revised version be considered for inclusion into the 2014 Fish and Wildlife Program during the amendment process

BACKGROUND:
Since the 1982 Program, the fish and wildlife programs have included uncertainty topics requiring research. These early Programs (1982, 1984, 1987, 1992 and 1994), however, did not specifically call for a comprehensive research plan. During the 1990s to present time, the Council began to seek a more comprehensive list of uncertainties resulting in the current task of updating the Council's Research Plan.

In the early ***1990s***, Council requested the Scientific Review Group (SRG) to produce a report entitled *Critical Uncertainties in the Fish and Wildlife Program* (Council Document SRG 93-2). In this report the SRG described the critical ecological uncertainties that identify important gaps in knowledge of the resources and functional relationships that determine fish and wildlife productivity in the Columbia River ecosystem.

The ***1994*** Fish and Wildlife Program recognized the need to address uncertainties to be able to fulfill the Northwest Power Act's requirement to rely on the best available scientific knowledge. In this Program the Council calls on *"an independent scientific group to identify "key uncertainties"… These key uncertainties should be those information needs most critical to the achievement of program goals, and rebuilding and survival targets. These uncertainties should be used to guide the prioritization and funding of research efforts conducted under this program."*

The ***1996*** Return to the River document produced by the Independent Science Group (which is the group that replaced the SRG that later evolved into the ISAB and ISRP), identified several research uncertainties related to the Program.

The ***2000*** Fish and Wildlife Program was the first Program to explicitly request a comprehensive Research Plan by calling for a basinwide research plan: *"The Council will establish a basinwide research plan, similar to the subbasin plans, which identifies key uncertainties for this program and its biological objectives and the steps needed to resolve them. The plan will identify major research topics, including ocean research, and establish priorities for research funding."*

In **2002** a draft research plan was produced**.** The ISRP recommended in its review that the development of a long-term Research Plan would be facilitated by a workshop. The workshop

should consist of members of the ISRP, ISAB and IEAB who would identify critical uncertainties and research recommendations.

During February ***2003***, the ISAB, ISRP, and IEAB met for a workshop and discussed the elements of a long-term research plan. An initial listing of critical uncertainties and research recommendations was drawn from the prior publications and recent reports of the Council's science review groups. The workshop members were then polled for what they considered the primary key uncertainties facing the basin. These were then discussed at the workshop, which provided a forum for the cross-pollination of ideas regarding critical uncertainties and research recommendations.

In ***2005*** a second draft of the research plan was produced and was reviewed by the ISAB and ISRP once in its preliminary version (ISAB/ISRP 2005-13) and then its draft version (ISAB/ISRP 2005-20).

In ***2006*** a revised and final research plan was produced by the Council (Council document 2006-3). The 2006 Research Plan aimed to provide certainty to the large body of knowledge about the needs of fish and wildlife. The Research Plan intends to facilitate prioritization and implementation of research that addresses uncertainties as they affect anadromous fish, resident fish, wildlife, and the ecosystems that support them. The Research Plan helps the Council manage the Program by informing decision-making, facilitating scientific review, focusing project selection, providing a basis for redirecting future research, and most importantly, making restoration projects more effective. The 2006 Research Plan divides important scientific critical uncertainties into 12 focal research themes. The list of critical uncertainties identified in the 2006 Research Plan is accepted in the region; the Research Plan contains abbreviated background necessary to establish the significance of each topic of uncertainty. The critical uncertainties are described at a high level so that the Research Plan can provide long-range guidance while preserving flexibility of implementation in the near-term. As well, the critical uncertainties are presented this way in order to elicit the development of specific research hypotheses and project proposals without constraining innovative approaches. The critical uncertainties were synthesized from the Fish and Wildlife Program, reports of the ISAB and ISRP, regional fish and wildlife managers, subbasin plans, national science groups, biological opinions, and other research plans within the region (*see* Appendix G for the 2006 Research Plan).

The ***2009*** Fish and Wildlife Program states, with respect to the Research Plan, that:

> *The Council, with assistance from the parties* [Bonneville, federal and state fish and wildlife agencies, Tribes, the Corps, the Bureau, and others as necessary] *listed above, will update its research plan, which identifies major research topics and establishes priorities for research funding. The research plan will be updated in a transparent manner to ensure all interested parties in the region have an opportunity for input.*

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Columbia River Basin Research Plan

By the

Northwest Power and Conservation Council

~~February 2006~~November 2012

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Council document ~~2006-3~~2013-xx

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I. INTRODUCTION

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For 25 years, the Northwest Power and Conservation Council (Council) has supported a diverse range of research to pursue the biological objectives of the Columbia River Basin Fish and Wildlife Program (program). Research is necessary to provide scientifically credible answers to questions addressing uncertainties pertinent to management. The term "research" is defined broadly to include parameter estimation, pattern recognition, observation, categorization, data collection to quantify important relationships and processes, tests of hypotheses, and improvements in statistical methods.

Research projects implemented under the program and others in the Columbia River Basin have advanced scientific understanding of fish and wildlife and their restoration. Despite this concerted effort, critical uncertainties remain and research lacks focus. Consequently, the Council requested development of a Columbia River Basin Research Plan (research plan) in the 2000 Program to guide the development of its research program and to foster collaboration with the research programs of the other resource management entities within the region. (For additional explanation of the context for the research plan, see Appendix A.). The 2009 Program recommended that the 2006 Research Plan be updated.

Vision Statement

> *The research plan will inform decision-making and management actions to conserve and recover fish and wildlife addressed in the Council's Fish and Wildlife Program by identifying and helping to resolve critical uncertainties.*

The research plan identifies major research themes and critical uncertainties for research funding. In so doing, the research plan provides guidance for addressing key uncertainties that affect anadromous fish, resident fish, wildlife, and the ecosystems that support them. The research plan will help the Council manage the program by informing decision-making, facilitating scientific review, focusing project selection, providing a basis for redirecting future research, and making the program more effective.

Scope and Audience of the Columbia River Basin Research Plan

The geographic scope of the research plan is limited to the Columbia River Basin. The primary audience for the research plan is policy- and decision-makers responsible for natural resource management within the Columbia River Basin, such as the Council members and regional executives. The research plan also will provide guidance useful to researchers, project sponsors, and planners. The research plan provides a programmatic framework for research under the program and associates the research needed for recovery planning under the Endangered Species Act (ESA) with the broader responsibilities of the program.

In addition to improving implementation of the program, the research plan forges links to the research activity of the many parties that share responsibility for fish and wildlife management in the Columbia River Basin. For example, Bonneville Power Administration (Bonneville) and its funding of the Council program supports the work of the U.S. Army Corps

of Engineers, Bureau of Reclamation, NOAA Fisheries, Environmental Protection Agency, and land management agencies such as the U.S. Forest Service, and the U.S. Bureau of Land Management. The Columbia Basin tribes, in their role as co-managers, make significant contributions in the areas of harvest management, hatchery production, monitoring, and habitat restoration. The state fish and wildlife agencies also play key roles in implementation of the program. ~~The Columbia Basin Fish and Wildlife Authority (CBFWA) represents state and federal fish and wildlife managers and tribes in the Council's program.~~

II. OBJECTIVES

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The objectives of the research plan are to:

- Improve monitoring, evaluation, and the application of results
- Address critical uncertainties identified in subbasin plans
- Increase accountability for the annual expenditures of research funds
- Improve input from independent scientists, fish and wildlife agencies and tribes, and other interested parties in the region
- Improve coordination among mainstem research programs
- Improve access to the information generated by the research and restoration projects of the program

The research plan is intended to improve communication among scientists, cooperation among institutions, and better coordination of long-term biological monitoring. A key dialogue that the research plan can facilitate regards the role and use of biological and ecological research to inform decision-making on major conflicts in the basin that have profound socio-political implications, such as the persistent disagreements about the relationship of flow and survival of fish or the influence of hatchery fish on wild stocks. For example, fundamental issues of fish migration and of the interaction of hatchery and wild fish remain poorly understood, yet the consequences are substantial both for listed species and for the economy of the region. ~~In fact, the President's Committee on the Environment and Natural Resources stated: "Basic scientific information is lacking for many of the remedial actions that must be taken over a longer term." (CENR 2000).~~

Despite a large body of knowledge about the needs of fish and wildlife, ~~-~~instances remain in which the region lacks information to understand fully which mitigation or restoration actions will be most effective. The intent of the research plan is to facilitate prioritization and implementation of research that addresses those uncertainties as they affect anadromous fish, resident fish, and wildlife and the ecosystems that support them. Over time, research completed under the research plan will reduce critical uncertainties by increasing scientifically based knowledge. In sum, the research plan will help the Council manage the program by informing decision-making, facilitating scientific review, focusing project selection, providing a basis for redirecting future research, and most importantly, making restoration projects more effective.

Scientific Principles

In 1998 the Council introduced a set of broad scientific principles and applied these principles to a description of the Columbia River as an ecosystem in the publication *Development of a Regional Framework* (NPCC 1998, Document 98-16). Subsequently, the Council continued to develop an explicit scientific foundation by articulating a set of eight

scientific principles and discussing their implications for salmon restoration (see, *2000 Columbia River Basin Fish and Wildlife Program*, NPCC Document 2000-19, page 15). These principles were derived from a number of reviews and recovery strategies for Columbia River salmon including *Return to the River* (Williams 2005) that developed a conceptual foundation for restoration of salmonid fish in the Columbia River Basin. The scientific principles are grounded in established scientific literature to provide a stable foundation for the Council's program (*see Columbia River Basin Fish and Wildlife Program*, 2000, Section B2 (Basinwide Provisions). The Council intends that all actions taken to implement this program be consistent with these principles:

Principle 1. The abundance, productivity and diversity of organisms are integrally linked to the characteristics of their ecosystems.

Principle 2. Ecosystems are dynamic, resilient and develop over time

Principle 3. Biological systems operate on various spatial and time scales that can be organized hierarchically

Principle 4. Habitats develop, and are maintained, by physical and biological processes

Principle 5. Species play key roles in developing and maintaining ecological conditions

Principle 6. Biological diversity allows ecosystems to persist in the face of environmental variation

Principle 7. Ecological management is adaptive and experimental

Principle 8. Ecosystem function, habitat structure and biological performance are affected by human actions

Other science review groups (National Research Council 1996; CENR 2000) also have emphasized the need for an ecosystem perspective as a basis for designing a recovery program for salmon in the Pacific Northwest. Consequently, the scientific foundation developed by the Council represents an important step in the development of restoration and recovery programs grounded on ecological principles.

III. IMPLEMENTING THE RESEARCH PLAN

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~~Research will be implemented by two different but complementary approaches, the Project Selection Process for fiscal years 2007-2009 and a Regional Research Partnership (research partnership). While the~~ The research plan is intended to guide funding of research under the Council's fish and wildlife program. The research plan~~, it~~ also can help initiate a regional dialogue and guide research policy ~~through the research~~through ~~-~~partnership~~s. The research plan could help launch the research partnership~~ by bringing focus to initial discussions of how best to address research topics that are shared by the Council and other entities. The advantage of ~~this dual approach~~engaging in these partnerships is that it allows for a coordination of approaches for addressing ~~encompasses~~ the range of research relevant to the Council's program, specifically:

- Research appropriate for the Council to fund
- Research that is funded in part by the Council, is broader in scope than the fish and wildlife program, but ultimately is necessary to reduce the scientific uncertainties affecting the program
- Research that is inappropriate for the Council to fund but needs to be synthesized to update and inform the conceptual foundation and strategies used in the Council's program

Fish and Wildlife Program Project Review ~~Selection~~ Process

The research plan identifies general research themes rather than specific issues in order to provide guidance that will be durable. These themes will be revisited to coincide with each program amendment process.~~during the next three funding cycles of the program~~. Thus, the life of the research plan will be ~~nine~~ five years~~, with sequential three-year research, monitoring, and evaluation implementation plans to be developed by a work group comprising staff from the Council, Bonneville, and CBFWA. The work group would develop a draft implementation plan by following the guidance of the research plan and by drawing from the pool of project proposals approved for funding by the Independent Scientific Review Panel (ISRP). Consequently, peer review of a draft implementation plan would not be a prerequisite for Council approval but could be sought if the plan identified gaps that required request for proposals. The work group will meet initially to draft an implementation plan in support of the program for fiscal years 2007-2009. The implementation plan will facilitate implementation of the research plan by:~~ The research plan will inform work undertaken by existing and new projects by:

- Identifying priority uncertainties ~~within the research plan~~ for implementation ~~in the pending funding cycle~~
- Identifying projects that address these uncertainties
- Being responsive to advancements in science and technology

- Ensuring continuity in data collection

Thus, the critical uncertainties identified in the research plan can serve to inform and shape the research agenda for the region ~~with details to be developed as the research plan is implemented~~. For these reasons the research plan is structured as a framework guidance document for decision-makers and executives. The ~~2007-2009~~ project review ~~selection~~ process will be used to address priority uncertainties set forth in the research plan, restoration priorities set forth in subbasin plans, and some of the monitoring priorities identified by the program and through Columbia River Basin regional processes involving federal and state fish and wildlife agencies and tribes ~~Pacific Northwest Aquatic Monitoring Partnership, or PNAMP (PNAMP, 2002)~~. (For additional explanation of implementation in the project ~~selection~~ review process and prioritization see Appendix B.)

Interaction with Other Research Plans in the Pacific Northwest

The Council recognizes that the status quo for research within the region consists of multiple, separate research plans. These plans refer to the "need to coordinate" with other similar efforts, but rarely set forth explicit steps to implement such coordination. Consequently, the Council developed the research plan, in part, to enhance current coordination and facilitate future collaboration. This research plan recognizes other research plans as important components of a potentially integrated regional research program and provides a framework for establishing linkages between existing research programs and initiatives. Many of the critical uncertainties identified in other research plans in the region have been incorporated into this research plan. Thus, this research plan identifies research that can be funded directly through the program as well as recommendations for research that will require collaborative, multi-party funding commitments by the Council and other entities with similar research mandates.

The Council does not intend to subsume other research programs into the fish and wildlife program and then direct their funding. To the contrary, the Council intends to use program resources to catalyze research requiring long-term commitments such as research supporting the development of a regional approach to monitoring. To the extent possible, the research plan will facilitate the coordination of processes already in place. For example, other plans include the Federal Research, Monitoring, and Evaluation Plan, Anadromous Fish Evaluation Program, the Research Monitoring and Evaluation Plan for the Willamette Valley Projects, Washington State Salmon Recovery Plan, and the PNAMP Aquatic Monitoring Strategy. These plans are not detailed in this research plan. ~~Facilitation will include the convocation of a Regional Research Partnership.~~

~~**Regional Research Partnership: A Forum for Collaboration**~~

~~Many other resource management entities share responsibility for research in support of fish and wildlife stewardship within the Columbia River Basin. Challenges to addressing critical~~

~~uncertainties include how to manage shared responsibility for funding under overlapping mandates and how to sustain long-term funding commitments to support research. Operating individually, resource management agencies have been unable to secure funding commitments necessary to mount and sustain long-term or large-scale field experiments — at the scale of river subbasins or basins. These challenges could be met, however, through a research partnership.~~

~~The partnership would facilitate coordination of research within the Columbia River Basin and also research outside the basin that is highly relevant to program management. The research partnership would provide a forum for Council involvement in discussion of how best to coordinate research conducted by others, such as federal programs that are implemented in states represented on the Council. To ensure the research partnership is a manageable size, membership would comprise entities that conduct a research program or fund research within the region and would exclude the multiple parties that receive research funds from those same entities. The research partnership would facilitate coordination of research within the Columbia River Basin by:~~

- ~~Eliminating redundancies~~
- ~~Facilitating collaborative projects~~
- ~~Redirecting savings to new research priorities~~
- ~~Improving communication among scientists, cooperation among institutions, and coordination of long-term biological monitoring~~

~~The Council is well positioned to co-sponsor a collaborative regional research program that encompasses the entities involved in fish, wildlife, and hydrosystem mitigation in the Columbia Basin. In particular, the Council's membership, structure, and open public meetings and hearings provide opportunities to facilitate coordination among the parties funding research programs. The effort to inaugurate the research partnership could be staffed by the Council until such time that the partnership becomes sufficiently organized for its members to provide support on a rotating basis. CBFWA, Bonneville, NOAA, and the U.S. Geologic Survey all have offered to work with Council staff to help sponsor the research partnership. Initial expectations for the research partnership should be modest, but as its members develop mutual trust over time the partnership could become a useful vehicle for negotiating and advancing on a regional research agenda. (Further explanation of the research partnership is provided in Appendix C.)~~

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Monitoring and Data Management in Support of Research

Implementation of the research plan will require administrative support in two key areas: monitoring and evaluation, and data management. Support for monitoring will come from PNAMP, a partnership that coordinates existing monitoring programs into a regional approach that can provide a basis for evaluation at the programmatic scale (*see* Appendix D). Support for data management will come from the ~~Northwest Environmental Data Network (NED) and~~data management projects supported through the program, such as ~~-~~StreamNet and~~,~~ PITAGIS, and regional collaborative process to facilitate data sharing, such as the PNAMP, Coordinated

Assessments for Salmon and Steelhead, and the Resident Fish Implementation Strategies which are working with others to develop ~~a regional data standards program to support regional data networking~~ tools and guidance to support regional data sharing — a concept the Council supports. ~~(*see* Appendix E).~~

The regional efforts occurring throughout the Columbia River Basin (e.g., ~~of~~ PNAMP, ~~NED,~~ StreamNet, Coordinated Assessments of Salmon and Steelhead), and others already benefit the region significantly. ~~The Regional Research Partnership~~Regional partnerships offer~~s~~ the opportunity to increase the regional benefit by ~~improving the coordination of~~ coordinating research, monitoring, evaluation, and data management and, as a result, potentially redirecting the Council's program based on project results.

Specifically:

- ~~The research p~~Partnerships and coordination of research activities ~~would~~ help improve the ability of the region to reduce scientific uncertainty
- ~~The~~ Partnerships and coordination of monitoring activities ~~partnership would~~help support the programmatic evaluation of the program
- The improvements in data management and sharing ~~partnership could develop a data repository for~~help inform ~~analytical manipulation of data at the~~evaluation and reporting at the programmatic scale

To succeed, the research program must institutionalize accountability at the programmatic scale and therefore must be closely coordinated with ~~PNAMP and NED~~regional efforts. It will be essential to make the results of these research initiatives available to the region. This could be accomplished by the publication of a "Columbia River Basin Journal," which could provide a vehicle for disseminating results of program actions and a forum for advancing regional knowledge (*see* Appendix F).

Relationship to Subbasin Plans

In 2000 the Council initiated subbasin planning to help local entities develop fish and wildlife restoration plans. In 2004 and 2005, 57 subbasin plans that identified needs and opportunities for restoration became part of the fish and wildlife program. The Council amended the 2009 Program to adopt two additional subbasin plans, the Bitterroot subbasin plan in 2010 and the Blackfoot subbasin plan in 2011.The cooperative and inclusive participation of federal, state, tribal, and local stakeholders in subbasin planning created the opportunity for stakeholders to address collectively the critical uncertainties within a subbasin. A staff review found that a minority of the subbasin plans explicitly identified critical uncertainties. Those ~~uncertainties~~ uncertainties will contribute to guiding review and solicitation of research projects~~will support the implementation plan for Fiscal Years 2007-2009~~.

~~Yet m~~Many subbasin plans, however, did not include research or monitoring strategies, and few addressed larger-scale conservation and restoration efforts at the provincial or basin

scale, indicating the need for coordinated planning to ensure that research -addresses uncertainties relevant to a majority of subbasins.

Prioritization Guidance

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The research plan addresses overarching research questions. However, from time to time rapidly emerging management uncertainties may arise that warrant updating the research plan with additional research priorities. Criteria are proposed to identify priority research in the project review process in Appendix B. The results of proposed research projects should have broad application to other provinces or to the basin as a whole, irrespective of where they are located. Consequently, research projects that address the critical uncertainties identified in the research plan and that potentially will help multiple subbasins will be given preference in the project review ~~selection~~ process.

IV. Focal Research Themes and Critical Uncertainties

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The research plan divides important scientific critical uncertainties into 12 focal research themes. The list of critical uncertainties is accepted in the region; the research plan does not include extensive background beyond that necessary to establish the significance of each topic of uncertainty. The critical uncertainties are described at a high level so that the research plan can provide long-range guidance while preserving flexibility of implementation in the near-term. As well, the critical uncertainties are presented this way in order to elicit the development of specific research hypotheses and project proposals without constraining innovative approaches. The critical uncertainties were synthesized from the fish and wildlife program, reports of the Independent Scientific Advisory Board (ISAB) and the ISRP, regional fish and wildlife managers, subbasin plans, national science groups, biological opinions, and other research plans within the region (*see* Appendix G).

(1) Hatcheries/Artificial Production

It is estimated that more than 83 million fish were released from hatcheries in the Columbia River Basin in 2004 (83 million juvenile salmon; FPC 2004) and more than 139.7 million hatchery fish were released in 2011 (139.7 million juvenile salmon, FPC 2012). There are many hatcheries in the basin, and they have diverse purposes including, for example, the culture and release of salmonids, white sturgeon, and largemouth bass. Hatchery uncertainties are therefore partitioned by purpose as defined in the Artificial Production Review (NPCC 1999, Council Document 99-15). These include uncertainties of supplementation and captive rearing for conservation and preservation and uncertainties of conventional production for harvest and reintroduction. The proportion of hatchery fish harvested in the various fisheries has not been determined.

Artificial production is authorized under many mandates in federal and state law, and the Council funds only a modest portion of total hatchery production. The purposes of artificial production include conventional production to mitigate for hydrosystem construction and operation by providing harvest for commercial, sport, and tribal fisheries; conservation of depleted (often ESA-listed) populations using supplementation, captive rearing, and captive broodstocks; and reintroductions of species such as coho and fall Chinook salmon into subbasins where they have been extirpated.

Using artificial production to provide a harvest opportunity carries with it a cost of increasing the risk of extinction or extirpation of naturally spawning independent populations. The Council's 1999 Artificial Production Review defined principles for using artificial production in the basin, beginning with determining the purpose of each hatchery program through the Artificial Production Review Evaluation (NPCC 2004, Document 2004-17). An urgent need remains for fundamental information on the interactions of hatchery-produced fish with wild fish populations (Galbreath et al., 2008; Williams 2005; CENR 2000; NPPC 1999, Document 99-15; NPPC 1999, Document 99-4; NPCC 2000, 2000 Columbia River Basin Fish and Wildlife Program; ISAB 2003, Document 2003-3).

The essential issue for hatcheries now is to determine the balance between their effectiveness and their hazards. Specifically, how detrimental are the releases from "segregated" mitigation and harvest-augmentation programs to wild fish owing to ecological interactions and interbreeding, and how detrimental are the supplementation programs to target and non-target natural populations from ecological interactions and interbreeding? The question of hatchery impacts on natural production extends from local and stock-specific interactions to interactions within large-scale mixed-stock fisheries over very large spatial and temporal scales. Moreover, there needs to be a better understanding of integrating the hatchery approach, which has expected limitations, with other approaches. The Council's 2009~~0~~ Program recommends that artificial production be used under the following conditions: 1) in an integrated manner to complement habitat improvements by supplementing native fish populations up to the sustainable carrying capacity of the habitat with fish that are as similar as possible, in genetics and behavior, to wild native fish; or 2) in a segregated manner to maintain the genetic integrity of the local populations in order to expand natural production while supporting harvest of artificially produced stocks; or 3) to replace lost salmon and steelhead in blocked areas.~~supplementation and habitat restoration be linked with the goal of reestablishing self-sustaining natural salmon populations~~. The 2009 Program incorporates the standards established by the Artificial Production Review (NPCC 1999, Council Document 99-15) as minimum standards for all artificial production projects. Included in these standards is that Artificial production must be implemented within an experimental, adaptive-management design that includes an aggressive program to evaluate the risks and benefits and addresses scientific uncertainties. ~~The program explicitly directs an experimental approach to all hatchery projects~~ (2009~~0~~ Fish and Wildlife Program, page ~~29~~18).

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Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

Conventional Hatchery Production —

1. What is the cost to natural populations from competition, predation (direct and indirect), and disease caused by interactions with hatchery-origin juveniles and from harvest in fisheries targeting hatchery-origin adults?

2. To what extent can interactions between production-hatchery fish and naturally produced wild fish be reduced — for example with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale?

Supplementation —

3. What is the magnitude of any demographic benefit to the production of natural-origin juveniles and adults from the natural spawning of hatchery-origin supplementation adults?

4. What are the range, magnitude, and rates of change of natural spawning fitness of integrated (supplemented) populations, and how are these related to management rules, including the proportion of hatchery fish permitted on the spawning grounds, the broodstock mining rate, and the proportion of natural origin adults in the hatchery broodstock?

5. Can the carrying capacity of freshwater habitat be accurately determined and, if so, how should this information be used to establish the goals and limitations of supplementation programs within subbasins?

All Hatcheries —

6. What is the relationship between basinwide hatchery production and the survival and growth of naturally produced fish in freshwater, estuarine, and ocean habitats?

7. What effect do hatchery fish have on other species in the freshwater and estuarine habitats where they are released?

(2) Hydrosystem

Construction and operation of the hydrosystem caused extensive changes in the Columbia River Basin including major alteration of the riverine environment. Evidence of this alteration includes slow-moving water in reservoirs, habitat degradation in the mainstems of rivers, power-peaking fluctuations in flow, elevated water temperatures, and barriers to fish migration. Therefore the fish and wildlife program emphasizes research of mainstem river operations, including spill, flow augmentation, and fish transportation. Fish-passage standards, objectives, designs, and evaluations must be related to increases in adult fish returning to spawning grounds (juvenile-to-adult survival rates), not just the incremental survival of juvenile fish or adult fish through the Columbia River Basin hydropower system.

Technologies that most closely approximate the natural physical and biological conditions of migration most likely would accommodate diverse species life histories, and multiple passage systems likely are needed to fully protect all species. For example, surface bypass systems take advantage of the tendency of yearling smolts to pass dams near the surface of the river. Fish that migrate lower in the water column can be diverted by screens into other bypass systems or passed through high efficiency~~the~~ turbines.

In some locations, such as the Willamette River subbasin, juvenile fish passage may be particularly challenging due to the difficulty in creating adequate attraction flows and safe passage routes over or around high head dams. A lack of successful examples of juvenile passage at high head dams elsewhere is notable. Experimental studies, fish passage model simulations, computational fluid dynamics (CFD) modeling[1] and perhaps even physical modeling may be required to assist researchers in developing workable solutions to high head juvenile fish passage impediments.

River operations significantly different than the status quo need to be tested to provide information for resolving key uncertainties about the hydrosystem impacts on fish. There is considerable uncertainty about the effects of changes in river flows, spill, and water quality on the migratory behavior of juvenile and adult fish. Experimental studies of all aspects of

[1] **Computational fluid dynamics**, usually abbreviated as **CFD**, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems involving fluid flows.

mainstem flow manipulation, including load following, are needed to determine the effects ~~-~~on fish survival (ISAB Document, 2003-1; Council's 2009 Program). For instance, determining the effects on migration of stage waves and turbulent bursts or pulsing flows may provide information that supports opportunities for water management that could be 1) more effective in moving fish; and, 2) provide greater opportunity for power generation than current procedures. The secondary effects of flow differences on near-shore habitat conditions in reservoirs (temperature, flow, and food production) and effects of shoreline modifications along reservoirs (rip-rap, erosion, and permanent sloughs) also need to be evaluated. Additionally, recent studies on out-migrating juvenile fall Chinook indicate that they have a more complex migratory life history than previously thought, calling into question the estimated juvenile survival through the hydrosystem and the current use of transportation, spill, and flow augmentation to protect fall Chinook (ISAB Document 2004-2).

Previous large-scale analytical assessments (Peters and Marmorek 2001; Karieva et al. 2000; Wilson 2003; Haeseker et al. 2012) evaluated management options for halting the decline of the Snake River stream-type Chinook populations. These results depended on whether the source of mortality in the estuary and early in the ocean residence of fish is related to earlier hydrosystem experience (delayed mortality) during downstream migration. ~~Substantial e~~Evidence suggests that ~~Snake River Chinook~~ salmon experience delayed mortality as the result of their passage through the hydrosystem (Budy et al. 2002; Marmorek et al 2004).

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What is the relationship between levels of flow and survival of juvenile and adult fish through the Columbia Basin hydrosystem? Do changes in spill and other flow manipulations significantly affect water quality, smolt travel rate, and survival during migration? How do effects vary among species, life-history stages, and migration timings? What is the role of hydrodynamic features other than mid-channel velocity in fish migration? What is the relationship between ratios of transport, inriver return rates, and measurements of juvenile survival (D values)?

~~2. Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?~~

2~~3~~. What are the effects of multiple dam passages, transportation, and spill operations on adult fish migration behavior, straying, and pre-spawn mortality, and juvenile-to-adult survival rates? E.g., Under what conditions is delayed mortality related to downstream migration through the hydrosystem, and what is the magnitude of that delayed mortality?

~~4~~3. What is the effect of hydrosystem flow stabilization, flow characteristics, and channel features on anadromous and resident fish species and stocks? What are the ecological effects of hydrosystem operations on (a) downstream mainstem, estuarine, and plume habitats and, (b) on different populations of fish and wildlife?

~~5~~4. What are the optimal temperature and water quality regimes for fish survival in tributary and mainstem reaches affected by dams, and are there options for hydrosystem operations that would enable these optimal water quality characteristics to be achieved? What would be the effects of such changes in operations and environment on fish, shoreline and riparian habitat, and wildlife?

5. Is passage juvenile passage over or around high-head dams feasible and practical?

(3) Tributary and Mainstem Habitat

Degradation, loss, and fragmentation of habitat have contributed substantially to the depletion of fish and wildlife populations in the Columbia River Basin. Fish and wildlife habitat has been severely degraded by dams and diversions, sedimentation from forestry and agriculture, and the introduction of nonnative species. Native fish and wildlife are sustained by complex and interconnected habitats, which are created, altered, and maintained by natural physical processes. Restoration efforts must focus on restoring habitats and habitat connectivity and on developing ecosystem conditions and functions that will support diverse species.

The 2009~~0~~ Fish and Wildlife Program places importance on improved natural habitat for fish spawning and rearing throughout their life cycle, including tributary, estuary, and marine stages. The critical ecosystem features for the full life cycle of salmonid species and stocks must be defined (CENR, 2000), and the dynamic relationships between habitat and fish and wildlife productivity must be better understood to conserve and restore fish and wildlife populations. A comprehensive life-cycle approach that addresses both natural variability in environmental conditions and human impacts on physical, chemical, and biological processes affecting fish and wildlife populations must be defined (ISAB, 2003-2). It is also necessary to have an understanding of food-webs in these systems to be able to assess interactions between mitigation efforts and the response in aquatic species~~-~~ (ISAB, 2011-11). A comprehensive landscape approach is also needed when mitigating and assessing effectiveness of habitat conservation and restoration as species and populations depend on the highly heterogeneous characteristics of land, water, and people (ISAB, 2011-4).

Several critical knowledge gaps must be addressed. The Interior Columbia Basin Ecosystem Management Project was largely limited to federally managed lands~~,~~. Recently the Council recommended that Bonneville funds a pilot project to assess the status and trend of aquatic tributary habitat for salmon and steelhead in the Columbia River Basin (i.e., Columbia Habitat and Monitoring Program – Pilot) and continues to support a comprehensive approach to monitoring of aquatic habitat in the lower Columbia River estuary (e.g. the Lower Columbia River Estuary Ecosystem Monitoring; consult www.cbfish.org for more information on these and other Council recommended and Bonneville funded aquatic habitat monitoring projects)~~and the Council should support a similar initiative to assess the status of habitat throughout the Columbia River Basin~~. Hopefully, ~~, as~~ this information ~~is essential in~~will assist in developing a sound, basinwide restoration strategy. The rate of habitat loss should be quantified, and locations of habitat loss and restoration should be inventoried and evaluated to assess how well the current and projected habitat template supports the life history needs of fish and wildlife. The

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effectiveness of present best management practices and restoration techniques must be resolved by scientific evaluation at both site-specific and watershed scales. Finally, little is known about the food webs in the Columbia Basin, especially in the tributaries (e.g., how have they been altered by land and water use, by the introduction of toxics and of non-native plants and animals, by harvesting, and by climate change). Scientific understanding of the role of nutrients in the growth of juvenile salmon in freshwater and estuarine conditions is also incomplete, but fewer adult salmon returning to spawn in many streams has resulted in decreased import and transport of nutrients such as nitrogen and phosphorus.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of native fish populations?

2. Are the current procedures being used to identify limiting habitat factors accurate?

3. What are the impacts of hydrosystem operations on mainstem habitats, including the freshwater tidal realm from Bonneville Dam to the salt wedge? How might hydrosystem operations be altered to recover mainstem habitats?

4. What pattern and amount of habitat protection and restoration is needed to ensure long-term viability of fish and wildlife populations in the face of natural environmental variation as well as likely human impacts on habitat in the future?

(4) The Estuary

The Columbia River estuary constitutes the physical and biological interface for fish as they move between their freshwater and ocean life stages. Juvenile anadromous fish rear and undergo adaptation to marine conditions in the estuary, and rearing locations, seasonal timing, residence timing, and migration pathways differ between species and stocks. Wetlands and tidal channels are important rearing habitats for some fish. The Columbia River estuary also provides important rearing habitat for other marine animals and year-round habitat for estuarine species.

The estuary has been impacted by habitat development and management locally, and upriver. Changes in biological processes range from alteration in the food web to the exclusion of fish from large portions of the tidal marshes. Changes in seasonal flows following the development of the hydrosystem have resulted in changes to estuarine circulation, sedimentation, and biological processes. Although all of the anadromous fish must migrate~~flow~~ through this unique environment, the effects of restoration projects in the estuary have not been fully evaluated and many basic biological functions of the estuary in the life cycle of fish remain poorly understood. Monitoring of the ~~physical~~fish and estuary habitat~~environment~~, ~~such as that currently under way by the Oregon Graduate Institute~~, and evaluation of large-scale manipulations of estuarine habitats can be combined to better understand the role of the estuarine

environment and its degradation or restoration in the success or failure of salmonid populations (ISRP, 2003-13).

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What is the significance to fish survival, production, and life-history diversities of habitat degradation or restoration in the estuary as compared with impacts to other habitats in the basin? How does this partitioning of effects vary among species and life-history types?

2. What are the highest priority estuarine habitat types and ecological functions for protection and restoration (e.g., what are most important habitats in the estuary for restoring and maintaining life-history diversities of subyearling Chinook and chum salmon, and how effective were past projects in restoring nursery/feeding areas)?

3. What specific factors affect survival and migration of species and life-history types of fish through the estuary, and how is the timing of ocean entry related to subsequent survival?

(5) The Ocean

Recent research has established that global- and regional-scale processes in the ocean and atmosphere can influence the production of anadromous species such as salmon, lamprey, and cutthroat trout, as well as the structure and dynamics of marine ecosystems. Natural variation in these processes must be understood to correctly interpret the response of fish to management actions in the Columbia Basin (e.g., ISRP, 2012-3; Jacobson et al., 2012).

The marine survival of juvenile fish, and their growth rates and age and size structures, are linked to local and regional processes in the North Pacific Ocean. Salmon abundances in the California Current region (off Washington, Oregon, and California) and in the Gulf of Alaska (Alaska Current) may respond in opposite ways to shifts in climatic regime. For example, during periods of a strong low pressure in atmospheric circulation over the North Pacific Ocean in winter (Aleutian Low), zooplankton production and early marine survival of juvenile salmonids generally increase in the Alaska Current and decrease in the California Current. Climatic phase shifts characteristic of the strong Aleutian Low regime occurred from about 1925 to 1946 and after 1976/77; both periods were marked by precipitous declines in the coho salmon fishery off Oregon. Opposing cycles of salmon abundance between the Alaska Current and the California Current regions underscore the importance of stock-specific regulation of ocean fisheries. In 1999, a phase shift in the Victoria climate pattern and sea surface temperature seems to have influenced productivity of the California Current more than the Alaska Current. As a result of favorable marine conditions in both the California and Alaska currents, the total production of salmon in the eastern North Pacific and Gulf of Alaska reached an all-time high in the early 2000s.

While the marine production of salmon can be tied to major oceanic and atmospheric circulation, salmon life cycles are shorter than the inter-decadal periods of large-scale climatic change, and short-term climate change phenomena such as the El Nino-Southern Oscillation also can have a strong influence on freshwater and marine survival of salmonids. Thus, the ability to predict adult salmon returns in the face of both short-term and long-term climate change is critical to harvest management and recovery of depressed stocks of Columbia River salmonids. While the abundance of salmonids is known to track large- and small-scale shifts in climate, the specific mechanisms of biological response are poorly understood. Decadal and interannual cycles of ocean productivity have the potential to mask changes in the survival of salmon during freshwater phases of their life cycle, confounding interpretation of the performance of restoration efforts and increasing losses of some stocks. There is also increasing evidence that ocean fisheries on groundfish (Pacific whiting, walleye, pollock, halibut, etc.) and coastal pelagic species (squid, sardines, anchovies, etc.) may affect salmonids through food web interactions. Stocks with different life history traits and ocean migration patterns may be favored under different combinations of climate and more local conditions, and such differences may afford stability to salmon species in the face of environmental variability. Conservative standards for harvest, hatchery practices, and freshwater habitat protection may be necessary even during periods of high ocean productivity to maintain the genetic diversity needed to withstand subsequent troughs in productivity.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. Can stock-specific data on ocean abundance, distribution, density-dependent growth and survival, and migration of salmonids, both hatchery and wild, be used to evaluate and adjust marine fishery interceptions[2], harvest, and hatchery production in order to optimize harvests and ecological benefits within the Columbia River Basin?

2. Can monitoring of ocean conditions and abundance of salmon and steelhead during their first weeks or months at sea improve our ability to predict interannual fluctuations in the production of Columbia Basin Evolutionarily Significant Units (ESUs) or populations to enable appropriate changes to harvest levels?

3. How can interannual and interdecadal changes in ocean conditions be incorporated into management decisions relating to hydrosystem operations, the numbers and timing of hatchery releases, and harvest levels to enhance survival rates, diversity, and viability of ESA-listed salmonids?

4. What are the effects of commercial and sport fishing on ocean food webs?

(6) Harvest

[2] Interceptions are catches of juvenile, immature, or maturing fish by non-target fisheries.

Harvest management for many fish populations in the Columbia River Basin has substantially changed due to state and federal listings. Recently, the Washington State Department of Fish and Wildlife and the Confederated Tribes of the Colville Reservation have begun experimenting with alternative gear to decrease the impact on fish species listed under the Endangered Species Act (see individual project proposals at www.cbfish.org). Harvest for listed populations is managed under biological opinions that attempt to ensure fisheries do not pose jeopardy to listed fish species. Most current harvest management targets fish from mitigation hatcheries; productivity to support harvest has been largely divorced from production in natural habitat.

The ISAB Harvest Management Review (ISAB, 2005-4) addressed the question: what constitutes a sound scientific basis for the management of Pacific salmonids in the Columbia River Basin? The report also noted critical uncertainties as to the effect of harvest on the conservation of naturally produced salmonids, including the fundamental need to better monitor and understand mixed-stock fisheries. Three fundamental components of harvest management were identified as causes of concern: a paucity of quantitative data for analyses by population units; limited identification and assessment of the catches of hatchery and wild stocks to identify trends in their status and provide a biological basis for production goals; and limited evidence of accounting for uncertainty in management plans. Similarly, concerns about the gap in knowledge in the biology of harvested species and in their management approach were recently highlighted by the ISRP for Columbia River white sturgeon, Pacific lamprey (ISRP, 2012-44a)

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What are the effects of fishery interceptions and harvest in mixed-stock areas, such as the ocean and mainstem Columbia, on the abundance, productivity, and viability of ESUs or populations, and how can fishery interceptions and harvests of ESUs or populations, both hatchery and wild, best be managed to minimize the effects of harvest on the abundance, productivity, and viability of those ESUs and populations?

2. What new harvest and escapement strategies can be employed to improve harvest opportunities and ecological benefits within the Columbia Basin while minimizing negative effects on ESUs or populations of concern? Can genetic techniques be used to quantify impacts on wild or ESA-listed stocks in ocean fisheries?

3. How can the multiple ecological benefits that salmon provide to the watersheds where they spawn (e.g., provision of a food resource for wildlife and a nutrient source for streams and riparian areas) be incorporated effectively into procedures for establishing escapement goals?

(7) Population Structure and Diversity [Erik/Jim/Laura: anything else from ISAB and ISRP?] Bear in mind we don't want to extend the length much]

Fish and wildlife populations are characterized by life history, ecological, behavioral, phenotypic, and genetic diversity, which buffer populations against short- and long-term environmental variation. For anadromous salmonids, stock diversity has been reduced by the extinction of many local populations, as well as a reduction in population size of most remaining populations. Moreover, losses of genetic diversity within populations may have decreased fitness and therefore decreased the probability of long-term persistence for many stocks. A better understanding is needed of the dominant processes influencing the distribution, interconnection, and dynamics of populations through time and space. These factors are likely true for pacific lamprey, white sturgeon, bull trout, and other resident fish species.

Additionally, populations are a fundamental unit of viability analysis, and effectively evaluating the status of a species may depend on correctly understanding its population structure. Identification of strong, weak, and at-risk native populations is a critical step in determining what actions can be taken to preserve and protect populations of salmoinds (*see* ISAB, 2001-7), and likely applicable to pacific lamprey, white sturgeon, bull trout, and other resident fish species, populations, and sub-populations. Several species (e.g., resident and anadromous rainbow, ocean and reservoir type fall Chinook) have co-occurring life-history types that are poorly understood and pose critical problems for management.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What approaches to population recovery and habitat restoration are most effective in regaining meta-population structure and diversity that will increase viability of fish and wildlife in the Columbia River Basin?

2. How do artificial production and supplementation impact the maintenance or restoration of an ecologically functional metapopulation structure?

3. What is the relationship between genetic diversity and ecological and evolutionary performance, and to what extent does the loss of stock diversity reduce the fitness, and hence survival rate and resilience, of remaining populations?

4. What are the differential effects of flow augmentation, transportation, and summer spill on “ocean type vs. reservoir type” fall Chinook?

(8) Effects of Climate Change on Fish and Wildlife

Variation in climate and ocean conditions are now recognized as major contributors to fluctuations and trends in fish and wildlife abundance. Global climate change may interact with shorter-term climate patterns to accentuate these effects on fish and wildlife. In the Pacific Northwest, reduced ocean survival of salmon and stressful freshwater conditions, due to low precipitation, low stream flow, and high stream temperatures, tend to be concurrent. The changes in regional snowpack and stream flows in the Columbia Basin that are projected by

many climate models could have a profound impact on the success of restoration efforts and the status of anadromous fish, resident fish and wildlife populations (ISAB, 2007-2). Nevertheless, climate change is rarely incorporated into natural resource planning. Additionally, the cumulative effects of human development of the Basin may become apparent only when climatic conditions trigger a dramatic response.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. Can integrated ecological monitoring be used to determine how climate change simultaneously affects fish and wildlife and the freshwater, estuarine, ocean, and terrestrial habitats and ecosystems that sustain them?

2. Can indices of climate change be used to better understand and predict interannual and interdecadal changes in production, abundance, diversity, and distribution of Columbia Basin fish and wildlife?

3. What long-term changes are predicted in the Columbia River Basin and the northeast Pacific Ocean, how will they affect the fish and wildlife in the region, and what actions can ameliorate increased water temperatures, decreased summer river flows, and other ecosystem changes?

(9) Toxics

Toxic contaminants need to be evaluated by the fish and wildlife program, as toxics could negate much of the good work being accomplished in the basin (ISAB, 2011-1). Toxics have been recognized as a problem since bald eagles and osprey, which eat fish from the river that contain various contaminants, were almost eliminated from the Columbia Basin by the mid-1970s. Reproduction continues to be adversely affected by DDE in a portion of the Columbia River osprey population. Many of the legacy contaminants (e.g., DDE, PCBs) have been declining for years, but new emerging contaminants are taking their place as contaminants of concern. Flame-retardants polybrominated diphenyl ethers (PBDEs) are one group of special concern in the Columbia River. Based upon data from the upper Columbia River, PBDE concentrations in fish are doubling every 1.6 years, and PBDEs have been found in bald eagle eggs from the lower Columbia River and in all 15-osprey eggs sampled from Puget Sound in 2003. Many other emerging contaminants, including modern pesticides and pharmaceuticals, need to be investigated. An adequate toxics monitoring and research program needs to be developed as a coordinated effort of various agencies and groups, including the Council. Guidance for this work could come from the interagency Columbia River Basin Toxics Reduction Action Plan (US EPA 2010).

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will

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inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What is the distribution and concentration of toxics, including emerging contaminants, in the Columbia River Basin, and what are/have been their trends over time?

2. How do toxic substances, alone and in combination, affect fish and wildlife distribution and abundance, survival, and productivity?

(10) Invasive Species

Invasive species[3] comprise one of the most significant alterations of native ecosystems and are rapidly becoming a dominant component of ecosystems within the Columbia River Basin (Office of Technology Assessment, 1993). For instance, a recent survey found 81 nonnative aquatic species below Bonneville Dam[4] and, although the impacts of non-native fish stocked for recreation are widely recognized, many other non-native plants and animals also could have a large impact on aquatic habitat and productivity (e.g., Eurasian milfoil, New Zealand mud snail, zebra mussel, Japanese knotweed, Himalayan blackberry, giant reed, and riparian-associated animals such as livestock). Non-native species affect native fish and wildlife both directly , such as by predation or competition, ~~(e.g., as predators or competitors,~~ or indirectly, by altering food webs, water chemistry, physical habitat attributes (e.g., ISAB, 2011-1; ISRP, 2012-6). Some of the most challenging long-term management problems involve nonnative, invasive species, such as the widespread rainbow and brook trout, which were introduced to provide angling opportunities. Intentional introductions of taxa have proven just as likely to cause harm as unintentional introductions (Office of Technology Assessment, 1993).

Additionally, there is conflict between the value of fish passage restoration for native species and the chance that such passage may allow non-native species, such as New Zealand mudsnails, crayfish, other nonnative fish (e.g., Atlantic salmon), and new diseases, to spread. Thus, there is a need for better assessments of the biological and economic consequences of invasions, including research to identify patterns and consequences of invasions on species and ecosystems. Initial baseline information and monitoring are necessary to detect trends in abundance of non-native and invasive species, and targeted research on invasives is required to better understand the structural and functional changes in ecosystems, habitats, and food webs that they cause.

There have been relatively few examples of success in eradicating well-established invasive species at an ecosystem level. Prevention of introduction and detection of new

[3] For the purpose of this plan, invasive and native species are defined as, as follows: "invasive species" means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health, and "native species" means a species that historically occurred or currently occurs in an ecosystem, without being the result of an introduction. (Section 1 of Presidential Executive Order 13112 Invasive Species).

[4] www.clr.pdx.edu/projects/cr_survey

introductions are therefore essential. A proactive approach to anticipating invasions and identifying areas at-risk could potentially save many millions of dollars in future efforts to control species once they become established and threaten native flora and fauna. Research is needed to identify pathways of introduction and related preventive actions that can reduce the risks of introduction and spread of non-native species.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What is the current distribution and abundance of invasive and deliberately introduced nonnative species (e.g., the baseline condition), and how is this distribution related to existing habitat conditions (e.g., flow and temperature regimes, human development, restoration actions)?

2. To what extent do (or will) invasive and nonnative species significantly affect the potential recovery of native fish and wildlife species in the Columbia River Basin?

3. What are the primary pathways of introduction of invasive and nonnative species, and what methods could limit new introductions or mitigate the effects of currently established invasives?

(11) Human Development

Like climate change, the impact of human population growth in the Columbia Basin is widely recognized (ISAB, 2007-3; ISAB, 2011-4), but is rarely incorporated into fish and wildlife planning. The human population of the Columbia Basin is increasing rapidly, a trend that is expected to continue. This increase is largely concentrated in and around urban areas, but affects non-urban areas as well, through recreation, housing, and changing land uses. At the same time, the economy of the region is shifting, with the potential for both positive and negative impacts on fish and wildlife and their habitats. The Council's program and the NOAA Fisheries restoration plans do not include consideration of human population trends. The fish and wildlife program mitigates human impacts on fish, wildlife, and their habitats, and it is important to consider demographic and economic trends and their potential impacts on efforts to restore and recover fish and wildlife resources.

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. What changes in human population density, distribution, and economic activity are expected over the next 20 years? 50 years?

2. How might the projected changes under different development scenarios affect land use patterns, protection and restoration efforts, habitats, and fish and wildlife populations?

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(12) Monitoring and Evaluation

Adaptive management, using scientifically well-informed management actions and information drawn from their implementation, is recognized as essential to effective implementation of the fish and wildlife program. Adaptive management requires monitoring and evaluation, including status and trend monitoring of fish, wildlife, habitats, and ecosystems, and action effectiveness research, to provide information with which to evaluate project outcomes relative to project objectives and programmatic standards. Monitoring contributes needed information to address whether biological and programmatic performance objectives established within the fish and wildlife program (e.g., subbasin plans and mainstem amendments; FCRPS BiOp; and ESA Recovery Plans) are being met; how current management should be changed to better meet those objectives; what factors are limiting ability to achieve performance standards or objectives; and what mitigation actions are most effective at addressing the limiting factors. This research plan identifies four critical monitoring and evaluation needs, listed below, in addition to the need to support additional monitoring priorities and programs as a collaborative partner. ~~in a Regional Research Partnership~~.

Some priority research topics require a monitoring program for answers. For example, supplementation has significant critical uncertainties that require extensive and coordinated monitoring to resolve (ISRP and ISAB, 2005-15; Galbreath et al., 2008). This can be addressed by coordination of supplementation projects across the Columbia River Basin so that, in aggregate, they constitute a basinwide adaptive management experiment that includes un-supplemented reference streams. Thus, an initial monitoring and evaluation priority will be to address the following four critical uncertainties:

Critical Uncertainties: [note: once a compilation of recent uncertainties is completed, we will assess if new questions are needed for the below section – input from the region and ISAB will inform whether others need to be added and whether any can be considered addressed and thus removed]

1. Can a common probabilistic (statistical) site selection procedure for population and habitat status and trend monitoring be developed cooperatively?

2. Can a scientifically credible trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format be developed?

3. Can empirical (e.g., regression) models for prediction of current abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat be developed?

4. Make best professional judgment, based on available data, as to whether any new research in the spirit of the Intensive Watershed Monitoring approach should be instigated

immediately. Most new intensive research should arise as a result of the interaction of existing inventory data with new data arising in population and habitat status and trend monitoring.

The last three uncertainties were identified as key steps for building a foundation to address critical monitoring needs of the fish and wildlife program, as well as to support the coordinated monitoring and evaluation needs of other regional research and management programs, *see* ISRP Retrospective Report (ISRP, 2005-14).

There are a number of existing efforts in the region to coordinate and collaborate around monitoring and evaluation, but until recently there has been a lack of an organizing principle or central forum to facilitate these efforts. In 2005, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) was chartered to provide such a forum. As members of PNAMP, the Council, Bonneville, and the fish and wildlife managers are working to implement the fish and wildlife program within the context of a regional network of monitoring effort so that the shared monitoring needs and objectives of the program can be achieved. Other regional efforts that have targeted specific monitoring and evaluation needs include the development of the draft Anadromous Salmonid Monitoring Strategy, the draft Resident Fish Implementation Monitoring Strategies, the draft Wildlife Implementation Monitoring Strategy, the Coordinated Assessment for Salmon and Steelhead (documents are accessible from http://www.nwcouncil.org/fw/merr/Default.asp). ~~The Council has directly supported this work through the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) to assure and facilitate implementation within the Columbia Basin. In close coordination with PNAMP, the CSMEP has been working since October 2003 to develop rigorous approaches to monitoring and evaluation that directly serve the needs of specific decisions, and build on the strengths of existing monitoring infrastructure. PNAMP and CSMEP have been, and will continue, working closely together.~~

V. APPENDIXES

Appendix A. Context for the Research Plan

Objectives of the Council's Fish and Wildlife Program

This appendix provides additional explanation of the rationale for the research plan. In 1980, Congress passed the Pacific Northwest Electric Power Planning and Conservation Act[5] that authorized the states of Idaho, Montana, Oregon, and Washington to create the Northwest Power and Conservation Council. The Act directs the Council to develop a program to:

> *"...protect, mitigate and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries ... affected by the development, operation and management of [hydroelectric projects] while assuring the Pacific Northwest an adequate, efficient, economical and reliable power supply."*

The Council's Columbia River Basin Fish and Wildlife Program is one of the largest regional efforts in the nation to recover, rebuild, and mitigate impacts of hydropower dams on fish and wildlife. As a planning, policy-making, and reviewing body, the Council develops and monitors the program, which is funded by the Bonneville Power Administration and implemented by tribal, state, and federal fish and wildlife managers and others. The Council adopted the first fish and wildlife program in November 1982. The ~~latest revision of the program, in~~ 2000 program, marked a significant departure from past versions, which consisted primarily of a collection of measures directing specific activities. In contrast, the 2000 Program establishes a basinwide vision for fish and wildlife along with four overarching biological objectives:

- A Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife
- Mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operation of the hydrosystem
- Sufficient populations of fish and wildlife providing abundant opportunities for tribal trust and treaty right harvest and for non-tribal harvest
- Recovery of the fish and wildlife affected by the development and operation of the hydrosystem that are listed under the Endangered Species Act

[5] Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501, 94 Stat. 2697 (December 5, 1980), codified with amendments in U.S Code Annotated 16, section 839 (2000)). Relevant to this research plan, Section 839b(h)(6)(B) directs the Council to include in the fish and wildlife program measures the Council determines are based on, and supported by, the best available scientific knowledge.

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The 2009 program maintained the scientific foundation of the 2000 program including the basinwide vision and overarching biological objectives.

Mandate for the Research Plan

Critical uncertainties have persisted for years because the relevant research questions are difficult to answer due to: environmental variability; the complexity of the Columbia River Basin environment; and the inherent difficulty in agreeing on specific problem definitions. In addition, over the course of the development of the program, the Council adopted specific measures for research without a research plan to provide clear prioritization of the remaining critical uncertainties. Without a research plan it was difficult to focus on those uncertainties, and so in the 2000 Program the Council called for development of a Columbia River Basin Research Plan. The plan will guide the development of a research program and foster collaboration with the research programs of other resource management entities within the region. Specifically, the Basinwide Provisions (D.9) state that:

> *"The Council will establish a basinwide research plan, similar to the subbasin plans, which identifies key uncertainties for this program and its biological objectives and the steps needed to resolve them. The plan will identify major research topics, including ocean research, and establish priorities for research funding."*

The 2009 program reiterates the commitment of the 2000 program to identify and prioritize uncertainties (Basinwide Provisions section D.9). The 2009 program further provides guidance mirroring the 2006 Research Plan (document 2006-03) about collaboration and coordination, and calls for the 2006 Research Plan to be updated:

> *"The Council, in collaboration with the parties listed above, will identify research priorities to resolve critical ecosystem or biological uncertainties. Research will focus on those areas where, in a reasonable amount of time, results could be generated or tools developed to better inform management decisions and to more efficiently deploy Program mitigation resources.*
>
> ***Research plan:** The Council, with assistance from the parties listed above, will update its research plan, which identifies major research topics and establishes priorities for research funding.*
>
> ***Coordination:** The research plan will be updated in a transparent manner to ensure all interested parties in the region have an opportunity for input."*

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Appendix B. Implementing the Research Plan ~~in Fiscal Years 2007-2009~~through Project Review Process and Prioritization

This appendix explains the methods by which research project proposals are ~~were~~ solicited; and reviewed by the Independent Scientific Review Panel, and evaluated against decision criteria for identifying priorities. ~~The appendix includes a table depicting the conceptual framework for a regional approach to research, monitoring, and evaluation and describes how the research plan will be implemented in Fiscal Years 2007-2009.~~

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~~**Project Selection Process for Fiscal Years 2007-2009**~~

~~**The project selection process for fiscal years 2007-2009 provides a vehicle for implementing research that is central to the program, research that supports the mitigation and restoration of wildlife, resident fish, unlisted anadromous fish, and listed anadromous fish. In contrast to the fiscal years 2004-2006 funding cycle, the fiscal years 2007-2009 process will benefit from the priorities established in the research plan, in subbasin plans, in the PNAMP Aquatic Monitoring Strategy, and in NOAA recovery planning documents. Furthermore, the authors of these planning documents collaboratively developed a framework for implementing a regional approach to research, monitoring, and evaluation. This is depicted in Table 1 at the end of this appendix. These sets of priorities, and the framework, have provided targets for project proposals and guidance for the review and evaluation of ongoing and proposed research.**~~

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~~**The Fiscal Years 2007-2009 project selection process provides an immediate opportunity to begin work on these critical uncertainties. The competing demands on program funding underscore the need for an assessment of proposed research activity in relation to on-going research. Many restoration projects contribute to resolving critical uncertainties because they have a research component, but research is a component and not the primary focus. Therefore, the implementation of new research may require a reallocation of research dollars during Fiscal Years 2007-2009 and subsequent funding cycles. In many cases, existing projects may provide a strong start for a new research focus. For example, ongoing projects with strong links to regional research priorities will be considered as vehicles for addressing those priorities.**~~

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~~**The fact that there may be multiple ongoing projects addressing a research topic does not preclude an enterprising sponsor from proposing a new or novel approach to the same problem. In the past, the Council has received project proposals submitted in response to solicitations that were geographic in scope; the Council did not actively seek proposals to address specific critical uncertainties. The prior open approach to solicitations proved costly in terms of failing to address the knowledge gaps, frustrating project sponsors, and expending ISRP review time on proposals that neither the Council nor Bonneville would consider funding. In the past the ISAB and ISRP have suggested directing the available research and monitoring resources to a smaller number of projects that are well-designed and have the intellectual and financial resources to generate useful information.**~~

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~~**Methods of Project Solicitation**~~

~~**The Northwest Power Act affords the Council broad discretion to develop the procedures for conducting project review and selection.**~~

~~**Rolling Provincial Reviews**~~

~~**For planning purposes within the Columbia River Basin, the Council has delineated 11 ecological provinces comprising groups of adjoining subbasins that have similar ecological attributes. These provinces constitute the geographic scale at which the recent project selection process was implemented on a three-year cycle.**~~

~~**Each province has its own uncertainties concerning environmental issues and fish and wildlife populations, some of which might be resolved by research projects. Subbasin plans have helped identify the most appropriate geographic locations for siting research projects. In cases where multiple provinces share similar uncertainties, solutions in one province may inform efforts in others. Project sponsors were free to propose research projects unique to their geographic location but were encouraged to propose research that provides a basis for extrapolation outside of the subbasin in which the project is located. Research projects with basinwide implications should compete with each other in the mainstem/systemwide project review, not in multiple provincial reviews.**~~

Requests for Proposals

To implement the Council's Fish and Wildlife Program, the Bonneville Power Administration (Bonneville) and the Northwest Power and Conservation Council (Council) regularly review projects to benefit fish and wildlife populations affected by the Federal Columbia River Power System. Past review processes have taken many forms including program-wide solicitations, rolling provincial reviews, and targeted solicitations.

Based on the experience with these past review processes, the Council and Bonneville, with input from fish and wildlife managers and Independent Scientific Review Panel (ISRP) staff, have developed a review structure to most effectively review projects for Program implementation beginning in Fiscal Year 2010 and beyond. This review structure includes a category review (i.e., strategy and topic) for existing projects that are similar in nature and intent, followed by a geographic review (by subbasin and province), that may result in targeted solicitations. For each of the reviews (categorical and geographic) there are five review steps that occur prior to final funding decisions. The process includes *planning*, *sponsor reports*, *ISRP review* (and site visits), *staff recommendations*, *Council recommendations*, and finally Bonneville funding decision (for details on each of these steps consult: http://www.nwcouncil.org/fw/budget/2010/wildlifereview2.pdf).

~~In the past, the Council identified questions of particular importance and initiated requests for proposals in coordination with Bonneville as needed. Future project solicitations that occur after completion of the research plan may attract research proposals consistent with recommendations in the plan. However, for research recommendations for which no proposals are forthcoming, and/or for recommendations the Council decides to implement in the interim,~~

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~~requests for proposals could be initiated. Requests for proposals should be used independent of, or in concert with, broader solicitations to ensure the efficient effort of project sponsors, the ISRP, the managers, and the Council.~~

Review of Project Proposals by the ISRP

The Northwest Power Act also requires all project proposals to undergo an independent scientific review of specific project proposals by the ISRP to ascertain their scientific and technical merits. The 1996 amendment to the Northwest Power Act requires the ISRP to determine whether projects proposed for funding:

- Are based on sound science principles
- Benefit fish and wildlife
- Have clearly defined objectives and outcomes
- Have provisions for monitoring and evaluation of results
- Are consistent with the program

The ISRP review process includes the following steps:

1. evaluation of proposals and supporting documents such as management plans, past reports, and monitoring and evaluation data;
2. a tour of a subset of past and proposed project sites;
3. project presentations (preceding or following the site visit depending on logistics) with an opportunity for questions from the ISRP;
4. a preliminary ISRP review with a response loop and public comment period to provide an opportunity for project sponsors and the public to address ISRP concerns and/or incorporate ISRP suggestions;
5. a final ISRP report with recommendations on each project and programmatic comments on scientific issues that apply across the wildlife category
6. an ISRP presentation to the Council summarizing the ISRP's findings

The ISRP's review criteria shown below further define and link these amendment criteria to the proposal form. This linkage allows the reviewers to read the proposal and determine to what extent the criteria are met in each section. The ISRP criteria apply to all kinds of projects from operation and maintenance of a hatchery to habitat acquisition to gamete preservation research. Some individual projects include several unique strategies.

The ISRP's preliminary and final reports will provide written recommendations and comments reflecting the consensus of the ISRP on each proposal that is amenable to scientific review.

For each proposal, the ISRP provides a recommendation to the Council based on the above assessment. The ISRP, as of April 2012, uses the following terms for final recommendations:

- Meets Scientific Review Criteria
- Meets Scientific Review Criteria (Qualified)
- Meets Scientific Review Criteria - In Part
- Meets Scientific Review Criteria - In Part (Qualified)

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- Does Not Meet Scientific Review Criteria
- Not Applicable

For preliminary reviews the ISRP also uses:

- Response Requested

The full definitions for the above ISRP recommendation categories are:

1. Meets Scientific Review Criteria is assigned to a proposal that substantially meets each of the ISRP criteria. Each proposal does not have to contain tasks that independently meet each of the criteria but can be an integral part of a program that provides the necessary elements. For example, a habitat restoration project may use data from a separate monitoring and evaluation project to measure results as long as such proposals clearly demonstrate this integration. Unless otherwise indicated, a "Meets Scientific Criteria" recommendation is not an indication of the ISRP's view on the priority of the proposal, nor an endorsement to fund the proposal, but rather reflects its scientific merit and compatibility with Program goals.

2. Meets Scientific Review Criteria - In Part is assigned to a proposal that includes some work that substantially meets each of the ISRP criteria and some work that does not. The ISRP specifies which elements do not meet the review criteria. In general, the proposal element that does not meet criteria is adequately described, but that element is not sound, is redundant, or would not benefit fish and wildlife. Required changes to a proposal will be determined by the Council and BPA in consultation with the project sponsors in the final project selection process.

(Qualified) is assigned to recommendations in the two categories above for which additional clarifications and adjustments to methods and objectives by the sponsor are needed to fully justify the entire proposal. The ISRP also uses "Qualified" in two other situations:

- for proposals that are technically sound but appear to offer marginal or very uncertain benefits to fish and wildlife and
- when further ISRP review of a project's final implementation plan or analysis of results is needed before the project moves to full implementation. An example is a proposal for both background assessment work and concurrent on-the-ground implementation that cannot be justified before results of the assessment are known. Another example is a proof of concept research project for which methods need to be tested at a pilot scale before full implementation. Please note, in past reviews, some ISRP recommendations to sequence assessment or test phases and full implementation were designated as "In Part" rather than "Qualified."

The ISRP expects that needed changes to a proposal will be determined by the Council and BPA in consultation with the project sponsor in the final project selection process. Regardless of the Council's or BPA's recommendations, the ISRP expects that, if a proposal is funded, subsequent proposals for continued funding will address the ISRP's comments.

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3. Does Not Meet Scientific Review Criteria is assigned to a proposal that is significantly deficient in one or more of the ISRP review criteria. One example is a proposal for an ongoing project that might offer benefits to fish and wildlife, but does not include provisions for monitoring and evaluation or reporting of past results. Another example is a research proposal that is technically sound but does not offer benefits to fish and wildlife because it substantially duplicates past efforts or is not sufficiently linked to management actions. In most cases, proposals that receive this recommendation lack detailed methods or adequate provisions for monitoring and evaluation, and some propose actions that have the potential for significant deleterious effects to non-target fish or wildlife. The ISRP notes that proposals in this category may address needed actions or are an integral part of a planned watershed effort, but the proposed methods or approaches are not scientifically sound. In some cases, a targeted request for proposals may be warranted to address the needed action.

4. Not Applicable is assigned to proposals with objectives that are not amenable to scientific review.

5. Response Requested is assigned to a proposal in a preliminary review that requires a response on specific issues before the ISRP can make its final recommendation. This does not mean that the proposal has failed the review. In general, the ISRP requests responses on a majority of proposals, and a majority of proposals provide sufficient information in the response loop to meet the ISRP's scientific review criteria.

Thus, current decision criteria for ranking projects as ~~"fundable~~ meet scientific review criteria" or not ~~fundable"~~ are based primarily on technical merit and do not include specific reference to research priorities. Consequently, this research plan should enable the ISRP to better compare and evaluate projects for relevance to critical uncertainties.

In addition to the ISRP's scientific review, proposals are evaluated within a policy context to determine their potential contribution to management decision-making. The regional fish and wildlife managers provide recommendations to the Council on these matters, and it is essential that they continue their key role in determining which projects are most likely to benefit fish and wildlife, including research projects that may provide the basis for eventual management actions. In summary, the Council's recommendations for Bonneville funding rest on a mix of priorities, legal considerations, technical adequacy, management urgency, regional opportunities, and available funding.

Identifying Projects that Address Research Priorities

~~The research plan addresses overarching research questions. However, from time to time rapidly emerging management uncertainties may arise that warrant updating the research plan with additional research priorities. The ISRP and ISAB recommend developing implementation plans that prioritize research for each three-year project funding cycle. This would include determining the relative importance of projects to research priorities.~~ The following criteria are proposed to identify priority research in the ~~Fiscal Years 2007-2009~~ project ~~selection~~ review process.

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Critical Uncertainties - Projects that address critical uncertainties identified in this research plan will be considered priority projects. The results of such work must have broad application. For example, they must provide a basis for extrapolation across ecologically similar subbasins, or provinces.

Time Required, Statistical Power - If the activity is likely to produce useful results within the five- to 10-year timeframe for the biological opinion, it will be ranked higher than one that requires more time to yield information relevant to management decisions. Activities that yield statistically reliable results given the design of the experiment (duration, type, and intensity of monitoring) will be ranked higher than those that do not. If survival rates are being monitored, the change should be large enough to be important in reducing extinction risks or increasing the likelihood of recovery.

ESU Significance - Monitoring directed at ESA-listed ESUs will be ranked higher than activities directed at other stocks. For those directed elsewhere, there should be another justification for conducting the activity (for example, determining smolt-to-adult returns for Middle Columbia Chinook in order to compare the Snake and Upper Columbia stocks). Populations with higher extinction risk or greater necessary increases in survival rates generally will receive higher priorities for both management and research actions.

Cost Feasibility - In prioritizing competing research activities intended to produce roughly the same information, cost of the different activities will be one criterion in selecting projects for funding. Feasibility also will be important. For example, a project may be powerful and well designed but also impractical due to logistical constraints — for example, take permits cannot be issued quickly or customized equipment may take too long to build.

Relationship to Other Research - To what extent does the proposed activity depend on other projects, and to what degree does it build on ongoing, related work? Some projects may conflict with other research. For example, a "control" stock for habitat enhancement cannot simultaneously be a "treatment" stock for nutrient supplementation. These conflicts require resolution before research activities are undertaken.

Innovation - Innovation is a critical element of any large management or research program and should be encouraged. The Innovative Project category was suggested by the ISRP in past annual program reviews and was designed to improve knowledge, encourage creative thinking, and provide an opportunity for project sponsors to test new methods and technologies. Innovative projects were funded in Fiscal Years 1998, 2000, 2001, and 2002. Although innovative project solicitations were not pursued in Fiscal Years 2003-2005, Council members have expressed continued support for an innovative-project category. Although the innovative category was~~is~~ not being used in ~~the Fiscal Years 2007-2009~~recent project review ~~funding~~ cycles, the project review cycle~~cycle~~ still provides an immediate opportunity to fund innovative projects. Given the intractability of some research challenges it is important to keep the spark of innovation alive.

Level of Scientific Support – If an uncertainty is associated with a low level of scientific support, as described in the Council document 2000-12 with number 1 being the highest level of certainty (see Chapter 2), then it may merit being prioritized over others:

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1. Thoroughly established, generally accepted, good peer-reviewed empirical evidence in its favor.
2. Strong weight of evidence in support but not fully conclusive.
3. Theoretical support with some evidence from experiments or observations.
4. Speculative, little empirical support.
5. Misleading or demonstrably wrong, based on good evidence to the contrary.

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RM&E Management Questions, Information Needs, and Cost Sharing Agencies (BPA 11/14/05)

RM&E Framework Component	Management Questions	Subordinate Questions	Regional Information Needs					
			Metrics	Data Required	Survey or Experimental Design	Spatial Scale	Temporal Scale	Agencies[6] with Cost Sharing Responsibilities
Tributary Habitat Status and Trend Monitoring	Are Columbia Basin fish populations meeting population level objectives (abundance, productivity, and diversity)?							
		What is size of adult salmonid and resident fish populations?	Numbers of adult fish	Numbers of adults, spawners, or redds	Census or spatially balanced survey[7]	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1^{st}: FR, S, T 2^{nd}: AA, LU
		What is the distribution of salmonid and resident fish populations??	Presence/absence of adult fish	Presence of adults, spawners, or redds	Census	Columbia Basin, ESU, Population, Core Area, or Sub-population	Sampling every 3 to 5 years	1st: FR, S, T 2^{nd}: AA, LU
		What is the	Returns/Spawn	Numbers	Census or	Columbia	Annual for	1^{st}: FR, S, T

[6] FR= Fish Regulatory Agencies (NOAA and/or USFWS); AA= FCRPS Action Agencies (BPA, COE, BOR); LU= Land Management Agencies (USFS, BLM); EPA= Environmental Protection Agency; S = State Agency; T= Tribe

[7] Spatially Balanced Survey Design (e.g., EMAP GRTS design; see Stevens and Olsen 2004)

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		growth rate of adult salmonid and resident fish populations??	er, Lambda, Temporal Trends	of adults, spawners, or redds	spatially balanced survey	Basin, ESU, Population, Core Area, or Sub-population	at least 3 generations	2nd: AA, LU
		What is the freshwater productivity of these populations?	Smolts, fry or parr produced per adult, spawner, or redd	Number of smolts, fry or parr	Census or spatially balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
		What is the age structure of these populations?	Age of returning adults or spawners	Otolith, scale, or length of adults or spawners	Census or spatially balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
		What fraction of the spawners of these populations is of hatchery origin?	Ratio of hatchery to total fish abundances	Number of hatchery produced adults or spawners	Census or spatially-balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
	Are aquatic, riparian, and upland ecosystems of the Columbia Basin being degraded, restored or maintained relative to desired conditions or objectives?							
		What is the biological	Macro-invertebrate		Spatially-Balanced	Stream, watershed,	Annual sampling	1st: FR, EPA, S, T

		~~condition of spawning and rearing habitat for Columbia Basin fish populations?~~	~~and fish assemblages~~		~~survey~~	~~subbasin~~		~~2nd: AA, LU~~
		~~What is the physical condition of spawning and rearing habitat for Columbia Basin fish populations?~~	~~Valley characteristics (valley bottom types, valley widths and gradients, valley containment, road density, land ownership, land use); Channel characteristics (bed form types, channel types, gradient, width/depth ratio, stability); Riparian vegetation (structure, disturbance, canopy cover); Habitat access (dams and diversions); Stream flows;~~		~~Spatially balanced survey.[1]~~	~~Stream, watershed, subbasin~~	~~Annual sampling~~	~~1st: LU, S, T~~ ~~2nd: AA, FR~~

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			Habitat quality (substrate, embeddedness, large woody debris, pools, off-channel habitat, fish cover)					
		What is the water quality in spawning and rearing habitats for Columbia Basin fish populations?	Temperature, Turbidity, Conductivity, pH, Dissolved Oxygen, Nutrients, Toxic Pollutants and Heavy Metals		Spatially balanced survey	Stream, watershed, subbasin	Annual sampling	1st: EPA, S, T, LU 2nd: FR, AA
Tributary Habitat Action Effectiveness Research	What actions are most effective at addressing the limiting factors preventing achievement of habitat, fish or wildlife performance objectives?							
		Did all tributary habitat actions in aggregate for a sub-population increase juvenile survival or adult	Type, location, timing and intensity of habitat actions, and juvenile survival or adult	Depends on management actions	Large-scale Before-After (BA) Studies[8]	Watershed, Subbasin	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU

[8] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005

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		abundance, compared to a similar sub-population with few or no habitat actions?	abundances					
		What contribution did all tributary habitat actions for an ESU make toward increasing the ESU-level population growth rate?	Type, location, timing and intensity of habitat actions, and ESU population growth rates	Depends on management actions	Large-scale Before-After (BA) Studies	ESU scale	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU
		Did a single tributary habitat action increase local fish abundance or distribution, or improve local environmental conditions, compared to a similar control or reference site?	Type, location, timing and intensity of habitat action, local fish abundance or distribution, and/or habitat conditions	Depends on management actions	Project-scale Before-After Studies[9]	Stream, Watershed	Depends on management action(s)	1st: AA, LU, S, T 2nd: FR
		Did some classes of actions (e.g., riparian	Type, location, timing and intensity of habitat actions,	Depends on management actions	Project-scale Before-After Studies	Stream, Watershed	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU

[9] Intensive BA, Extensive BA, or replicated BACI; see Roni et al. 2005

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		restoration actions) perform better than other classes (e.g., passage improvement actions) in improving localized conditions or sub-population juvenile survival rates?	and local habitat conditions and/or juvenile fish survivals					
Tributary Habitat Uncertainty Research	What are the limiting factors or threats preventing the achievement of desired habitat, fish or wildlife performance objectives?							
		What is the relationship of habitat processes and functions of upslope, riparian, and aquatic systems to biological and environmental habitat attributes?	Watershed condition metrics identified above.	Watershed condition data identified above.	Depends on correlation or experimental approach	Stream, watershed, subbasin	Depends on correlation or experimental approach	1st: LU, S, T, EPA 2nd: FR, AA
		What is the relationship of	Watershed condition and	Watershed condition	Depends on correlation or	Stream, watershed,	Depends on	1st: FR, S, T 2nd: AA, LU,

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		habitat attributes, processes, and/or functions to fish and wildlife abundance, productivity, and diversity?	fish population metrics identified above.	and fish population data identified above.	experimental approach	subbasin	correlation or experimental approach	EPA
Hydro Status and Trend Monitoring	Are salmon and steelhead meeting juvenile and adult hydro passage objectives?	Are smolts achieving survival standards prescribed in the NOAA BOs?	Smolt survival estimates through impounded reaches of the Snake and lower Columbia System survival estimates reflecting delayed effects of transported smolts	PIT tag detection histories through the FCRPS Tagging ample # of fish at hatcheries as surrogates for wild ones. Annual estimates of D	Cormack-Jolly-Seber single release model	LGR to BON tailrace, when possible	Annual	1st: AA 2nd: FR
		Are adults achieving survival standards prescribed in the NOAA BOs?	Survival indices of adult salmon and steelhead through the FCRPS. *NOTE- AFEP*	PIT detection histories at ladder-based detectors, for known source	Accounting of fates for returning PIT tagged fish.	BON to uppermost dam as applicable to an ESU	Annual	1st: AA 2nd: FR

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			~~*funds some, but not all, data elements required under this objective. Close coordination with AFEP required*~~	~~fish.~~ ~~Estimates of stray rates~~ ~~Estimates of harvest removals of PIT tagged fish in the Mainstem.~~ ~~Estimates of incidental harvest mortality, e.g., net drop out rates, catch and release related mortality, etc.~~				
~~**Hydro Action Effectiveness Research**~~	~~*NOTE- AFEP funds elements required under this objective. Close coordination with AFEP is required.*~~							
~~**Hydro Uncertainty Research**~~	~~What is the magnitude of delayed effects~~	~~Under what conditions does~~	~~Estimates of D for wild and hatchery fish~~	~~PIT tag detections juveniles~~	~~Empirical estimates &~~	~~Individual transport sites to~~	~~Annual~~	~~1st: AA 2nd: FR~~

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	associated with transporting smolts?	inriver passage yield higher SARs than transport?		and returning adults SAR for transport and inriver groups, i.e. TIR estimates Inriver survival estimates Direct transport survival estimates	model derived estimates for populations of some inriver migrants	designated return site.		
		Is transport appropriate for some locations and not others?	TIR estimates for wild and hatchery fish					1st: AA 2nd: FR
	Do smolts migrating through the FCRPS incur delayed effects?	What is the magnitude of such effects?	SARs linked to different smolt passage fates or experiences	PIT tag detections as juveniles to describe migratory experience PIT detections of returning adults	Compare SAR among treatment groups	Variable	One to several years	1st: AA 2nd: FR

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		What are the causes and can they be rectified?	Localized smolt survival rates (Identify zones of particularly intense mortality that could depress SAR)	Variety, e.g. PIT, acoustic tag or radio telemetry data from smolts.	Compare survival with reference areas.	Geographically localized, e.g. bird predation centered at islands	One to several years	1st: AA 2nd: FR
Estuary Habitat Environmental Status and Trend Monitoring	Are aquatic, riparian, and upland ecosystems of the estuary (from Bonneville Dam to the mouth of the Col. R.) being degraded, restored or maintained relative to desired conditions or objectives?	Using a hierarchical habitat classification system based on existing hydro-geomorphology, to what quantitative extent are we avoiding further loss to existing shallow water wetland habitat and restoring degraded habitats, in particular for listed salmonids?	Characterization of Vegetation cover, Geology/ soils, Floodplain topography, Bathymetry	Habitat classification	Census (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What is the amount of habitat in absolute acreage, by	Measurements of Area affected	Habitat classification Habitat condition	Census (mensurative) or spatially balanced survey	BON to mouth	Annually	1st: FR 2nd: AA, S

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		habitat type, that was restored annually and by proportion of the total lost historically for each habitat type for each reach of the CRE?						
		What is the index of habitat connectivity by reach and its status/trend?	Connectivity — Inventory of Passage barriers and Total edge, density and sinuosity of floodplain and tidal channels,	Habitat connectivity	Census (mensurative) or spatially balanced survey	BON to mouth	Annually	1st: FR 2nd: AA, S
	What are the status/trends in attributes of the CRE, plume, and ocean ecosystems?	What are estuary habitat physical properties?	Habitat — Characterization of Vegetation cover, Geology/ soils, Floodplain topography, Measurements of Bathymetry	Habitat condition and classification	Statistical (mensurative) or Spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are estuary fish population properties, especially with respect listed salmonids?	Fish – Estimates of Species composition, Age/size structure, Stock identity, Temporal	Life history diversity, spatial distribution, growth, survival	Statistical (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S

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			distribution, Spatial distribution, Migration pathways, Growth rate, Residence time, Prey availability, Foraging success, Survival rate, Predation index					
		What are estuary hydrograph and water quality properties?	Water — Measurements of Hydrograph, Temperature, Salinity, Dissolved oxygen, pH, Turbidity, Nutrients, Toxics	River discharge, water quality	Statistical (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR, 2nd: AA, S
		What are invasive species properties?	Invasives — Invasive species list, Invasive spatial distribution, Invasive abundance	Invasive species assessment	Statistical (mensurative) or spatially balanced survey	BON to mouth	3 yrs	1st: FR, 2nd: AA, S
		What are the environmental conditions and salmon ecology	Plume and Ocean — Estimates of Juvenile	Ocean and plume conditions, Growth,	Statistical (mensurative) or spatially balanced	Plume and N. Pacific Ocean	Depends on metric	1st: FR, 2nd: AA, S

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		in the Col. R. plume and ocean relative to salmon production and survival?	salmon usage, Growth, Survival, Zooplankton prey base, and Anchovy/ herring index in the plume and Measurements of Sea surface temperature, Northern oscillation index, Upwelling index, chlorophyll	residence time, survival,	survey			
Estuary Action Effectiveness Research	What actions are most effective at addressing the limiting factors preventing achievement of habitat, fish or wildlife performance objectives?	What is the cumulative effect of multiple habitat restoration projects on the CRE ecosystem?	See "Connectivity", "Habitat" and "Fish" above	Habitat cond's, habitat connectivity, fauna, life history diversity, spatial dist., growth, survival, predation, water quality physical cond.,	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are the effects of	See "Connectivity"	Habitat connectivit	Effectiveness (mensurative)	BON to mouth	Annually	1st: FR, AA 2nd: S

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		hydrologic reconnection projects (e.g., dike breaches, new tide gates and culverts) and revegetation projects?	, "Habitat", "Fish" and "Invasives" above	y, life history diversity, spatial dist., growth, survival, invasive species	or Project-scale Before-After Studies			
		What possible changes to FCRPS operations might improve habitat conditions in the CRE for Columbia basin salmonids?	Ibid.	Ibid.	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to plume	Depends on metric	1st: FR, AA 2nd: S
Estuary Uncertainties Research	What are the limiting factors or threats in the estuary preventing the achievement of desired habitat, fish or wildlife performance objectives in the Col. Basin?	What is the ecological importance of the Columbia River estuary and oceanic plume to the viability and recovery of salmonid populations in the Columbia Basin?	See "Connectivity", "Habitat", "Fish", "Invasives" and "Plume and Ocean" above	Habitat cond's, habitat connectivity, fauna, life history diversity, spatial dist., growth, survival, predation, water quality physical cond., river discharge,	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to plume	Depends on the metric	1st: AA 2nd: FR, S

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				plume conditions				
		What are the effects of toxics on salmonids?	See "Fish" above, plus estimates of concentrations and distributions of Toxics	Water quality, life history diversity, spatial distribution, growth	Depends on correlation or experimental approach	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are the causal mechanisms affecting survival of juvenile salmon during their first months in the ocean?	See "Fish" and "Plume and Ocean" above	life history diversity, spatial dist., growth, survival, predation plume conditions	Depends on correlation or experimental approach	BON to plume	Depends on metric	1st: FR 2nd: AA, S
		What is the survival rate by species of juvenile salmonids migrating downstream from Bonneville Dam to the mouth of the Columbia River?	Estimates of smolt survival rates, predation indices	Survival	Cormack-Jolly-Seber single release model	BON to mouth	Seasonally	1st: FR 2nd: AA, S
Hatchery Status and Trend	What is the relative proportion of hatchery		Ratio of hatchery fish to total fish	Numbers of hatchery-	Develop requisite marking	Census or spatially balanced	Annual sampling	1st: AA 2nd: FR

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Monitoring	spawning salmon and steelhead compared to wild fish populations?		abundance	origin and natural-origin fish on spawning grounds	guidelines and proceed with the marking of remaining groups of unmarked fish released from hatcheries to facilitate monitoring of hatchery-origin fish in natural spawning areas	survey		
Hatchery Action Effectiveness Research	Can hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction in extinction risk for affected natural populations?		Returns/spawner, lambda, temporal trends, or other metrics as determined by experimental design	Numbers of adults, spawners, or redds, or other data as determined by experimental design	Studies of modifiied hatchery practices ("reforms") that involve controlled experiments designed and replicated sufficiently to provide statistically and biologically meaningful results pertinent to multiple programs.	As required by experimental design	As required by experimental design	1st: AA 2nd: FR
	Can properly designed intervention		Returns/spawner, lambda, temporal	Numbers of adults, spawners,	Treatment and control studies using existing	Selected populations	Annual	1st: AA 2nd: FR

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	programs using artificial production make a net positive contribution to recovery of listed populations?		trends	or redds	safety net programs intended to reduce extinction risk of targeted populations.			
Hatchery Uncertainties Research	What is the reproductive success of hatchery fish spawning in the wild relative to the reproductive success of wild fish?		Number of offsping produced by hatchery x hatchery, hatchery x wild, and wild x wild matings in natural spawning areas and subsequent adult returns from each type of cross	DNA pedigree analysis	Hatchery/wild reproductive success studies	Selected populations	Annual for 2 or 3 generations	1st: AA 2nd: FR
Harvest Status and Trend Monitoring	What are the boundaries of uncertainty around harvest point estimates?	What are the harvest rates on listed wild fish?	Numbers of adult fish harvested and numbers of adult fish escaping	Dam Counts; harvest estimates; PIT tag detections at dams	Census at Dams; sub-sample in fisheries	Columbia Basin; ESU	Continual during fishery	1st: FR 2nd: AA
Harvest Action Effectiveness Research	Are new selective gear types effective at harvesting?		Catch Per Unit of Effort; Catch related to capital and operating expense	Standardized measures of catch and effort		Columbia Basin, ESU	Continual during fishery	1st: FR 2nd: AA

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Harvest Action Effectiveness Research	What is the post-release survival of salmon caught in a mark-selective fishery compared to fish that were not harvested?		Survival rates	Tagging for fish that are caught compared to those not caught	Treatment/control	Columbia Basin, ESU	Continual during fishery	1st: FR 2nd: AA
Predator Status and Trend Monitoring	What is the impact of predators on juvenile salmonids within the Columbia River Basin?							
		What are the nesting distribution, colony size, and colony productivity for the major avian predators within the Columbia River Basin?	Presence/absence of avian predator colonies, colony size, number of nesting pairs, reproductive chronology, reproductive success rates	Colony location, colony size, number of nesting pairs, timing of reproductive events, reproductive success	Census; statistical sample	Columbia Basin or colony	Annual sampling	1st: AA 2nd: FR
		What are the juvenile salmonid consumption rates of major avian predators within the	Diet composition, consumption rates	On-colony PIT tag deposition rates and detection efficiency, diet samples,	Statistical sampling of targeted populations	Columbia Basin or colony	Annual sampling	1st: AA 2nd: FR

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		~~Columbia River Basin?~~		~~bill load observation~~				
		~~What are the consumption rates of major piscivorous predators in the Columbia River Basin?~~	~~Abundance, distribution, diet composition, fecundity consumption rates~~	~~Abundance, distribution, diet composition, consumption rates~~	~~Statistical sampling of targeted populations~~	~~Columbia Basin~~	~~Annual sampling~~	~~1st: AA~~ ~~2nd: S~~
	~~What is the impact of predators on adult salmonids within the Columbia River Basin?~~							
		~~What are the consumption rates of mammalian predators (marine) in the Columbia River Basin?~~	~~Abundance, distribution, consumption rates, diet composition~~	~~Abundance, distribution, consumption rates, diet composition~~	~~Census or statistical sampling~~	~~Columbia Basin (BON to estuary)~~	~~Annual~~	~~1st: FR~~ ~~2nd: AA, S~~
~~**Predator Action Effectiveness Research**~~	~~What are the most effective management alternatives/actions that could be used to reduce the impact of predators?~~							
		~~What is the effect of~~	~~% Change in Juvenile~~	~~Colony location,~~	~~Large-scale Before-After~~	~~Columbia River,~~	~~Depends on~~	~~1st: AA~~ ~~2nd: FR~~

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		alternative management alternatives/actions used to reduce the impact of avian predators?	Salmonid Survival, % Change in Avian Predation Rate	colony size, number of nesting pairs, timing of reproductive events, reproductive success, On-colony PIT tag deposition rates and detection efficiency, diet samples, bill load observation	(BA) Studies[10]	alternate habitat location, or colony	management action(s)	
		What is the effect of management alternatives/actions used to reduce the impact of piscivorous predators?	% Change in Juvenile Salmonid Survival, % Change in piscivorous Predation Rate	Abundance, distribution, diet composition, fecundity consumption rates	Large-scale Before-After (BA) Studies	Systemwide Columbia Basin	Depends on management action(s)	1st: AA 2nd: S
Predator Uncertainty Research								

[10] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005

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Wildlife Status and Trend Monitoring								
Wildlife Action Effectiveness Research	What are the species response to the various protection/restoration efforts?	How has the mitigation target species responded to fee title versus conservation easements?	Target species abundance for pre/post protection measure	Numbers of adults by target species	Large-scale Before-After (BA) Studies[11] or Project-scale Before-After Studies[12]	Columbia basin	Depends on management action(s)	1st: S,T 2nd: LU
		How has the mitigation target species responded to various habitat enhancement efforts?	Target species abundance for pre/post enhancement measure	Numbers of adults by target species	Large-scale Before-After (BA) Studies or Project-scale Before-After Studies	Columbia basin	Depends on management action(s)	1st: S,T 2nd: LU
Wildlife Action Effectiveness Research								

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[11] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005

[12] Intensive BA, Extensive BA, or replicated BACI; see Roni et al. 2005

Appendix C, Developing New Institutional Arrangements

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Historically, science has played two different roles in salmon management. The first, a technical leadership role, has involved establishing the fundamental relationship between salmon and their environment that collectively forms the basis for management decisions. The second, a "sustaining," has involved selectively seeking data and analyses to support regulatory actions or policy decisions by agencies, tribes, or other organizations. Ideally, science focuses on the more objective first role, but in fact, salmon management has been dominated by the second.

— Committee on the Environment and Natural Resources, 2000

The "sustaining" role of science dominates restoration and recovery efforts in the Columbia River Basin today. This does not impugn the quality of the science, but it does help explain why some work of apparently low relevance continues while results of higher relevance from other work are not applied. It also helps explain disparities in the availability of data to support various management alternatives, particularly alternatives that are politically controversial. In selecting new research projects agencies understandably tend to avoid those that seem to offer limited support for, or might contradict, current management practices. Thus, the scientific basis for management decisions is skewed by the almost indefinite institutional funding of non-controversial research. This results in repetitive research that generates data of diminishing value.

The National Research Council (NRC) stated that current institutional arrangements in the Pacific Northwest have contributed to the salmon problem and probably will need modification if an understanding of how to include "good science" as part of the institutional arrangement is important (National Research Council 1996). The NRC recommended that the adoption of a coordinated, interagency approach to new scientific efforts could help reduce the tendency to fund research in areas of past agency investment.

Further, the NRC found that cooperative management implies an institutional change or shift in the structure of decision-making that acknowledges the role of various interests, such as consumers, representatives of different industries, and environmentalists in the areas of policy, planning, implementation, and evaluation. Although the Northwest Power Act process falls short of the ideal of "power-sharing in the exercise of resource management" (Pinkerton, 1992), it does merge the inherent conflicts of fish and wildlife mitigation and hydropower production in a way that forces conflicts into the open and fosters joint action.

A great deal is known about the requirements of salmon, yet much remains unknown, and some gaps in knowledge are crucial to a long-term, stable solution to the salmon problem. Enough is known in the short term to improve the prospects of salmon if knowledge is applied wisely and quickly, but not enough information is known to warrant confidence in a long-term regional plan for salmon….the components of the salmon problem are so diverse that no one person can know all that needs to be known for a comprehensive solution. Thus, the salmon problem is in a sense a cognitive problem whose solution will depend on ***close cooperation and collaboration of people with many kinds of experience and expertise****.* (Emphasis added.)

— National Research Council, 1996

Regional Research Partnership: A Forum for Collaboration

The Columbia River Basin research plan could provide a starting point for the development of a regional research agenda by providing a rough framework on which discussion of coordination among potential partners could focus. While the research plan does not constitute a complete research agenda for the region, it does provide a framework for developing one through the identification of potential partners, programs, and funding sources for working on research questions in which all have interests. The disagreement that exists over priorities for research stems from the various different, yet sometimes overlapping, management authorities within the Columbia River Basin and the broad geographic scope of the region. The research plan can help diminish this disagreement by:

- Fostering agreement on a manageable number of well-chosen priorities
- Stating the priorities in ways that promote effective research solutions
- Providing a means for resolving disagreements on priorities
- Taking advantage of unforeseen research opportunities that arise from advancements in technology and scientific knowledge or are simply facilitated by immediate environmental or social opportunities
- Fostering collaborative research with other entities

The 2000 Fish and Wildlife Program states that a meeting of fish and wildlife agencies, tribes and hydrosystem operating agencies should be convened regularly to identify key uncertainties about the operation of the hydrosystem and associated mainstem mitigation activities. Executives of the agencies and tribes have tried in the past to coordinate decision-making on various aspects of resource management across the Columbia River Basin. Yet no similar effort has been mandated to coordinate the research agendas of the various management entities. Therefore, this research plan proposes the convocation of a Regional Research Partnership as a vehicle for meeting the directives set forth above and making a major step toward implementing the recommendation of the NRC.

Implementing Regional Research Priorities

The role of the Regional Research Partnership would be to update and prioritize currently identified research needs and facilitate coordination of the research efforts of the various state, federal, and tribal agencies to ensure that limited funds are allocated for the most important critical uncertainties. The Council is strongly positioned to convene the Regional Research Partnership as the framework established by the Northwest Power Act has been characterized as the largest attempt to cooperatively manage power and fish and wildlife (Lee et al. 1980). A Regional Research Partnership could help the region move beyond the institutional impediments to coordinating research and providing a forum where researchers could transcend disciplinary and institutional boundaries, cross-pollinate ideas, and find peer support for potentially controversial recommendations. The partnership could foster integration of the currently compartmentalized research agendas and budgets of entities that share common objectives. The fish and wildlife scientists and managers in the region could accomplish this by cooperatively

developing the forum and a process for identifying research priorities that address shared critical uncertainties.

A major challenge for the research partnership would be to develop a programmatic approach for managing research within the region and, as a result, move beyond the piecemeal solutions that have undercut the success of past restoration efforts. For example, the partnership could develop a comprehensive effort to reduce sources of mortality across the life cycle of the salmon.

The research partnership could be an appropriate forum for organizing the type of multiparty experiments that often have been proposed in ISAB and ISRP reports, or by the Council itself, such as studies of the flow/survival relationship for juvenile salmonids. Uncertainties related to supplementation, tributary restoration actions, mainstem passage and survival, and other issues have been discussed in many ISAB and ISRP reports. These reports provide suggestions as to how these uncertainties might be addressed. In most cases, it is suggested that answers can best be obtained by coordinated experiments such as the load-following experiment suggested by the ISAB. In sum, the research partnership could provide a venue to support coordinated experiments by identifying ways to share resources, experience, and expertise; fostering teamwork; and leveraging investments from multiple sources.

Identifying Regional Research Priorities

There always will be more research questions to answer than there are resources to provide answers. Therefore, research should be focused first on those questions that have the greatest relevance to the region. For example, does a critical management uncertainty apply to single or multiple subbasins, a single population or multiple populations?

Scientists who work with "systems theory" often warn that trying to optimize one component of a complex system like the Columbia River Basin, such as the mainstem, may not necessarily increase the system's overall performance. Furthermore, the current emphasis on mainstem research may not provide the certainty that is sought in relation to the recovery of ESA-listed salmonids. In order to achieve an ecological approach it will be important to maintain a diversity of research activities across the basin that supports anadromous fish, resident fish, and wildlife. The critical uncertainties set forth in the research plan should guide the selection of projects so that the funded projects move the program forward in a defined and consistent way that provides synergy across the projects.

The federal, state, and tribal members of the research partnership should work together to identify shared critical uncertainties. The diverse membership of the research partnership should provide an opportunity for open debate among peers and a sense of equity in the outcomes. An initial task will be to develop a set of decision criteria to guide the identification of research priorities. It is anticipated that these decision criteria will be drawn from the prior experience with the internal prioritization processes of the respective members. Four key questions need to be addressed by the research partnership:

- Who should decide the priority of the research agenda?

- How should collaborative experiments be designed and implemented (e.g., cost sharing and other means)?

- Why and how should data be collected, stored, and analyzed?

- Who should be responsible for synthesis and dissemination of the results and for identifying management implications?

The research partnership should meet as necessary to identify priorities and develop funding estimates that the members can use to inform their respective budget requests.

Facilitating Programmatic Coordination

Currently, a myriad of entities such as universities, private consultants, tribes, state and federal agencies conduct research within the region, yet the lack of a forum for coordination often results in poor communication between project sponsors. This increases the risks of: duplication of effort and inefficient use of funds; conflict among research project objectives; damage to long-term monitoring sites; and increased intrusive sampling of ESA-listed and sensitive native species. The research partnership could facilitate communication between all researchers working within a specific watershed so that they are aware of and coordinate with each other's plans and projects in advance. The research partnership also could facilitate communication between individuals conducting similar research in different locales. It could also help identify research projects that complement one another, such as multiple treatments of the same question in different locations to increase sample size. Additionally, multiple studies of different issues within a single watershed could share monitoring to provide a more holistic view of the outcomes. Restoration activities could be coordinated so as not to interfere with ongoing research. Finally, the research partnership could coordinate the compilation of technical information on the best tools for research and monitoring and its dissemination to the region.

Collaborative Funding

In 2000, the Council shifted from an annual project funding cycle to a three-year cycle. Because state and federal agencies remain on an annual funding cycle, it is difficult for them to make long-term funding agreements. Consequently, formal arrangements such as memoranda of agreement (MOAs) may be necessary to secure long-term funding commitments for selected large-scale field experiments. Bonneville and the U.S. Forest Service have such an agreement, for example. In regard to the program, it is important to acknowledge the difficulty inherent in reprogramming existing funds to support additional research initiatives within the available direct-program budget.

Yet the important question is not how much investment in additional research the program might afford, but rather how to develop a comprehensive regional research agenda that can be funded from multiple sources, sustained, and managed mutually. A more systematic and strategic approach to leveraging investment by many parties is warranted. The research plan

identifies critical uncertainties that need to be addressed by multi-agency initiatives, cooperative funding agreements, and shared responsibility for implementation.

New large-scale field experiments should be conducted collaboratively via shared funding arrangements with other entities. It might be argued that there are already de-facto large-scale field experiments underway, but they were not designed to resolve specific uncertainties or establish cause-and-effect relationships. It may be possible to link project-scale efforts in order to achieve large-scale field experiments, such as by sharing controls for hatchery and habitat projects. However, the current funding structure does not facilitate development of controls; for example, much of the research on hatchery effectiveness has been done without paired study of natural production. Similarly, much of the research on habitat treatments has been conducted without paired control sites. For these reasons current research activity that resembles large-scale field experiments does so by default, not by design.

Some identified research and monitoring needs are currently, or should be more appropriately, the requirement or shared responsibility of federal or state agencies other than Bonneville under mandates other than the Northwest Power Act. This point is particularly relevant to ESA recovery planning and implementation research needs that are proposed for the Columbia River Basin but have application coast-wide. Discrete elements of the identified research and monitoring present differing degrees of opportunities for regional coordination and shared funding. To succeed it is incumbent upon the research partnership to develop and implement incentive strategies. Incentives may include funding, regulatory flexibility, or recognition, all of which can work in combination. Thus, there is a need to work cooperatively with entities that represent alternative funding sources, such as the Trust for Public Land, and others, and have responsibilities that overlap those of the Council. The regional entities should recognize that all programs are limited by what they can afford to sustain but that by working together all could benefit from focused, coordinated expenditures.

Appendix ~~D~~C. Monitoring and Evaluation

~~In the 2000 Fish and Wildlife Program Basinwide Provision D.9 states:~~

~~*"The Council will initiate a process involving all interested parties in the region to establish guidelines appropriate for the collection and reporting of data in the Columbia River Basin."*~~

~~Consequently an~~ An important objective of the research plan is to encourage development of an effective and economical approach to long-term monitoring that provides a basis for future programmatic-scale evaluations. Some components of a regional monitoring program, such as counts of returning anadromous adult fish at dams, estimates of the number of out-migrating juvenile fish, harvest estimates, hatchery production, and so on, already have been developed in the Columbia Basin. Yet the program needs to facilitate the development of additional components that are important, including long-term PIT-tagging of important populations of anadromous fish, coordinated estimates of spawners or escapement into tributaries by standardized sampling and estimation methods, and standardized habitat and water quality sampling and estimation methods.

In order to effectively implement subbasin, recovery, and conservation plans, it is necessary to follow a logical process and paradigm of *Assess, Design, Implement, Monitor, Evaluate and Adaptively Adjust* plans and their implementation processes (Figure 1.).

The axiom that "all plans fail at implementation" can be avoided by following the steps toward adaptive management set forth in Figure 1.

- *Assessing* limiting factors and critical uncertainties
- *Designing* projects, programs and monitoring to maximize both on-the-ground effectiveness and learning
- Coordinated and documented *implementation* of projects
- Consistent *monitoring* through standardized methods, protocols, and training
- Timely and thorough *evaluation* of effectiveness
- Overall guidance to the region to *adjust* plans and programs at the province and subbasin levels

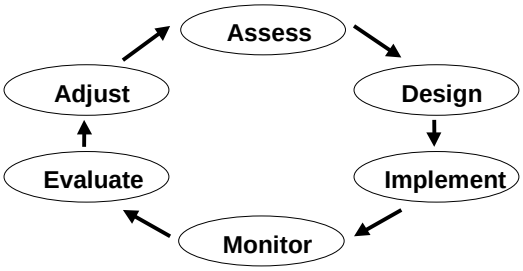

Figure 1. A framework for adaptive management (Nyberg, 1999).

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Monitoring and evaluation are at the heart of adaptive management because they provide the information, data, and analysis that decision-makers and resource managers need to track the progress, or lack of progress, of plans and populations. The success of current plans and programs depends on the consistent application of well-designed research, monitoring, and evaluation at multiple scales. These scales range across tributaries with major projects, populations, major population groups, subbasins, ESUs or Distinct Population Segments, and the entire Columbia Basin. To be useful to decision-makers, a regional approach to monitoring must identify the information required for different types of decisions at each scale, such as management of harvests, the hydrosystem, and hatcheries; and decisions on the protection and restoration of habitat).

Evaluating the occurrence and magnitude of trends over time requires a commitment to long-term monitoring (multiple years), and consistent data collection through networks of sites that represent the target population(s) of interest. Substantial research has been conducted on trend detection — discussion of form of trend, best tools to detect trend — (*see* Esterby 1993). Yet there has been little discussion in the ecological literature of what constitutes a ‘‘policy-relevant’’ trend and how well we can measure or detect it (Urquhart, Paulsen and Larsen 1998).

~~Current~~ Monitoring Activity

Monitoring under the program primarily has been conducted to evaluate work across all subject areas, but at the project scale. This approach has generated information from monitoring individual or opportunistic protection and restoration efforts and the effects of isolated or tactical actions and activities. To advance, the limited resources available for monitoring must be focused on a more programmatic approach that is designed to identify the need for and detect the sum total effect of actions at the population, subbasin, and/or province scale. This can support future analyses of more strategic actions and plans and allow decisions to be made at a higher scale that is population- and ecosystem-based. Finally, performance metrics and high-level indicators can support a programmatic approach to evaluation that can be reported to Congress, the Council and to state, federal, and tribal resource managers (*see* Figure 2.)

While work at the project scale has intrinsic value and should be continued in many cases, it cannot substitute for the lack of a monitoring program of sufficient scope to provide a basis upon which the program as a whole can be evaluated and re-directed. Monitoring is required at a number of different scales to assess the performance of the program relative to biological and programmatic objectives, to identify where and why there are performance problems, and to identify the most effective actions needed to correct problems so that program objectives can be achieved. This type of monitoring and evaluation across multiple geographic and temporal scales requires standardized approaches and programmatic, long-term commitments and interconnections for effectively combining information and answering program management questions. The absence of a regionally coordinated approach to monitoring and evaluation in the Columbia River Basin has constrained restoration and planning efforts for

~~Figure 1. A framework for adaptive management (Nyberg, 1999).~~

decades.

For this reason, it is important that a more hierarchical approach be utilized with increased emphasis on achieving useful outcomes from monitoring. Specifically, methods need to be developed and implemented so that monitoring results can be "rolled up" to provide scientifically defensible evaluations of whether the ecological condition of a subbasin, an ESU, or the Columbia River Basin as a whole is improving or declining over time.

This capability would be very useful to policy and decision-makers as they deliberate on future actions that affect the long-term, ecological health of the basin.

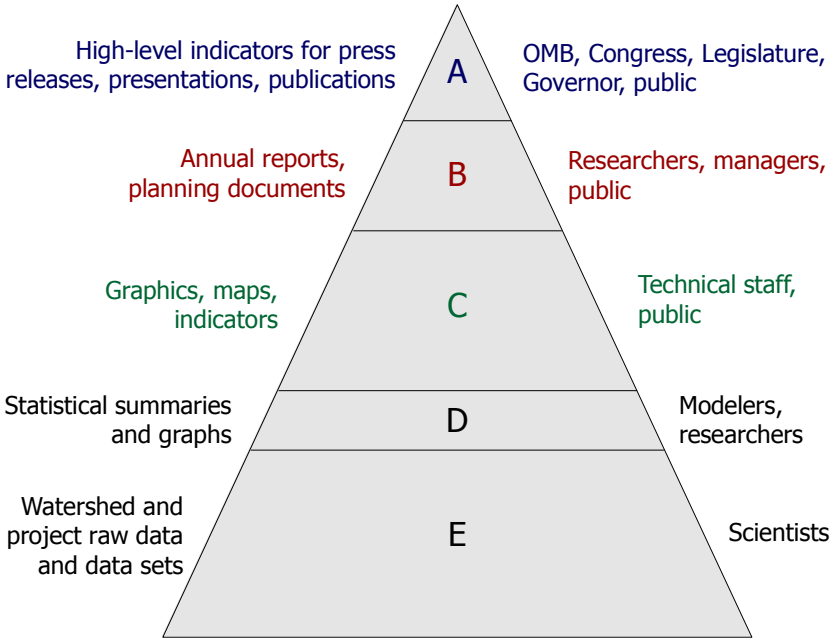

Figure 2. In the monitoring information pyramid, examples of types of information are on the left and related users or generators of that information are represented on the right.

Moving monitoring from the project scale to larger spatial scales has both benefits and challenges. One benefit of focusing on the population scale is that it has direct relevance to fish managers, who want to know whether actions upstream of the monitoring location actually improved a fish population's production in addition to improving habitat conditions in the restored reaches. For example, did actions lead to an increase in the number of smolts per spawner? The population scale is also of great interest to agencies like NOAA Fisheries, which is charged with evaluating the status of listed populations.

There are also some significant challenges at larger spatial scales. Reliably attributing observed changes in fish survival or production to particular sets of management actions requires careful monitoring design. Otherwise one might erroneously infer that observed changes were

due to management actions when in fact they were the result of natural variation in freshwater climate or ocean conditions. Ideally, one would monitor both 'treated' areas (those with habitat restoration actions) and nearby 'reference' areas (those without restoration actions) for several generations of fish populations both before and after implementation of actions while simultaneously measuring other explanatory variables. One significant challenge in shifting monitoring to larger spatial scales — populations, subbasins, and provinces — is that at larger scales it becomes increasingly difficult to establish the strong contrasts required to evaluate effectiveness. That is, it is increasingly difficult to compare and contrast specific areas and times with and without certain classes of restoration actions. For example, adjacent subbasins could have a variety of implemented restoration actions. Comparing fish production among these subbasins over time would not lead to any clear inferences about which actions (if any) were responsible for the observed differences in trends. Therefore, it still would be necessary to conduct effectiveness evaluations at finer spatial scales (project to population) for a carefully selected subset of restoration actions and locations in order to generate information of value to the program.

~~Provincial~~Province-scale Objectives and the Need for High-Level Indicators

It will be important for the ~~provincial~~province-scale objectives required by the program to encompass a set of core objectives common to the four states while respecting additional reporting needs of each state. The process of developing, negotiating, and gaining regional acceptance of province-level objectives will be highly analogous to the ongoing efforts of Washington and Oregon. These efforts have been driven either by statutory requirements or by pressure from Congress and legislatures for accountability. Once established, province-scale objectives will provide focus for efforts to develop a regional approach to monitoring that can support evaluation of the overall effectiveness of the program. Figure 2. above shows the relationship between types of information and how each supports decision-making. For example, the status of high-level indicators compels the activities at the bottom of the pyramid — on-the-ground methods, protocols, and logistical implementation requirements. High-level indicators also can help direct decisions and recommendations about the analytical processes and statistical designs in the middle of the pyramid.

In order to implement adaptive management, resource management agencies need high-level indicators that are easy to understand in terms of every-day definitions and experiences and yet flow explicitly from on-the-ground monitoring programs providing information on progress toward biological objectives. During 2009, the Council adopted three high-level indicators (1) Abundance of Fish and Wildlife, 2) Hydrosystem Survival and Passage, and 3) Council Actions), differed adoption of a fourth indicator (Ecosystem Health) until it was more clearly defined, and approved fish and wildlife management questions as a working list (http://www.nwcouncil.org/fw/program/hli/2009_10.htm#background). A subcommittee of PNAMP currently is working to develop a pool of high-level indicators that can be used as the basis for developing province-scale objectives that the agencies and tribes of the Pacific Northwest can endorse and implement. Through the coordinated use of high-level indicators, a uniform message about watershed health can be developed with all participating agencies using the same terms and coming to similar conclusions.

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Components of a Regional Framework For Research, Monitoring and Evaluation

Through this research plan, the program will contribute to the design and implementation of a coordinated and integrated regional approach to monitoring. Existing regional programs (*see* Figure 3) ~~are being networked~~should be networked based on a monitoring framework comprising:

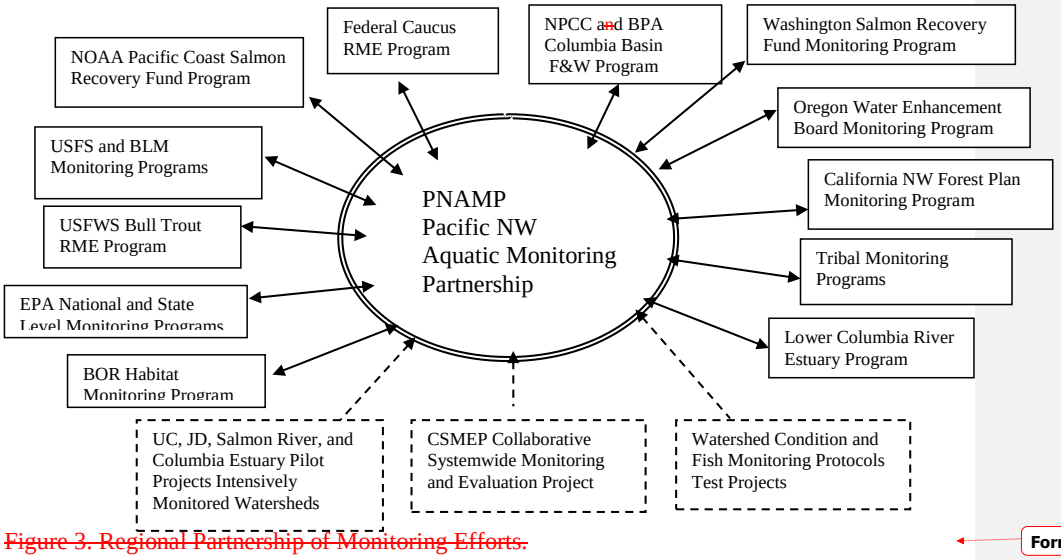
- Common management questions and information needs supporting the management questions
- Common research, monitoring, and evaluation categories, monitoring designs and protocols that allow the communication and networking of regional programs
- Common understanding of responsibilities and cost sharing of the monitoring needs

The management questions and project category components of this framework are well developed through ongoing regional coordination efforts~~ as set forth in Table 1~~. ~~It is clear that m~~Many of the objectives and management questions of the fish and wildlife program overlap with those of other regional entities and local, state, federal, and tribal governments. The costs of the monitoring and research needed to adequately address these common management questions are more than one program can adequately support or fund. Only through the combined efforts of multiple entities can a sufficient level of information be developed to guide these regionally shared resource management decisions through coordinated, standardized, and programmatic approaches to monitoring.

The components of the research plan that provide support for the development of a regional monitoring framework are its long-term vision and its organization around biological concepts and management questions. Several other large-scale planning documents support this approach by identifying similar objectives and priorities. Source documents that have contributed to the conceptual foundation of the regional approach include:

- Monitoring Section of ISRP's Retrospective Report (NPCC 2005)
- Research Plan for the Columbia River Basin (NPCC 2006)
- Strategy for Coordinating Monitoring of Aquatic Environments in the Pacific Northwest (PNAMP 2005)
- Considerations for Monitoring in Subbasin Plans 2004 (PNAMP 2004)
- Conservation of Columbia Basin Fish; Final Basinwide Salmon Recovery Strategy (Federal Caucus 2000)
- Research, Monitoring, and Evaluation (RME) Plan for the NOAA Fisheries 2000 Federal Columbia River Power System (FCRPS) Biological Opinion (Action Agencies and NOAA 2003)
- ISAB and ISRP Review of the Action Agencies and NOAA Fisheries' Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion (RME Plan) (ISAB and ISRP, 2004-1)
- Updated Proposed Action for the FCRPS Biological Opinion Remand (Action Agencies 2004)

- Proposed Design and Evaluation of Preliminary Design Templates (CSMEP 2004)
- Data Quality Objectives for Decisions Relating to Status and Trend of Fish Populations, as well as Action Effectiveness of Habitat, Hatchery, Harvest and Hydrosystem Actions (CSMEP 2005)
- Scope of Work for Implementation of the Northwest Environmental Data Network Project (Northwest Environmental Data Network 2005).



~~Figure 3. Regional Partnership of Monitoring Efforts.~~

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~~Appendix E. Data Management~~

~~A regional approach to monitoring cannot be achieved without the support of a data management system that can serve as a repository for the data and provide public access on a timely basis for analytical manipulation. To be successful a data management system must be able to assist scientists in the identification and development of data standards as they relate to the monitoring of wildlife, resident, and anadromous fish and their habitats. This objective helps to identify solutions that improve access, sharing, and coordination among different collectors and users of this monitoring data. It also provides a data reporting foundation that could support coordinated agency reporting, uniform monitoring protocols, and improved data quality and quantity. Objectives include:~~

- ~~Develop a consistent data management methodology within and across each of the types of monitoring~~
- ~~Establish a close working relationship for data consistency across the data sources~~
- ~~Identify and document the specific data needs of the region for watershed condition monitoring, fish population monitoring, and effectiveness monitoring~~
- ~~Develop and recommend data collection standards and information to be shared across the various monitoring programs~~
- ~~Share requirements and results with regional data networking entities to ensure sharing of monitoring data~~
- ~~Test the collection protocols, sampling methods, and data-sharing mechanisms~~
- ~~Implement coordinated solutions within regional programs~~
- ~~Incorporate common analytical capabilities and reporting capacity~~
- ~~Provide public access sections or linked Web sites for informational and collaborative processes~~

~~There are many different interests and initiatives concerned with improving data collection or management in the Columbia Basin and the Pacific Northwest. These efforts involve many different constituencies, mandates, and obligations. At present there is no common regional data management network that links these interests and initiatives. To address this situation the Council initiated a process to identify data needs in the basin by surveying available data and filling any data gaps. The Council, NOAA Fisheries, and other regional entities supporting this effort consider it imperative to develop a regional data network. This network would utilize existing data bases, facilitate data management and sharing, help subbasin planners, and underpin salmonid recovery efforts under the FCRPS Biological Opinion. This initiative is being led by the Northwest Environmental Data Network (NED).~~

~~A memorandum of agreement between the Council and NOAA Fisheries guides this initiative, which currently is developing an administrative arrangement, a cost sharing agreement, and a draft memorandum of understanding for potential partners in regional information system development. This initiative has been supported within the region by the ISRP (Council Document ISRP 2000-3), from independent analysis by Science Applications International Corporation (SAIC 2003), and in comments received from the public. The data management strategy also is intended to increase the public accountability~~

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~~**of this program by making the results accessible not only to specialists but also to the public. The Council is collaborating on a process for establishing an Internet-based system for the efficient dissemination of data for the Columbia Basin. This system will be based on a network of data sites, such as StreamNet, Northwest Habitat Institute, Fish Passage Center, Columbia River Data Access in Real Time (DART), and others, linked by Internet technology.**~~

~~The methods and protocols used in data collection must be consistent with guidelines approved by the Council and adopted by the region. It is important to note that while the ISRP checks these criteria, it is Bonneville that enforces the guidelines. Guidelines appropriate for the collection and reporting of data at the project scale include:~~

- ~~The project must have measurable, quantitative biological objectives~~
- ~~The project must either collect or identify data that are appropriate for measuring the biological outcomes identified in the objectives~~
- ~~Projects that collect their own data for evaluation must make this data and accompanying metadata available to the region in electronic form~~
- ~~Data and reports developed with Bonneville funds should be considered to be in the public domain~~
- ~~Data and metadata must be submitted within six months of their collection~~

~~It is important that all projects reach completion in a timely manner. At the present time many researchers do not end their projects at the completion of the performance period but add new objectives that extend the performance period. This gives rise to projects with multiple and sometimes unrelated objectives that more closely resemble small programs than discrete projects. ("Infrastructure" projects may warrant an exception to the requirement for an end date.)~~

~~In order to satisfy their contractual obligation, sponsors should be required to submit to Bonneville a final report at the conclusion of every research project. Specific ending dates should be required for project objectives and tasks to help sponsors meet their intended deadlines. Bonneville should enforce its contracts to withhold payment for projects that have not completed the reporting requirement. The final report should be in a form that facilitates review of the results.~~

Appendix ~~F~~E. Integrating Research Results into Council Policy and Decision-making

Research results must be reviewed and evaluated in order to direct new research and inform ongoing work to protect and restore fish and wildlife. The effectiveness of new actions and the results of research into those actions must be evaluated objectively before the results are widely applied in order to avoid misinterpretation. For example, for a time logjams were considered impediments to salmon passage and were removed from streams. This is what research appeared to support. But further objective evaluation revealed that logjams have value in moderating stream flows, reducing sediment transport, and creating pools where smolts rest and rear. So rather than remove logjams, fisheries scientists began placing logs and logjams in streams.

The review of research results must be conducted across projects and subject areas to determine the contribution of particular results to overall improvements in management. Some tools and metrics for evaluating research contributions across the "H" topic areas — hydropower, harvest, hatcheries, and habitat — and across all life stages of a species were developed and used during subbasin planning. Others currently are being developed under the auspices of PNAMP and through various ESA-related processes. Additional tools and metrics may need to be developed.

Annual workshops sponsored by the Council, federal and state agencies, and tribes~~Regional Research Partnership~~ could provide a forum for evaluating and disseminating the results of research. The results of individual research projects can provide a basis for larger-scale reviews of the effectiveness of the research program and discussion of additional complementary approaches, including:

- Broader-scale analysis that applies information from several projects to address a particular question
- Synthesis reports of work completed in a particular area, such as the Giorgi report, "Mainstem Passage Strategies in the Columbia River System: Transportation, Spill, and Flow Augmentation" (Council Document 2002-3)
- Expanded ~~provincial~~ project review presentations
- Workshops and science and policy exchanges structured around single topics driven by specific questions, such as transportation effects, and projects synthesized to address that topic
- Workshops, science and policy exchanges, and symposia on emerging topics, such as toxics

These ~~workshops~~ forums could help assess future research priorities through oral presentations, reporting of results of relevant studies, and the development of scenarios for applying research results in support of management actions. These forum ~~workshop~~s could

promote the exchange of scientific results and provide the Council with information to better inform future funding decisions.

Dissemination of Research Results

The Council will work with ~~the other members of the Regional Research Partnership~~federal and state agencies, and tribes ~~-~~to develop a strategy for the transfer of research results to other researchers and interested parties.

The public nature of Bonneville funding implies that research results are the property of the general public. Bonneville should post all final research reports on its PISCES database ~~Web site~~ and Columbia Basin Fish & Wildlife Program Projects & Portfolio database to facilitate access. Research reports and data should be made available to scientific collaborators, administrators, and the public for additional analyses. The final reports, and any other products derived from them, should be made available through the ~~submitted to th~~e StreamNet Library (project # 2008-505-00) either by linking to the reports on the Bonneville databases or by submitting an electronic copy to the library. This library includes materials relating to the natural resources of the Pacific Northwest and maintains a regional depository of all research projects funded under the fish and wildlife program. The StreamNet Library provides regional services that include reference, referral, data base searching, inter-library lending, and document delivery.

The ISRP has recommended that all project proposals reference past achievements and that annual and final project progress reports be issued on time and made available to the region. ~~The ISRP also recommended that "…CBFWA … include in its Annual Implementation Plan a report of past accomplishments at the watershed and subregional/subbasin levels or topical level…."~~ Further, the ISRP has supported publication of evaluations of work conducted under the fish and wildlife program in a "Columbia River Basin Journal," as a way to disseminate results and provide a forum for advancing regional knowledge on program actions (see document 2000-6~~Fiscal Year 2000 Annual Implementation Work Plan, Vol. I., p. 21~~). Such a journal could:

- Provide short turn-around on the presentation of program results to a regional audience that includes managers
- Provide a common information base to support decision-making by the middle-management groups
- Help focus discussion on future directions

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Appendix ~~G~~F. Critical Uncertainties

Critical Uncertainties Defined

Critical uncertainties arise from the most important policy issues facing the region. In 1993 the Scientific Review Group (SRG) defined critical uncertainties:

> "…*as questions concerning the validity of key assumptions implied or stated in the Fish and Wildlife Program. Critical uncertainties identify important gaps in our knowledge about the resources and functional relationships that determine fish and wildlife productivity. Resolution of uncertainties will greatly improve chances of attaining recovery goals in the Fish and Wildlife Program*."

The research plan divides complex scientifically important issues into critical uncertainties. The research plan provides a rationale for why the critical uncertainties are important, but does not include extensive background beyond that necessary to establish significance of the issue. Full syntheses of current knowledge on each research topic are not provided because doing so would require a much longer research plan. The critical uncertainties are described at a high level to preserve flexibility of implementation and to prevent the research plan from quickly becoming dated. The critical uncertainties were compiled from the fish and wildlife program, the Council's 2006 Research Plan, the draft research and monitoring implementation strategies (e.g., Anadromous Salmonid Monitoring Strategy, ASMS) and synthesis (e.g., ocean synthesis report) documents produced by managers, the Counicl's Science-Policy Exchange materials, various reports of the ISAB and the ISRP including those produced by their predecessors the Independent Scientific Group and Scientific Review Group, input from regional fish and wildlife managers, subbasin plans, recommendations from national science groups, biological opinions, and other research plans within the region. Chapter IV introduces long-standing and contemporary focal research themes and critical uncertainties important to the program and to the region.

By articulating and organizing these uncertainties the research plan will help the region agree upon research priorities, address knowledge gaps, and avoid duplication of effort. The research plan describes the critical uncertainties in terms that are intended to elicit the development of specific research hypothesis and project proposals. Therefore each research theme profiles the topic and why it is important. This approach highlights the central issues while preserving the challenge for investigators to develop more innovative or integrative approaches.

The ISAB and ISRP recommend against an overly detailed rendition of research needs, pointing out that this inadvertently might diminish innovative responses; preclude flexibility to incorporate new information and techniques; and result in early obsolescence of the research plan. Further, the ISAB and ISRP cautioned that too many research recommendations could precipitate difficulty in reaching consensus on priorities. Consequently inventories of all the potential research topics identified during the public review of the research plan do not appear in the plan. ~~but will be~~All uncertainties, however, are to be compiled ~~considered during the development of the implementation plan~~in the supporting research uncertainty database initiated in 2012 (insert link to database). Taken together the critical uncertainties set forth in Chapter IV

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and the ~~inventories~~ supporting database~~supporting the implementation plan~~ will provide a framework for guiding more detailed discussions of the allocation of research funding.

Sources of Critical Uncertainties

Independent Science Groups

The Council has relied on committees of scientists for their expert advice on fish and wildlife issues ever since the Council was formed. In the early 1990s, the Council asked its Scientific Review Group to identify critical scientific uncertainties for the purpose of focusing implementation of the fish and wildlife program. In January 1993 the SRG issued its report, entitled *Critical Uncertainties in the Fish and Wildlife Program* (SRG 1993-2).

The SRG concluded that a major shortcoming of the fish and wildlife program was that it lacked an explicit conceptual foundation "that couples life histories and production with appropriate ecosystem components." The SRG identified six "ecological uncertainties that encompass the fish and wildlife program as a whole, as opposed to a long list of uncertainties associated with each of the program elements." The six uncertainties were programmatic in scale, and are included here in their original form, but phrased as questions:

- What are the key assumptions in the fish and wildlife program, and are they scientifically valid?
- Can salmonid populations in the Columbia River be increased and sustained over the long-term, given the multitude of biological, physical, and cultural constraints?
- Can the diversity of anadromous salmonid stocks be sustained over the long-term?
- What are the relative contributions of habitat loss, harvest, predation, and mainstem passage to reduced riverine survival and production of anadromous salmonids and other fish targeted in the program?
- To what extent are hatchery production and supplementation programs detrimental to wild salmonid productivity and stock diversity?
- To what extent are assumptions in the wildlife part of the fish and wildlife program ecologically sound?

Subsequently, the Council revised the fish and wildlife program and included actions to address the uncertainties, including creation of the Independent Scientific Group to provide an ongoing evaluation of the program on its scientific merits. Importantly, the Council made clear that uncertainties should be used to guide the prioritization and funding of research efforts conducted under the program. The Council created the ISRP for the purpose of reviewing projects proposed for funding under the program, and in this role the ISRP provides guidance on prioritizing research. The Council and NOAA Fisheries also jointly created the ISAB to provide advice to both agencies, and now also to the Columbia River Indian Tribes. Further background

on the science review groups can be found at www.nwcouncil.org/fw/science.htm. Uncertainties extracted from ISAB and ISRP reports during the 2012-2013 update of the Research Plan are identified in the Council's working draft of research uncertainties database available: [insert weblink].

Fish and Wildlife Program

The Fish and Wildlife Program captures uncertainties related to the program that have been identified and incorporated during each amendment process. The uncertainties extracted from the Fish and Wildlife Program during the 2012-2013 update of the Research Plan are identified in the Council's working draft of research uncertainties database available: [insert weblink].

Fish and Wildlife Managers

Many valuable recommendations were received from the fish and wildlife managers and other resource management entities and incorporated in the research plan. Uncertainties extracted from managers' during the 2012-2013 update of the Research Plan are identified in the Council's working draft of research uncertainties database available: [insert weblink]. The fish and wildlife managers are uniquely qualified to help identify research priorities and determine when and where to implement projects. This is an important part of coordinating large-scale planning. The types of comments received ranged from very general points regarding the organization of the document to very specific comments on a particular research topic [update to reflect 2012-2013 comments].

National Scientific Reviews

The Committee on Protection and Management of Pacific Northwest Anadromous Salmon was formed in 1992 under the auspices of the National Research Council's Board on Environmental Studies and Toxicology. The Committee was charged with assessing the state of the stocks, analyzing the causes of decline, and analyzing options for management, taking into consideration socioeconomic costs and benefits. The NRC Committee's efforts culminated in the 1996 publication of *Upstream: Salmon and Society in the Pacific Northwest*. Although this initiative did not focus on research needs per se, it addressed gaps in knowledge, information needs, and scientific uncertainty. Key points from these topics as well as insights on institutional arrangements have been included in the 2006 research plan and remain in the current version.

In November 2000, the National Science and Technology Council Committee on Environment and Natural Resources released *From the Edge: Science to Support Restoration of Pacific Salmon* (CENR 2000). The report was prepared to support President Clinton's Pacific Coastal Salmon Recovery Initiative, initiated in 1999 to help reverse the decline of Pacific salmon. It is important to note that key authors of this report included members of the ISAB. A major element of the initiative was to accelerate the use of federal science and technology to assist in the conservation of Pacific salmon. The CENR was requested to develop an assessment that identified knowledge gaps and research priorities based on the considerable amount of scientific information already in existence. The report discusses the science needs for remediation, reviews the findings of several management-oriented science summaries for the

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Columbia River Basin, discusses the role of science in a restoration program, and underscores the importance of monitoring the status of salmon stocks and the magnitude of risk factors. The report also identified six broad categories of relevant and important research that have been underemphasized in the past, including:

- Definition of critical ecosystem features for the full life cycle of salmonid species and stocks
- Quantitative definition and assessment of risks (natural and human caused) during upstream, downstream, and estuary/ocean life stages
- Clarification of fundamentals of biological diversity in salmon species, races, and stocks
- Development of remedial technologies that work with nature rather than replacing it
- Clarification of the regional variation in the physical, biological, social, cultural, and economic environments of salmon
- Development of quantitative indicators and analytical methods to assess the status of salmon, characterize risk factors, and evaluate outcomes of remediation efforts to improve environmental conditions or reduce risks

2004 Public Review of the Columbia River Basin Research Plan

The Council accepted public comments on the draft Columbia River Basin Research Plan from October 1 to November 30, 2004. A total of 28 comments were received from the tribes (three), state agencies (eight), federal agencies (eight), local government (one), academic institutions (two), consulting firms (four), and private individuals (two). A list of all the entities that provided comments follows.

Alaska Resource and Economic Development, Inc. (consulting firm, Wrangell, Alaska)
Columbia Basin Fish and Wildlife Authority
Columbia River Inter-Tribal Fish Commission
Confederated Tribes of the Umatilla Indian Reservation
Oregon State University, Institute for Natural Resources
Economic Development Council, Clatsop County
ESSA Technologies Limited (consulting firm Vancouver, British Columbia, Canada)
Federal Caucus
Lathim, Mr. Del (citizen, Pasco Washington)
Lower Columbia River Estuary Partnership
Montana Department of Fish, Wildlife, and Parks
Natural Solutions (consulting firm, Helena MT.)
Northwest Fisheries Science Center, NOAA
Oregon Department of Environmental Quality
Oregon Department of Fish and Wildlife
Pacific States Marine Fisheries Commission
Taylor, Mr. Bernie (citizen, Newberg, Oregon)
Tinsley, Mr. Thomas (citizen, Springfield, Oregon)
University of Notre Dame, Department of Biological Sciences
US Bureau of Reclamation

US Department of Energy, Bonneville Power Administration
US Fish and Wildlife Service
US Forest Service
US Environmental Protection Agency
US Geological Survey
Washington Department of Fish and Wildlife
Washington Department of Ecology
Wyoming Game and Fish Department

2013 Public Review of the Columbia River Basin Research Plan

The Council accepted public comments on the draft Columbia River Basin Research Plan from November 8 2012 to February 8 2013. A total of x comments were received from the tribes (x), state agencies (x federal agencies (x), local government (x), academic institutions (x consulting firms (x), and private individuals (x). A list of all the entities that provided comments follows.

[insert the list of entities that provided comments]

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Discussion on Program objectives, research plan and ocean research

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Report Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist
Patty O'Toole, Program Implementation Manager

Fish and Wildlife Committee
November 7, 2012
Cœur d'Alene, Idaho

Northwest Power and Conservation Council

Program Objectives

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist

- Per the 2009 Program's guidance, staff has assessed the feasibility of and need for revising the Biological Objectives.
- Staff reviewed the multitude of past attempts, and the previously developed and suggested approaches to complete this task.
- Staff suggests three options for addressing the Biological Objectives in the 'letter calling for recommendations'

Northwest Power and Conservation Council

Program Objectives

Nancy Leonard, Fish Wildlife Ecosystem Monitoring and Evaluation Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist

ALTERNATIVE ACTIONS (for the letter):

1) Suggest managers/region use the Program amendment process to propose
   - how the Program's biological objectives should be refined, if at all.
   - refinement should be based on the 2009 Fish and Wildlife Program guidance for developing objectives (topics, format, etc)

Program Objectives

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist

ALTERNATIVE ACTIONS (for the letter):

1) Suggest managers/region use the Program amendment process to propose (1) how the Program's biological objectives should be refined, if at all; (2)refinement should be based on the 2009 Fish and Wildlife Program guidance for developing objectives (topics, format, etc)

2) Suggest managers consider the below changes during the 2014 Program amendment process:

-numerical references removed from the Program Biological Objectives but their text kept the same

-numerical references are then inserted as part of the Program's Vision and Mainstem Plan objectives, as appropriate.

-obtain specificity for the new Mainstem Plan numerical objectives during the 2014 Program amendment process.

Program Objectives

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Peter Paquet, Wildlife and Resident Fish Manager
Laura Robinson, Program Implementation and Liaison Specialist

ALTERNATIVE ACTIONS (for the letter):

1) Suggest managers/region use the Program amendment process to propose (1) how the Program's biological objectives should be refined, if at all; (2)refinement should be based on the 2009 Fish and Wildlife Program guidance for developing objectives (topics, format, etc)

2) Suggest managers consider the below changes during the 2014 Program amendment process: (1) numerical references removed from the Program Biological Objectives but their text kept the same; (2) numerical references are then inserted as part of the Program's Vision and Mainstem Plan objectives, as appropriate (3)obtain specificity for the new Mainstem Plan numerical objectives during the 2014 Program amendment process.

3) Suggest managers keep the existing 2009 Fish and Wildlife Program's Biological Objectives during the 2014 Program.

- The Program language directing the region and the Council to assess the value of having and developing quantitative biological objectives would be removed from the 2014 Program.

Research Plan

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Laura Robinson, Program Implementation and Liaison Specialist

- Per the 2009 Program's guidance staff has:
  - Updated the research plan by removing obsolete information and updating its content
  - Developed a draft database of research uncertainties relying mainly on Council documents published since 2005

Northwest Power and Conservation Council

Research Plan

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Laura Robinson, Program Implementation and Liaison Specialist

3 ALTERNATIVE ACTIONS:

1) Post the updated Research Plan and supporting uncertainties database for a 3-month public comment period starting in November 2012. Once revised, the 2013 draft Research Plan would be posted to replace the 2006 Research Plan

Research Plan

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Laura Robinson, Program Implementation and Liaison Specialist

3 ALTERNATIVE ACTIONS:

1) Post the updated Research Plan and supporting uncertainties database for a 3-month public comment period starting in November 2012. Once revised, the 2013 draft Research Plan would be posted to replace the 2006 Research Plan

2) Include the updated Research Plan and database for consideration during the Program amendment process …. per the 2000 Fish and Wildlife Program intent to adopt it:

> *"The Council will establish a basinwide research plan, similar to the subbasin plans, which identifies key uncertainties for this program and its biological objectives and the steps needed to resolve them. The plan will identify major research topics, including ocean research, and establish priorities for research funding."*

Research Plan

Nancy Leonard, Fish, Wildlife and Ecosystem M&E Manager
Laura Robinson, Program Implementation and Liaison Specialist

3 ALTERNATIVE ACTIONS:

1) Post the updated Research Plan and supporting uncertainties database for a 3-month public comment period starting in November 2012. This comment period would provide feedback on the uncertainties compiled, and their linkages to program objectives, questions, and the 12 research themes. This comment period would also serve to identify additional newly recognized uncertainties and those that have been resolved. Once revised, the 2013 draft Research Plan would be posted to replace the 2006 Research Plan

2) Include the updated Research Plan and its supporting database during the 2014 Fish and Wildlife Program amendment process. Per the 2000 Fish and Wildlife Program intent to adopt it: *"The Council **will establish a basinwide research plan, similar to the subbasin plans, which identifies key uncertainties for this program and its biological objectives and the steps needed to resolve them. The plan will identify major research topics, including ocean research, and establish priorities for research funding."***

3) A mixture of the above 2 options.

- Post for a 3-month public comment period.
- Consider revised plan for inclusion into the 2014 Fish and Wildlife Program during the amendment process

Ocean Research

Patty O'Toole, Program Implementation Manager

The Marine Ecology of Juvenile Columbia River Basin Salmonids: A Synthesis of Research 1998-2011

Kym Jacobson, Bill Peterson, Marc Trudel, John Ferguson, Cheryl Morgan, David Welch, Antonio Baptista, Brian Beckman, Richard Brodeur, Edmundo Casillas, Robert Emmett, Jessica Miller, David Teel, Thomas Wainwright, Laurie Weitkamp, Jeannette Zamon and Kurt Fresh

Report of the U.S. National Marine Fisheries Service,
National Oceanic and Atmospheric Administration
Fisheries and Oceans Canada
Kintama Research Services, Ltd.
and Oregon State University

to

Northwest Power and Conservation Council
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Northwest Power and Conservation Council