Example Summary Research Plan 2007-2013

Extracted from the Northwest Power and Conservation Council staff's *draft* Columbia River Basin Research Plan (November 2005 version) by the ISAB and ISRP

December 20, 2005
ISRP&ISAB 2005-20 Part 2

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I. Introduction

For 25 years, the Northwest Power and Conservation Council (Council) has supported a diverse range of research to support the biological objectives of the Columbia River Basin Fish and Wildlife Program (FWP or Program). Projects implemented under the FWP, and others in the Columbia River Basin, have advanced scientific understanding of fish and wildlife and their restoration. Despite this concerted effort, the absence of a research plan has contributed to a lack of focus on priorities for effectively resolving critical uncertainties for the implementation of the FWP to conserve and restore Columbia Basin fish and wildlife. Consequently, the Council requested development of a Columbia River Basin Research Plan (Research Plan) in the 2000 Program (Basinwide Provisions D.9) 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.

This 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. 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, the collection of data to better quantify important relationships and processes, hypothesis testing, and improvements in statistical methods.

II. Objectives

The primary objective of the Research Plan is to identify and help resolve critical uncertainties to design management and other actions that will conserve and recover native fish and wildlife in the Columbia River Basin. The Plan identifies major research topics to establish priorities for research funding. In so doing, the Plan will facilitate research that addresses key uncertainties that affect anadromous fish, resident fish, wildlife, and the ecosystems that support them. The Research Plan will help the Council manage the Fish and Wildlife Program by informing decision-making, facilitating scientific review, focusing project selection, providing a basis for redirecting future research, and making restoration more effective. The Research Plan also is intended to increase accountability for the annual expenditures of research funds; improve input from independent scientists, fish and wildlife agencies, tribes, and other interested parties; improve coordination among regional research programs; implement research important to subbasin plans; improve monitoring, evaluation, and the application of results; and make information generated by the research and restoration projects of the Fish and Wildlife Program more accessible.

III. Process

Scientific research within the region is guided by many separate plans, including the Federal Research, Monitoring and Evaluation Plan, the Anadromous Fish Evaluation Program, the Strategy of the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), and the Washington State Salmon Recovery Plan. These plans make reference to the need to coordinate with other efforts, but rarely set forth explicit steps to implement such coordination. Consequently, the Council developed the Research Plan to enhance coordination and facilitate 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 Council Research Plan, which thus identifies research that can be funded directly through the Fish and Wildlife Program, as well as research that will require collaborative, multi-party funding.

Many other resource management entities share responsibility for research in support of fish and wildlife stewardship within the Columbia River Basin. Shared responsibility for funding under overlapping mandates and the need to sustain long-term funding commitments to support research pose challenges to addressing key uncertainties. The separate resource management agencies have been unable to secure the funding commitments necessary to mount organized, long-term, and/or large-scale field experiments. For this reason, the convocation of a Regional Research Partnership is proposed. The Regional Research Partnership would facilitate the coordination of research within the Columbia River Basin by identifying unnecessary redundancies, facilitating collaborative projects, and redirecting savings to new research priorities. The Council is well positioned to serve as a sponsor of 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 processes (e.g., open public meetings and hearings) provide opportunities to facilitate coordination among the parties involved in research. A Regional Research Partnership could improve communication among scientists, cooperation among institutions, and coordination of long-term biological monitoring.

It is not the intention of the Council to subsume other research programs and then direct their funding. Rather, the Council intends to use Fish and Wildlife Program resources to help the Partnership catalyze research requiring long-term commitments (e.g., research supporting the development of a regional approach to monitoring). The Plan forges links to the research activity of the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, Bonneville Power Administration, NOAA Fisheries, U.S. Fish and Wildlife Service, U.S. Geologic Survey, U.S. Forest Service, U.S. Environmental Protection Agency (EPA), the Tribes, and other entities.

Relationship to Subbasin Plans

In 2000, the Council initiated subbasin planning to help local entities develop restoration plans. In 2005, 57 subbasin plans that identified needs and opportunities for fish and wildlife restoration were adopted into the Program. The cooperative and inclusive participation of federal, state, tribal, and local stakeholders in subbasin planning created the opportunity for stakeholders to collectively address the critical management uncertainties within a subbasin. Nevertheless, most subbasin plans were deficient in monitoring and research strategies, and few addressed larger-scale (e.g., Province or Basin) conservation and restoration, indicating a need for a coordinated level of planning to ensure that the proposed science was implemented to answer critical uncertainties and recover and sustain fish and wildlife. This Research Plan and the proposed Regional Research Partnership will provide the needed overarching research and monitoring.

Implementation

The critical uncertainties identified in the plan will inform the research agenda for the region, with the more specific details to be developed over time as the Plan is implemented. The anticipated life of this Plan is six years, with three-year work-plans to be developed by Council staff in collaboration with Bonneville and the fish and wildlife managers. The work-plans should be responsive to advancements in science and technology and help guide project selection process. The work-plans would be peer-reviewed, potentially by the ISAB and ISRP. Additional plans for larger-scale coordinated research that includes contributions from other entities conducting research in the Basin would be developed by the Regional Research Partnership, and these also would be peer-reviewed by independent scientific advisors. It is recommended that the Regional Research Partnership develop implementation scenarios in which parties other than the Council have leadership roles and responsibilities and a substantial cost-share for research topics that encompass broader federal and state resource management issues.

The Fiscal Year 2007-09 project selection process will be used to implement the restoration priorities set forth in subbasin plans, the research priorities set forth in this Research Plan, and some of the monitoring priorities identified in the PNAMP Aquatic Monitoring Strategy (PNAMP, 2002). The Research Plan includes the critical uncertainties identified in subbasin plans and elsewhere that have broad application across provinces or to the entire Columbia basin. In the project selection process, research projects that help more than one subbasin and that address the critical uncertainties identified in the Plan will be given preference.

IV. Focal Research Themes and Critical Uncertainties

The Research Plan divides scientifically important issues into critical uncertainties associated with 11 priority research themes. The Plan does not include extensive background beyond that necessary to establish significance of each topic. The critical uncertainties are described at a high level to preserve flexibility of implementation and to prevent the Plan from quickly becoming dated. The critical uncertainties were synthesized from the Fish and Wildlife Program, reports of the Independent Scientific Advisory Board (ISAB) and the Independent Scientific Review Panel (ISRP), regional fish and wildlife managers, subbasin plans, national science groups, biological opinions, and other research plans within the region (*see* Appendix A. Sources of Critical Management Uncertainties for an inventory of the potential research topics identified during the public review of the plan). Critical uncertainties are presented in terms to elicit the development of specific research hypotheses and project proposals, without constraining innovative approaches.

(1) Hatcheries/Artificial Production

Hatchery uncertainties are partitioned by purpose: the uncertainties of conventional production for harvest, and the uncertainties of supplementation and captive rearing for conservation. For the purpose of this plan, relevant terms such as "stock, population, etc." are defined in Appendix D., under Definition of Hatchery Terms.

Many hatcheries operate within the Columbia River Basin, and these have diverse purposes. *[State the number of smolts released annually, and the proportions of various species that are captured in fisheries that are derived from hatchery production]*. Artificial production is authorized under many congressional mandates, and the Northwest Power and Conservation 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 a harvestable surplus for commercial, sport, and tribal fisheries; conservation of depleted (often ESA-listed) populations using supplementation, captive rearing, and captive broodstocks; and reintroductions of species (e.g., coho and fall chinook) into subbasins where they have been extirpated.

It is recognized that 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 use of artificial production in the basin, beginning with determination of the purpose of each hatchery program by an Artificial Production Review Evaluation (Council Document 2004-17). An urgent need remains for fundamental information on the interactions of hatchery-produced fish with wild populations (Return to the River, 1996 and Williams, 2005; CENR, 2000, NPPC 99-15, NPPC 99-4, 2000 Columbia River Basin Fish and Wildlife Program, ISAB 2003-3).

The essential issue for hatcheries now is to determine the balance of 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 are expected limitations of the hatchery approach, and integration with other approaches begs better understanding. The Council's 2000 Program recommends that supplementation and habitat restoration be linked with the goal of reestablishing self-sustaining natural salmon populations and explicitly directs an experimental approach to all hatchery projects (page 29, 2000 Fish and Wildlife Program).

<u>Critical Uncertainties:</u>
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 smolts 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, e.g., by spatial or temporal partitioning of natural and artificial production at the subbasin, province, basin, and regional scale, with the goal of achieving sustainable long-term productivity and resilience of the wild component of the population?

Supplementation--
3. What is the magnitude of any demographic benefit to the production of natural-origin smolts 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 salmon and other species in freshwater, estuarine, and oceanic habitats?

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

(2) Hydrosystem

Construction and operation of the hydrosystem have caused extensive changes in the Columbia River Basin, including major alteration of the riverine environment, such as slow moving reservoirs, mainstem habitat degradation, power-peaking fluctuations in flow, elevated temperatures, and barriers. Major alterations to the hydrosystem are necessary to achieve conditions suitable for salmonid restoration (e.g., Return to the River, Williams, 2005). Thus, the Fish and Wildlife Program emphasizes research in mainstem operations, including spill, flow augmentation, and fish transportation. Passage standards, objectives, designs, and evaluations, must be related to increases in adults back to the spawning grounds (smolt-to-adult survival rates), not just the incremental survival of juveniles or adults through the federal Columbia River hydropower system.

Technologies that most closely approximate the natural physical and biological conditions of migration would most likely accommodate diverse species/stocks, and multiple passage systems are likely needed to fully protect all anadromous stocks. For example, surface bypass systems take advantage of the tendency for yearling smolts to pass dams near the surface, whereas passage systems other than screens and turbines are needed to pass juvenile lamprey and subyearling Chinook, which pass lower in the water column.

River operations significantly different than the status quo need to be tested to provide information to resolve key uncertainties about the hydrosystem impacts on anadromous fish. There is considerable uncertainty about the effects of changes in river flows, spill, and water quality on outmigrating yearlings and subyearling smolts and returning adult salmonids. There is a need to determine the effects of mainstem flow manipulation on survival through experimental studies of all aspects of flow manipulation, including load following (*See* ISAB, 2003-1). For instance, determining the effects on migration of such features as stage waves and turbulent bursts or pulsing flows may offer opportunities for water management that might be more effective in moving fish with greater opportunity for power generation than current procedures. The secondary effects of flow differences on near shore habitat conditions of present-day 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 application of transportation, spill and flow augmentation to protect fall Chinook (ISAB 2004-2). Finally, hydro-operations must take into account effects on resident fish and wildlife through alteration of habitats and ecosystem processes.

Critical Uncertainties:

1. What is the relationship between levels of flow and survival of juvenile and adult salmon and steelhead (including kelts) through the Columbia 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?

2. What are the effects of multiple dam passages, transportation, and spill operations on adult salmon migration behavior, straying, and pre-spawn mortality, and SARs?

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 downstream mainstem, estuarine, and plume habitats and on populations of fish and wildlife?

4. What are the optimal temperature and water quality regimes for salmonid 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 anadromous and resident fishes, shoreline and riparian habitat, and wildlife?

(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 2000 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).

Several critical knowledge gaps must be addressed. The Interior Columbia Basin Ecosystem Management Project (ICBEMP) was largely limited to federally managed lands, and the Council should support a similar initiative to assess the status of habitat throughout the Columbia River basin, as this information is essential 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 effectiveness of present best management practices (BMPs) 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.

<u>Critical Uncertainties:</u>

1. To what extent do tributary habitat restoration actions affect the survival, productivity, distribution, and abundance of anadromous and resident 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 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 salmon and trout 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 anadromous salmonids. 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 local habitat and upriver development and management. Changes in biological processes range from alteration in the food web to the exclusion of salmonids 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 fishes flow through this unique environment, the effects of restoration projects in the estuary have not been evaluated and many basic biological functions of the estuary in the life cycle of salmonids remain poorly understood. Monitoring of the physical 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:

1. What is the significance to salmon 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 salmonids 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.

The marine survival of juvenile salmonids, 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 El Nino-Southern Oscillation can also 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:

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[1], 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 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?

[1] interceptions = catches of juvenile, immature, or maturing fish by non-target fisheries

(6) Harvest

Harvest management has changed substantially since the listing of anadromous salmonids and bull trout. Harvest 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 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.

<u>Critical Uncertainties:</u>

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

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.

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 (see ISAB, 2001-7). 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:

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

2. How do hatchery 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 effect do resident rainbow trout have on the metapopulation structure, productivity, and viability of sympatric anadromous populations?

5. 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 fish and wildlife populations. 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:
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 fishes 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 on the river. Toxics have been recognized as a problem since bald eagles and ssprey, which eat fish from the river that contain various contaminants, were almost eliminated from the Columbia Basin by the mid-1970s. Reproduction is still (1998) 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 Northwest Power and Conservation Council. The toxics program also should be broader than salmonids, because some contaminants are best evaluated or monitored in resident fish or top avian predators of fish that biomagnify contaminants.

Critical Uncertainties:
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[2] 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[3] 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, e.g., as predators or competitors, or indirectly, by altering food webs, water chemistry, physical habitat attributes, etc. 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 have unintentional introductions (OTA 1993); for instance, walleye, smallmouth bass, and channel catfish account for over 20 percent of predation of juvenile salmon, and smallmouth and walleye prey proportionally more on salmonids than do native pike minnows (Zimmerman). 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 fishes (e.g., northern pike, 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 introductions are therefore important. A proactive approach to anticipating invasions and identifying areas at-risk could potentially save millions of dollars in future efforts to control species once they become established and threaten native fisheries. 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.

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[2] 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 Executive Order 13112 on invasive species).

[3] www.clr.pdx.edu/projects/cr_survey/index.htm

Critical Uncertainties:
1. What is the current distribution and abundance of invasive and deliberately introduced nonnative species, i.e., 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, 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:
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?

V. 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 Columbia Basin 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). 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 critical uncertainty:

1. 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?

Additionally, the ISRP Retrospective Report (ISRP 2005-14) identified three steps to build 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. These form three additional monitoring and evaluation priorities for this Plan:

2. Develop, cooperatively, a common probabilistic (statistical) site selection procedures for population and habitat status and trend monitoring.

3. Develop a sound trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format.

4. Develop 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.