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Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem

Development of an Alternative Conceptual Foundation
and
Review and Synthesis of Science
underlying the Fish and Wildlife Program
of the Northwest Power Planning Council

by
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EXECUTIVE SUMMARY

BACKGROUND

In the December 1994 amendments to the Columbia River Basin Fish and Wildlife Program (Section 3.2B), the Northwest Power Planning Council called on the Bonneville Power Administration to fund the Independent Scientific Group to conduct a biennial review of the science underlying salmon and steelhead recovery efforts and Columbia River Basin ecosystem health. The Council's objective was to provide the region, to the greatest extent possible, clear and authoritative analysis conducted by impartial experts.

The Council also asked that the independent scientists develop a conceptual foundation for the fish and wildlife program (Section 5.0F), to 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.

On September 18, 1996, we delivered to the Council this report, which contains the first biennial review and a proposed conceptual foundation for the Fish and Wildlife Program. This report has been peer reviewed by additional scientists, whose comments, where appropriate, are reflected in this report. Appendix A, contains a history of the Independent Scientific Group and brief biographies of its members.

After an introductory chapter, this report is divided into four main components: Chapter 2 contains the proposed conceptual foundation for the Fish and Wildlife Program; Chapter 3 contains the review of the scientific basis for measures included in the current Fish and Wildlife Program, using the conceptual foundation as a template for this evaluation; Chapters 4 through 10 contain the detailed technical data and documentation on which Chapters 2 and 3 are based; Chapter 11 describes general conclusions from our review.

It must be noted at the outset that we were not asked to carry on original research. Nor were we asked to provide specific recommendations for revising the Council's Fish and Wildlife Program. Our charge was to analyze existing data and measures currently in the program, and draw conclusions based on that analysis. The relevant scientific literature we reviewed and cited in this analysis is listed at the end of each chapter.

In submitting this report, the Independent Scientific Group hopes that it will be a valuable resource for decision-makers. The findings should enable fishery managers to focus future research activities on areas that still are not thoroughly understood. However, the review does not include policy recommendations for recovery and restoration. Nor does it recommend specific measures or strategies or deal with institutional structures. It is not an implementation plan. Instead, the conceptual foundation proposed in this report should provide the scientific foundation for public policy to be developed by the Council and other decision-making bodies. It

can be used to guide salmon restoration activities in general, as well as future development of the Columbia River Basin Fish and Wildlife Program.

AN ALTERNATIVE CONCEPTUAL FOUNDATION

Defining a Conceptual Foundation

A conceptual foundation is a set of scientific principles and assumptions that can give direction to management activities, including biological restoration programs. It is the filter through which information is viewed and interpreted. Recovery measures and research findings will take on different meanings when viewed through different filters.

Because ecosystems that have been disrupted over several decades, such as the Columbia River Basin, have scarce evidence left of thriving natural ecologies, scientists must rely on the best available information and remnant populations to assemble as complete a picture as possible. In these instances, the conceptual foundation is designed to be changed over time as new information, about the problems *or* the solutions, becomes available.

Conceptual Foundations in the Current Fish and Wildlife Program

As we began our development of this conceptual foundation, we looked first to the Columbia River Basin Fish and Wildlife Program to determine whether such a foundation already exists in that document. Our answer is yes and no. The Fish and Wildlife Program actually has several implied conceptual foundations. This is likely a result of the process through which it is created, in which recommendations from fish and wildlife managers and others are reviewed and adopted. Each participating agency or individual brings to the process some version of a conceptual foundation on which their recommendations are based. In nearly every instance, these conceptual foundations are not stated outright, but are only implied. In some cases, the foundations that make their way into the program through the adoption of specific measures are in conflict.

In our review of the Fish and Wildlife Program, we analyzed the general assumptions that seem to determine the direction of program activities. The most fundamental assumption appears to be that the natural ecological processes that result in a healthy salmon population can be, to a large degree, circumvented, simplified and controlled by humans. Out of this context, we drew three further assumptions:

1. The number of adult salmon made available to spawn is primarily a direct response to the number of smolts produced. (More young fish will automatically result in more adult spawners.)

2. Salmon production can be increased by actions taken within the river without accounting for conditions in the estuary or ocean.
3. Management actions will not compromise environmental attributes of the ecosystem that supports salmon.

The assumptions above drive management toward actions that are best characterized as technological substitutes for ecological processes. They are often measures that respond to individual problems and they may be credible scientific approaches to those problems if they are viewed in isolation: hatcheries and mechanisms for improving salmon survival at hydroelectric projects, for example, rather than actions that look at the broader context of salmon life history, behavior and habitat. They reflect a good faith effort by the Council and the region's fisheries managers to recover salmon populations. However, the continuing decline of the basin's salmon populations indicates that the conceptual foundations in the current fish and wildlife program and the actions based on those foundations are inadequate.

Our Proposed Conceptual Foundation

The conceptual foundation we propose departs from some of those in the current program. It is not intended to validate existing measures in the program, nor does it derive out of those measures. It is instead designed to form a framework into which recovery measures can be integrated, when they are appropriate. It can provide a template against which recovery actions can be measured and evaluated.

In this proposed conceptual foundation, we treat the Columbia River and its tributaries as both a natural *and* a cultural system. A natural-cultural ecosystem encompasses all the ecological and social processes that link organisms, including humans, with their environments. This approach integrates the habitat of salmon and other wildlife, as well as human habitat, with land use and other cultural developments.

We draw our conceptual foundation from established ecological principles, based on what we understand about the decline of salmon populations and their habitat in the Columbia River Basin.

There are three critical elements of our conceptual foundation:

1. Restoration of Columbia River salmon must address the entire natural and cultural ecosystem, which encompasses the continuum of freshwater, estuarine and ocean habitats where salmon complete their life histories. This consideration includes human developments, as well as natural habitats.
2. Sustained salmon productivity requires a network of complex and interconnected habitats, which are created, altered and maintained by natural physical processes in freshwater, the estuary and the ocean. These diverse and high-quality habitats are crucial for salmon spawning, rearing, migration, maintenance of food webs and predator avoidance.

3. Life history diversity, genetic diversity and metapopulation organization are ways salmon adapt to their complex and connected habitats. This biodiversity and its organization contribute to the ability of salmon to cope with the environmental variation that is typical of freshwater and saltwater environments.

1. The Natural-Cultural Ecosystem

We believe an ecosystem with a mix of natural and cultural features can still sustain a broad diversity of salmon populations in the Columbia River Basin. We call this ecosystem "normative," by which we mean an ecosystem where specific functional norms or standards that are essential to maintain diverse and productive populations are provided. In developing our definition of normative, we looked at what conditions lead to high levels of salmon productivity in less-constrained river systems, as well as in the historic Columbia River Basin.

Key among the conditions we define as normative is the availability of a continuum of high-quality habitat throughout the salmon life cycle, from freshwater streams along the entire migratory path into and back out of the Pacific Ocean. This habitat varies from freshwater to saltwater, from fast-moving, gravel-bottom streams to deep pools and deeper seas. We assume that this habitat is dynamic, responding to daily, seasonal, annual or longer life-cycle changes. We also assume that a diverse array of salmon populations and other occupants of this habitat have adapted over time to the majority of these natural changes. Under some circumstances, salmon in mainstem reaches and adjacent subbasins of the Columbia formed groups of interconnected populations, which we refer to as metapopulations.

Development of the Columbia River for hydropower, irrigation, navigation and other purposes has led to a reduction in both the quantity and quality of salmon habitat, and most critical, a disruption in the continuum of that habitat. Depleted salmon populations cannot rebuild if any habitat that is critical during any of their life stages is seriously compromised.

Consequently, we believe that the most promising way to help salmon populations rebuild is to reduce or remove conditions that limit the restoration of high-quality salmon habitat at each of their life history stages. Our intent in describing a normative ecosystem for salmon is to point out key characteristics that are critical to their survival and productivity. Our description is necessarily general. Specific prescriptions, such as flow regimes, levels of stock diversity, etc., will need to be developed through a process that includes policy development and trade-offs between the natural and cultural elements of the ecosystem. Our normative ecosystem is also dynamic. Conditions in the normative ecosystem will vary, progressing from the current state of the river toward historic conditions, based on the region's decisions and actions.

2. Productivity and the Network of Habitats

The Columbia River is a complex network of habitat types from the headwaters to the estuary. Populations of salmon, as well as other fauna and flora, are distributed throughout this network, thriving wherever there are sufficient resources to sustain their growth and reproduction. Some species are relatively localized, finding adequate resources within a narrow geographic range. These include resident fish. Others, such as anadromous salmon, require vast migrations and specific conditions at each "post" in those migrations, if they are to thrive.

The system of hydropower dams on the Columbia has greatly diminished the diversity of habitat once characteristic of this watershed. The dams severed the continuum of habitat, leaving very little riverine habitat left in the mainstem and isolating other types of habitat. Dams also altered flooding and draining patterns, which further reduced available habitat types and food webs in those habitats. Two key consequences of this loss of habitat diversity have been a reduction in the biodiversity of native salmon stocks and the proliferation of non-native species. Certain species have been able to adapt to conditions created by the dams, while others have not. For example, invertebrates, fish and plants that are not native to the Columbia have proliferated in the impounded river reaches rather than in free-flowing reaches, generally because impounded habitat is more homogeneous.

Normative river conditions are re-expressed at some distance downstream from dams – the further from the dam, the more habitat recovery occurs. This has been demonstrated on the Flathead and Clearwater rivers, for example. However, the mainstem dams on the Columbia and Snake rivers, for the most part, preclude such resetting of habitat conditions because water released from each dam pours directly into the reservoir behind the next downstream dam. The exception is the Hanford Reach on the mid-Columbia, the last free-flowing stretch of the river. The Hanford Reach provides a model of the productivity possible in river reaches that are not fully regulated by dams. It supports a healthy population of fall chinook capable of surviving downstream migration, harvest in the ocean and return upstream to spawn.

Our study has led us to the further conclusion that ocean conditions, which are variable, also are important in determining the overall productivity of salmon populations. Fluctuations in atmospheric and oceanic processes change the physical environment of the ocean, including food webs, water temperatures and other conditions.

Traditionally, fishery managers did not account for ocean conditions in their management decisions. This was largely for two reasons: they assumed the ocean environment and its food webs were substantially in equilibrium, and they recognized that it is impossible to control the climatic patterns and physical factors that influence ocean productivity.

While we agree that the ocean itself is uncontrollable, our management decisions in response to ocean conditions *can* be altered. What we need is a better understanding of and more attention

paid to the linkages between freshwater and marine environments and the processes in the ocean that influence production of salmon. For example, conservation programs designed to address one set of ocean conditions may not be appropriate for another set. Furthermore, river-based management programs and dependence on hatcheries for production have led to a significant reduction in salmon diversity, potentially eliminating those salmon that have adapted to the greatest variety of ocean conditions.

3. Life History Diversity and Metapopulation Organization

In a natural river system, the availability of complex and connected habitats is a critical contributor to salmon productivity. These habitats, whether riverine, estuarine or oceanic, are dynamic. They change daily, annually and sometimes over decades. They change in response to cyclic events, such as the annual spring runoff, and to major non-cyclic events, such as volcanic eruptions, droughts or landslides. How effectively salmon populations survive these changes, or fail to survive them, is influenced by their life history characteristics.

Life history characteristics of salmonids include such traits as: age and size at juvenile migration; growth and maturity during migrations; spawning habitat preferences; migration patterns; and age and timing of spawning migration. These are the characteristics that enable salmon to survive and reproduce within the range of their interconnected habitats. But it is the diversity of habitats that is the template for this diversity of life history characteristics. Salmonids evolved over time in response to their diverse and ever-changing environment.

In the salmon ecosystem of the Columbia River Basin, the variety of habitat types was vast. The loss of much of the habitat and degradation of even more, as well as the loss of connectivity, have constrained salmonid production and reduced life history diversity.

In their 1996 review of the status of Pacific salmon, the National Research Council recommended that salmon be viewed as metapopulations rather than as isolated stocks. This application of metapopulation concepts to natural populations is still being debated among scientists, so our inclusion of the metapopulation structure as it applies to salmon should be viewed as a hypothesis that requires further study and confirmation.

Metapopulations are groups of local populations that are linked by individuals that stray among the populations. Metapopulations persist through the mechanism of straying. When local populations become extinct, they can be re-established through colonization by strays from neighboring local populations. We believe that metapopulation structure is likely in salmon because these fish display both a high degree of homing to their natal streams, which establishes the groups of local populations, and a variable level of straying, which provides the dispersal of genetic traits needed to successfully recolonize habitat vacated by lost populations.

Salmonid metapopulations appear to structure themselves into core and satellite groups. The core populations are generally large productive populations that occupy high-quality habitat. Such large, core populations tend to be less susceptible to extinction than are satellite populations, which have fewer numbers and may occupy lower-quality habitat. Core populations appear to be important as sources for re-colonizing habitat following extinction of local populations.

Studies indicate that the most abundant salmon spawning populations likely occurred in river segments with well-developed floodplains and gravel bars, where habitat complexity was high, including areas suitable to spawning, egg incubation and juvenile rearing. We conclude that salmon populations spawning in large alluvial mainstem reaches of the Columbia may have served as core populations and, as such, may have played critical roles in sustaining salmonid populations in the basin.

Loss of prime mainstem spawning habitat for core populations, and further losses from fragmentation, isolation and degradation of habitats in tributary systems, could have significantly reduced the long-term persistence and stability of regional salmon production. For example, most fall chinook that spawned in the mainstem Columbia and Snake rivers are now extinct.

One of the only surviving mainstem populations of fall chinook spawns in the Hanford Reach in the mid-Columbia. This is the largest naturally spawning population of chinook salmon above Bonneville Dam, and it has been stable during the years when salmon in other parts of the basin have undergone severe decline. It is possible that fall chinook in the Hanford Reach now function as a core population, which might serve as a source for colonization of adjacent habitats if normative conditions were restored in those areas.

Isolated populations of salmon are less likely to be recolonized should they be driven toward extinction because they may lack adjacent populations with similar genetic traits. For the same reason, surviving isolated populations also have less likelihood of successfully contributing to efforts to replenish declining populations elsewhere in the basin. As populations become isolated, local extinctions become permanent, and the entire metapopulation moves toward extinction. Therefore, we believe that restoring salmon populations in this basin will require both the restoration of more diverse habitat conditions and the reconnecting of habitats into the continuum necessary to support salmonids at every stage of their life histories. If this continuum can be restored, we believe that metapopulations will re-emerge to help stabilize regional salmon populations against environmental fluctuations.

REVIEW OF THE SCIENCE UNDERLYING THE FISH AND WILDLIFE PROGRAM

Using our proposed conceptual foundation as the template, we examined the scientific assumptions underlying the Council's Fish and Wildlife Program. However, while our conceptual foundation addresses the continuum of salmon habitat from freshwater streams, through the

estuary and into the ocean, the Council's program is only required to address salmon habitat within the Columbia River Basin. Furthermore, while we looked at all causes of salmon decline and sought ways to reduce and reverse losses from all causes, the Council is mandated to respond only to hydropower-related losses. Consequently, the Fish and Wildlife Program addresses only a subset of the factors contained in our conceptual foundation, and we believe it is fundamentally limited in its effectiveness by these constraints.

Our approach to reviewing the scientific basis for the fish and wildlife program was to examine general principles and specific assumptions implied by the measures in the program and then assess the validity of those assumptions. We did not evaluate individual measures, but looked instead at the biological rationale for measures or groups of related measures. For example, the large number of program measures that relate to flow augmentation in the mainstem river suggests an assumption that flow rates, altered by the hydroelectric system, contributed to the decline in salmon populations. Once stated, that assumption can be analyzed scientifically, while the individual measures may be more difficult to analyze.

On the other hand, it is possible that individual measures or groups of measures may have solid scientific justification, but combined with other measures or strategies the outcome may be inadequate for recovery or inappropriate. In our analysis, we looked at the program, the process through which it is developed and the validity of assumptions reflected in it, based on existing scientific data.

Development of the Fish and Wildlife Program

The Northwest Power Act requires that the Columbia River Basin Fish and Wildlife Program be assembled from recommendations submitted to the Council by the region's fish and wildlife managers, including Indian tribes from the basin. The recommendations are proposed by these managers and other interested parties, reviewed by members of the public throughout the Northwest and adopted by the Council. The measures that are approved for inclusion in the program do not necessarily spring from or respond to a common understanding of the basin or its fish and wildlife resources. They are not necessarily based on a common conceptual foundation. In fact, as we noted above, there appears to be some conflict among implied conceptual foundations in the program.

We argue in Chapter 3 that there are three major problems with this approach to building a recovery program and incorporating new information as it is learned. First, the program becomes a "list" of measures, with advocates for various measures competing for recognition rather than working together to build the most cohesive and comprehensive effort. Second, measures are not prioritized based on overall goals or objectives. There are no overall schedules, nor is there an integrated means to monitor and evaluate measures. Third, the emphasis on individual measures

immerses the Council and implementors in endless details rather than an attention to the broader picture.

Our recommendation is to incorporate an integrated approach with measures based on the conceptual foundation we propose in Chapter 2. Measures could then be evaluated against that framework. They could be judged on how they contribute to the protection, mitigation and enhancement of ecosystem characteristics that are consistent with the biological needs of salmon, while providing for environmentally responsible energy production.

In addition, we suggest that credible, scientific review is needed of projects proposed for funding. We have prepared guidelines for research proposals, for proposal review and for peer review of projects, which can help the Council design a peer review process for the program.

Adaptive Management in the Fish and Wildlife Program

The Council incorporated the concept of adaptive management in the Fish and Wildlife Program in 1987, as a means of moving forward with recovery actions while the region continued to debate questions of biology and hydrology. In our view, adaptive management has since been used to justify a variety of actions on the premise that they may provide new information. We contend that adaptive management is intended as a much more rigorous scientific approach. The term should only be used in reference to explicit management experiments that include hypotheses, test conditions and a detailed experimental design. The concept of adaptive management should not be used as justification for every action about which the outcome is uncertain.

Assessment of the Fish and Wildlife Program

In our review of the scientific basis of the fish and wildlife program, we assigned a qualitative rating that summarized our assessment of the scientific support for various assumptions. Our numeric rating ranked assumptions and principles based on what we deem the “level of proof.” A “level one” would apply to an assumption for which there is solid peer-reviewed empirical evidence. A “level two” would be backed by strong evidence, but not conclusive evidence. “Level three” assumptions have theoretical support with some evidence. “Level four” assumptions are speculative, with little empirical evidence to support them. Finally, “level five” assumptions are contradicted by good evidence to the contrary. Chapters 4 through 10 contain our analysis of the data we reviewed to establish these conclusions.

We first reviewed three general principles that appear in both the Council’s program and in the Northwest Power Act.

1. *The salmon bearing ecosystem in the Pacific Northwest and northeast Pacific Ocean has considerable excess carrying capacity.* Level of proof: four. This assumption leads to the further assumption that there is a simple relationship between the numbers of smolts and increasing overall productivity over the long term. What confounds this assumption is the complexity of both freshwater and marine conditions. Inriver, estuary and ocean environments fluctuate dramatically in response to both human-caused and environmental changes. These fluctuations influence the long-term carrying capacities of the available habitat. The key to resilience in a variable environment is not just the numbers of smolts nor the quantity of habitat. Given the dynamic nature of the environment, we conclude from our analysis that it is the diversity of both habitat and genetic traits that is critical to restoring Columbia Basin salmon, not the quantity alone.
2. *Abundance of salmon and steelhead in the Columbia River Basin has, to a significant degree, declined due to, and is presently limited by, human actions.* Level of proof: one. This assumption is irrefutable. Even accounting for natural variation in the environment, decline of most species has closely paralleled the development of the basin. Damage from early and ongoing development has removed substantial portions of the basin from access by salmon, altered remaining habitat, reduced the abundance of salmon and decreased the ability of surviving salmon populations to cope with natural environmental variations. Focusing only on hydropower impacts severely constrains the region's ability to reverse these trends.
3. *Ecosystem functions lost as a result of development of the Columbia River can be replaced by technological solutions to individual problems.* Level of proof: four. The best evidence against this assumption is the continuing decline of the basin's salmon populations. Despite decades of experiments with technological solutions and the expenditure of billions of dollars in recovery efforts, salmon populations remain depressed. While technology will continue to be a part of any restoration effort in the Columbia River, we recommend that the region move from a strategy of "fixing" ecosystem damage to one that places greater reliance on re-expression of the natural biological and physical processes of the Columbia River salmon-bearing ecosystem.

We also analyzed 29 specific assumptions contained in the Fish and Wildlife Program, assigned a numeric ranking to each, and provide in Chapter 3 a brief overview of the science supporting our ranking. In Chapters 4 through 10, we expand on this evidence.

GENERAL AND SPECIFIC CONCLUSIONS

As we noted above, restoration of Columbia River Basin salmon populations will require a new definition and understanding of the salmon ecosystem. Humans have transformed the Columbia River Basin from a thriving natural environment to a great hydroelectric, irrigation and transportation system, one that drives this region's economy. The human approach to salmon recovery has reflected these impressive technological accomplishments: hatcheries have attempted to replaced natural productivity, flow augmentation has attempted to replace the spring freshet, barge transportation has attempted to replace inriver migration, and so on. To reverse the decline of salmon populations, we believe the region must endorse a conceptual foundation for salmon recovery, such as the one we describe in Chapter 2, and base its efforts on that foundation.

The key to salmon productivity in the future will be the degree to which normative ecosystem conditions are re-introduced into the Columbia River Basin. To accomplish this return to normative conditions, we recommend the following:

1. Recognize explicitly that salmon in the Columbia Basin exist naturally as collections of locally adapted populations organized into aggregates of core and satellite populations known as metapopulations. To increase total productivity, management decisions should nurture life history and population diversity. That diversity will require protection for the remaining core populations, and restoration and reconnection of potential core habitats at strategic areas within the basin. The Hanford Reach, the last free-flowing stretch of the Columbia, could be a model for this management approach.
2. Protect and restore freshwater habitat for all life history stages, with a focus on key Columbia River and tributary reaches and lakes. This approach would include: restoration of the spring freshet to revitalize inriver habitats; stabilization of daily fluctuations in flows to allow food webs to persist in shallow-water habitats that are important juvenile rearing areas; provision of incentives for watershed planning that emphasizes riparian and upland land-use activities to enhance instream and lake habitats; and identification of food web compositions and other key conditions that are critical for migrating juveniles in key habitats. Wherever possible, reconnect restored tributary habitats to restored mainstem habitats, particularly where remnant core populations, such as the Hanford Reach fall chinook, exist.
3. Manage stocks with a more complete understanding of migratory behavior and the limitations that migratory behavior could place on river operations. From our review, we concluded that the Columbia and Snake rivers should not be treated merely as conduits through which young salmon passively migrate to the sea. On the contrary, we learned that the young fish have ecological requirements that must be met during their downstream migration through the

mainstem habitat. Fishery managers need to better understand these needs and manage accordingly.

4. Reduce sources of mortality throughout the salmonid ecosystem, including the ocean and the estuary, as well as the rivers and tributaries of the Columbia River Basin.
5. Current and future salmon recovery measures should correspond to the normative ecosystem concept and be evaluated for their effectiveness in meeting stated objectives. For example, an approach whose goal is a normative ecosystem would highlight restoration of life history diversity, rather than more technological approaches, such as transporting fish in barges or producing them in hatcheries. Hatcheries and transportation should only be used selectively and experimentally, and they should be monitored carefully. To deal with the uncertainties associated with the region's efforts, the FWP as a whole needs an integrated ecosystem monitoring and evaluation program.
6. Recognize that estuary and ocean dynamics are important regulators of the patterns of salmon productivity. While repairing conditions in the ocean is difficult, if not impossible, some management actions can be taken to improve the productivity of salmon in these environments. For example, managers can regulate harvests to maintain viable food chains, they can set sustainable escapement targets so sufficient numbers of spawning pairs are allowed to reach upriver habitats, and they can implement hatchery protocols that allow fish populations to respond to natural fluctuations in ocean productivity. The estuary can be improved and protected through pollution abatement, enhancement of riverine flows and restoration of wetland habitats within the estuary.
7. Re-evaluate the concept of salmon reserves as a means of protecting core populations and potential core population habitat. These core populations could enable reseeding of available healthy habitat, which in turn could rebuild salmon abundance and metapopulation structure throughout the Columbia Basin. The region should consider establishing a salmon reserve in the vicinity of the confluence of the Snake and Columbia rivers, including the Hanford Reach.

IMPLEMENTATION OF NORMATIVE CONDITIONS

We recognize that what we are proposing is an ecosystem recovery that, if we are successful, will be unmatched anywhere in the world. Uncertainties remain, but those uncertainties can be addressed through innovative research and adaptive management. We are convinced that restoring normative conditions at every stage of the salmon life cycle will give this region the opportunity to accomplish the goal of restoring salmon populations in this basin. Salmon are remarkably resilient and productive in healthy habitat. If the focus of our management actions returns to the river, so that natural processes and habitat are restored, the salmon also are likely to return to the river.