CHAPTER 1. INTRODUCTION

Purpose of the review

The Columbia River Basin Fish and Wildlife Program was developed by the Northwest Power Planning Council (hereafter NPPC or Council) as directed by Congress in the Pacific Northwest Electric Power Planning and Conservation Act of 1980. Congress charged the Council to develop a plan to "protect, mitigate and enhance" the fish and wildlife of the Columbia River as affected by development and operation of the Columbia River Basin hydroelectric system. In its latest revision of the Fish and Wildlife Program, FWP (Northwest Power Planning Council, 1994), the Council created the Independent Scientific Group and directed them to 1) develop a conceptual foundation for the Fish and Wildlife Program (section 5.0F), and 2) provide a biennial review of the scientific basis for the Fish and Wildlife Program (section 3.2B). This report responds by providing a conceptual foundation based on current ecological science and by evaluating the assumptions and beliefs embodied in the Fish and Wildlife Program in light of this scientific foundation.

Following this introduction that provides the background for our review, the report is organized into four sections:

1. An explicit, ecologically based conceptual foundation for the FWP (Chapter 2),
2. A review of the scientific basis for the assumptions and beliefs implied by measures in the FWP based on this conceptual foundation (Chapter 3),
3. A technical review and documentation supporting the conceptual foundation and the review of the FWP (Chapters 4-10).
4. Conclusions and implications of the overall review (Chapter 11).

History of the Fish and Wildlife Program

Congress directed the Council as its first act to prepare a fish and wildlife plan to address the loss of fish and wildlife in the Columbia River Basin resulting from the operation and development of the hydroelectric system. The first Fish and Wildlife Program was adopted in November, 1982, following an extensive public process to garner ideas and projects. The Council conducted similar processes to revise the program in 1984, 1987, 1992 (Strategy for Salmon), and most recently December of 1994. Unless otherwise specified, the focus of this review is the Fish and Wildlife Program of December 1994 (Northwest Power Planning Council, 1994). Our report constitutes the first scientific review of the Fish and Wildlife Program.

Each version of the Council's Fish and Wildlife Program (FWP) has described a wide variety of actions to be carried out by the Bonneville Power Administration, other federal agencies and the region's state and tribal fish and wildlife managers. These have focused on in-river returns and production of anadromous salmonids. The Fish and Wildlife Program emphasizes actions to increase survival of salmon and steelhead in the Lower Snake River (i.e., downstream from Hells Canyon Dam), the middle and lower reaches of the mainstem Columbia River (i.e., downstream from Chief Joseph Dam), and their tributaries. Actions implemented so far, include: modification of mainstem dam operations and facilities to improve bypass of adults and juveniles; coordination of river operations to provide enhanced spring flows; reduction of smolt predators; construction and operation of hatcheries, modification of existing artificial production operations, including supplementation of naturally reproducing populations; implementation of "best management practices" for land use activities; and a variety of research and monitoring objectives designed to answer critical questions. Similar measures have been implemented, but at a reduced scale, for resident salmonids and sturgeon in headwater tributaries (Northwest Power Planning Council, 1994). The Fish and Wildlife Program also counsels against new hydropower development on any anadromous fish stream or in stream reaches with a high value to resident fish or wildlife habitat.

Congress included the fish and wildlife provisions in the Act because it recognized the impact of hydroelectric development on salmon and steelhead in the Columbia River. By the time the hydroelectric system was completed in 1975 with the construction of Lower Granite Dam on the Snake River, salmon runs had declined considerably from their previous abundance. As the Act was being debated in Congress, the National Marine Fisheries Service began to analyze the status of Snake River chinook populations to determine if they warranted protection under the Endangered Species Act (ESA; 43 Fed. Reg. 45628 (1978)). Passage of the Act forestalled ESA listing determinations by NMFS for approximately a decade. However, declines resumed in the late 1980's and Snake River sockeye, spring, summer, and fall chinook were listed under the Endangered Species Act in the early 1990's. These listings, and the listing of Kootenai River white sturgeon in 1991, has added another layer of complexity and additional capital cost to the restoration effort in the Columbia River. Development of recovery plans for listed fish populations in the Columbia River are the responsibility of the National Marine Fisheries Service (NMFS). The Fish and Wildlife Program may constitute one of the most ambitious environmental restoration efforts ever undertaken worldwide (Lee and Lawrence, 1986).

As the river basin has been developed over the last 100 years or so, piecemeal technological approaches, such as artificial production, fish bypass, and transportation, among others, have been developed to substitute for losses in salmon production and habitat and to sustain harvest. Despite these efforts, populations of anadromous and resident salmonid species have declined

markedly from their historical abundance and distribution. Prior to development in the basin, the Columbia River may have supported over 200 distinct anadromous stocks, which returned several million adult salmon and steelhead to the river annually (Northwest Power Planning Council, 1986; Nehlsen et al., 1991). All five native eastern Pacific salmon species and steelhead historically returned to the Columbia River, although chinook stocks dominated the runs. Today, most chum, pink, and wild coho stocks (with the possible exceptions of Hamilton Creek, Hardy Creek and Grays River chum stocks, and Hood, Clackamas, and Klickitat river coho stocks) are extinct and the other species are at risk of extinction. Nehlsen (1991) identified 69 extinct stocks and 75 others at risk of extinction in some areas of the basin. Only Lewis River (WA) and Hanford Reach (WA) fall chinook, Lake Wenatchee and Lake Osoyoos (WA) sockeye, and five summer steelhead stocks in the John Day River (OR) can be classified as healthy (Mullan et al., 1992; Huntington et al., 1996). Total returns of cultured and wild chinook and sockeye reached an all time low in 1995 (Figure 1.1). Likewise, resident salmonid populations, such as bull trout, also are increasingly isolated by habitat fragmentation and have been eliminated from many river segments. Many remaining populations are reduced in size and vulnerable to extinction. Evaluation of native salmonids in headwater reaches of the Columbia River shows that the distribution of healthy stocks are reduced to 10-30% of their original distribution, depending upon species (Behnke, 1992; Anderson et al., 1996; Lee et al., *In Press*).

Legal Objectives and Constraints

The Act was intended to restore salmon and steelhead as affected by hydroelectric development while ensuring an efficient, adequate, economical, and reliable power system. It placed specific objectives and constraints on development of the Council's Fish and Wildlife Program including:

1. The program should improve the survival of anadromous fish at dams.
2. It should provide adequate flows between dams to improve production, migration, and survival as needed to reach sound biological objectives.
3. Measures must complement the activities of federal and state fish and wildlife agencies, and appropriate Indian tribes.
4. The program should use the best available scientific information.
5. It must be consistent with the legal rights of appropriate treaty Indian tribes.
6. Where equally effective means of achieving the same sound biological objectives are available, the Program must use the least costly alternative.

The Fish and Wildlife Program was not intended to deal comprehensively with salmonid restoration in the basin, but was to address the effects of development and operation of the hydroelectric system. The Act also allowed the Council to seek off-site mitigation to compensate for hydroelectric losses. In other words, mitigation activities need not be confined to dam sites.

The Council is primarily a policy development body; it has no jurisdiction or regulatory authority over harvest, water rights, or land management in the basin. The Bonneville Power Administration (BPA) is obligated to fund actions in a manner consistent with the Council's program. The U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation and the Federal Energy Regulatory Commission must take the program into account "to the fullest extent practicable."

Goals of the Fish and Wildlife Program

The Council evaluated the historical abundance of salmon and steelhead in the basin and inferred the impact of operation and development of the hydroelectric system to derive general goals for the Fish and Wildlife Program (Northwest Power Planning Council, 1987). While the goals have been reworded and modified in subsequent versions, they remain essentially unchanged in the 1994 Fish and Wildlife Program. The goal is to increase (i.e., double) numbers of salmon and steelhead in the Columbia Basin, while preserving genetic and life history (phenotypic) diversity by reducing human-caused mortality at all life stages. We take this to mean that salmon and steelhead should increase without loss of species diversity or decreases in genetic and life history diversity within populations and species. The Fish and Wildlife Program emphasizes production in areas above Bonneville Dam where hydropower development has been most extensive.

Development of the Fish and Wildlife Program

The Act requires the Council to base Fish and Wildlife Program measures (actions) on recommendations submitted by the region's fish and wildlife managers, and Indian Tribes, and other regional parties. Consequently, the Fish and Wildlife Program is a collection of individual measures proposed by a diverse constituency. The measures were discussed in public before they were adopted by the Council. The measures, as a whole, do not necessarily reflect an explicit concept of the system. As a result, the Fish and Wildlife Program does not originate from a single *a priori* framework of assumptions and information about how the physical and biological components interact to form the salmon bearing ecosystem. We think this is a fundamental shortcoming and germane to this review. Sets of measures, however, such as for artificial propagation in hatcheries or for mainstem passage of smolts, do have underlying assumptions and

concepts, although they are not clearly stated or integrated. We have attempted to identify these topical assumptions as a basis for our review (see Chapter 3).

Relationship to Other Plans and Reviews

Other insightful scientific syntheses of the salmonid fisheries problems in the Columbia River and adjacent region predate our effort, e.g., (Netboy, 1980; Ebel et al., 1989; Rhodes et al., 1994; Lichatowich et al., 1995). Also, at least six recent reviews (Table 1.1) provide detailed action plans or recommendations to reduce mortality and increase salmonid production, in addition to reviewing the status of the fisheries and the causes and consequences of declines. A main theme in these reviews, and our review, is that the downward trend in numbers (i.e., adult returns in anadromous species and population size in resident species) and stock diversity is due in large part to human actions occurring against a backdrop of natural environmental change (Figure 1.2). Agents of natural environmental changes are cyclic oceanic changes such as El Nino, floods, drought, predation, competition and disease. Examples of human-mediated environmental change is related to habitat degradation and loss, hatchery effects, harvest, and introductions of non-native biota. Effects of human mediated changes may be exacerbated by ineffective transfer of information among research scientists, managers, and policy makers.

Our report follows logically from other recent reviews and recovery plans (Table 1.1). It focuses primarily on the Columbia Basin ecosystem and the Council's Fish and Wildlife Program. Nevertheless, our report emphasizes many of the same factors and reaches many of the same conclusions as the recent NRC report, which examined the decline of Pacific salmon stocks at large. The NRC panel (National Research Council 1996) emphasized the importance of life history and genetic diversity of salmon populations and recommended management efforts be directed at the local population and metapopulation levels. The panel also focused on rehabilitation of the Columbia Basin salmon ecosystem through regeneration of natural processes, rather than through a primary reliance on substitution oriented technological solutions, such as hatcheries, transportation, or modification of stream channels.

Application of RETURN TO THE RIVER to Future Efforts

Throughout our review, RETURN TO THE RIVER, we attempt to identify ecological processes that require restoration, as opposed to identification of technological methods. We stress the need to restore the natural functions of the Columbia River ecosystem that produce salmonid fishes, as opposed to circumventing natural ecological processes. Salmonid populations, and other riverine biota, cannot recover in the absence of quality habitat for each life history stage. Despite decades of effort, the present condition of most populations in the Columbia River Basin demonstrates the failure of technological methods to substitute for lost ecosystem functions.

Normative conditions, which provide critical habitat functions in the natural-cultural landscape, must be restored, not mitigated. By conducting our review in the context of a conceptual foundation that focuses on ecosystem-scale habitat restoration, we hope we have provided a perspective for the salmon recovery effort in general, as well as a logical mechanism for evaluating the scientific efficacy of measures (and the implied assumptions) contained in the Fish and Wildlife Program.

Implementation

The ISG presented its preliminary findings to the Council and to the region's salmon managers on April 23, 1996 and May 9, 1996 respectively and solicited scientific and technical peer reviews of the draft document. Responses to the presentations and comments from some of the peer reviewers revealed a common concern: the need for specific prescriptions to implement the recommendations contained in our review. An implementation program containing specific recommendations would have to incorporate social and economic concerns in addition to a scientific basis for action. This is beyond the scope and role of this group and our charge to evaluate the science underlying the Council's Fish and Wildlife Program. Although this is not an implementation document and the review is not intended to fill that role, concerns about implementation raise important questions concerning the application of RETURN TO THE RIVER in subsequent regional efforts to develop an ecosystem restoration program. These include:

1. What should the Council do with RETURN TO THE RIVER?

2. What strategic actions would be consistent with the conceptual foundation in RETURN TO THE RIVER?

3. What could the Council and the region expect of a program based on the RETURN TO THE RIVER?

What should the Council do with RETURN TO THE RIVER?

We believe that the conceptual foundation presented in RETURN TO THE RIVER (Chapter 2), is consistent with the objectives of the Northwest Power Act and the broad policies expressed in the Fish and Wildlife Program. Nevertheless, the conceptual foundation described in the next chapter is a departure from the overall approach to restoration that has characterized the region's

efforts to date and is embodied in the assumptions underlying the Council's program (see Chapters 2, 3 and 11).

We believe a failure to adopt an ecologically based conceptual foundation and to change the approach to salmon restoration in the basin will lead to more extinctions of salmon populations and little progress towards the rebuilding goal. Temporary increases in some populations may occur in response to fluctuations in ocean conditions, but the overall downward trend in returns that has occurred throughout this century will likely continue. We recommend that the Council accept RETURN TO THE RIVER as a scientific basis for refocusing the region's efforts.

What strategic actions would be consistent with RETURN TO THE RIVER?

As stated above, the development of specific prescriptions is beyond the scope of this study. Developing tactical steps to implement the recommendations in RETURN TO THE RIVER is a separate project that should be undertaken after appropriate strategic steps are taken. The recommendations contained in RETURN TO THE RIVER, in particular the movement towards a more normative river ecosystem involves policy decisions that include tradeoffs between salmon and important regional social and economic factors. As a first strategic step in implementing the recommendations contained in RETURN TO THE RIVER, the Council should examine the implications of the normative ecosystem concept; in particular, what steps would move the Columbia River along the continuum from its current state to a more normative state (i. e., the restoration of natural ecological processes consistent with the needs of native fish and wildlife species). Steps ranging from watershed level restoration in subbasins, manipulation of mainstem flows, permanent drawdowns and dam removal should be evaluated in terms of the social and economic costs to the region. The potential social, economic and biological costs and benefits of implementing normative conditions should be determined and become part of the regional debate regarding salmon restoration.

What could the Council and the region expect of a program based on RETURN TO THE RIVER ?

The normative river is not a static target; it is a continuum of conditions covering a broad range of values from slightly better than the current state of the river to conditions that closely approximate the pre-development state (Figure 1.3). Because the region lacks experience in the approach to restoration described in RETURN TO THE RIVER, we cannot predict the exact relationship between increasingly normative conditions and salmon production. The relationship might be linear with salmon production increasing continuously in proportion to the movement

towards normative conditions (Figure 1.3). It may be non-linear (logistic) with little or no increase in production until significant changes accumulate followed by rapid increases in production (Figure 1.3). We believe the more likely relationship will be characterized by a series of thresholds and plateaus (Figure 1.3). As the river moves towards more normative conditions little improvement may be observed until a threshold is reached causing an increase in production to a new level or plateau. The shape of the response of the ecosystem to restoration actions has important implications for scaling the region's expectations and the amount of effort required to elicit identifiable change (Figure 1.3).

The region does have experience with taking very small steps toward the normative conditions and tinkering around the edges of the existing system of natural resource use in the basin (see Box 1.1). Those small steps have produced no discernible progress towards the objectives of the Northwest Power Act, the Council's goals or the condition of populations listed under the Endangered Species Act. Because of this, it is reasonable to question the underlying rationale that has guided these efforts. It is becoming increasingly clear that more substantial changes, based on a scientifically derived rationale, must be taken. At the same time, our knowledge of how to restore key attributes of an ecological system of the scope and complexity of the Columbia River is imperfect and a rigorous program of evaluation, monitoring and research will be required. In the following chapters, we present a scientifically rigorous framework for making those major changes. A fish and wildlife program based on this conceptual foundation is unlikely to be socially painless or inexpensive nor is it likely to provide short-term gratification. Scientific uncertainties abound and unforeseen events will occur. However, we believe that an approach based on the principles described in following pages, combined with an implementation program governed by the principles of adaptive management, offers the best hope for preventing large scale extinction of salmon in the basin and making meaningful progress towards the Council's goals.

Box 1.1. In his review of the 1993 National Marine Fisheries Service Biological Opinion on Columbia River mainstem operations (the Biological Opinion is similar in scope and rationale to the mainstem actions in the Council's program). Judge Marsh concluded: "... the process is seriously, "significantly," flawed because it is too heavily geared towards a status quo that has allowed all forms of river activity to proceed in a deficit situation-- that is, relatively small steps, minor improvements and adjustments-- when the situation literally cries out for a major overhaul." Idaho Department of Fish and Game v. National Marine Fisheries Service, Civil No. 92-973-MA, slip opinion at p. 36 (D. Ore. 1994).

Table 1.1. Recent recovery or enhancement plans and other detailed analyses of scientific information pertaining to the decline of anadromous salmonid fishes of the Columbia River.

NAME	CITATION(S)	NOTES
USA v. OR & WA management plan	see Chapter 7	Federal, court-ordered plan to meet tribal treaty rights; emphasizes escapement and hatchery production
Inter-tribal plan for restoration	(Columbia River Inter-Tribal Fish Commission, 1995)	Evolved from USA v. OR & WA; emphasizes supplementation and habitat restoration
Chapman plan for Snake River chinook and sockeye	(Chapman et al. 1990; Chapman et al. 1991)	Analysis of status and causes of decline; emphasizes habitat restoration and supplementation
Fish and Wildlife Program	(Northwest Power Planning Council 1994)	Mandated by Congress; emphasizes hatchery production, transportation, flow augmentation and mitigation studies by agencies (see Chapter II)
Snake River salmon (NMFS) recovery program	(National Marine Fisheries Service 1995)	Mandated by Congress; emphasizes supplementation, transportation and flow augmentation

Botkin report	(Botkin et al., 1995)	Analysis of regional salmon status and causes for declines; emphasizes habitat degradation and overharvest as problems and provides generalized restoration mechanisms
National Research Council report (Upstream)	(National Research Council 1996)	Analysis of regional salmon decline by National Research Council of National Academy of Science; emphasizes habitat degradation, genetic problems associated with hatchery production, overharvest and institutional constraints as problems and provides generalized restoration mechanisms
East-Side Assessment Broad-Scale Assessment of Aquatic Species And Habitats	(Lee et al., *in press*)	Assessment of aquatic resources within the interior Columbia River basin ecosystem. Concludes that losses and degradation of habitat have severely reduced native fish diversity and abundance. Identifies strategies to manage and rehabilitate habitats and fish populations.

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