Return to Table of Contents
Go to Next Chapter

RETURN TO THE RIVER

PART I: A NEW CONCEPTUAL FOUNDATION

- INTRODUCTION AND BACKGROUND -

- THE EXISTING CONCEPTUAL FOUNDATION -

- THE COLUMBIA RIVER BASIN FISH AND WILDLIFE PROGRAM -

- A NEW CONCEPTUAL FOUNDATION FOR SALMONID FISHES RESTORATION -

CHAPTER 1. INTRODUCTION AND BACKGROUND OF THE COLUMBIA RIVER SALMON PROBLEM

"... 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."

- Judge Marsh in his review of the 1993 National Marine Fisheries Service Biological Opinion on Columbia River mainstem operations (Idaho Department of Fish and Game v. National Marine Fisheries Service, Civil No. 92-973-MA, slip opinion at p. 36 (D. Ore. 1994)).

Introduction

On October 16, 1805 Merriwether Lewis, William Clark and the other members of the *Corps of Discovery* reached the confluence of the Columbia and Snake rivers following their seventeen-month overland trek from St. Louis, Missouri. Their arrival coincided with the arrival of vast numbers of salmon (anadromous salmon and steelhead trout, *Oncorhynchus spp.*) returning to the river on their annual spawning migration. William Clark's journal entry of October 17, 1805 noted, "The number of dead Salmon on the Shores & floating in the river is incrediable (sic) to say…" (DeVoto 1953). They described a thriving native culture centered on the salmon: "they have only to collect the fish Split them open and dry them on their Scaffolds on which they have great numbers" (Clark: DeVoto 1953). The number of salmon returning annually to the Columbia River prior to European settlement has been estimated to be between 10 and 16 million fish (NPPC 1987).

The arrival of the *Corps of Discovery* heralded a period of dramatic environmental change brought on by the encroachment and subsequent growth of European civilization in the Pacific Northwest. In the latter part of the nineteenth century, salmon became the object of an intense commercial fishery that culminated with an estimated catch of 40 million pounds of salmon in 1883 (Van Hyning 1973). At the same time, logging, agricultural development and urbanization produced profound changes in the natural character of the Columbia River Basin. Coincident with these changes, salmon abundance during the twentieth century has shown an overall pattern of decline. The present annual return of salmon to the river is approximately 1 million fish, the majority of which are produced artificially in hatcheries. Salmon and steelhead populations throughout the Columbia and Snake River basins, are listed as endangered or threatened under the Endangered Species Act.

The changes in the natural character of the basin, and especially the decline in salmon, have not gone unattended. The decline in salmon abundance and harvest in the late nineteenth century prompted early fish recovery efforts including the basin's first salmon hatchery constructed in 1877 (Stone 1879; Hayden 1930). The twentieth century has seen several salmon recovery programs. Most of these have been associated with fishery impacts from development of the river's hydroelectric potential.

The most recent fishery recovery program resulted from passage of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (the Northwest Power Act). This legislation, while focused on electric power conservation and marketing of power from the Columbia River hydroelectric system, contained important provisions regarding mitigation for the impacts of hydroelectric development on fish and wildlife in the basin. The act authorized the states of Montana, Idaho, Oregon and Washington to enter into an interstate compact to create a policy-making and planning body for production of electrical power and for fish and wildlife in the Columbia River Basin. The resulting entity was the Northwest Electric Power and Conservation Planning Council – more commonly known as the Northwest Power Planning Council (the Council). The Council was directed by the Northwest Power Act to develop a program to "protect, mitigate and enhance" fish and wildlife as affected by development and operation of the hydroelectric system to be funded by BPA. The Council was instructed to treat the Columbia River as a system rather than the collection of disparate parochial interests that had previously characterized river management. Beginning in 1982, the Council has developed a basin-wide Fish and Wildlife Program to direct fish and wildlife funding by the Bonneville Power Administration (BPA) that markets electric power produced by the Columbia River hydroelectric system. Funding is primarily directed by BPA to tribal, state, and federal fisheries management agencies. Annual revenue from the hydroelectric system is around 2.4 billion dollars (Bonneville Power Administration 1996). The latest revision of the Council's fish and wildlife program was released in December of 1994 (NPPC 1994a); however, this program, like its predecessors, has so far failed to halt the decline of salmon in the basin.

Annual expenditures by BPA as a result of this program are around 200 million dollars, or approximately 45% of the 435 million dollars set aside annually for salmon recovery by an executive agreement between Congress and the President. The remaining $235 million is an amount charged to foregone power (i.e., credited to BPA), for revenues lost on the amount of water used for juvenile salmon migration.

In the 1992 Fish and Wildlife Program (NPPC 1992b; NPPC 1992a; NPPC 1992c), the Council created the Independent Scientific Group (ISG) to provide scientific advice. In an initial review, the ISG criticized the Council's Fish and Wildlife Program for its lack of an explicit scientific basis (Independent Scientific Group (ISG) 1993). The ISG felt that this lack resulted in conflicting strategies within the Fish and Wildlife Program that often were not based on a rigorous scientific rationale. As a result, in its 1994 program, the Council directed the ISG to develop an explicit conceptual foundation and conduct a biennial review of the Fish and Wildlife Program.

This report is the result of that directive. We have examined the scientific basis for fish and wildlife recovery in the Columbia River and, in the light of continued declines of salmon and other species, have developed an alternative conceptual foundation that is grounded in modern scientific thought. The Council's fish and wildlife program is developed from recommendations submitted by a variety of interested parties, but especially the region's tribal, state, and federal fish and wildlife management agencies. As such, it mirrors the themes of traditional fisheries management in North America. Because of this, our review and development of a conceptual foundation, while focused on the Columbia River and the Council's program, are applicable to a broad spectrum and wider geographic extent of fisheries management problems.

Our report is organized into three sections:

Part I. An introduction and background to the salmon problem (Chapter 1), followed by a description of the current conceptual foundation directing salmon restoration and an analysis of the scientific basis for the assumptions and beliefs implied by measures in the Council's Fish and Wildlife Program (Chapter 2), and finally, an explicit description of an alternative ecologically based conceptual foundation for fish and wildlife management (Chapter 3).

Part II. A technical review and documentation of major scientific issues and topics supporting the conceptual foundation (Chapters 4-9).

Part III. A review of the role of monitoring and evaluation in salmon restoration (Chapter 10), and the Independent Scientific Group's conclusions and strategies for restoration from 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 (Figure 1.1) resulting from the development and operation 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, and most recently December 1994. Unless otherwise specified, the focus of this review is the Fish and

Wildlife Program of December 1994 (NPPC 1994). Our report constitutes the first independent scientific review of the Fish and Wildlife Program.

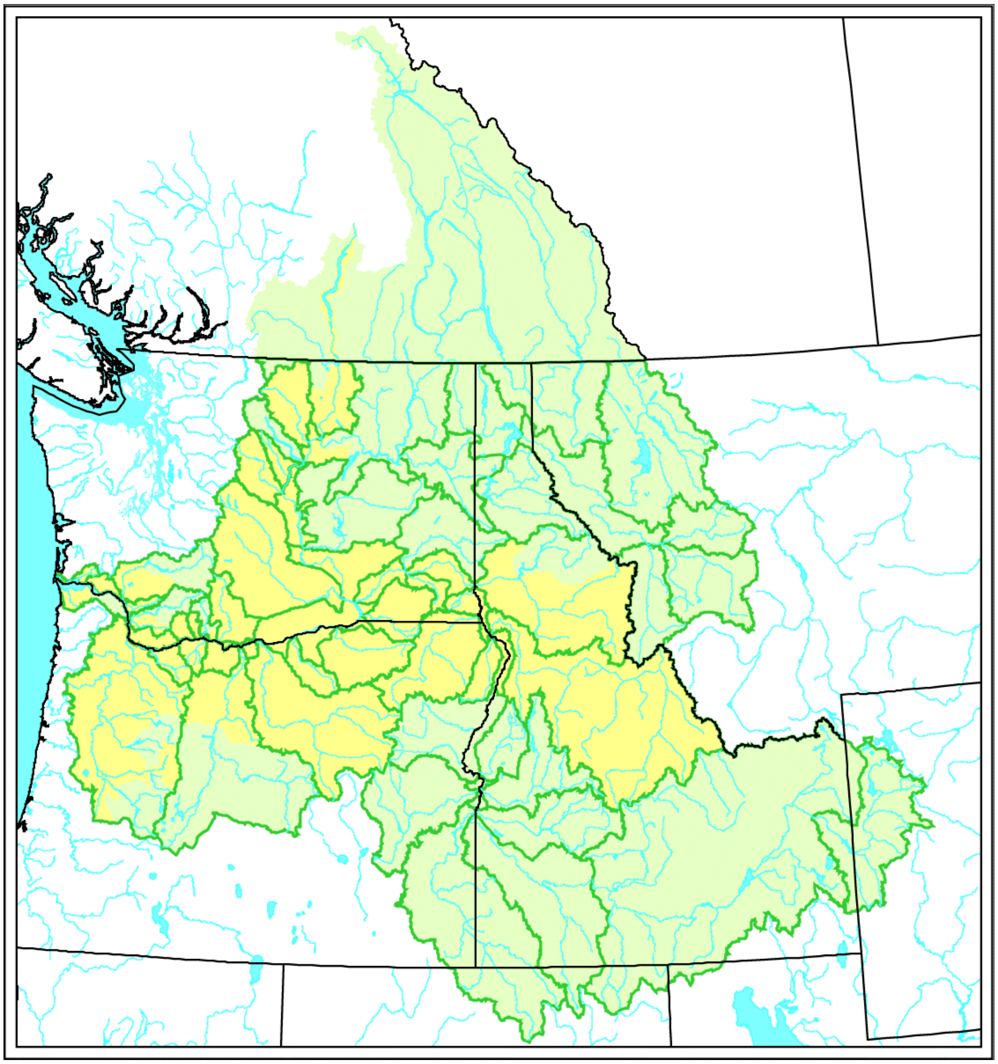

Figure 1.1. Map showing the Columbia River Basin and subbasins (within the U.S. portion). The green dolor denotes the entire basin, while yellow indicates the portion of the basin to which anadromous salmonids presently have access. Figure provided by Columbia Basin Fish and Wildlife Authority and StreamNet.

Each version of the Council's Fish and Wildlife Program has described a 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. Many of these actions have focused on in-river returns and production of anadromous salmonids, while others have addressed the needs of resident fish and wildlife. Reflecting the legislated focus on the impacts of the hydroelectric system, the program emphasizes actions to increase survival of salmon and steelhead in the Lower Snake River (i.e., downstream from Hells Canyon Dam, the most upstream point accessible to anadromous fish), the middle and lower reaches of the mainstem Columbia River (i.e., downstream from Chief Joseph Dam, the upstream point of accessibility in the Columbia River), and their accessible tributaries (Figure 1.2). These actions include modification of mainstem dam operations and facilities to improve passage of adults and juveniles and coordination of river operations to provide enhanced spring flows. Other actions call for reduction of predators of downstream migrating juveniles, construction and operation of hatcheries, and modification of existing artificial production operations, including supplementation of naturally reproducing populations with hatchery-raised juveniles. In recent years the Fish and Wildlife Program has attempted to address stream habitat through implementation of "best management practices" for land use activities and protection of many tributaries from further hydroelectric development. The program also contains a variety of research and monitoring projects designed to answer critical questions. Many of these activities and projects have been funded or implemented through complementary programs overseen by the National Marine Fisheries Service and the U. S. Army Corps of Engineers.

By including fish and wildlife provisions in the Power Act, Congress recognized the impact of hydroelectric development on salmon and steelhead in the Columbia River. The mainstem Columbia River’s first hydroelectric project was Rock Island Dam in 1933, followed by Bonneville Dam in 1938 and Grand Coulee Dam in 1941 (Figure 1.2). By the time the hydroelectric system was completed in 1975 with the construction of Lower Granite Dam on the Snake River, a total of 211 dams existed in the Columbia River Basin (including tributary dams) (Logie 1993), of which 83 multipurpose projects in the United States and Canada could provide a total generating capacity of 30,813 megawatts (NPPC 1986). Salmon and other native fish and wildlife declined throughout the basin coincident with the development of the hydroelectric system and increases in logging, agriculture and urbanization.

The National Marine Fisheries Service (NMFS) first began to analyze the status of Snake River salmon populations in 1979 to determine if they warranted protection under the Endangered Species Act (ESA; 43 Fed. Reg. 45628 (1978)). Inclusion of fish and wildlife protection during the development of the Northwest Power Act, and its ultimate passage in 1980, helped forestall ESA listings by NMFS for more than a decade.

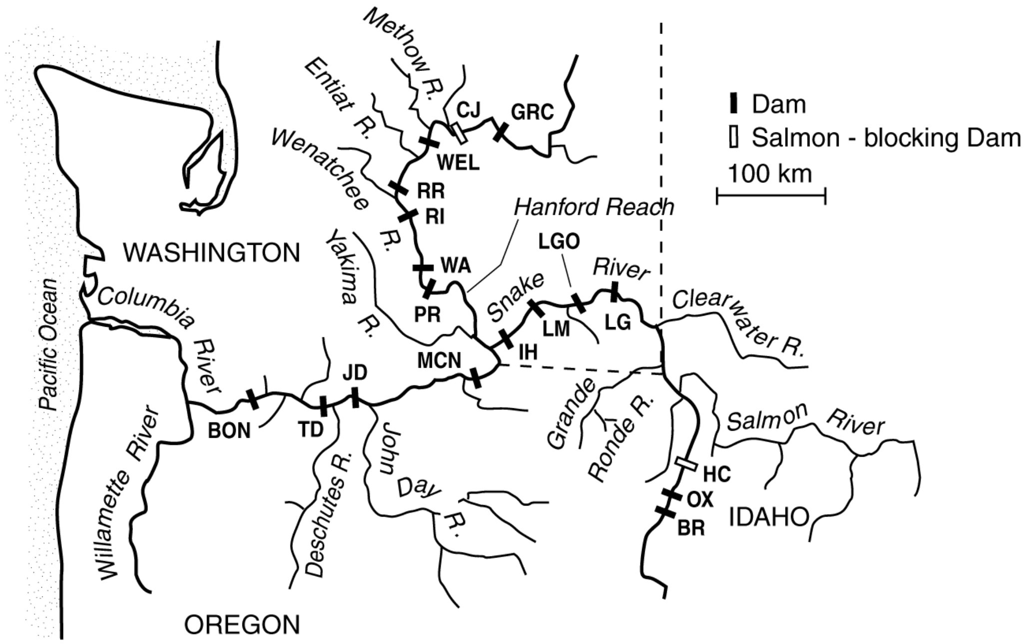

Figure 1.2. Major features of the Columbia River Basin hydropower system. There is no fish passage upstream of Chief Joseph and Hells Canyon dams.
(Dam identifiers and date of completion are: BON=Bonneville (1938), TD=The Dalles (1959), JD=John Day (1968), MCN=McNary (1954), PR=Priest Rapids (1959), WA=Wanapum (1963), RI=Rock Island (1933), RR=Rocky Reach (1961), WEL=Wells (1967), CJ=Chief Joseph (1955), GRC=Grand Coulee (1941), IH=Ice Harbor (1961), LM=Lower Monumental (1969), LGO=Little Goose (1970), LG=Lower Granite (1975), HC=Hells Canyon (1967), OX=Oxbow (1961), BR=Brownlee (1958)).

The abundance of many salmon populations continued to decline, while others were extirpated, after passage of the Power Act and passage of the Council's first Fish and Wildlife Program (1982). These declines led to petitions and listings under the Endangered Species Act. Between 1991 and 1998, first sockeye *O. nerka*, then spring-summer, and fall chinook *O. tshawytscha*, and finally steelhead *O. mykiss* from the Snake River were listed under the Endangered Species Act (Matthews and Waples 1991; Waples et al. 1991a; Waples et al. 1991b; Waples 1995; Busby et al. 1996). Another species of salmon known to have occurred in the Snake River Basin, the coho salmon *O. kisutch*, declined sharply in the 1980's to become extinct some time prior to 1992 (Hassemer et al. 1996).

These and other recent listings[1], and the listing of Kootenai River white sturgeon *Acipenser transmontanus* (1991) and the bull trout *Salvelinus confluentes* (1997), have added another layer of complexity and additional capital cost to the restoration effort in the Columbia River. Development of recovery plans for listed anadromous salmonid fish populations in the Columbia River are the responsibility of the National Marine Fisheries Service, while the U.S. Fish and Wildlife Service (USFWS) has responsibility for the listed resident fish species such as bull trout, westslope cutthroat trout *O. clarki lewisi*, and sturgeon[2]. Within this milieu of management authorities, the Council's program retains the greatest geographic and biological breadth and may constitute one of the most ambitious environmental restoration efforts ever undertaken worldwide (Lee and Lawrence 1986). It has absorbed many of the mandates of the Endangered Species Act into project planning in the program. However, NMFS is asserting a primary role in implementing measures aimed at recovery of the endangered and threatened species.

As salmon and other fish taxa declined over the last century, a variety of recovery programs have been developed. In general, these program have been grounded in the belief that habitat lost to development could be replaced with technology such as artificial production, fish passage structures in dams, and physical transportation of juvenile fish around the hydroelectric system in barges and trucks (NRC 1996).

Despite these efforts, both numbers of fish and numbers of discrete populations of anadromous and resident salmon have declined markedly from their historical abundance and distribution (Netboy 1980). 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 (NPPC 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 chum stocks in Hamilton Creek, Hardy Creek and Grays River, and coho stocks in the Hood, Clackamas, and Klickitat rivers) are extinct and the other species are at risk of extinction. Nehlsen et al. (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

[1] Presently, twelve species (or "evolutionary significant units" of species) of salmon and steelhead that spawn in the Columbia River or its tributaries have now been listed as threatened or endangered under the Endangered Species Act. These include Snake River fall chinook, Snake River spring/summer chinook, Snake River sockeye, Snake River steelhead, upper Columbia River spring chinook, upper Columbia River steelhead, middle Columbia River steelhead, lower Columbia River spring chinook, lower Columbia River steelhead, Columbia River chum salmon, upper Willamette River spring chinook, and upper Willamette River steelhead.

[2] Although sturgeon are anadromous fish, populations above Bonneville Dam are prevented from migrating to the ocean by the dams and are considered resident species for management purposes.

Wenatchee and Lake Osoyoos (WA) sockeye, and five summer steelhead stocks in the John Day River (OR) can be classified as healthy[3] (Mullan et al. 1992a; Huntington et al. 1996). Total returns of cultured and wild chinook and sockeye reached an all time low in 1995 (Figure 1.3). Likewise, resident salmonid populations, such as bull trout and westslope cutthroat 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; Henjum et al. 1994; Anderson et al. 1996; Quigley et al. 1996).

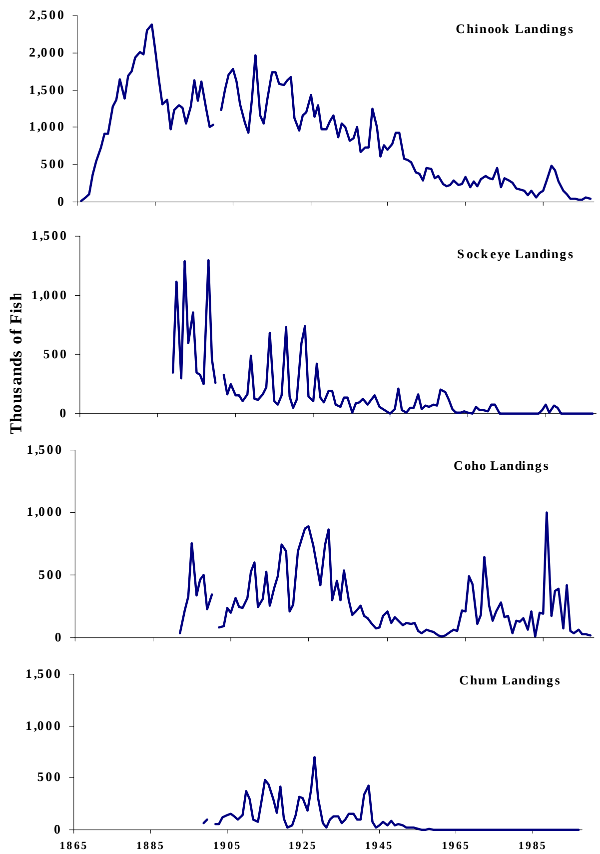

Figure 1.3. Columbia River commercial salmon fishery landings, 1866-1994.

3 Huntington et al. (1996) noted that native stocks of anadromous salmonids could be considered healthy from several perspectives. Their final criteria for classifying stocks as healthy were that they be at least one-third as abundant as expected in the absence of human impacts, abundant relative to current habitat capacity, self-sustaining (not recently declining in abundance or dependent on hatchery supplementation), and not previously identified as being at substantial risk of extinction.

Legal Objectives and Constraints

In the Power Act, Congress charged the Council to "protect, mitigate and enhance" salmon and steelhead *as affected by hydroelectric development and operation* (emphasis added). The Council was constrained by its responsibility to ensure the region an "efficient, adequate, economical, and reliable power system." Congress 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 but could include enhancement to tributary habitats affected by other activities.

The Council is primarily a policy development body; it has no management or regulatory authority over harvest, water rights, or land management in the basin. It must base its Fish and Wildlife Program on recommendations, especially those submitted by the region's fishery management agencies and Indian tribes. In turn, the Council makes recommendations to the operating agencies in the basin with respect to program directions and funding or research priorities. The BPA is required by the Act 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."

Since the Council's first Fish and Wildlife Program was released in 1982, implementation of program measures has been negotiated between the Bonneville Power Administration, the major funder of the actions, and regional fish and wildlife managers and Indian tribes. The Council's role in oversight of implementation of the Fish and Wildlife Program measures was ill-defined. However, in September 1996, Congress passed the first and only amendment to the

Northwest Power Act. This amendment charged the Council to conduct a public and scientific review of the projects proposed to be funded under its program and make recommendations to Bonneville Power Administration regarding the appropriate mix of projects to be funded in each year. The Council's fulfillment of this amendment is currently being litigated in federal court by some of the region's Treaty Indian tribes.

Goals of the Fish and Wildlife Program

Because the Power Act charged the Council with mitigating for fish and wildlfe impacts of hydroelectric development, the question of the extent of hydropower impacts on the decline in fish and wildlife was asked early on. 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. The historical abundance of salmon and steelhead returning to the Columbia River was estimated to be between 10 and 16 million fish annually. Development of the hydroelectric system was estimated to have decreased this abundance by 5 to 11 million fish annually (NPPC 1987). While these numbers are necessarily speculative and not without controversy, they support the contention that development of the hydroelectric system was a major contributor to the decline of salmon and steelhead in the basin. Wildlife losses have been estimated in amount of habitat lost for specific species, but, in general, the loss of habitat due to development of the hydroelectric system amounts to several hundred thousand acres (NPPC 1994). Losses to resident fishes and other ecosystem components have not been estimated.

The Council set goals for fish and wildlife in its 1987 program based on these estimates. While the goals have been reworded and modified in subsequent versions, they remain essentially unchanged in essence in the 1994 Fish and Wildlife Program. The goal for salmon and steelhead is to double the numbers of adult returning fish in the Columbia Basin, while preserving genetic and life history (phenotypic) diversity by reducing human-caused mortality at all life stages. The goal of doubling is relative to the 1987 return level of approximately 2 million fish and does not represent a full accounting of estimated hydroelectric produced losses. We take this goal to mean that salmon and steelhead abundance should markedly increase without loss of species diversity or decreases in genetic and life history diversity within populations and species. The Fish and Wildlife Program emphasizes fish and wildlife production in areas above Bonneville Dam where hydropower development has been most extensive. In contrast to fisheries goals that identified numerical goals for fish, wildlife goals were described in terms of habitat units that needed to be restored or acquired based on assumptions that the habitat would support wildlife numbers described in the loss estimates.

Measures under the Fish and Wildlife Program

The Power 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. The Power Act language, affirmed by federal court action, requires the Council to give particular deference to the recommendations of the region's fish and wildlife managers and Indian tribes. Consequently, the Fish and Wildlife Program is a collection of individual measures proposed by a diverse constituency. The Power Act requires that the Council conduct an extensive public process to review and discuss measures prior to their being incorporated into its program. Because each of the various parties submitting recommendations have different goals and interpretations of the scientific information, the recommendations do not necessarily reflect an explicit concept of the system or a unified direction for the program. The Fish and Wildlife Program does not originate from a single *a priori* framework of goals, assumptions and information about how the physical and biological components interact to form the ecosystem that supports salmon. The lack of an overarching conceptual foundation is a fundamental shortcoming addressed by this review. Sets of measures, such as those 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 2: Analysis of the Fish and Wildlife Program).

Relationship to Other Plans and Reviews

Although ours is the first scientific review of the Council's Fish and Wildlife Program, other insightful historical and scientific syntheses of salmonid fisheries problems in the Columbia River and adjacent regions predate our effort, including Netboy (1980), Ebel et al. (1989), Rhodes et al. (1994), and Lichatowich et al. (1995). Also, at least seven 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 (Chapman et al. 1991; Henjum et al. 1994; Botkin et al. 1995; Chapman et al. 1995; Columbia River Inter-Tribal Fish Commission (CRITFC) 1995; National Marine Fisheries Service (NMFS) 1995; National Research Council (NRC) 1996; Quigley et al. 1996). The review by the National Research Council, in particular, addressed issues that are also addressed in our analysis. A main theme in these reviews, and ours, 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 and institutional conflicts occurring against a backdrop of natural environmental change. 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 are related to habitat degradation and loss including those lost to the effects of dams, irrigation withdrawals, hatchery effects, harvest, and introductions of non-native biota, including predators, as well as hydropower. Effects of human mediated changes may be exacerbated by conflicting sets of values and goals and ineffective transfer of information among research scientists, managers, and policy makers.

Our report follows and is a conceptual addition to 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, we emphasize many of the same factors, and initially reach many of the same conclusions as the recent NRC report. The NRC panel (NRC 1996) examined the decline of Pacific salmon along the entire West Coast of North America. They 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 the substitution of technological solutions, such as hatcheries, barge transportation, or modification of stream channels. Our report makes explicit the need for an ecologically-based conceptual foundation as the basis for developing viable recovery programs.

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
"*Wy-Kan-Ush-Mi Wa-Kish-Wit, Spirit of the Salmon*" (CRITFC 1995)	Columbia River Inter-Tribal Fish Commission 1995	Evolved from USA v. OR & WA; emphasizes supplementation and habitat restoration
"Status of Snake River Sockeye Salmon", "Status of Snake River Chinook Salmon"	Chapman et al. 1990; 1991	Analysis of status and causes of decline; emphasizes habitat restoration and supplementation

Name	***Citation(s)***	***Notes***
Columbia River Basin Fish and Wildlife Program	NPPC 1994	Mandated by Congress; emphasizes hatchery production, transportation, flow augmentation and mitigation studies by agencies.
Draft Proposed Recovery Plan for Snake River Salmon	NMFS (National Marine Fisheries Service) 1995	Mandated by Congress; emphasizes supplementation, transportation and flow augmentation
"Status and Future of Salmon of Western Oregon and Northern California: Findings and Options"	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
"Upstream: salmon and society in the Pacific Northwest. Report on the Committee on Protection and Management of Pacific Northwest Anadromous Salmonids for the National Research Council of the National Academy of Sciences."	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
"Interim protection for late successional forests, fisheries and watersheds: National forests east of the Cascade Crest, Oregon and Washington."	Henjun et al. 1994	Review of studies and recommendations for interim protection of late-successional forests, fisheries, and watersheds on federal forest lands east of the crest of the Cascade Mountains in Oregon and Washington
"Integrated scientific assessment for ecosystem management in the Interior Columbia Basin and portions of the Klamath and Great Basins"	Quigley et al. 1996	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.

Summary of our Findings

Throughout our review, we attempt to identify ecological processes that require restoration. Because of our emphasis on the need to restore functioning ecosystems in order to restore salmon and other species of interest, we take a somewhat negative view of many traditional technological fixes to ecological problems. This does not mean that we are anti-technology. The Columbia River, like most rivers, exists within a human cultural system. It will continue to be managed to provide goods and services to the people of the Pacific Northwest. We do not propose or advocate turning back the clock and returning the river to some state that predates human development of the basin. Nonetheless, we stress the close coupling of species of interest, such as salmon, with their associated ecosystems. We conclude that efforts to apply technology to sustain salmon production in the absence of ecological functions (i.e., engineer substitutes for ecological functions) have generally proven unsuccessful, largely because the efforts have failed to understand and incorporate the ecological processes they wished to replace. Instead, they often created something totally artificial. Restoration of particular species implies restoration of their ecosystems to the greatest extent possible. If we are to have salmon and other species of interest, technology, either as a means to restore fish and wildlife or to benefit humans in some fashion, must operate within the context of restoring and maintaining necessary ecosystem functions. The technological fixes, where used, must mimic natural conditions, not run counter to them. Moving the Columbia River toward a healthy state of ecological functions with respect to salmon and other native species will constrain or eliminate some activities and it is likely to have significant economic impact. However, we conclude that it is the only route that, in the long run, will meet the Council's goals for fish and wildlife, satisfy the requirements of the Northwest Power Act, and successfully deal with populations listed under the Endangered Species Act.

In our review, we describe the characteristics of the Columbia River ecosystem with respect to salmon, recognizing that there are other fish and wildlife species of interest. The paradigm that has governed fisheries management for most of this century holds that destruction of ecological functions by human actions can be compensated by using technology to devise substitutes (Bottom 1997). We believe this paradigm to be false. Despite decades of effort and the expenditure of billions of dollars, the present condition of fish and wildlife in the Columbia River Basin and elsewhere demonstrates the failure of the technological paradigm. Technology provides no lasting substitutes for the benefits of ecosystem functions. Technology can only be effective in the context of functioning ecosystems where it can augment, but nor replace, natural processes. In most cases, ecological restoration requires relaxation of human-imposed constraints to allow reexpression of natural physical and biological processes.

We believe that the conceptual foundation presented in Chapter 3 is consistent with the objectives of the Northwest Power Act and the broad policies expressed in the Council's Fish and Wildlife Program. It is equally applicable to recovery programs aimed at endangered species. Nevertheless, it is a departure from the overall approach to restoration that has characterized the region's efforts to date and the assumptions underlying the Council's program (see Chapters 2, 3, and 11) and in fish and wildlife management in general.

In our opinion, failure to adopt an ecologically-based conceptual foundation and to change the approach to salmon restoration in the basin will lead to more listings of salmon and other species under the Endangered Species Act, continued expenditures, and little progress toward the Council's rebuilding goals. Temporary increases in some populations may occur in response to fluctuations in ocean and climatic conditions, but the overall downward trend in returns that has occurred throughout this century will likely continue. To us, the continued failure of restoration to date, calls for the region to question the basic premises of its fish and wildlife recovery effort, and to consider alternatives. It is our task in the following chapters to describe such an alternative, an ecologically based conceptual foundation for the Columbia River.

Where Do We Go From Here?

The conceptual foundation presented here represents a new approach to salmon management and restoration in the Columbia River basin. It is one with which the region has little experience. The approach is based on the relationship between natural ecological functions and processes, including habitat diversity, complexity, and connectivity, and salmonid diversity and productivity.

Recovery actions will occur against the backdrop of regional environmental change and fluctuations that will dominate short and long-term trends in fish abundance. Thus, it is not possible to predict the exact relationship between improved conditions and salmon production. A variety of responses are possible. The underlying relationship might be linear with salmon production increasing continuously in proportion to the improvement in ecological conditions (Figure 1.4). Alternatively, the response might be non-linear increasing at first in small proportional increments with little or no discernable increase in production until significant changes accumulate which precipitate rapid increases in production (Figure 1.4). A third possibility would be characterized by a series of thresholds and plateaus. In this case as riverine conditions improve, little increase in salmon production might be observed until a threshold is reached precipitating a subsequent increase in production to a new level or plateau. The shape of the response of the ecosystem (and salmon) to restoration actions has important implications for scaling the region's expectations and the amount of effort required to elicit identifiable change.

The region does have experience with taking very small steps toward improving ecological conditions and tinkering around the edges of the existing system of natural resource use in the basin (e.g., quote from Judge Marsh at start of this chapter). Unfortunately, those small steps have produced little discernible progress toward 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. 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 these major changes.

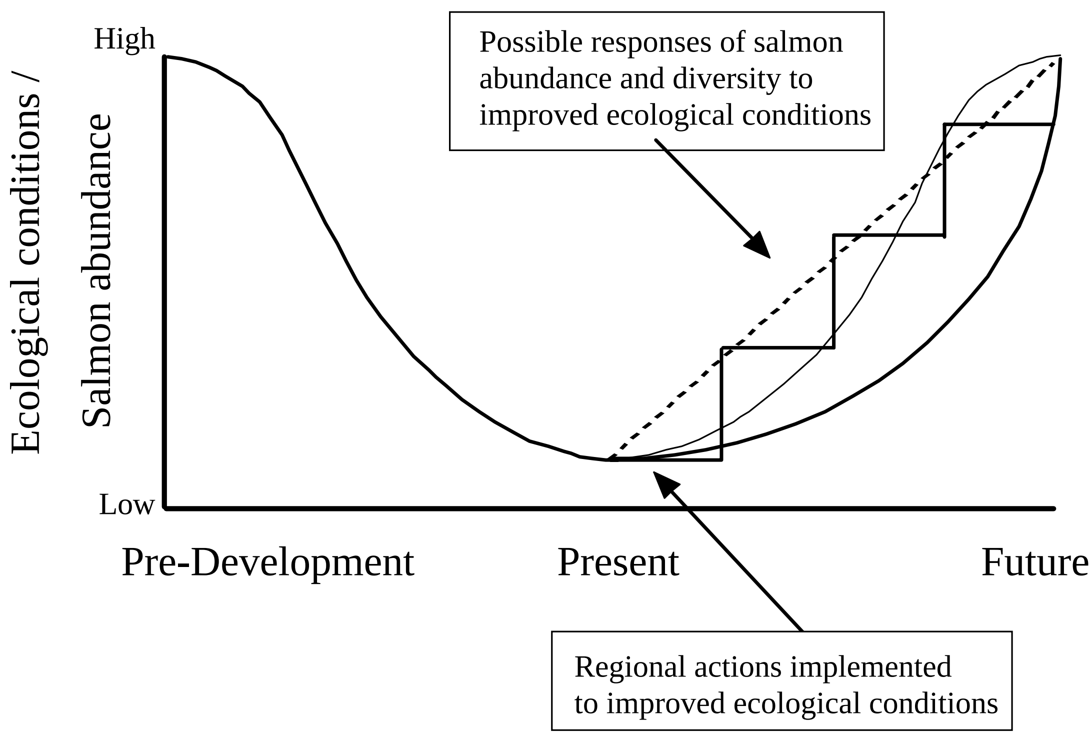

Figure 1.4. Diagrammatic representation of the relationship between status of ecological conditions and salmon abundance at historic, present, and potential future points in time. Future responses are based on the assumption that the region initiates a salmon management plan that improves ecological conditions in the future. The different shaped future responses of the ecosystem and salmon resources to improved ecological conditions indicate our uncertainty about the nature and timing of their response. The diagram shows only four examples of many possible response curves.

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 the 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 toward the Council's goals.

Return to Table of Contents
Go to Next Chapter