NORTHWEST POWER PLANNING COUNCIL

851 S.W. SIXTH AVENUE, SUITE 1100
PORTLAND, OREGON 97204-1348

Fax:
503-795-3370

Phone:
503-222-5161
1-800-222-3355

Internet:
www.nwppc.org

April 10, 1997

Dear Interested Parties:

Enclosed is Issue Paper 97-2, "An Integrated Framework for Fish and Wildlife Management in the Columbia River Basin," which describes a process for developing a regional framework. This paper was developed in consultation with numerous parties in the region and is considered a collaborative effort. It is called an issue paper because it raises the issue, "Is developing the framework a useful approach in developing a regional recovery program?"

We ask that you consider this question and respond in writing, giving us your thoughts and comments by **June 16, 1997.** In the coming weeks, the Council will also provide an opportunity to discuss this matter at a Council meeting and/or work session.

This paper is designed as the first step in the process of developing a regional framework for fish and wildlife recovery. The Council believes that creating a regional framework, with all the components described in this paper, is the key to developing a consensus on the major questions the region is facing. The framework will include which goals the region seeks to achieve; the conceptual foundation upon which both the goals and strategies are based (this includes both scientific and social considerations); the strategies used to achieve the goals; and how the region's expenditures for fish and wildlife recovery are evaluated and monitored.

We believe it is important to approach these tasks carefully and with sufficient time for thoughtful resolution. At the same time, many recovery decisions are being made without the benefit of a framework. Because of this, we suggest a completion date for the framework of mid-December 1997. This will provide guidance for the Fiscal Year 1999 prioritization process and other important decisions.

In the coming weeks, the Council also will decide on a work plan and schedule to develop the framework. Your comments this paper, and the framework process, are requested by June 16, 1997.

Sincerely,

John N. Etchart

John Etchart
Chairman

Enclosure

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AN INTEGRATED FRAMEWORK FOR FISH AND WILDLIFE MANAGEMENT IN THE COLUMBIA RIVER BASIN

97-2

Northwest
Power Planning
Council

April 10, 1997

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Summary: A Framework for Fish and Wildlife Management in the Columbia River Basin

The decline of salmon and steelhead in the Columbia River Basin is a central concern to natural resource management in the Pacific Northwest. The region's efforts to reverse the decline are structured around two statutory recovery programs. The first of these is the Columbia Basin Fish and Wildlife Program of the Northwest Power Planning Council (the Council). The second statutory program is the proposed plan for recovery of populations of salmon in the Snake River that are listed under the federal Endangered Species Act. This program is directed by the National Marine Fisheries Service.

In addition, the four Indian tribes with treaty fishing rights in the Columbia River Basin have developed their own recovery plan, coordinated through the Columbia River Intertribal Fish Commission. The tribal plan has a significant influence on the substance and implementation of the other two programs.

Each of the recovery plans provides a piece of the puzzle that is restoration of the Columbia River ecosystem. Delisting of Snake River chinook is a subset of a larger problem of restoring Columbia River salmon, in general, which in turn is closely related to the restoration of wildlife, resident fish, other animal and plant species and the ecosystem as a whole. While each plan may address different aspects of a larger problem, it is clear that considering the goals and strategies of each plan sequentially or in isolation will not be as effective as a comprehensive integration of their common goals and strategies. A recovery program that addresses regional goals will require a coordinated approach that focuses on the underlying changes in the ecosystem that have occurred during this century.

This paper describes the elements and structure of a common, scientifically based framework for regional fish and wildlife recovery in the Columbia River Basin. The framework is intended to embrace and unite the goals and mandates of the three plans and other regionally identified goals as well. While important, a framework is simply a structure or scaffolding around which to build a regional plan; it is not itself a regional plan. Development of the substance of a regional recovery effort will require a concerted effort to resolve long-standing policy and scientific issues.

The need for a framework has been highlighted by a scientific review of the Council's program by the Independent Scientific Group. This group of scientists noted three general problems associated with the structure and development of the Council's program that can, for the most part, apply generally to fish and wildlife management in the Columbia River Basin:

1) There is a need for a comprehensive scientific foundation.
2) The goals and expectations need to be clarified and linked to actions.
3) Indices and provisions for evaluating success and progress need to be developed.

The Independent Scientific Group also cautioned against the mechanistic, single-species focus of traditional fish and wildlife management. Instead, they recommended an approach that focuses on restoration of ecosystem characteristics consistent with the needs of native fish and wildlife species. The traditional approach has addressed the needs of each economically important species in isolation and has often attempted to devise technological substitutes, such as hatcheries, juvenile fish transportation and bypass systems at the dams, that are intended to replace or mitigate for environmental conditions lost to development activities. The scientists urged an ecosystem-based approach that would rehabilitate the habitat and restore the natural processes needed by salmon and other native fish and wildlife.

The problems identified by the Independent Scientific Group can be addressed through development of an ecologically based framework for regional fish and wildlife recovery. The framework would consist of several elements structured hierarchically to reflect the structure of the Columbia River ecosystem. The elements of the framework are as follows:

- **Goals**, **constraints and obligations.** These describe the rationale and purpose behind fish and wildlife recovery. Goals drive the program by articulating a "vision" of the ecosystem in terms of the needs for natural resources and constraints posed by competing interests.
- **Conceptual foundation.** The conceptual foundation is the scientific basis for a regional fish and wildlife recovery program. It is more than simply a collection of facts and information. It includes the synthesis of information into a body of knowledge upon which to base actions as well. The conceptual foundation translates goals into ecological objectives and strategies based on scientifically derived facts, assumptions and hypotheses relating to functioning of the ecosystem.
- **Ecological objectives.** These describe the biological and physical condition needed to achieve the goals based on the conceptual foundation. Ecological objectives can be time-specific and provide benchmarks for achievement of specific biological and ecological conditions.
- **Strategies.** These are broad statements of the types of actions needed to achieve the ecological conditions and the goals based on the conceptual foundation.
- **Adaptive management.** Because ecosystems are not fixed, and because our knowledge of them is imperfect, the conceptual foundation must be continually modified and supplemented with improved information. Adaptive management refers here collectively to the research, evaluation and directed management experiments that continually inform the conceptual foundation.

While these elements exist in various forms in current recovery programs, they are not linked to form a logical basis for action. It is the relationship among the elements that distinguishes the framework. In the framework, goals lead to ecological objectives and strategies based on the conceptual foundation. Strategies only emerge from a clear articulation of both the direction (goals) and the scientific basis (conceptual foundation). Goals are derived within the political process, while the conceptual foundation emerges from established modes of scientific discourse.

The linkages among elements in the framework are similar to those that exist in functioning ecosystems. Ecosystems are organized as hierarchies reflecting the network of relationships among small-scale features and larger-scale performance. A higher level refers to the Columbia Basin as a whole, while lower levels are individual watersheds or distinct ecological features within watersheds. Each level is linked to other levels. Within each level, biological and physical elements are linked to form a network of interactions resulting in the ecosystem as a whole. In a like manner, the framework elements are linked by a logical structure joining goals to strategies through the conceptual foundation. The framework elements can be described at different hierarchical levels. Goals, a conceptual foundation and strategies can be described for the Columbia River Basin as a whole, for various subregions, as well as for individual watersheds. Like the ecosystem, however, levels within the framework do not exist independently, but are linked to adjacent higher and lower levels. Goals for a watershed must be consistent with goals developed for the subregion which in turn must be consistent with basin wide goals.

Developing a regional framework will require a balance between what we want (goals) and what is possible (conceptual foundation). Once goals are developed, the needed ecosystem condition and a set of strategies are defined based on the conceptual foundation. These strategies may conflict with constraints posed by other uses of the basin. In this case, the region must reconcile the biological reality with social, economic and cultural constraints. This occurs through the political process. The focus of the political process should be on resolving conflicts between goals and constraints. The scientific process of experimentation, observation and synthesis expands, improves and adapts the conceptual foundation.

I. An Integrated Regional Framework

A. NEED FOR A REGIONAL APPROACH

Fish and wildlife in the Columbia River Basin have declined through most of this century. This has occurred in concert with widespread modification of the regional ecosystem as a result of development of the river's economic potential and the increase in human population. The most visible indicator of ecological change has been the dramatic decline in the abundance of the salmon and steelhead. Early declines in salmon harvests prompted some of the first efforts in the region to confront the ecological changes to the basin.[1]

The decreasing abundance of salmon and steelhead in the Columbia River continues to dominate natural resource management in the basin. The region's current salmon rebuilding efforts are structured around two statutory recovery programs. Both of these are influenced by a third program devised by the Columbia Basin Indian tribes that have treaty fishing and hunting rights.

The first statutory program is the Columbia River Basin Fish and Wildlife Program of the Northwest Power Planning Council (the Council). In the Northwest Power Act , Congress directed the Council to develop a program to "protect, mitigate and enhance" fish and wildlife in the Columbia River Basin that were affected by development and operation of the hydroelectric system. The Council's first program was issued in 1982 and has been followed by several revisions, the most recent of which is dated December 1994.

The second statutory program in the region focuses on the recovery of populations of salmon in the Snake River that are listed under the federal Endangered Species Act. This program is directed by the National Marine Fisheries Service. This program has particular impact on the operations of the mainstem Snake and Columbia rivers as well as on habitat associated with the listed species.

The four Indian tribes with treaty guaranteed fishing and hunting rights on the Columbia River have developed their own recovery plan, which was coordinated through the Columbia River Inter-tribal Fish Commission. This plan has a significant influence on the substance and implementation of the other two programs.

Although these recovery programs have a majority of features in common, they differ in their goals and scope. None of the existing programs represents a truly comprehensive approach to the problems facing Columbia River Basin fish and wildlife. The Council's program, for example, addresses all fish and wildlife in the basin, but only to the extent that they are affected by development and operation of the river's hydroelectric system. The National Marine Fisheries

[1] Lichatowich, James 1996. A history of frameworks used in the management of Columbia River chinook salmon. Mobrand Biometrics, Vashon, WA, May 1996.

Service recovery plan focuses only on restoring a subset of fish populations to the point of delisting under the Endangered Species Act. This plan does, however, address all causes of decline for listed populations including hydropower, harvest, production and habitat. The tribal plan is, perhaps, the most comprehensive of the three, but stresses recovery of salmon populations in treaty fishing areas to harvestable numbers.

It is clear that each of these recovery plans provides a piece of the puzzle that is restoration of the Columbia River ecosystem. Delisting of Snake River chinook is a subset of a larger problem of restoring Columbia River salmon in general, which in turn is closely related to the restoration of wildlife, resident fish, other animal and plant species and the ecosystem as a whole.

While each plan addresses different aspects of a larger problem, it is clear that considering the goals and strategies of each plan sequentially or in isolation is not as effective as a comprehensive solution to achieve their common goals. Focusing only on recovery of endangered species, for example, may preclude consideration of broader solutions that would address longer-term regional goals while satisfying the needs of listed and weak populations throughout the basin. On the other hand, if the focus is too broad, important populations that are essential to a long-term solution could be lost.

What is needed is an integrated regional approach that addresses both the goal of delisting specific listed fish species (and potentially other species) and broader goals such as restoration of harvestable fish and wildlife populations and a return to an ecosystem in line with regional cultural and spiritual values. The fragmented management of Columbia Basin fish and wildlife lacks scientific support as a strategy for restoring fish and wildlife. Increasingly, scientists are emphasizing the coupling of species and their ecosystems and calling for holistic, ecosystem-based management.

This paper describes the elements and structure of a framework for regional fish and wildlife recovery in the Columbia River Basin. This framework should embrace and unite the goals and mandates of the three existing plans as well as other regional goals. The framework provides a structure to develop a scientifically based approach to achieving regional and local goals. A framework is a structure or scaffolding around which to build a regional plan; it is not itself a regional plan. Development of a regional recovery plan will still require resolution of many long-standing political and technical debates.

B. NEED FOR A FRAMEWORK

The idea for a framework to structure fish and wildlife recovery is not new. Both the 1992 and 1994 versions of the Council's fish and wildlife program have contained elements of a framework as has the draft recovery plan for Snake River salmon and the tribal recovery plan. However, framework elements contained in these plans largely exist independently, and do not form an integral logical structure for recovery efforts. What is unique to the framework proposed here is the emphasis on the relationship between the elements intended to provide a scientifically based set of strategies to achieve a set of explicit goals.

The need for a structure to explicitly link goals and strategies through a scientifically derived conceptual foundation was heightened by a scientific review of the Council's program by the Independent Scientific Group.[2] While their report, entitled *Return to the River*, focused on the Council's program, it addressed problems with Columbia River salmon management present in all the existing programs. At the request of the Council, the Independent Scientific Group analyzed the structure, content and development of the fish and wildlife program. Their analysis identified three major problems regarding the structure of the region's efforts:

1) There is a need for a comprehensive scientific foundation. The Independent Scientific Group found that the program lacked an explicit, scientifically based conceptual foundation. This is the body of knowledge, assumptions and hypotheses that form the basis for taking action. More precisely, the present program lacks an *explicit* conceptual foundation. Its scientific basis is only implied by the collection of measures. As a result, the rationale and basis for the program is difficult to review, critique or refine.

2) Goals and expectations need to be clarified and linked to actions. Directions and goals for the program are derived after recommendations for actions are received. Recommendations are not necessarily aimed at achieving overall goals, but instead, represent each party's solutions to specific problems. The result is a focus on the means rather than the ends regarding fish and wildlife recovery. Since the recommendations and views of the parties are not constrained by a common or explicit conceptual foundation, there is opportunity for the recommendations to conflict, have weak scientific support or not be linked to program goals.

3) Indices and provisions for evaluating the success need to be developed. Because the goals of the program and its scientific basis are not clear, evaluation of the success of the program is difficult. Lacking an explicit scientific foundation, the underlying assumptions cannot be scientifically tested or refined, and it is difficult to identify criteria for measuring progress. There is little basis for focusing on successful approaches and abandoning unsuccessful strategies and measures. The program simply incorporates new ideas for measures, while rarely discarding older measures. As a result, the program becomes larger and more diffuse over time.

The lack of a clear expression of regional goals and the scientific foundation for actions is one reason why it has been difficult for the region to implement an adaptive approach to fish and wildlife recovery programs.[3] Adaptive management is characterized by an explicit scientific approach to learning using management experiments, research and evaluation to test and refine scientific hypotheses.[4] It has been proposed for use in regional fish and wildlife management in recognition of the need to deal with important scientific uncertainties while taking action to

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[2] Williams, Richard N. and eight other authors, 1996. *Return to the River*. Prepublication Draft submitted to the Northwest Power Planning Council, Portland, OR.

[3] Volkman, J. and W. McConnaha 1992. Through a glass, darkly: Columbia River salmon, the Endangered Species Act, and adaptive management. Environmental Law 23:1249-1272.
McConnaha, W. and P. Paquet 1997. Adaptive strategies for the management of ecosystems: The Columbia River experience. *in*, Dennis DeVries, [ed], *Multidimensional approaches to Reservoir Fisheries Management*. American Fisheries Society syposium number 16: 410-421.

[4] Walters, Carl 1986. *Adaptive management of renewable resources.* New York: Macmillan.

address identified problems.[5] A conceptual foundation is the critical starting point for adaptive management. Uncertainties and questions within the conceptual foundation indicate points to be addressed through adaptive approaches. Without a coherent scientific and policy foundation, program implementation becomes merely a trial and error exercise without scientific rigor or strategic management. It is not clear whether strategies reflect the best available scientific knowledge, and it is also difficult to capture and incorporate new knowledge.

A theme woven throughout *Return to the River* is the recognition of the fundamental linkage between the organisms of interest, e.g., salmon, and their ecosystems. This runs counter to the view that has governed fish and wildlife management for most of this century. The conventional approach has been characterized by a rigid view of ecosystems and the belief that individual environmental problems can be addressed by devising technological fixes for each. In the case of salmon in the Columbia River, this includes separating fish from their ecosystem through the development of alternative environments in hatcheries and barges.

The Independent Scientific Group suggested a more dynamic view of ecosystems. Their analysis stresses the key role of natural processes in shaping the physical and biological components of ecosystems and especially the interactions between components, such as salmon, and other aspects of the ecosystem. Consequently, achievement of regional goals for salmon and other species requires an approach that fosters and takes advantage of these ecological processes. Goals for different species can be achieved by managing the ecosystem to achieve habitat and biological conditions consistent with the common needs of naturally coexisting species.

The Independent Scientific Group builds on a growing body of knowledge that is rapidly being incorporated into natural resource management in general.[6] Similar ideas and criticisms of Columbia River salmon management are also raised in the report *Upstream*[7], commissioned by the National Research Council, and, to a lesser degree, the report of the scientific team advising National Marine Fisheries Service efforts to recover Snake River salmon listed under the Endangered Species Act.[8] The concept of ecosystem management is now the basis for U.S. Forest Service forest management plans[9] and has also been the subject of several recent symposia.[10]

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[5] Lee, K. and J. Lawrence 1986. Adaptive management: Learning from the Columbia River Basin Fish and Wildlife Program. Environmental Law 16(3):431-460.

[6] Christensen, Norman L. and twelve other authors 1996. The report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. Ecological Applications 6(3): 665-691.

[7] Magnuson, John, H. and fourteen other authors 1996. *Upstream: Salmon and Society in the Pacific Northwest*. National Academy Press, Washington, D.C.

[8] Bevan, Donald and six other authors 1994. Snake River Salmon Recovery Team: Final recommendations to the National Marine Fisheries Service. National Marine Fisheries Service, Seattle, WA.

[9] Haynes, R.W., R.T. Graham and T.M. Quigley 1996. A framework for ecosystem management in the interior Columbia Basin. U.S. Forest Service, Portland, OR

[10] For example, summarized by, Nielsen, J.L., editor 1995. Evolution and the aquatic ecosystem: Defining unique units in population conservation. American Fisheries Service, Bethesda, MD;
Kelso, J.R.M. editor, 1994. Proceedings of a workshop on the science and management for habitat conservation and restoration strategies (HabCARES) in the Great Lakes. Can. J. Fish. Aquat. Sci. 53(supplement 1); Stouder, D.J., P. A. Bisson and R.J. Naiman eds. 1996. Pacific salmon and their ecosystems. Chapman Hall, New York.

A regional framework for fish and wildlife recovery responds to the points raised by the Independent Scientific Group. It would result in a coherent, scientifically based regional fish and wildlife program with explicit goals, a scientifically-based conceptual foundation, a resulting set of strategies and a focus for adaptive management. These elements would apply to the basin as a whole, subregions within the basin as well as individual watersheds reflecting the structure of the ecosystem itself. A framework would serve three major functions:

- It would foster a logical relationship among goals, the conceptual foundation and the resulting strategies. Under the framework, strategies emerge in response to a clear understanding of the goals and constraints and based on an explicit scientific foundation.

- It would provide a biologically based structure for regional efforts. This reflects the underlying biological foundation and a coherent, scientifically based philosophy or paradigm for recovery.

- A framework would help distinguish between policy and scientific processes. This would minimize politicization of the scientific process while ensuring that legitimate social, legal and cultural concerns are considered in establishing regional goals and directions.

While a framework would encourage development of a logical and scientifically based approach to fish and wildlife recovery, by itself, it will not ensure success. The substance of the framework, the goals, objectives, scientific basis and strategies, will determine which measures are actually taken and how conditions are changed to encourage recovery of fish and wildlife. It is possible for the region to embrace the concept of a framework, adopt a limited set of goals, employ a restricted scientific foundation, and end up with a set of measures that are little changed from the status quo, an approach that has been criticized in recent scientific reviews.[11] The framework is a tool to help the region develop and implement a scientifically based recovery plan. Arriving at a successful framework will call on the region to address a number of long standing differences regarding directions, goals and priorities.

This paper begins by describing the elements that make up an integrated regional framework. This will be followed by a discussion of how these elements could be organized to reflect the underlying structure of the ecosystem. A third section will provide an example of a framework with these components.

C. FRAMEWORK ELEMENTS.

The elements of the framework are intended to directly address the points raised by the Independent Scientific Group. The elements can be organized hierarchically to provide goals and scientific information pertinent to the region as a whole, individual subregions or watersheds. While the elements will first be discussed separately, it is stressed that it is the relationship

[11] Bevan et al. op. cit., Magnuson et al. op. cit., Williams et al. op.cit.

among the elements -- how we move from goals through the conceptual foundation to the strategies -- that distinguishes the framework from conventional management.

Framework elements are:

- **Goals**, **constraints and obligations.** These describe the rationale and purpose behind fish and wildlife recovery. Goals drive the program by articulating a "vision" of the ecosystem in terms of the needs for natural resources and constraints posed by competing interests.
- **Conceptual foundation.** The conceptual foundation is the scientific basis for a regional fish and wildlife recovery program. It is more than simply a collection of facts and information. It includes the synthesis of information into a body of knowledge upon which to base actions as well. The conceptual foundation translates goals into ecological objectives and strategies based on scientifically derived facts, assumptions and hypotheses relating to functioning of the ecosystem.
- **Ecological objectives.** These describe the biological and physical condition needed to achieve the goals based on the conceptual foundation. Ecological objectives can be time-specific and provide benchmarks for achievement of specific biological and ecological conditions.
- **Strategies.** These are broad statements of the types of actions needed to achieve the ecological conditions and the goals based on the conceptual foundation.
- **Adaptive management.** The conceptual foundation must be continually modified and supplemented with improved information. Adaptive management is used here to refer collectively to the research, evaluation and directed management experiments that continually inform the conceptual foundation.

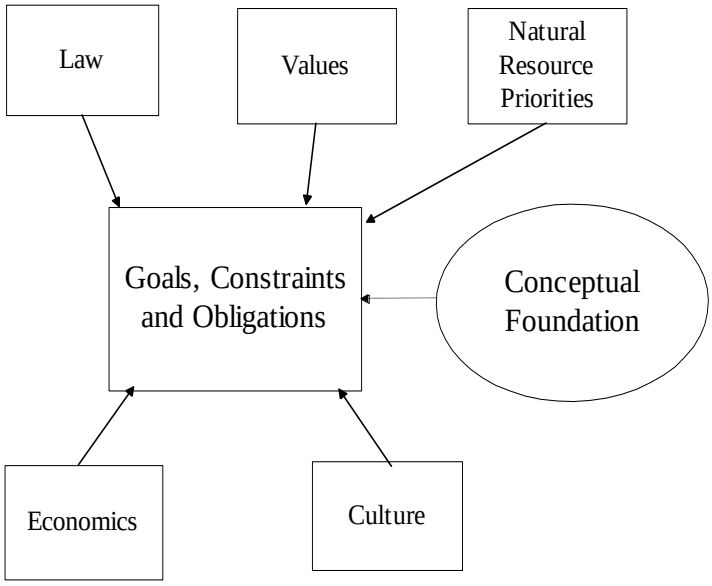
1. Goals, constraints and obligations

Goals are the driving force behind the framework and the resulting program. They state the management purpose and describe a regional vision for the ecosystem. A statement of goals is recognized as a necessary first step in virtually any exercise. Goals are described in the Council's program as well as in the Draft Snake River Salmon Recovery Plan and the tribal plan. Unfortunately, in many cases, goals become simply statements of overall policy and direction and do not directly drive selection of strategies and measures. The distinguishing feature of goals in the framework is that they drive selection of strategies based on the conceptual foundation.

Because the choice of goals drives the region's priorities for setting major capital expenditures, altering hydroelectric system operations and determining management priorities, the explicit recognition of goals and their power in driving future decisions is essential. Although the region may aspire to a lofty set of goals, the goals that actually drive implementation of actions are often quite different, and usually more modest. Even if these more modest goals are characterized as interim, they determine prioritization of funds and guide efforts for many years. By committing the region to a certain set of actions, these interim goals may preclude future progress toward the region's real goals.

Goals describe the basin or watershed with respect to natural resources. They are an articulation of the desires and objectives of the management agencies, residents and other interested parties. Goals may be expressed as numbers of fish at various life stages, desired harvest levels, wildlife species or other natural resources benchmarks. They incorporate legal, cultural and political concerns and are developed within political and policy processes (Figure 1). The conceptual foundation translates the goals into a set of ecological objectives. The conceptual foundation influences the goals by defining the possibilities, given the scientific understanding of the ecosystem. The components in Figure 1 are melded within the political process to form goals. This involves the balancing of natural resource priorities, regional constraints and obligations to arrive at a set of goals that drives the recovery plan.

Figure 1. Considerations melded through the political process to form goals and constraints.



It is important to distinguish goals, which are the ends, from strategies, which are the means. Donald Worster has called this confusion, "instrumental reason" which he defined as "thinking carefully and systematically about means while ignoring the problem of ends."[12]

Columbia River salmon restoration over the last century has aimed at a wide array of ends including delisting populations under the Endangered Species Act, doubling runs, providing harvest, restoring natural ecosystems or minimizing cost and maintaining other uses of the river. These are not all consistent or compatible. Over time, the ends become obscured under layers of debate regarding the means. Regional debate focuses on implementing strategies rather than facing the difficult task of resolving the goals, values and constraints that will guide the region's

[12] Worster, Donald, 1985. *Rivers of Empire*. Oxford University Press.

efforts. In many cases, these strategies have become the ends rather than means. The goal becomes "build a hatchery," "increase flows," "transport juvenile fish," or "minimize costs" rather than achieve a certain type of biological system to reach a set of goals. If it is consistent with the conceptual foundation, building a hatchery, increasing flows or transporting fish may be the means to achieve a goal, but they should not be confused with the goal. Strategies emerge from the conceptual foundation as the means to achieve goals and can be evaluated in regard to their cost.

Constraints are factors that limit goals because of competing regional needs. The amount of money available to finance recovery efforts is a constraint. Other examples of constraints include urban development, agriculture, energy production and other industrial uses of the river system or habitat.

For example, one of the Council's goals in its 1994 Fish and Wildlife Program was to double the abundance of salmon and steelhead returning to the Columbia River. But the Northwest Power Act imposed the constraint on the Council to ensure "an adequate, efficient, economical and reliable" power supply for the region. The Council does not have complete liberty in devising a recovery plan but is constrained by regional power supply needs.

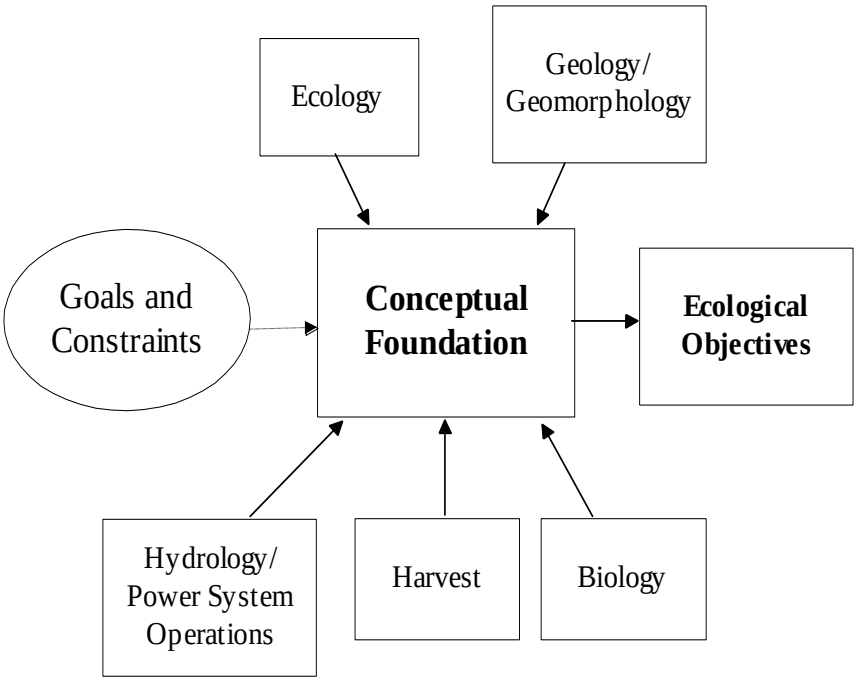
At the same time, goals for natural resources become constraints in regard to other uses of the river. For power planning purposes, for example, the charge in the Northwest Power Act to provide flows "of sufficient quality and quantity" to meet biological objectives becomes a constraint on power production. Thus, the region's task is to balance the goals and constraints of various competing uses of the river's resources.

Obligations are distinguished from constraints by having the weight of law and because they do not necessarily inhibit or constrain natural resource goals but instead can expand and shape these goals. Examples of obligations are treaties between the United States and regional Indian tribes and laws such as the Endangered Species Act, National Environmental Policy Act and the Pacific Northwest Electric Power Planning and Conservation Act. These are obligations that mandate certain courses of action and preclude debate on particular issues. For example, setting goals that do not include meaningful restoration of native fish and wildlife species is probably precluded because of obligations based on treaties and laws.

2. Conceptual foundation

A conceptual foundation is the body of scientifically based knowledge that provides direction and technical substance to the program. It includes the scientific principals, assumptions, beliefs and hypotheses that form the prevailing model of how the system functions (Figure 2). The conceptual foundation is not limited to information and data but also includes the scientific synthesis of these into knowledge. Goals and constraints focus the conceptual foundation on the appropriate body of knowledge. The conceptual foundation is developed separately from the goals using established routes of scientific investigation and review.

Figure 2. Information developed through scientific process to form the Conceptual Foundation.



The conceptual foundation is the information used to translate the goals into the necessary ecological condition expressed as a set of ecological objectives (Figure 2). The conceptual foundation is also the basis for a set of strategies intended to achieve the needed ecological condition.

A conceptual foundation for the program would include information on human activities as well as physical and biological features of the ecosystem (Figure 2). The Columbia River is a highly developed ecosystem and can only be understood by inclusion of human culture. Together, human and non-human aspects form the "natural/cultural ecosystem" described by the Independent Scientific Group. Human activities are key to understanding the functioning of the ecosystem in the natural/cultural context that exists today. For example, the existing condition of the ecosystem can only be understood by including in the conceptual foundation an understanding of the pervasive impacts of human activities such as the hydroelectric generation, irrigation and harvest.

The conceptual foundation is developed using the scientific process of observation, experimentation and synthesis, mediated by established review procedures. This is distinct from the process used to meld cultural values, law and economics into regional goals and constraints. Confusion occurs when these processes are mixed -- when development of goals and policies occurs under the guise of science, and when scientific knowledge is manipulated through the political process.

3. Ecological Objectives

The ecological objectives describe the conditions needed to achieve a set of goals based on the scientific information in the conceptual foundation. In describing an ecological condition, the objectives should relate to the organisms themselves (life history diversity, abundance, survival rate, productivity), associated physical conditions (temperatures, flow, sediment) and ecological conditions (habitat connectivity, species assemblages, ecological integrity).

Ecological objectives can be arrayed on a time line to provide performance benchmarks. However, ecological objectives must go through the conceptual foundation to ensure a firm linkage to the goals and a scientific basis. It is important to distinguish goals from the ecological objectives. The goals drive the framework and are the sources from which other elements of the framework are derived. Objectives emerge from the conceptual foundation as a description of a needed ecological condition. Strategies are designed to achieve ecological objectives.

A related concept is that of performance indicators. These are readily measurable indices of the ecological objectives. Parameters used as ecological objectives may be difficult to measure or respond slowly to strategies and actions. Performance indicators can be used to provide timely indications of change or to indicate problems. In any event, performance indicators relate directly to the ecological objectives.

4. Strategies.

Functionally, strategies are alternative ways to achieve specified ecological conditions. They are derived from the conceptual foundation as the means to achieve the condition described by the ecological objectives. Strategies lead directly to the measures that describe specific actions. A strategy, for example, might be to increase life history diversity of salmon in a watershed to accommodate a variable environment. Measures would be specific actions in the watershed designed to accomplish this strategy.

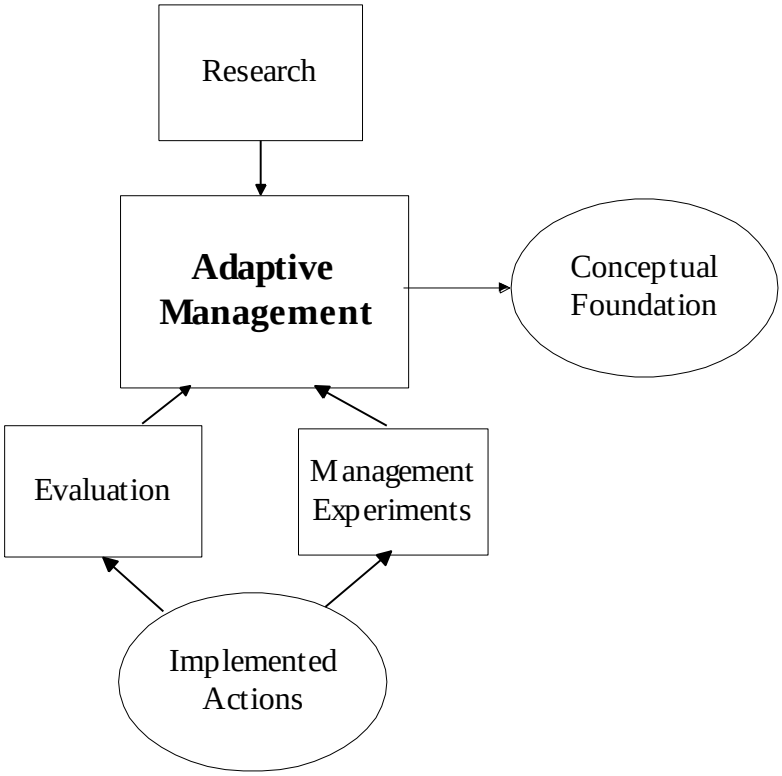
Strategies emerge from a conceptual foundation as the means to achieve the ecological objectives. The goals articulate a regional vision for the ecosystem, while the conceptual foundation translates these into an ecological condition needed to accomplish the goals based on currently available information.

5. Adaptive management

A conceptual foundation is based on the existing general body of ecological and biological knowledge. However, our knowledge of the Columbia River as an ecosystem is limited, as are the techniques for ecosystem management. As a consequence, specifics regarding the Columbia River ecosystem are often framed as hypotheses and assumptions based on the general body of existing knowledge. Within the framework concept, adaptive management includes the various components that collectively provide feedback to expand the base of ecological and biological knowledge (Figure 3). Adaptive management allows the conceptual foundation to flex in response to ecosystem change and adapt to new circumstances. Recovery actions are used as experimental treatments to evaluate key hypotheses. Research involves more focused

experimentation, while evaluation examines the validity of hypotheses underlying specific actions.

Figure 3. Components of adaptive management within the framework.



The underlying concept of the ecosystem has a significant effect on learning. If the ecosystem is viewed as a fixed, definable system, then learning has a finite horizon. Under this view, research and learning are aimed at what are perceived to be pivotal questions. Clear answers to these few questions are seen as leading to a clear strategy for recovery. The region's preoccupation over the last decade or more with deriving a simple relationship between river flow and salmon survival is an example of this kind of thinking.

On the other hand, if ecosystems are viewed as dynamic systems, changing in response to variation in their biological and physical components, learning is a continuous exercise that allows management to adapt. The long and short term variations in ocean conditions and regional climate and their impact on salmon abundance are notable examples that we have only recently

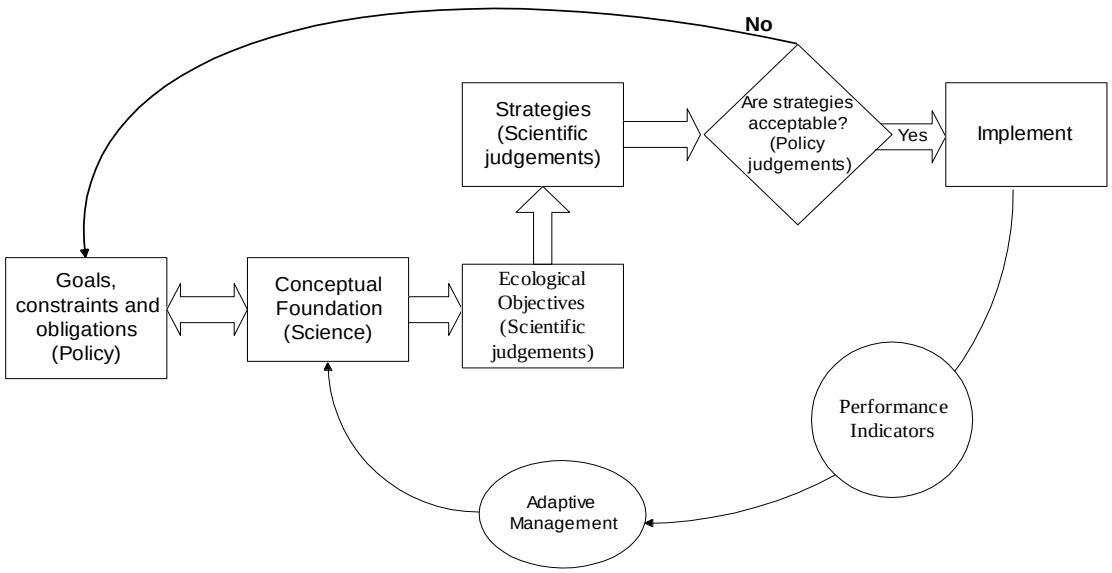
come to appreciate.[13] A framework or program that attempts to impose a narrow range of solutions is likely to fail when ecosystem fluctuations negate key planning assumptions.

D. INTEGRATION OF FRAMEWORK ELEMENTS.

Although the framework elements have so far been discussed separately, they are inter-related to a significant degree. Indeed, it is the interaction among the elements, more than their exact definition, that is the key to the ability of the framework to help develop and structure a logical, scientifically based fish and wildlife program.

The framework fosters a logical relationship between goals and strategies linked by the scientific basis for action (Figure 4). The conceptual foundation tempers the goals and constraints by defining what is possible given existing scientific knowledge. The double-headed arrow linking goals/constraints and the conceptual foundation in Figure 4 reflects how goals and constraints focus the conceptual foundation, while the conceptual foundation tempers the goals based on scientific understanding of the problem. Goals, constraints and obligations are based on political judgments (Figure 1) while the conceptual foundation is a body of scientific information and knowledge (Figure 2).

Figure 4. Integration of framework elements.



Ecological objectives are scientific judgments based on the conceptual foundation. They are descriptors of a condition needed to meet the goals. Strategies are similarly based on the

[13] Francis, R. and S.R. Hare 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. Fisheries Oceanography 3(4): 279-291.

conceptual foundation. They are scientifically supportable means to achieve the ecological objectives based on the conceptual foundation (Figure 4).

The strategies are then evaluated within the political process in regard to their social, cultural and economic impacts. This evaluation could include determination of the cost effectiveness of the strategies as the means to achieve the biological objectives. Scientific feasibility has already been determined through the conceptual foundation. If the region decides that a certain set of strategies is acceptable, then measures are developed and implemented. However, if the strategies are not acceptable -- they could be judged too expensive or socially disruptive-- the appropriate response is to go back and reconsider the goals and constraints (Figure 4). A negative answer to the question posed in the diamond in Figure 4 usually signifies a conflict between the goals for natural resources and constraints from other uses of the river. A logical and scientifically based regional recovery program will require that these conflicts be resolved in the context of a scientifically derived conceptual foundation.

Figure 4 shows a second feedback loop from implementation of strategies back to the conceptual foundation through the performance indicators and adaptive management. The conceptual foundation is modified and refined through the accumulation of knowledge derived through the scientific process. Even as goals and constraints may change over time due to shifting laws and cultural values, the conceptual foundation changes due to alternative scientific perspectives and improved knowledge. For example, through much of this century, the underlying (although rarely articulated) conceptual foundation regarding fisheries management was that hatcheries and other devices could mitigate or substitute for ecosystem functions lost as a result of development of the basin.[14] Over time, scientific observation, experimentation and synthesis have led to an evolution of the conceptual foundation. While acknowledging the role of technology in ecosystem management, science now stresses the need for a close coupling of the species and their ecosystems, resulting in a reassessment of the role of artificial production[15]. The implications of this refined conceptual foundation may lead to a modification of goals and a restructuring of regional strategies.

[14] Lichatowich, op.cit.
[15] Christensen et al. op.cit., Williams et al. op.cit.

E. FRAMEWORK STRUCTURE

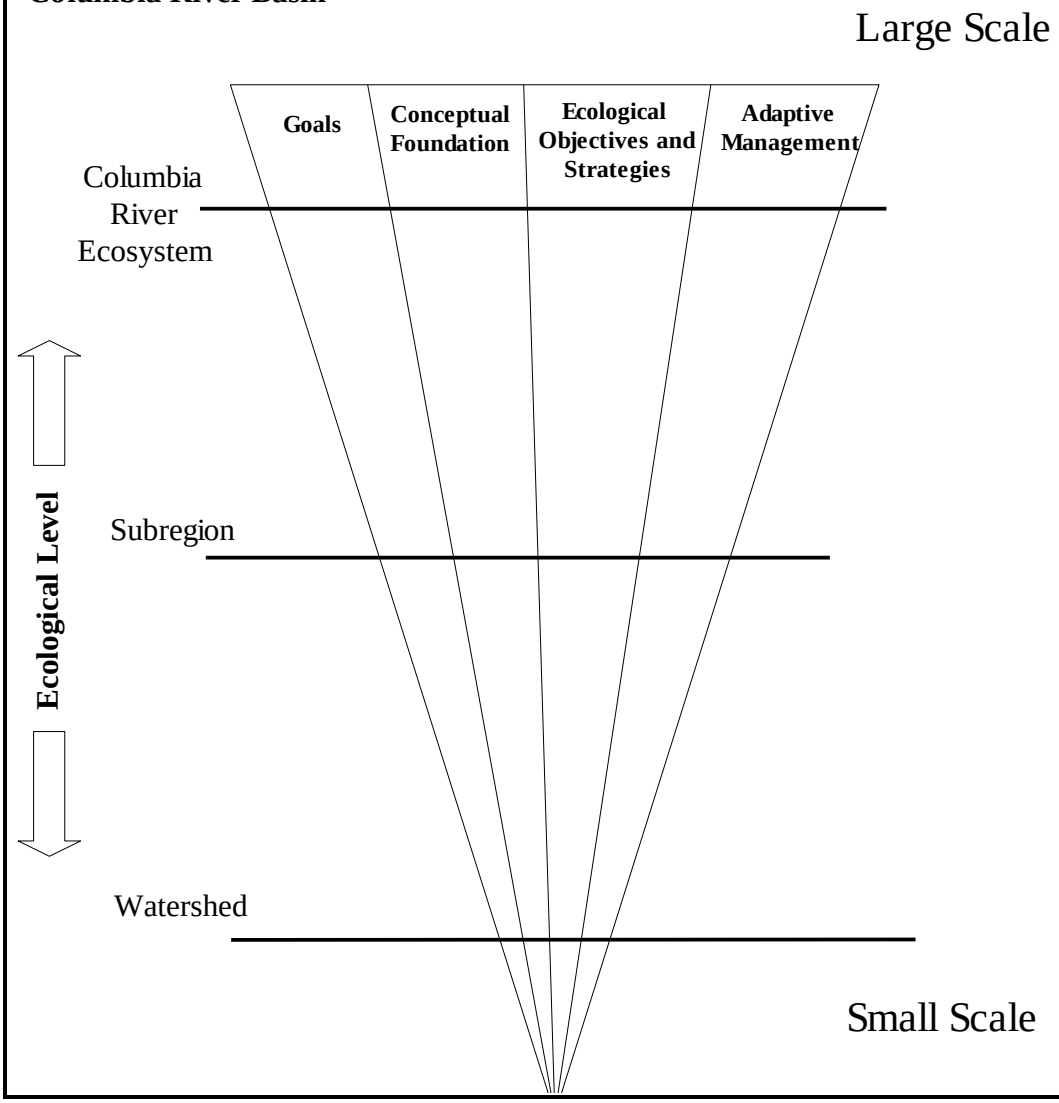
The arrangement of framework elements in Figure 4 provides a logical structure that can be applied at different levels of a regional recovery program. The linkages among elements in the framework are similar to those that exist in functioning ecosystems. Biological and physical elements interact to form a functioning ecosystem. In turn, these elements are organized as hierarchies reflecting a network of relationships among small-scale features and larger-scale ecosystem performance. In a like manner, the relationship among framework elements in Figure 4 should be applied hierarchically to form a network linked by a common scientific and policy basis.

Levels within ecosystems represent different scales of observation. The Columbia River ecosystem can be considered at one level as a large-scale phenomenon responding to regional climate, geology and general biological features. At the same time, focus can shift to a finer-scale features, such as subregions within the basin, and then further focus on individual watersheds. In each case, we can apply the framework elements as a means to structure recovery efforts (Figure 5). Goals can be set for the basin as a whole, for subregions within the basin and for individual watersheds or other distinct ecological units. In a like manner, a conceptual foundation could focus on large-scale features and describe the ecosystem as a whole including the Columbia River watershed and associated marine areas. Because each watershed has unique biological and physical features, the conceptual foundation can be refined and focused on smaller-scale features such as watersheds as well. Similarly, strategies can defined for the basin as a whole as well as for subregions, tributary watersheds or other smaller-scale features.

In applying framework elements at each level, it is important to bear in mind that the differences between levels is a question of scale. Beyond the level of the basin as a whole, elements are developed for each level by focusing on finer-scale information. Moving from the top to the bottom of Figure 5 increases the magnification and consideration of finer-scale detail. The conceptual foundation for each watershed must be consistent with the principles describing the ecosystem at higher levels, even while the conceptual foundation for each watershed will contain unique elements relating to local biological and physical conditions. Goals for each watershed reflect local situations and cultural needs but must be consistent with policies and goals articulated for higher levels.

As a non-biological example how large-scale regional goals and science can be focused on smaller-scale problems, consider construction of an interstate highway between, say, Portland, Oregon, and Boise, Idaho. At the largest scale, the need is to have an efficient and rapid highway system connecting the two cities (the goal). Sideboards are placed on how much money is available, how it should be funded and how right of ways are to be acquired (constraints). A set of characteristics that distinguish an interstate highway is developed (ecological objectives) based on engineering theory, construction practices, geology and climate (conceptual foundation). Techniques are developed to deal with problems and to achieve the desired characteristics (strategies). At the local level, the highway is constructed based on these larger scale elements. An interstate highway has certain characteristics that are applied throughout the country. However, the City of Boise, for example, gets to decide how many entrance and exit ramps they want and which streets will directly interact with the new highway. The local conceptual foundation relating to the geology, climate and other factors unique to Boise go into refining the larger scale definition of an interstate highway into a solution that is workable at the smaller scale, local level.

Figure 5. Proposed regional framework for fish and wildlife recovery in the Columbia River Basin



F. DEVELOPMENT OF A PROGRAM FRAMEWORK.

The integrated framework in Figure 5 presents a biologically based structure for a regional program. However, there is a large gulf between describing a logical structure and developing the substance of the elements at each ecological level. Developing goals for the ecosystem, for example, will require the region to address deep-seated policy issues that reflect differences in values and culture. The strategies that might emerge from an explicit, scientifically based conceptual foundation may result in a painful confrontation between these goals and their economic and social cost.

At the same time, it can be argued that the region's inability to confront these conflicts within the context of a scientifically based foundation has resulted in a situation where much has

been spent on restoration efforts with limited success. The mechanistic paradigm for fish and wildlife management that has prevailed in the region for most of this century[16] has bolstered the belief that we could have it all: abundant, inexpensive electricity, irrigation to turn deserts into verdant agricultural areas, transportation to provide far inland sea ports and, at the same time, abundant fish and wildlife. The depressed condition of many fish and wildlife resources in the basin challenges this notion. Development of an integrated framework, with its emphasis on a consistent policy and scientific foundation for the region's efforts, will force an examination of the basis for fish and wildlife management.

To develop a framework, the region will consider alternative combinations of goals and constraints. Strategies appropriate to different goals and constraints are derived from a common conceptual foundation. The conceptual foundation may indicate that some combinations of goals and constraints are not compatible, in other words, that the goals are not achievable given the constraints and given existing understanding of the ecological situation. Feasible combinations of goals and constraints will differ in regard to cost and social and legal implications.

The process of comparing the implications of different goals and constraints is likely to require some sort of analytical tool or computer model that will enable experimentation with different combinations of goals and constraints. The social, economic and legal implications of these can then be compared using the steps in Figure 4. The conceptual foundation would provide the scientific assumptions that would be incorporated into the models.

Several models exist that could be applied to framework development. Most of these have been extensively reviewed and developed within the PATH (Plan for Analyzing and Testing Hypotheses) process.[17] These models embody what might be called the existing conceptual foundation to distinguish it from the conceptual foundation proposed by the Independent Scientific Group. The reasoning behind these models has been the basis for the region's actions for many years. In general, these are mechanistic models based on classic stock-recruitment theory that keep track of the numbers of fish from specific populations throughout their life cycles.

However, as has been discussed at several points in this paper, there are many indications that the existing conceptual foundation does not provide an adequate basis for efforts to restore ecosystems. If, as was suggested in *Return to the River*, salmon recovery should focus on restoration of ecological functions rather than "fixing" individual salmon populations, it is not clear that the existing models are properly geared.

Appropriate models remain to be developed. The team working on PATH certainly has the technical capability to develop new models, while the Independent Scientific Group has provided an ecosystem based conceptual foundation. What is needed is a closer, streamlined

[16] Lichatowich et al. op.cit

[17] Marmorek, D. et al. 1996. PATH - Plan for Analyzing and Testing Hypotheses: Conclusions of FY96 Retrospective Analyses. ESSA, Vancouver, B.C.

partnership between PATH and the Independent Scientific Group.[18] Working closely with an appropriate policy group to evaluate alternative goals, constraints and strategies, such a group could provide the analytical and scientific backbone for a regional framework.

[18] Since the Independent Scientific Group began their work on *Return to the River*, the Northwest Power Planning Council (the sponsor of the Independent Scientific Group) and the National Marine Fisheries Service agreed to jointly form the Independent Scientific Advisory Boad based on the membership of the Independent Scientific Group. This new board has replaced the Independent Scientific Group, but has continued with similar membership and mission.

II. A Sample Framework

To this point, the discussion of the framework has been somewhat abstract. We have described the elements and organization of a framework and argued the need for a structured regional approach to fish and wildlife management. In this section we will make these concepts more concrete by providing an example of two alternative frameworks. These examples are sketches intended to illustrate the concepts discussed above. We stress the value of these only as examples. They are not intended to characterize the views or positions of any particular entity or group, and they do not represent any proposed direction contemplated by the Northwest Power Planning Council or others.

The two alternative frameworks have a common set of goals and constraints. These roughly represent those in the Council's 1994 Fish and Wildlife Program. This set of goals was then examined using alternative conceptual foundations. This results in alternative sets of strategies and performance indicators. To simplify the examples, we did not extend the framework to include research and evaluation questions although we stress that these are integral to the framework concept.

The first conceptual foundation is a characterization of the beliefs that have guided management in the basin for much of this century. This is contrasted to a more ecosystem-based approach suggested by the work of the Independent Scientific Group. These alternative conceptual foundations are caricatures designed to contrast two views by exaggerating particular points. Many will argue with particular points in the conceptual foundations, feeling that we have mischaracterized, in the first case, the basis for existing actions, and, in the second case, the work of the Independent Scientific Group. However, to do so misses the point: these are not suggested as alternative conceptual foundations for adoption by the region. They are intended to illustrate the concepts. It remains for the region to translate the concepts into substance.

COLUMBIA BASIN WIDE GOALS

- A healthy Columbia River ecosystem with respect to fish and wildlife.
- Where possible, native fish in native habitats
- Double the abundance of salmon and steelhead in the Columbia River Basin
- Preserve existing biological diversity
- Halt declines of weak populations
- Delist populations listed under the Endangered Species Act
- Focus on populations above Bonneville Dam
- Recover wildlife habitat lost to hydroelectric development
- Compensate for a portion of salmon lost through development of resident fish above areas blocked to anadromous passage.

COLUMBIA BASIN WIDE CONSTRAINTS

- Ensure an adequate, economical, efficient and reliable power supply system
- Maintain regional flood control protection
- Respect Indian treaty fishing rights
- Protect established regional life styles where possible
- Respect individual land and water rights
- Northwest Power Planning and Conservation Act
- Endangered Species Act
- National Environmental Policy Act

Alternative A

CONCEPTUAL FOUNDATION

This alternative views the ecosystem as a machine. It can be analyzed understood, predicted and therefore engineered. The river has been converted to a hydroelectric generating plant, navigational route and agricultural system. These changes have occurred through innovative engineering of the natural system to provide attributes consistent with these needs. The resulting loss of natural resources such as salmon, can be addressed in a similar fashion by engineering and manipulating the system to provide biological attributes.

- The ecosystem as a machine: It is relatively fixed, describable and ultimately predictable. Changes in ecosystems resulting from removal or decline of species can be rectified by adding increased numbers of these species into the ecosystem.
- Species can be manipulated by overt and covert management action to achieve maximum production within the ecosystem.

- Introduction of non-native species (resident and anadromous fish and wildlife) will have allowable impacts on co-occurring native species or on populations and species elsewhere in the basin.
- Simplification and stabilization of the ecosystem due to system constraints has no important effect on biological productivity.
- Populations of anadromous fish, resident fish and wildlife can be managed separately.
- Actions developed for one species or population will not adversely impact other species or populations.
- Technological solutions can be devised to mitigate for, or replace, natural production capacity (ecosystem functions) lost to human actions.
- Excepting the Hanford Reach, mainstem river areas are not important as habitat but function largely as outbound and inbound migrational corridors.

STRATEGIES

- Consider each species and population of interest (anadromous and resident fish and wildlife) a distinct and separate unit to be managed in relative isolation from other species and ecosystem components.
- As habitat is lost, engineer an alternative ecosystem (e.g., hatcheries, smolt transportation) that is under human control, leaving the natural system available to provide other benefits (power production, transportation, flood control, recreation and irrigation).
- Manipulate the attributes of species to minimize conflicts between goals and constraints (e.g. alter smolt migration timing to fit water release schedules).
- Manage conditions in the mainstem rivers to hasten downstream migration of salmon.
- Focus salmon restoration efforts on preservation of remaining fragmented populations in upriver tributaries.
- Where habitats above migrational blockages have been altered to meet other societal needs, introduce non-native species that may be more compatible with altered natural environment.
- Restoration of wildlife can be achieved by acquiring isolated areas of suitable habitat.

PERFORMANCE INDICATORS

- Numbers of adult fish counted at dams
- Redds counted in index areas
- Number of fish harvested or available harvest opportunities
- Pounds of fish released from production facilities
- Stability of production and harvest
- Dollars spent

Alternative B

CONCEPTUAL FOUNDATION

This alternative views ecosystems as highly dynamic networks of natural and human factors. While the ecosystem can be described and studied, it is a constantly moving target, and opportunities for prediction and manipulation are limited. Species reflect their associated landscapes and ecosystems. Hence, the condition and abundance of desired species reflects the condition of the ecosystem. Technology should play a subsidiary role supporting and fostering needed ecosystem attributes.

- Environmental variability is an inherent feature of ecosystems and affecting large and small scale features over long and short time frames.
- Biological variability at genetic levels, manifest as physical, behavioral and life history diversity, is an evolved response to environmental variability.
- Population structure develops in response to spatial and temporal variation in the ecosystem. Metapopulations have been proposed to describe this structure.
- Goals for specific species or populations can be achieved by development of suitable ecosystem conditions.
- Species assemblages and abundance reflect ecosystem condition. Hence, development of conditions to support some species (e.g. native species) may be incompatible with other species that do not naturally occur together (e.g. introduced non-native species).
- Suitable ecosystem conditions can be achieved by managing human impacts to allow natural development of needed characteristics.
- Needs of multiple, co-evolved species (i.e. naturally occurring assemblages of species) can by met by allowing development of common suitable ecosystem condition.
- Technology should be used to foster development of suitable conditions rather than replace natural functions.

STRATEGIES

- Identify ecological condition that balances identified biological and non-biological constraints on the system.
- Temper non-biological benefits of the system to achieve balance with ecological condition needed to achieve biological goals
- Develop management strategies for co-occurring assemblages of anadromous and resident fish and wildlife based on common ecological needs.
- Manage non-biological constraints to enhance natural environmental complexity and variability (e.g. manage system operations foster development of natural hydrograph, allow development of natural near shore habitats).
- View the mainstem rivers as habitat to be developed and maintained through natural processes and system operations.
- Recognize natural characteristics of the system in regard to historically successful species, populations and life histories and design actions to take advantage of these

strengths.
PERFORMANCE INDICATORS
• Life history diversity • Values of environmental integrity • Flows, temperatures • Habitat connectivity • Establishment of reference species composition and abundance • Abundance and productivity of indicator species • Survival rates of key species