An Ecological Framework for the Multi-Species Planning Process

November 3, 1998

Introduction

This document describes a framework for arriving at informed alternatives for the future of the Columbia River Basin. These alternatives are being developed within the regional Multi-Species Planning Process. The Multi-Species Planning Process is not a decision making venture or a new governmental structure. It is an attempt to engage the region in a collective discussion of the future of the Columbia River, especially with respect to fish and wildlife resources. It is based on the premise is that fish and wildlife are components of ecosystems, and therefore, fish and wildlife management is an ecological problem requiring ecological solutions.

This report has been prepared by the Ecological Work Group (EWG)[1] as a contribution to the first Alternatives Workshop (November 17-19). The workshop is the starting point in a process whose ultimate objective is to describe a range of alternatives for the future of the Basin that have a high likelihood of achieving their stated vision and for which their ecological, economic, social and cultural implications have been described. These alternatives will form the basis for a policy debate over which vision is appropriate for the region.

The provisional nature of this document must be emphasized. The Multi-Species Planning Process introduces several new concepts for both ecological analysis and regional planning. The process that we will initiate on November 17 will be collaborative and iterative; scientists and analysts will work together with those suggesting alternatives to develop the final set of alternative futures. Over the course of the process, the EWG will likely revise and develop documents such as this one partly in reaction to discussion with the participants. Open discussion, constructive suggestions and revisions should flow freely between the EWG and the Alternatives Group. This report should be read and discussed in that context.

Report Overview

At the outset, we would like to make an important distinction that we will carry forward in our terminology. This is the difference between the ecological framework and the overall, Multi-Species Planning Process. Our focus is the ecological framework. This describes the structure and components of the Columbia River Ecosystem and a set of concepts, measures and metrics that we can use to describe its performance and how human actions affect that performance.

[1] This report was jointly prepared by the Ecological Work Group and the Scientific Steering Committee. For convenience, this joint team is referred to here only as the Ecological Work Group (EWG).

Figure 1. Ecological Framework for the Columbia River Multi-Species Planning Process

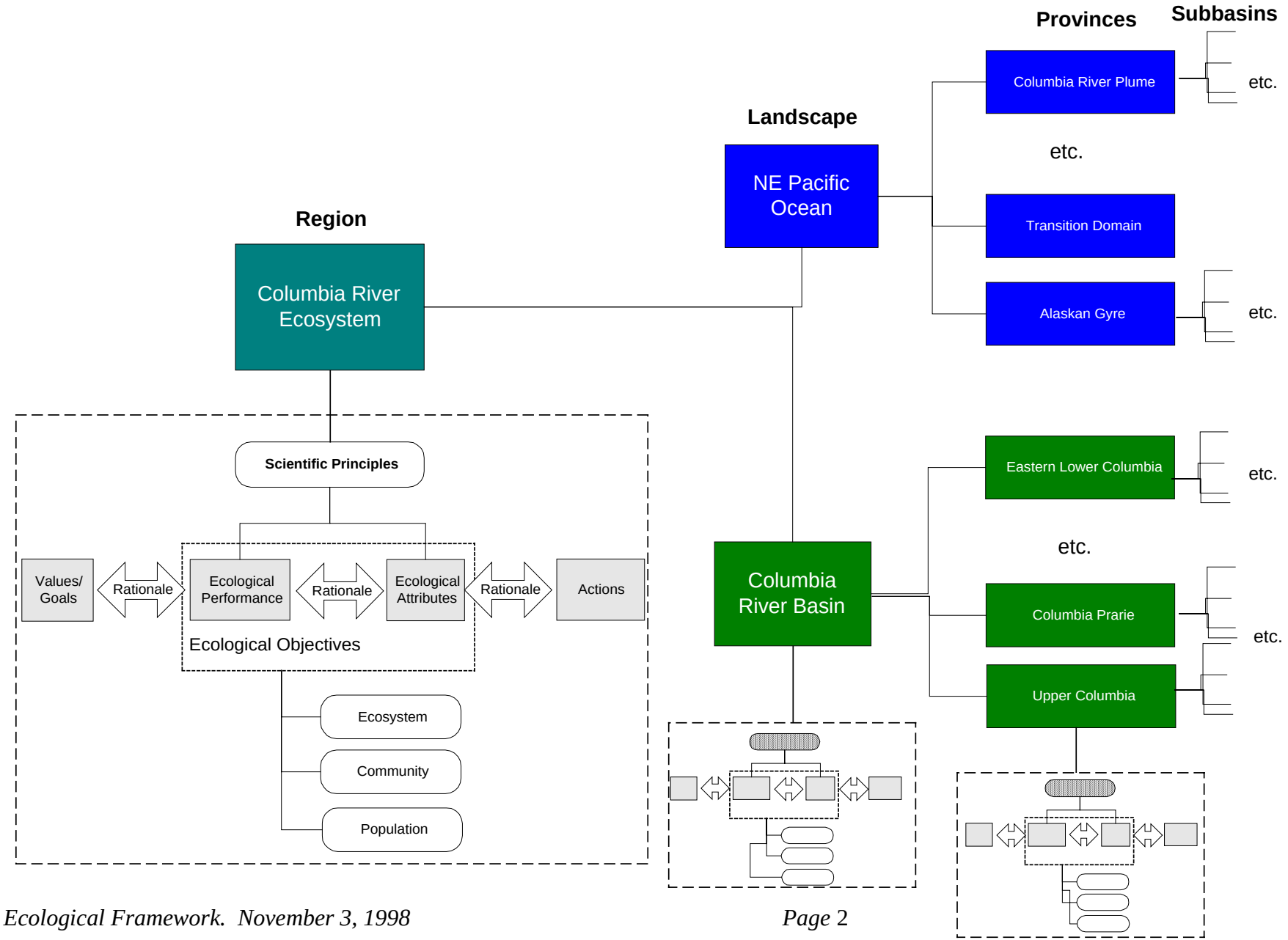


Figure 1 provides an overall "map" of the Ecological Framework. We emphasize that Figure 1 depicts a two-dimensional snap-shot of the ecosystem in time. Variation across time is an important characteristic of ecosystems (Scientific Principle 2). This adds an important third dimension to Figure 1. The concepts in Figure 1 will be discussed in the Preliminary Ecological Overview, below.

The Multi-Species Planning Process is the overall, regional process to develop alternatives for the future of the Columbia River Basin. It provides the regional context for the ecological framework. The ecological framework we describe is just that—the framework for the Multi-Species Planning Process. The Multi-Species Planning Process is based on the ecological framework but also includes the development of alternatives, the economic/cultural/social analysis and the process for discussing the alternatives within the region.

This document consists of three major components. (I) The Preliminary Ecological Overview discusses the ecological framework for the Multi-Species Planning Process. This includes the structure and key concepts shown in Figure 1 that are the basis for development of alternatives. It leads to (II) the Alternatives Template that provides the initial instructions for the development of alternatives. Finally, (III) we provide a preliminary discussion of our Analytical Approach. This describes the type of feedback that we expect to provide proposers based on our review of the alternatives. We emphasize the active collaboration between the ecological analysis and the development of alternatives. Our feedback is intended to be non-judgmental and lead to the improvement and refinement of the alternatives.

1. Preliminary Ecological Overview

This section is the heart of the document. It describes a structure for consideration of the Columbia River as an ecological system. This provides the basis for linking policy and science and the processes of alternative building. The sections of the report that follow are all based on the Ecological Overview. The Ecological Overview has three key elements: Scientific Principles, Framework Components and Rationale and the Geographic Structure. These form the ecological framework (Figure 1). The scientific principles are the basic building blocks of ecologically informed alternatives. They are the basis for how we describe and think of the Columbia River Ecosystem. They constrain and guide the alternative building process and are the basis for evaluation. The Framework links policy (Visions), science (Ecological Performance and Attributes) and action (Strategies and Measures) via explicit Rationale that are based on the Scientific Principles. This section defines key terms and ideas and it describes the linkage among the policy and science elements that are part of the alternative building process. The Geographic Structure suggests an organization to the system that ensures consistency among the alternatives and their evaluation.

2. Alternative Template

The components and structure of the ecosystem are the basis for components and structure of the alternative futures for the Columbia River. The Alternative Template provides guidelines and instructions for those developing alternatives. This section emphasizes that the development of alternatives is an iterative procedure. It also describes a five step process for developing an alternative consistent with the framework.

3. Analytical Approach

Application of ecological analysis to large-scale regional planning is relatively new, although based on a long history of scientific research. It is a quite different approach than that usually employed in Columbia River planning. The techniques for ecological analysis are being actively developed by the EWG. This third section describes our preliminary assessment of the kinds of feedback that we are likely to provide given the limitations on time and techniques. It is our hope that the November 17 workshop will provide us with information that will guide our analysis. For this reason, a major revision of the analytical approach should be expected.

4. Future Work

Even as this report is being released, the EWG is continuing to develop the concepts and techniques it describes. After the November workshop, we expect to develop a decription of the present system and its trajectory. This can be thought of as the "no-action" alternative and it can provide the starting point for alternatives that suggest changes that could alter this trajectory. This could take the outline of the Ecological Overview and enhance it with historical data and discussion of ongoing trends that will determine future trajectory.

In parallel with the analysis of the alternatives, the EWG will be preparing a plan that will couple the alternatives to a monitoring, evaluation and research plan. This will address the uncertainties and performance measures appropriate to the alternatives.

Also following the November workshop, the EWG will examine the first iteration alternatives. We expect to characterize the alternatives in ecological terms. Our first analysis will likely result in many questions regarding the intent of the alternatives and should form the basis for a constructive dialogue between the proposers and the EWG.

I. Ecological Overview of the Columbia River

This report describes an ecological framework for the Columbia River. It is intended to introduce the concept of the Columbia River as a system of interacting biological and physical components (the ecosystem). This first version of the overview is intended to introduce the basic structure and concepts for consideration of the Columbia River as an ecosystem. Future work will use this ecological framework to organize existing data into a description of the Columbia River Ecosystem.

The premise of this effort is that an ecologically based approach is the most effective way to achieve goals for individual species, populations and communities. By recognizing the ecological basis of fish and wildlife management, we stress the need to address problems at different scales and to consider the relationship between species and their habitats. However, the framework recognizes that ecosystems change naturally and that the rate of change in the Columbia River ecosystem has greatly accelerated in the 20th Century due to the increase in human population and impact. The system will continue to change in the future with or without a change in human activities. The system also has a finite ability to deliver goods and services. As a result, development of system-wide alternatives will involve compromise and tradeoffs between uses of the river. It is anticipated that improved ecosystem function will result in the rebound of some, but not all species/stocks of interest, to some measure of historical levels.

A. Scientific Principles[2]

Recent reviews of fish and wildlife restoration activities have highlighted the need for a comprehensive vision for Columbia Basin fish and wildlife restoration based upon fundamental ecological principles. The common message in these reports (e.g., *Return to the River*, *Upstream* and *Wy-Kan-Ush-Mi Wa-Kish Wit*.) is the need for an overarching plan that is integrated across the "4-Hs" (Hatcheries, Hydro, Harvest and Habitat). They point to the elements of an ecologically based scientific foundation for fish and wildlife recovery.

To this end, we have developed an explicit scientific foundation that will guide the development of the ecological framework. This foundation is stated in eight principles[3]:

Principle 1: The abundance and productivity of fish and wildlife reflect the conditions they experience in their ecosystems over the course of their lifecycle.

Principle 2. Natural ecosystems are dynamic, evolutionary and resilient.

Principle 3. Ecosystems are structured hierarchically.

[2] An expanded discussion of the principles and their scientific basis can be found in Issue Paper 98-6 from The NW Power Planning Council.

[3] These principles have been reviewed by the Independent Scientific Advisory Board (ISD. They are being revised to reflect their suggested wording changes and organization and will be submitted for final approval by the ISAB. ISAB comments do not substantively modify the principles.

Principle 4. Ecosystems are defined relative to specific communities of plant and animal species.

Principle 5. Biological diversity accommodates environmental variation.

Principle 6. Ecosystem conditions develop primarily through natural processes.

Principle 7. Ecological management is adaptive and experimental.

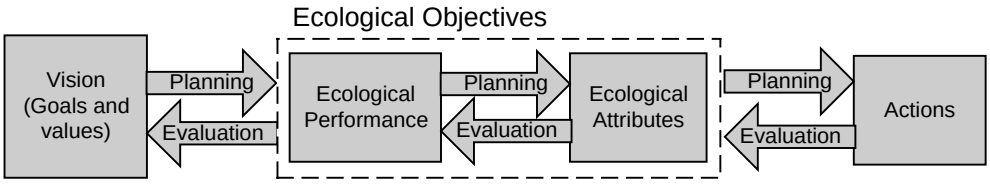
Principle 8. Human actions can be key factors structuring ecosystems.

This foundation will be the basis for measures we will use to characterize the ecosystem and to evaluate changes that may result from strategies and actions. The principles may be refined with experience and new information. However, changes to the principles will be made using established routes of scientific review and in consultation with the Independent Scientific Advisory Board.

B. Components of the Framework

There are four components of the framework. The Vision describes the values attached to the ecosystem, Ecological Objectives describe the condition of the ecosystem needed to achieve the Vision, and Actions are the extrinsic process and human interventions that affect Ecological Objectives. The four components are linked by a Rationale. Each component has significance only in the context of the ecosystem framework. A Vision for the region that does not consider the needed change in Ecological Objectives and actions is little more than wishful thinking. Similarly, Actions that are not tied to specific changes in the environment (Ecological Objectives) and ultimately tied to some purpose (Vision) are disjointed and unlikely satisfying regional needs.

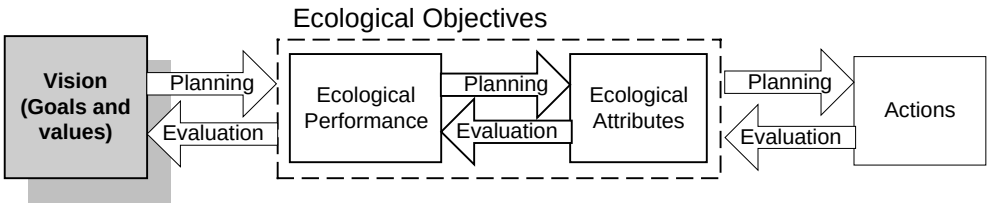
To emphasize the linkage between the four components, we will use the following recurring icon:



The arrows represent the Rationale and emphasize the continuity of the components. During planning (development of alternatives), the flow is from left to right. Feedback on the alternatives from the EWG will reverse this flow and the rationale will address how the Actions achieve the Objectives, and how this changed ecosystem achieves the Vision.

The Framework Components are applied to the Columbia River Ecosystem at different scales (Figure 1). For example, a Vision can apply to the Columbia River Basin and a Vision can apply to a specific subbasin or a regional aggregation of subbasins. While this will be discussed further in Section I.C, below, it is important to keep in mind the geographic scaling shown in Figure 1 when thinking about the Framework Components.

1. Vision.



The values/goals component of the framework identifies the ecological/biological, economic, social, cultural, aesthetic and other values associated with the Columbia River. This includes aspects or qualities of the river that are valued by the alternative proposer. Examples include: goals for harvest of fish, persistence, abundance and distribution of native fish and wildlife, recreational opportunities, preservation of cultural and ceremonial traditions related to fish and wildlife, etc. Values can also include things other than fish and wildlife goals and can describe commercial or spiritual values as well. Values and goals are defined at all geographic levels.

The Vision defines a set of ecological/biological, economic, social, cultural and other values that the proposer expects the Columbia River Basin to sustain in the future. The Vision captures not only those values to be gained, but should also reflect values the proposer expects to forgo.

Traditional goals for harvest, abundance or persistence of species can be part of a Vision. However, vision is actually a larger concept that tries to paint a picture for the future of the river. It addresses broad themes for the basin and can include intrinsic values in addition to more narrowly focused goals for specific species or populations.

A Vision can also be painted in terms of Values. This does not refer dollar amounts but rather to intrinsic qualities of the basin and specific goods and services. Visions should address terrestrial as well as aquatic values of the system and the needs of many species. While focusing on values for natural resources, a Vision also could address values for industry, agriculture or commerce and specifically should contemplate the balance and trade-offs in values. “Wild and scenic,” “harvestable spring chinook” and “adequate, efficient, economical and reliable power supply” are examples of values that could be derived from the Columbia River ecosystem.

The Vision component is the basis from which an alternative is developed and the standard against which an alternative is evaluated. In developing an alternative, the proposers need to start with the Vision and sequentially determine what ecological objectives will accomplish the Vision, and then what actions will achieve the ecological objectives. In evaluating an alternative, the EWG will start with the actions and examine the degree to which they lead to ecological objectives that support the Vision.

2. Ecological Objectives.

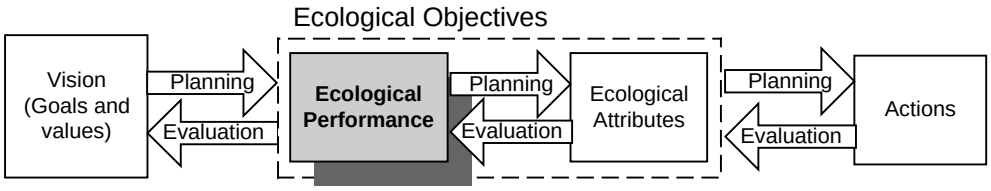
The Vision presented by different alternatives will likely require differing amounts of change from relatively modest to perhaps dramatic. The ecological conditions needed to achieve the Vision

are described by the Ecological Objectives. Objectives specify the kind, magnitude, and timing of change needed to achieve the Vision. The Objectives relate to three aspects of the Columbia River Ecosystem:

a) Ecosystem: relationships between species and their habitats,
b) Communities: relationships among species,
c) Populations: relationships within individual species.

The ecological objectives have two components, descriptors or indicators of Ecological Performance and a set of measurable Ecological Attributes. These can apply to the ecosystem, communities or to populations (Figure 1).

a. Ecological Performance.



Ecological performance defines the structure and function of the ecosystem and includes performance indicators which address the Vision (values and goals). Performance is described at three ecological levels: ecosystems, communities, and populations. Ecological performance defines relationships among fish and wildlife and their habitats within the context of human economies and over different spatial and temporal scales. Ecological performance indicators are useful for identifying limits on what products and services society can expect from the ecosystem. They also provide the basis for deriving ecological attributes.

There are two important aspects of ecological performance. First, performance relates to variation over time and space that defines the boundaries of the system. These scales can be associated with species or groups of species of interest so that ecosystems, communities and populations have tangible boundaries, components and processes (Scientific Principle 4). In other words, there is a need to define a geographically discrete ecological classification so that performance can be assessed for those components and processes that are important in the context of a particular alternative. As will be discussed further in Section I.C, below, the vision, goals, and actions of an alternative partly determine the geographical structure appropriate to an alternative.

Second, performance can be described relative to a defined reference conditions (e.g. current or historical status and trends of the system). The presumed limits of the system (its performance potential) should also be defined, perhaps in terms of its historical performance. In other words we might describe the ecosystem performance expected from an alternative by comparing it to the historic and the present systems. The EWG is working on a description of the current ecological system that could serve as a reference point for describing future conditions.

Ecosystem Performance can be described by a number of terms. In Table 1, we provide a provisional set of appropriate concepts to describe performance. Appendix A indicates the logical relationship between these and specific Scientific Principles. The terms we provide in Table 1 will

be the vocabulary and concepts that we will use to describe Ecosystem Performance for a particular alternative. However, we recognize that many of these are foreign to the conventional planning process in the Columbia River. Indeed, it is the consideration of the alternatives in the context of these terms that reflects the ecological basis that is unique to the Multi-Species Planning Process. We suggest that, for the initial iteration of the alternatives development (November 17 workshop), planners attempt to familiarize themselves with the concepts, use them if possible, but not feel constrained by the use of unfamiliar vocabulary and concepts. The feedback from the EWG after the workshop should increase the appreciation of the concepts and facilitate further development of the alternatives.

The values attached to the measures of Ecological Performance depend on the goals and values articulated in the Vision. In other words, whether the amount of, say, species diversity or system robustness is "good" depends on whether it is "enough" to achieve the Vision. Ecological Performance is not inherently "good" or "bad" except as it relates to the standards provided by the needs of the Vision.

The key indicators of ecological performance in Table 1 can be organized into four groups, based on whether they describe (1) organization, (2) response or (3) the output of ecological or systems behavior. A fourth category includes indicators that are composites of two or more of the terms in the first three groups. These groups and the terms used to define ecological performance are in common use in ecosystems theory that has been applied to ecosystem assessment and adaptive management in various contexts[4]. The generalized definitions given in the table below are meant to apply to each level of ecological organization, to be related directly to one or more of the Scientific Principles (see Appendix A), and to describe different properties of the Ecological Performance.

Table 1. Proposed measures of Ecosystem Performance.

Organizational indicators

Diversity	The richness of the biological and/or physical elements of a system and the evenness of the abundance of elements of a system
Connectivity	The degree of biophysical linkage between different elements of a system in time and space
Complexity	The diversity of ecologically connected elements of a system, including especially elements operating at different time and space scales
Pattern	The location, arrangements, and distribution of different elements of a system in time and space

Response-related indicators

Resilience	The ability of a system to regain its former state or trajectory, without additional interventions, following a disturbance
Resistance	The ability of a system to maintain its prior state or trajectory without change in the face of environmental variation

[4] For example, Walters, C. 1986. *Adaptive management of renewable resources*. MacMillan Publishing Company, New York, NY.

Reversibility	The ability of a system to regain a prior state or trajectory after an intentional alteration (management action); may necessitate restorative treatment
Malleability	The ability of a system to be reshaped by human management into a new self-sustaining state
Assimilative capacity	The ability of a system to absorb inputs of material or energy without eliciting a major change in its organization
Predictability	The ability of a system to respond in a predictable and consistent manner to a particular set of environmental conditions
Subsidization	The degree to which the organization or outputs of a system are dependent on human inputs of energy or material

Output-related indicators

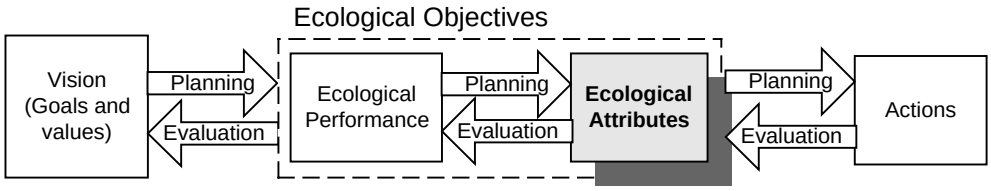
Productivity	The ability of a system to provide a product of interest, often applied to a specific quantity; may include either or both the maximum potential capacity and the realized yield
Sustainability	The ability of a system to provide economic goods and ecological services, e.g., water purification, over an indefinitely long period of time
Viability	The ability of a system to persist as an integral unit over time
Human appropriations	The proportion of biomass or functional capacity diverted from natural to human uses (e.g. harvest or flow diversion)

Aggregate indicators

Stability	An aggregate measure that incorporates both the resilience and resistance aspects of a system and generally indicates the degree of constancy of a state or trajectory in space and time
Integrity	The ability of a system to maintain natural historical structure, functions, and processes without continued human intervention
Succession	The process of system change; may be an ordered sequence of change or an unpredictable sequence resulting from stochastic events

Quantitative indicators	
Extent	The relative size of the system described by the indicators
Richness	The quantity of resources (energy) per unit area of the system

b. Ecosystem Attributes.

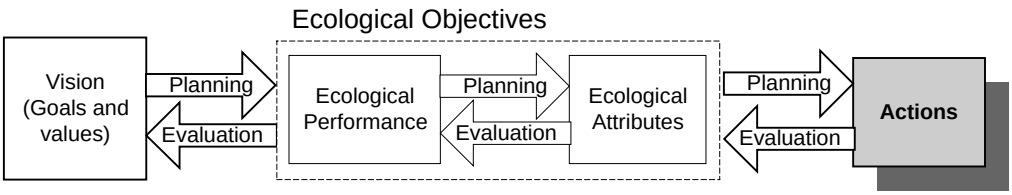


Ecological Attributes are the specific metrics that can be used to measure Ecological Performance and evaluate the consequences of actions and events. They are the directly measurable *effects* of actions designed to achieve a change in an Ecological Performance measure. Ecological attributes are defined at all geographic and ecological levels (Figure 1). A provisional list of Ecological Attributes is provided in Appendix B.

Ecological Attributes have three key features: First, they are measurable indicators of effect. Flow, temperature, substrate embededness, and the Shannon-Weaver index of diversity are examples of attributes. Second, attributes are directly related to measures of Ecosystem Performance. The Shannon-Weaver index, for example, might relate to the Ecosystem Performance measure of diversity. Third, attributes are, in effect, hypotheses between *actions* and Ecosystem Performance. The *action* of providing for periodic scouring floods might have the *Ecosystem Attribute* of a measure of substrate embededness that is hypothesized to have a relation to the *Ecosystem Performance* measures of habitat complexity and biological diversity. The validity of these hypotheses might be tested through directed experimentation or monitoring and evaluation (see Future Products section).

These features apply to different ways of addressing attributes. They can describe the *direct effects* of the Actions of an alternative (e.g. river flow changes from 250 kcfs to 300 kcfs during April). These are ecosystem features that are directly and immediately altered by the proposed action. Attributes can also describe *indirect* or ancillary effects that take a longer time to manifest themselves (e.g. increased flow decreases juvenile salmon outmigration time or re-configures habitat) or affect other parts of the biological community. The rationale should link the *direct* effect attributes with these *indirect or cumulative effect attributes*, i.e. what mechanism links flow and juvenile fish outmigration time or habitat structure? This is the hypothesis between the action and change in Ecosystem Performance. Appendix B provides suggestions for measures that could be applied to either of the aspects of attributes.

3. Actions



Actions refer to natural and human caused forces that affect the performance of the Columbia River Ecosystem. For purposes of this framework, we distinguish two types. Extrinsic processes are presumed to be outside the purview of the Multi-Species Planning Process. These include natural factors such as long-term climate trends, as well as factors that are affected by humans but operate at scales that are not likely to be directly affected by this process. This includes things like global warming and human population increase[5]. The second category of Actions addresses the effects of smaller scale human actions that are likely to be the subject of Multi-Species Planning alternatives.

a. Extrinsic Processes

Extrinsic processes include fire, drought, flood, decadal cycles in ocean condition, global warming and myriad other processes. They establish a background context within which human interventions must be planned. Extrinsic processes operate at all geographic scales (Figure 1). Regional climate changes affect the system at its broadest scale (Columbia River Ecosystem) while floods or droughts may have more localized effects at the Province or Subbasin level.

Generally, extrinsic processes can be treated as externalities during planning. Human interventions need to be planned and implemented in a manner that is consistent with what we know about the influence of extrinsic processes on ecological attributes and performance. For example, strategies and activities for anadromous fish management need to be robust so that they can respond to changes in ocean condition. At the same time, extrinsic processes can be influenced by human interventions. As human interventions disconnect streams from their flood plains, for example, floods and droughts occur more frequently and at greater intensities.

b. Planned Interventions

Human Interventions have two parts, strategies and management activities, that describe how humans affect the ecological attributes and thereby influence ecological performance. Tactics, or management activities, must be congruent with and directed by overall strategies, and at the same time strategies must be shaped by the limitations of tactical capabilities.

[5] Note that actions that address human actions at this scale are not categorically excluded from the process and may be addressed if appropriate to an alternative.

i. Strategies.

Strategies concern the comprehensive, large-scale marshalling and allocation of resources that are intended to make the kind of ecological change needed to achieve a given set of ecological objectives. Strategies describe broad approaches and provide a conceptual link between management actions and ecological conditions.

It is helpful to consider different types of strategies. Strategies consist of actions that (1) protect existing fish and wildlife resources, including ecosystems, communities and populations; (2) restore fish and wildlife resources that have been degraded to some measure of historical conditions; and (3) mitigate for fish and wildlife resources that have been lost or that will be lost due to future actions. Additional types of strategies are those that (4) monitor and evaluate progress toward the desired ecological condition and research identified uncertainties, and (5) identify opportunities for experimental management (adaptive management).

Protection. Maintaining and protecting all or a portion of current fish and wildlife resources is the focus of protection strategies. Examples of protection strategies could include: a Key Watershed protection strategy to secure existing good habitat, a hatchery-free zone to protect genetic characteristics of specific fish stocks, or a water quality protection strategy to ensure a non-degradation standard is met.

Restoration. The focus of restoration strategies is to improve the condition of fish and wildlife resources to some portion of an historical level. For example, an alternative with a vision of restoring salmon runs to harvestable levels could include strategies focused on habitat restoration or hatchery supplementation.

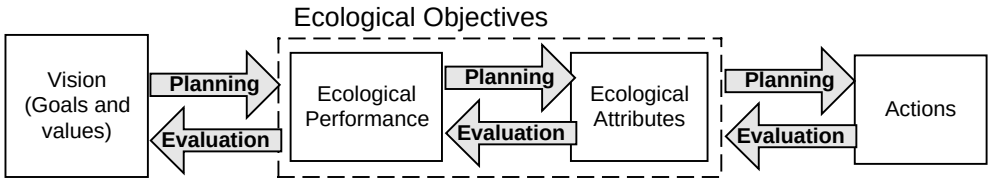
Mitigation. A third category, mitigation strategies, addresses fish and wildlife resources that either already have been lost or that are expected to be forfeited as a result of attaining a vision. For example, differing mitigation strategies could include cash compensation, in-kind and in-place replacement with a hatchery, or species substitution.

Monitoring and Research. Monitoring and evaluation strategies describe how progress towards attainment of the objectives and vision should be tracked, and *research strategies* detail how new information critical to the alternative's vision will be identified and obtained. Among other things, these two types of strategies describe approaches for dealing with uncertainty. They are also the way that the hypotheses posed as the Attributes (above) are tested and refined.

ii. Measures

Measures are human actions undertaken consistent with a specified strategy, to achieve the desired change in ecological objectives. Measures can be discussed in the traditional categories referred to as "the 4-Hs" (hatcheries, harvest, hydro and habitat). They tend to concern local, immediate and/or short-term activities. For example, if the restoration strategy is to encourage natural recovery of riparian habitats for fish and wildlife, a management action consistent with that strategy could be the reduction of grazing intensity and duration. Measures describe not only the type of action but specify where it should occur and a time schedule for its implementation.

4. Rationale



The rationale explains in ecological terms the linkages from the Vision to the Actions and Actions to Vision. During alternative preparation the rationale proceeds from Vision to Action and is a logical explanation, discussed in terms consistent with the Scientific Principles, of how and why a Vision depends upon certain Ecological Objectives and how and why attaining those Objectives necessitates implementation of specific Actions. During evaluation, the rationale proceeds from Actions to Vision, discussing how and why specific Actions result in certain responses in Ecological Attributes and Performance, and how and why those ecological responses do or do not meet the Vision.

The Rationale explains the connections among the Vision, Ecological Performance, Ecological Attributes, Strategies and Measures and explores these connections to identify ancillary effects. During planning the rationale is structured from Vision through Objectives (Performance and Attributes) to Actions (Strategies and Measures), that is from left to right in the icon above. During evaluation the rationale explores the connections in the opposite direction from Actions through Objectives to Vision. The Rationale is based upon the Scientific Principles discussed in Part IA, above.

An example serves to illustrate the relationship between Actions and the *direct* and *indirect* effects on Ecological Attributes and Ecological Performance, and between the Ecological Attributes and Performance and the Vision. Suppose an alternative proposes the Measure of using water leasing to achieve an historic pattern of instream flows in some tributary during the summer as part of a Strategy for that tributary. The purpose might be to have the *direct* effect on Ecological Attributes of nudging a subbasin toward more natural flow regime, temperature regime, riparian vegetation structure, and lateral stream habitat complexity. The Action also might be undertaken with the further intent of inducing the indirect effect of re-establishing riparian habitat to increase bird and other wildlife abundance and to increase life history diversity and abundance of native fishes. These changes in Ecological Attributes resulting from the Action would be linked to needed changes in Ecological Performance such as increasing habitat complexity, diversity and integrity, improving the resilience of the tributary ecosystem to disturbance, and increasing its salmonid productivity and diversity. These changes would be linked to a Vision for the tributary of strong, self-sustaining salmonid populations. The Rationale would explain these linkages and the underlying assumptions supporting the assessment of direct and indirect effects on the Ecological Attributes and Performance.

The Rationale should address the effect of actions on Ecological Objectives comprehensively to include the broader biological community of target species. In the example above, the success of the Actions relative to the Vision could be reduced if the native targeted fish species were connected

to non-native fishes. Although, some warmwater non-native species might be reduced, other coolwater non-natives, such as smallmouth bass whose biological requirements overlap with many native salmonid fishes, might expand into streams that previously were inhospitable because of low summer flows. Competition and predation by these non-natives could be detrimental to the targeted native species. Therefore, the indirect effects of using water leasing to achieve an historic pattern of instream flows could also have the ancillary effect of reorganizing the fish community in a way that reduces the benefits of the Action for the targeted native fishes. The net result, for example, on the Ecological Performance of integrity may be neutral or even negative for the salmonid fish community thereby precluding accomplishment of the Vision, even as the viability, productivity and resilience of the fish community increases, and the diversity of riparian birds increases greatly.

C. Geographic Structure.

The dimensions, components and functions of the ecosystem are defined relative to questions being asked. More specifically, this means they are defined with respect to species or communities of species that are of interest (Scientific Principle 4). With this rationale, we define the Columbia River Ecosystem to be composed of the watershed of the Columbia River and marine areas frequented by anadromous salmon, lamprey and sturgeon. This recognizes that ecosystem boundaries are fuzzy due to the movement of energy back and forth between adjacent systems and between systems of different scales.

Within this ecosystem can be discerned considerable spatial and ecological variation. This suggests a further organization that can be used to describe the system and its management. Any organization is arbitrary; lines are drawn to group areas in regard to criteria that depend on the question asked. We suggest a possible organization that may be appropriate to many alternatives but allow for its modification by the alternative proposers if it seems appropriate.

We provisionally recognize five levels of geographic/ecological organization:

The Columbia River Ecosystem
Landscapes
Ecological Provinces
Subbasins
HUCs

These levels are the basis for the framework organization shown in Figure 1.

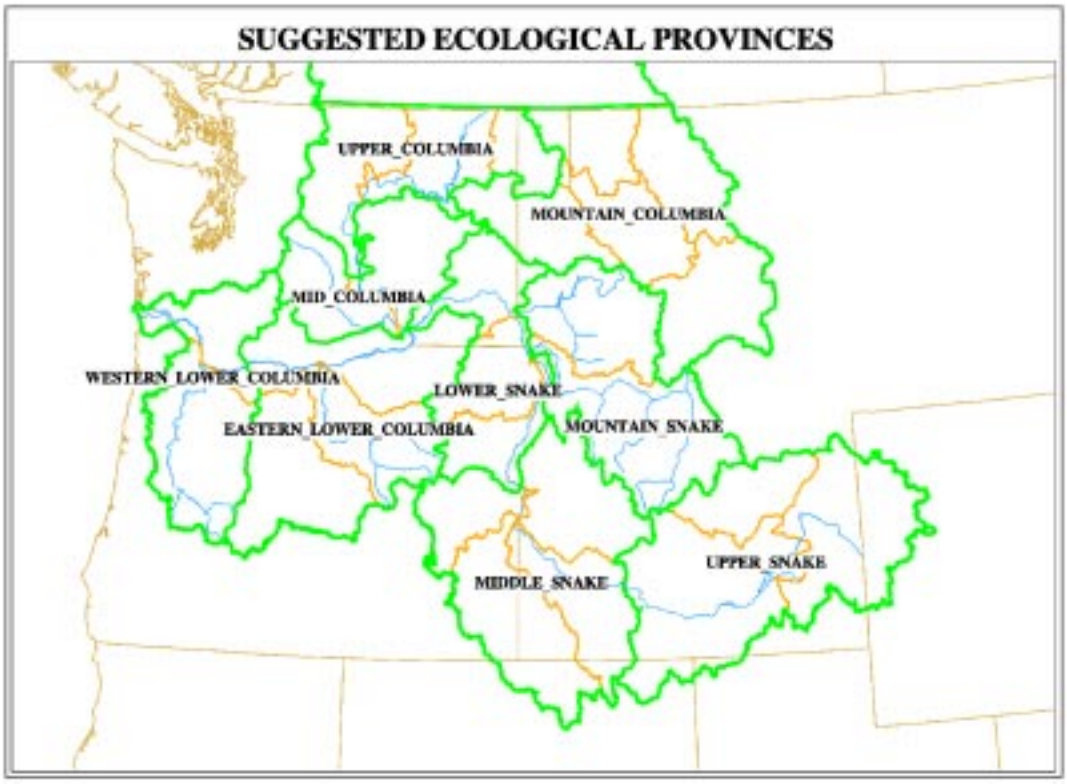
Our suggested organization begins with 4th order HUCs (Hydrological Unit Codes) that constitute a basic information and ecological unit. HUCs are in common usage by land and water management agencies and the StreamNet data system.

These 4th order HUCs are aggregated into subbasins, for example, the John Day subbasin. The HUCs and subbasins are well defined in the region and are not likely to change between alternatives. Higher level aggregations, however, may be adjusted to suite the needs of different alternatives.

At the top of the hierarchy the system is divided into two major *landscape* categories: the marine *landscape* and the Columbia River Basin *landscap*e. The marine *landscape* is divided into

five marine *provinces* based on oceanographic characteristics. The Columbia River is partitioned provisionally into eight *physiographic provinces*, each of which is an aggregation of *subbasins and/or mainstem river reaches.* The *province* groupings are flexible, but should be composed of whole subbasins. Appendix C lists provinces and their contained subbasins. They are also shown in Figure 2.

Figure 2. Provisional organization of the Columbia River Basin.



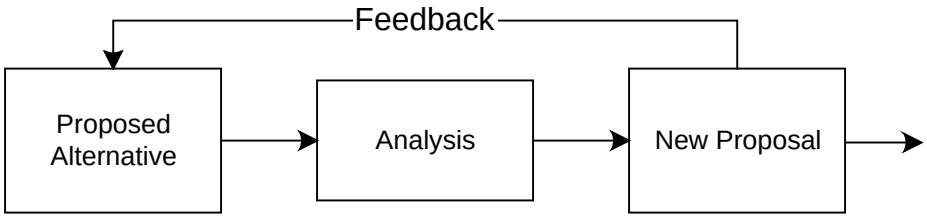
II. Alternatives Template

A. The process of alternatives development

Ecologically based planning is an area of rapidly developing scientific, social and legal issues. There is no ready "cook-book" to guide planners and scientists. For this reason we emphasize the iterative development of alternatives that will allow scientists and planners the opportunity to refine their ideas and techniques as the process develops.

The framework process will stress the interaction between the alternative proposers and the scientists and analysts charged to evaluate and provide feedback on the alternatives. Analysts will fairly characterize the alternatives without judgment on the vision or goals reflected in the alternative. The evaluation will examine the fit between the vision, the ecological objectives and the strategies and management activities.

Although the process still is being planned, alternatives development is based on a simple model of alternative proposal and analysis:



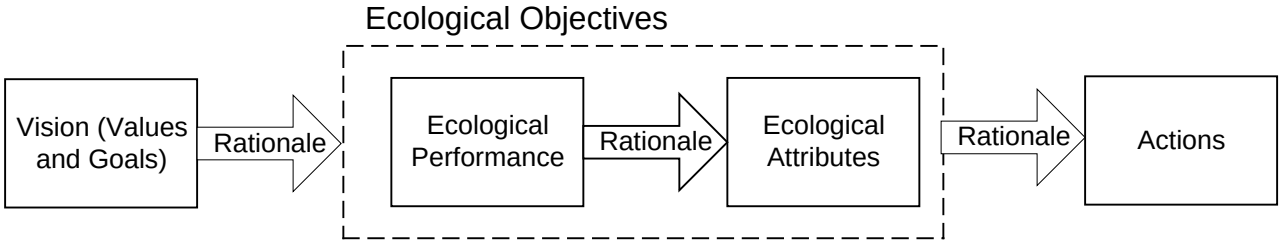
It is expected that each iteration will result in greater refinement and detail in both the description and the analysis of the alternative. Proposers will develop alternatives based on the template described below. The EWG will evaluate the likelihood that the actions will achieve the ecological objectives and accomplish the vision for the alternative. This feedback will enable the proposers to refine their alternative. This process will be repeated in an effort to produce a coherent alternative.

The steps in the first iteration that currently are scheduled are as follows:

Concept papers	November 6
First alternatives workshop	November 17-19
First analysis	January 15
Second alternatives workshop	To be scheduled

The concept papers (November 6) are intended to be brief descriptions that will be used to plan the first alternatives workshop. They will be developed further at the first alternatives workshop (November 17-19) where the proposers will interact with the scientists and analysts. After the workshop, the EWG will examine the draft alternatives and provide feedback to the proposers. This feedback will enable the proposers to revise and improve the alternatives. Subsequent iterations between the proposers and analysts will be scheduled.

B. Steps for development of alternatives.



Within the structure of the ecosystem framework, regional planners will describe alternative approaches to Columbia River Basin fish and wildlife management that describe proposed changes needed to plot a new course towards their vision. As depicted in the figure, each alternative should include a *vision* that describes a set of values for the Columbia River Basin, a group of *objectives* describing the system needed to achieve the vision, an integrated *strategy* for achieving the objectives and an array of *measures* that implement the strategy. The alternatives also should be accompanied by a *rationale* that discusses how and why the elements of the alternative fit together to accomplish the vision for which they were proposed.

The elements of an alternative should address the ecosystem at different scales. Consistent with the geographic structure described previously, apply the following steps. At each step in developing an alternative, document your key assumptions and uncertainties.

1ST STEP: FORMULATING YOUR VISION. Formulate a broad vision for the Columbia River Basin that reflects the biological/ecological, cultural, social and economic priorities of the proposers. This vision should be in the form of statements that outline a specific regional vision or management intent for the Columbia River Basin; capturing the values the alternative has been developed to attain and reflecting which values the alternative is intended to forgo. Visions may vary considerably from one alternative to another and no vision is deemed — a priori — to be "better" or "worse" than any other. For example, one alternative could be developed to achieve the restoration of sustainable, naturally reproducing fish and wildlife populations to support tribal and non-tribal harvest and cultural and economic practices, while another alternative could be developed to achieve a stipulated level of mitigation for fish and wildlife populations lost as a result of management to meet other specified societal visions for the basin. However, a major focus of the Ecological Working Group evaluation will be the degree to which a given alternative is likely to achieve its stated vision. Therefore, each alternative must include explicit visions that paint a clear picture of the end state or purpose the alternative seeks to achieve.

2ND STEP: DETERMINING YOUR OBJECTIVES. Once the vision has been articulated, *objectives* are specified. Objectives should be stated in measurable terms to the extent possible because they will be used as signposts by which progress towards the goal can be evaluated. The EWG will work with the proposers to translate objectives into terms of ecological performance and ecological attributes so that biological soundness and to consistency between goals and actions can be evaluated. Developers of alternatives should initially consider stating their objectives in these terms to the extent possible to avoid later misunderstanding. Also note that similar information is requested as part of the rationale described below.

3RD STEP: DEVELOPING YOUR STRATEGIES. *Strategies* are comprehensive, large-scale marshaling and allocation of resources that must be implemented to achieve the objectives. Each alternative should consider the strategies it intends to take to

(1) protect existing fish and wildlife resources,
(2) restore fish and wildlife resources that have been degraded,
(3) mitigate what resources have been or will be lost, as well as to
(4) monitor and evaluate progress towards the goal and
(5) identify critical information needs and conduct research that supplies that information.

Depending upon an alternative's vision and objectives, strategies in one or all of these categories may be important.

4TH STEP: DETAILING YOUR MANAGEMENT ACTIONS. Identify those *management actions*, or tactics, needed to implement the strategies. The geographic area to which any change in management would be applied (e.g., basin-wide, in a specified province or subbasin, etc.), the kind, magnitude and direction of change, and the entity responsible for undertaking the management action must be specified. A number of management action categories are listed below. When developing an alternative, these categories should be examined to determine if changes are needed in any or all of them to implement the strategies and achieve the objectives and goals of the alternative.

1. Hatcheries
   - Supplementation
   - Captive brood stock
   - Production
2. Harvest (address both direct and indirect effects)
   - Commercial
   - Sport
   - Subsistence and ceremonial
   - Oceanic
   - Freshwater
3. Hydro
   - Port and river traffic/navigation operations (facility, route, timing, etc.)
   - Dam operations (configuration, flood control, flow regimes, instream flows, etc.)
   - Structural modifications to dams
   - Fish collection/barging/transportation practices
   - Water diversions/withdrawals
4. Habitat
   - Land use and allocation changes
   - Changes in water quality
   - Flow regulation
   - Protection, restoration and enhancement
   - Exotic species and predator management

5TH STEP: EXPLAINING YOUR RATIONALE. To complete the presentation of an alternative, a *rationale* must be included explaining how the individual elements of the alternative fit together to accomplish the goals. This rationale, which must be founded upon the Scientific Principles, should:

1) Explain how the vision can be translated into a description of the system in ecological terms
2) Define the relationship between ecological attributes and ecological performance in the proposed new system, and
3) Define the relationship between ecological attributes and the proposed strategies and management actions.

The rationale should demonstrate how and why undertaking the management actions implements the strategies; how implementing the strategies achieves the objectives; and how achieving the objectives will accomplish the vision. It also should identify any negative effects anticipated as a result of undertaking the management actions.

III. Analytical Approach

The analytical approach will be used in both the planning and the evaluation of the Multi-Species Planning Process. The planners will use the concepts to assess and justify whether or not their proposed ecological attributes and performances are likely to meet their vision/goals. The EWG will use these same concepts to evaluate the alternatives provided by the planning process. Their evaluation will assess the scientific adequacy of the rationale used to develop alternatives and will provide insight whether or not the proposed alternatives will meet their goals.

The analytical approach will be developed in an interactive process with the planners and the EWG. Preliminary work on this has been initiated by the EWG and several approaches have been identified. These range from reductionist approaches that require massive amounts of site specific data to integrative approaches that use synthesized data to address issues on a regional basis. Work on developing the analytical approach will continue once the EWG learns about the range of alternatives that are proposed in the first workshop(s) with the planners. Ongoing work (following the first workshop) on the analytical approach will continue the search for tools that have been developed for similar regional processes that address ecological-based regional management. Potential analytical tools identified to date include Indices of Biological Integrity developed by Karr, Qualitative Simulation Modeling used by Holling, habitat/salmonid modeling being developed in the PATH process and modeling efforts used as part of the regional water management effort in Florida.

While significant features of the analysis remain to be developed, it is clear that the feedback provided to the proposers by the EWG will include synthetic information based on existing data, quantitative analysis and qualitative conceptual information. Given the time frame contemplated by the Multi-Species Planning Process, we do not anticipate the opportunity of developing new models or quantitative tools. We will not be able to collect or even search out new data. As a result we propose a very pragmatic approach that relies on existing information and tools that will be organized around the concepts described in this paper. We will build on past efforts such as PATH, the Systems Operation Review and Subbasin Planning. Where quantitative tools exist, such as those in PATH, we will provide quantitative feedback. Where they do not we will provide qualitative discussion. Both quantitative and qualitative information will be synthesized within the ecosystem framework to assess the ecological consequences of different alternatives.

Planners input to developing the analytical approach will consist of feedback to the EWG regarding questions they generated as they developed their alternative and supporting rationale. The EWG expects that the initial feedback used by the planners and the EWG will be more qualitative and address: 1) the linkage between the scientific principles and the projected ecological performances and attributes, 2) general ecological responses and attributes not included in the vision/goal, 3) the likelihood that their alternative will meet their goals/vision and 4) sources of uncertainty in their planning process. The qualitative statements will provide the EWG insight to the planners thought process, will initiate a dialogue between the two groups and will provide the EWG the guidance they need as they refine the analytical approach.

The overall intent of the evaluation is to end up with a set of coherent alternatives that are likely to achieve their vision/goals. Decision-makers and the public can then debate the selection of the regional alternative.

Future Products

A. No Action alternative

An analysis of the present state of the Columbia River ecosystem will be provided in the next iteration of this document. This will describe likely future conditions for anadromous fish, resident fish and wildlife populations, within the context of the framework described here, under a *status quo* or "no action" alternative.

The alternative will use regionally available data sources to present a description of the Columbia Basin ecosystem. It will focus on describing the present trajectory of the Columbia River Ecosystem. Alternatives will be intended, in most cases, to change this trajectory in some way. The present trajectory is influenced by the cumulative impact of past events and larger scale forces such as global warming and climate change. This description will be quantified where possible. Those aspects of the ecosystem that cannot be quantified will be described qualitatively within the overall framework context.

This alternative will provide a practical application of framework principles, an example of the analyses available to characterize alternatives, and a baseline scenario or alternative against which to compare other alternatives.

B. Monitoring Plan

Each alternative that ultimately emerges from this process should include a plan for monitoring, evaluating and researching its implementation. As discussed at several points above, in most cases, there will be an hypothesis linking Measures and Ecological Attributes. The monitoring plan should address how these hypotheses will be tested and refined. The plan should be based upon the key assumptions, uncertainties, and information needs identified during the development and evaluation of management alternatives. The Ecological Working Group believes much of the necessary information is presently being collected under ongoing programs. The monitoring plan will, therefore, focus on identifying which ongoing data collection activities are essential to monitoring framework implementation and what new efforts must be started.

Development of the monitoring plan cannot begin until after the initial round of alternative evaluations is completed. We anticipate a schedule for this effort will be available by the second workshop early in 1999.

APPENDIX A: Relationship between Scientific Principles and Ecological Performance.

The scientific principles for ecological analysis, and the indicators of ecological performance that most directly pertain to each principle. Other relationships are possible, but those listed below should capture the majority of circumstances.

Principle	**Performance indicator**
Principle 1: The abundance and productivity of fish and wildlife reflect the conditions they experience in their ecosystems over the course of their life cycle	Productivity Sustainability Viability
Principle 2: Natural ecosystems are dynamic, evolutionary, and resilient	Resilience Succession Viability
Principle 3: Ecosystems are structured hierarchically	Connectivity Integrity Complexity
Principle 4: Ecosystems are defined relative to specific communities of plant and animal species	Pattern Succession Viability Connectivity
Principle 5: Biological diversity accommodates environmental variation	Diversity Resilience Malleability Assimilative capacity Complexity Pattern Reversibility Predictability
Principle 6: Ecosystem conditions develop primarily through natural processes	Integrity Resilience Succession
Principle 7: Ecological management is adaptive and experimental	Malleability Reversibility Predictability Resilience Subsidization
Principle 8: Human actions can structure ecosystems	Malleability Sustainability Human appropriation Subsidization

APPENDIX B: Attributes of Ecological Performance

List of Attributes:

This is a provisional list of attributes that we expect will be modified as the evaluation process proceeds. We will be working iteratively to refine this list with respect to several considerations: its consistency with our list of ecological performances of interest, to ensure as comprehensive coverage of ecological conditions and changes as possible, to ensure that the attributes together capture the dominant effects and differences among the kinds of alternatives offered for review (i.e., all alternatives will be screened with the same set of attributes, but the list may be modified to improve its sensitivity); and in response to input from our cohorts in the policy and socioeconomic groups.

These specific attributes are a small subset of the possible range of metrics, selected on the basis of several criteria: 1) generality and explanatory power, i.e., changes in the metric broadly reflect, integrate, or affect many ecosystem processes and components; 2) data are widely available that can be used to assess the direction and trend in the attribute; 3) the attribute is relatively unambiguous in its qualitative or quantitative response, and prediction and assessment of its trend in response to a management action is feasible with existing knowledge; 4) (some) attributes directly reflect the status of resources traditionally valued by various human interests; 5) the attribute has been identified as a useful metric by other groups or institutions in other assessment efforts.

Habitat Codes: T= tributary streams, rivers, lakes, and wetlands, MS = major river mainstem segments, ES = estuary, CP = Columbia River plume, NP= NE Pacific Ocean.

Level of Ecological Organization	**Ecological Attribute**	**Habitat**
Ecosystem/Landscape Level Food web dynamics/integrity:	Proportion of top aquatic carnivores native	T, MS, ES, CP
	Presence of medium-body size, nonnative pelagic omnivores in aquatic food web (e.g., Mysis or Neomysis)	T, MS, ES, CP
	Proportion of fish with littoral and adfluvial or anadromous life history vs. Pelagic and benthic, nonmigratory species (i.e., affects availability of aquatic prey to terrestrial predators)	T, MS, ES
	Percent of large terrestrial herbivorous mammals of native species (i.e., not livestock)	T, MS, ES
	Number of livestock within area	T, MS, ES
	Proportion of the top native terrestrial carnivore assemblage that remains present in the area	T, MS, ES, CP, NP
	Aggregate fish harvest (proportion of aquatic biomass allocated to human use)	T, MS, ES, CP, NP
	Aggregate wildlife harvest (proportion of terrestrial biomass allocated to human use)	T, MS, ES, CP, NP

	Interannual variability in nearshore pelagic fish assemblage	ES, CP, NP
	Human energy subsidy index: annual dollars invested in fish and wildlife artificial propagation programs	T, MS, ES, CP, NP
	Human energy subsidy index: annual dollars invested in fish and wildlife habitat modification and mitigation programs	T, MS, ES, CP, NP
	Human population size	T, MS, ES, CP, NP
Ecosystem/Landscape Level Landscape pattern, dynamics/integrity	Proportion of landscape occupied by late-successional or primary forest cover	T, MS, ES
	Proportion of floodplain and riparian areas (within 300 m of a channel or shoreline) traversing or abutting late-successional forest cover types (including deciduous gallery forests)	T, MS, ES
	Proportion of landscape in cropland agriculture, transportation, urban and exurban land uses vs. "natural" or "seminatural" ecosystem types	T, MS, ES
	Proportion of floodplain and riparian areas occupied by cropland agriculture, transportation, urban and exurban land uses (i.e., within 500 m of shoreline or channel)	T, MS, ES
	Proportion of catchment occupied by wetland habitats	T, MS, ES
	Proportion of stream, lake and wetland shorelines within 300 m of a road or human structure (e.g., building, roads, railroads, dams, powerlines, pipelines)	T, MS, ES
	Road density of catchment (includes railroads, pipelines, primary and secondary roads)	T, MS, ES
	Number of HUC-6 watersheds with active or historical mining operations present	T, MS, ES
	Number of point-source discharge permits in area	T, MS, ES
Ecosystem/Landscape Level Geophysical dynamics/integrity	Rate of erosion and sedimentation within the area (proportion of catchment with elevated surface or mass erosion rates)	T, MS, ES, CP
	Proportion of natural flow impounded in reservoirs	T, MS, ES/CP
	Proportion of natural flow diverted for human use	T, MS, ES/CP
	Deviation from natural flow regime, seasonal scale (Richter Index??)	T, MS, ES

	Deviation from natural flow regime, daily and hourly scale (Richter Index??)	T, MS, ES
	Deviation from natural thermal regime, seasonal scale	T, MS, ES, CP
	Deviation from natural thermal regime, daily or hourly scale	T, MS, ES< CP
	Variation in salinity or total alkalinity, seasonal scale	T, MS, ES, CP, NP
	Total release within catchment of regulated toxic substances into air and water (tons per year)	T, MS, ES, CP
	Lateral channel complexity (sinuosity + anabranching + sloughs, etc.) in alluvial valley segments	T, MS, ES
	Linear density of deep pools (> 2m depth at summer low flow) in alluvial stream segments	T, MS
	Linear density of coarse woody debris within active channel (minimum length > active channel width)	T, MS, ES
	Number of dams or diversions	T, MS
Community/Assemblage Level	Proportion of streams and lakes known to contain brook trout or other introduced fishes outside their native range	T, MS, ES
	Proportion of naturally fishless water bodies (lakes, ponds, streams and wetlands) that remain fishless	T, MS, ES
	Proportion of fish species present of alien origin (i.e., not native to area)	T, MS, ES, CP, NP
	Proportion of large terrestrial herbivores of nonnative origin (introduced or domestic species such as sheep, cows)	T, MS, ES
Population Level	Spatial and temporal distribution of indicator taxon spawning and early rearing within area (extent and fragmentation)	T, MS, ES
	Spatial and temporal distribution of adult migration, rearing and holding habitat within area (extent and fragmentation)	T, MS, ES, CP, NP
	Spawning population size of indicator taxa (average annual escapement to spawning)	T, MS, ES
	Temporal correlation in abundance among populations of indicator taxon within the area	T, MS, ES< CP, NP

	Proportion of area identified as presently functional “refugia,” “core areas” or “hotspots” where the target taxon remains locally abundant or robust	T, MS, ES
	Proportion of resident trout populations demonstrated to be of wild heritage (not introgressed with hatchery stocks or introduced species)	T, MS, ES
	Number of hatchery fish of indicator taxon released in the area	T, MS, ES, CP, NP
	Cumulative harvest rate from directed and incidental sources for each indicator taxon	T, MS, ES< CP, NP
	Proportion of fishes with externally evident lesions, deformities, scars or parasites	T, MS, CP, ES, NP
	Incidence of abnormal lesions or deformities in terrestrial carnivores	MS, CP, ES, NP

APPENDIX C: Provisional Geographic Description of Columbia River Ecosystem

Landscape	Province	Subbasin	Watershed	Code
MARINE	ALASKAN GYRE			
	COASTAL DOWNWELLING DOMAIN			
	TRANSITION DOMAIN			
	COASTAL UPWELLING DOMAIN			
	COLUMBIA RIVER PLUME			
COLUMBIA RIVER DRAINAGE BASIN	MAINSTEM	ESTUARY		
		LOWER COLUMBIA		
		LOWER MID-COLUMBIA		
		UPPER MID-COLUMBIA		
		UPPER COLUMBIA		
		LOWER SNAKE		
		UPPER SNAKE		
	WESTERN LOWER COLUMBIA	LOWER COLUMBIA	LOWER COLUMBIA-SANDY	17080001
			LEWIS	17080002
			LOWER COLUMBIA-CLATSKANIE	17080003
			UPPER COWLITZ	17080004
			LOWER COWLITZ	17080005
			LOWER COLUMBIA	17080006
		WILLAMETTE	MIDDLE FORK WILLAMETTE	17090001
			COAST FORK WILLAMETTE	17090002
			UPPER WILLAMETTE	17090003
			MCKENZIE	17090004
			NORTH SANTIAM	17090005
			SOUTH SANTIAM	17090006
			MIDDLE WILLAMETTE	17090007
			YAMHILL	17090008
			MOLALLA-PUDDING	17090009
			TUALATIN	17090010
			LOWER WILLAMETTE	17090011
			LOWER WILLAMETTE	17090012
	EASTERN LOWER COLUMBIA	DESCHUTES	UPPER DESCHUTES	17070301
			LITTLE DESCHUTES	17070302
			BEAVER-SOUTH FORK	17070303
			UPPER CROOKED	17070304

			LOWER CROOKED	17070305
			LOWER DESCHUTES	17070306
			TROUT	17070307
		JOHN DAY	UPPER JOHN DAY	17070201
			NORTH FORK JOHN DAY	17070202
			MIDDLE FORK JOHN DAY	17070203
			LOWER JOHN DAY	17070204
		MIDDLE COLUMBIA	MIDDLE COLUMBIA-LAKE WALLULA	17070101
			WALLA WALLA	17070102
			UMATILLA	17070103
			WILLOW	17070104
			MIDDLE COLUMBIA-HOOD	17070105
			KLICKITAT	17070106
	COLUMBIA PRARIE	COLUMBIA PLATEAU	MOSES COULEE	17020012
			UPPER CRAB	17020013
			BANKS LAKE	17020014
			LOWER CRAB	17020015
			UPPER COLUMBIA-PRIEST RAPIDS	17020016
		YAKIMA	UPPER YAKIMA	17030001
			NACHES	17030002
			LOWER YAKIMA	17030003
	UPPER COLUMBIA	NORTHEAST CASCADE	OKANOGAN	17020006
			SIMILKAMEEN	17020007
			METHOW	17020008
			LAKE CHELAN	17020009
			UPPER COLUMBIA-ENTIAT	17020010
			WENATCHEE	17020011
		PEND OREILLE	PEND OREILLE LAKE	17010214
			PRIEST	17010215
			PEND OREILLE	17010216
		UPPER COLUMBIA	FRANKLIN D. ROOSEVELT LAKE	17020001
			KETTLE	17020002
			COLVILLE	17020003
			SANPOIL	17020004
			CHIEF JOSEPH	17020005
	INTER MOUNTAIN	COEUR D'ALENE	UPPER COEUR DALENE	17010301
			SOUTH FORK COEUR DALENE	17010302
			COEUR DALENE LAKE	17010303
			ST. JOE	17010304
			UPPER SPOKANE	17010305
			HANGMAN	17010306
			LOWER SPOKANE	17010307

			LITTLE SPOKANE	17010308
		FLATHEAD	NORTH FORK FLATHEAD	17010206
			MIDDLE FORK FLATHEAD	17010207
			FLATHEAD LAKE	17010208
			SOUTH FORK FLATHEAD	17010209
			STILLWATER	17010210
			SWAN	17010211
		KOOTENAI	UPPER KOOTENAI	17010101
			FISHER	17010102
			YAAK	17010103
			LOWER KOOTENAI	17010104
			MOYIE	17010105
		LOWER CLARK FORK	MIDDLE CLARK FORK	17010204
			LOWER FLATHEAD	17010212
			LOWER CLARK FORK	17010213
		UPPER CLARK FORK	UPPER CLARK FORK	17010201
			FLINT-ROCK	17010202
			BLACKFOOT	17010203
			BITTERROOT	17010205
	LOWER SNAKE	BLUE WALLOWA	IMNAHA	17060102
			LOWER SNAKE-TUCANNON	17060103
			UPPER GRANDE RONDE	17060104
			WALLOWA	17060105
			LOWER GRANDE RONDE	17060106
		SNAKE HELLS CANYON	BROWNLEE RESERVOIR	17050201
			BURNT	17050202
			POWDER	17050203
			HELLS CANYON	17060101
		SNAKE LOWER	LOWER SNAKE-TUCANNON	17060107
			PALOUSE	17060108
			ROCK	17060109
			LOWER SNAKE	17060110
	MOUNTAIN SNAKE	CLEARWATER	UPPER SELWAY	17060301
			LOWER SELWAY	17060302
			LOCHSA	17060303
			MIDDLE FORK CLEARWATER	17060304
			SOUTH FORK CLEARWATER	17060305
			CLEARWATER	17060306
			UPPER NORTH FORK CLEARWATER	17060307
			LOWER NORTH FORK CLEARWATER	17060308
		SALMON	UPPER SALMON	17060201
			PAHSIMEROI	17060202

			MIDDLE SALMON-PANTHER	17060203
			LEMHI	17060204
			UPPER MIDDLE FORK SALMON	17060205
			LOWER MIDDLE FORK SALMON	17060206
			MIDDLE SALMON-CHAMBERLAIN	17060207
			SOUTH FORK SALMON	17060208
			LOWER SALMON	17060209
			LITTLE SALMON	17060210
	MIDDLE SNAKE	BOISE PAYETTE	NORTH AND MIDDLE FORK BOISE	17050111
			BOISE-MORES	17050112
			SOUTH FORK BOISE	17050113
			LOWER BOISE	17050114
			SOUTH FORK PAYETTE	17050120
			MIDDLE FORK PAYETTE	17050121
			PAYETTE	17050122
			NORTH FORK PAYETTE	17050123
			WEISER	17050124
		MALHEUR	MIDDLE SNAKE-PAYETTE	17050115
			UPPER MALHEUR	17050116
			LOWER MALHEUR	17050117
			BULLY	17050118
			WILLOW	17050119
		OWYHEE	UPPER OWYHEE	17050104
			SOUTH FORK OWYHEE	17050105
			EAST LITTLE OWYHEE	17050106
			MIDDLE OWYHEE	17050107
			JORDAN	17050108
			CROOKED-RATTLESNAKE	17050109
			LOWER OWYHEE	17050110
		SNAKE BRUNEAU	C. J. STRIKE RESERVOIR	17050101
			BRUNEAU	17050102
			MIDDLE SNAKE-SUCCOR	17050103
	UPPER SNAKE	SNAKE CLOSED	BEAVER-CAMAS	17040214
			MEDICINE LODGE	17040215
			BIRCH	17040216
			LITTLE LOST	17040217
			BIG LOST	17040218
		SNAKE HEADWATERS	SNAKE HEADWATERS	17040101
			GROS VENTRE	17040102
			GREYS-HOBOCK	17040103
			PALISADES	17040104
			SALT	17040105
			IDAHO FALLS	17040201

			UPPER HENRYS	17040202
			LOWER HENRYS	17040203
			TETON	17040204
			WILLOW	17040205
			BLACKFOOT	17040207
			PORTNEUF	17040208
		SNAKE UPPER	AMERICAN FALLS	17040206
			LAKE WALCOTT	17040209
			RAFT	17040210
			GOOSE	17040211
			UPPER SNAKE-ROCK	17040212
			SALMON FALLS	17040213
			BIG WOOD	17040219
			CAMAS	17040220
			BIG WOOD	17040221

APPENDIX D: Suggested Readings and Information Sources.

The references listed below provide a background for the ecological approach to fish and wildlife management embodied in the framework. Most of these are accessible accounts that can provide useful background information for those preparing framework alternatives.

A. Selected Readings

Columbia River Intertribal Fish Commission. 1995. Wy-Kan-Ush-Mi-Wa-Kush-Wit: The spirit of the salmon. Columbia River Intertribal Fish Commission, Portland, OR.

Cone, J., and S. Ridlington. 1996. The Northwest Salmon Crisis: A Documentary History. Oregon State University Press, Corvallis, OR.

Frissell, C. A., W. J. Liss, R. E. Gresswell, R. K. Nawa, and J. L. Ebersole. 1996. A resource in crisis: changing the measure of salmon management. Pages 411-444 in D. J. Stouder, P. A. Bisson, and R. J. Naiman, eds. Pacific salmon and their ecosystems. Chapman and Hall, New York.

Independent Scientific Group. 1996. Return to the River: restoration of salmonid fishes in the Columbia River Ecosystem. Northwest Power Planning Council, Portland, OR.

McIntosh, B. A., J. R. Sedell, J. E. Smith, R. C. Wissmar, S. E. Clarke, G. H. Reeves, and L. A. Brown. 1990. Historical changes in fish habitat for select river basins of Eastern Oregon and Washington. Northwest Science 68: 36-53.

Naiman, R. and Bilby R.E. eds. 1998. River ecology and management. Lessons from the Pacific coastal Ecoregion. Springer-Verlag. New York, NY

National Research Council. 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press, Washington, DC.

Northwest Power Planning Council. 1997. An integrated framework for fish and wildlife managment in the Columbia River Basin. Northwest Power Planning Council, NPPC 97-2. Portland, OR.

Northwest Power Planning Council, 1998. A proposed scientific framework for fish and wildlife recovery in the Columbia River. Northwest Power Planning Council, NPPC 98-6. Portland, OR

Quigley, T. M., R. W. Haynes, R. T. Graham, and T. Russel. 1996. An integrated scientific assessment for ecosystem management in the interior Columbia basin and portions of the Klamath and Great basins. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife 1998. Columbia River Fish Runs and Fisheries, 1938-1997. Oregon Department of Fish and Wildlife, Portland, OR

Wissmar, R. C., J. E. Smith, B. A. McIntosh, H. W. Li, G. H. Reeves, and J. R. Sedell. 1994. A history of resource use and disturbance in riverine basins of Eastern Oregon and Washington (Early 1880-1990s). Northwest Science 68: 1-35.

B. Internet Information Sites.

National Marine Fisheries Service
Northwest Fisheries Science Center
www.nwfsc.noaa.gov

Northwest Power Planning Council
www.nwppc.org

StreamNet
www.streamnet.org

The Multi-species Framework Process
www.nwframework.org

Interior Columbia Basin Ecosystem Management Project
www.icbemp.gov