ENTIAT

Subbasin Plan

Prepared for the Northwest Power & Conservation Council

Entiat Subbasin Plan

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1 Introduction

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Entiat Subbasin Plan

Table of Contents

List of Tables

List of Figures

2 Executive Summary

2.1 Purpose and Scope

National Oceanographic and Atmospheric Administration (NOAA) Fisheries (formerly the National Marine Fisheries Service (NMFS)) released a biological opinion (BiOp) on the operation of the Federal Columbia River Power System (FCRPS). This system is operated by the U.S. Bureau of Reclamation (BOR), the Bonneville Power Administration (BPA), and the U.S. Army Corps of Engineers (ACOE). The FCRPS operation has impacts on six fish species listed in 1999, under the Endangered Species Act (ESA), as threatened or endangered. The FCRPS BiOp proposed a set of Reasonable and Prudent Alternatives (RPA) for the operation and configuration of hydropower facilities on the Columbia River to mitigate impacts to the survival of listed juvenile and adult salmonids in the Columbia River basin. As part of the 2000 FCRPS BiOp, NOAA Fisheries advised the aforementioned federal agencies that, in addition to hydropower facility modifications, offsite mitigation for habitat, hatcheries and harvest would be required to avoid jeopardy. It also established performance standards and schedules to monitor the success of mitigation measures.

In order to help meet offsite ESA obligations under the 2000 FCRPS BiOp, the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program collaborated with other federal caucus members to develop the subbasin planning process. When complete, subbasin plans will identify and prioritize actions needed to recover listed salmonids in tributary habitats within the Columbia River basin, and guide the expenditure of BPA revenues on these offsite mitigation projects. The Qualitative Habitat Assessment methodology is being utilized in the development of subbasin plans in order to compare the ecological effects of proposed actions, and determine what benefit is likely from each restoration alternative.

The three main parts of a subbasin plan are:

The Assessment - A subbasin assessment is a technical analysis to determine the biological potential of each subbasin and the opportunities for restoration. It describes the existing and historic environmental resources, conditions and characteristics within the subbasin.

The Inventory - The inventory includes information on fish and wildlife protection, restoration and artificial production activities and management plans within the subbasin.

The Management Plan - The management plan is the heart of the subbasin plan. It includes a vision for the subbasin, biological objectives, and strategies. The management plan addresses a 10-15 year planning horizon.

2.2 Planning Approach

In 1993 members of the Chelan County Conservation District (CCCD), Natural Resource Conservation Service (NRCS) and the US Forest Service Entiat Ranger District (USFS Entiat RD) met with the Entiat Chamber of Commerce and secured its support for a watershed planning effort for the Entiat and Mad River watersheds. The Chamber initiated a search for local citizens interested in initiating and participating in the watershed study.

Watershed planning under the Watershed Planning Act (WPA) may be initiated for a subbasin only with the concurrence of: all counties within the subbasin; the largest city or town within the subbasin; and the water supply utility obtaining the largest quantity of water from the subbasin (Chapter 90.82.060 RCW). Recognizing that the voluntary emphasis and locally-led focus of the WPA paralleled the existing Entiat Coordinated Resources Management Plan (CRMP) group's structure and collaborative nature, the CCCD and USFS worked with Chelan County, the City of Entiat, and the Entiat Irrigation District to initiate the watershed planning process for the Entiat subbasin (WRIA 46; see Chapter 173-500 WAC) in 1998. The invitation to become initiating governments was also extended to the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) and the Confederated Tribes and Bands of the Colville Nation (Colville Nation). Although neither tribe accepted this offer, the Yakama Nation did agree to actively participate in the process.

The initiating governments designated the CCCD as the lead agency responsible for developing the subbasin planning process and scope of work; convening representation from a wide range of water resource interests; coordinating watershed plan development; and applying for and managing watershed planning grant funds. In 1998 the CRMP group led a successful effort to secure funding from the Washington Department of Ecology (WDOE) to develop a management plan for the Entiat subbasin (WRIA 46) and continue the group's efforts under the framework outlined in the act. With support of the initiating governments and the CCCD, stakeholders and participants that were already part of the Entiat CRMP group reorganized to become the Entiat WRIA Planning Unit (EWPU). Additional interest groups, such as the Yakama Nation and Chelan County PUD, also joined and broadened the makeup of the EWPU (CCCD 2004).

Over the past ten years, many individuals have contributed towards the watershed vision that is captured in the Final Draft Entiat Watershed Plan (January 2004). Because of the similarities in content and intent of the NPCC Subbasin Planning and State 2514 Watershed Planning, most of the materials developed for the Entiat Watershed Plan and approved by the Entiat Planning Unit is the basis for the Entiat Subbasin Management Plan contained in this document. This document was developed under the purview of the Entiat Planning Unit and associated Technical Teams and the implementation of the recommended Management Strategies will continue to be guided within this public forum.

2.3 Entiat Watershed Planning Unit Vision Statement and Goals

To voluntarily bring people together in a collaborative setting to improve communication, reduce conflicts, address problems, reach consensus and implement actions to improve coordinated natural resource management on private and public lands in the Entiat subbasin. The vision is to implement the locally developed, science based subbasin management plan using watershed specific information ultimately leading towards compliance with the federal Endangered Species Act (ESA) and Clean Water Act (CWA). Our end products will reflect a balance between existing natural resources and human uses and will capitalize on opportunities to improve these values.

Specific goals to move us forward towards this vision under the Watershed Planning Act are as follows:

- Optimize quantity and quality of water to achieve a balance between natural resources and human use both current and projected
- Provide for coexistence of people, fish and wildlife while sustaining lifestyles through planned community growth, and maintaining and/or improving habitats
- No avoidable human-caused mortality of State and Federal Threatened, Endangered and Candidate species
- Develop and implement an adaptive action plan to address priority issues, emphasizing local customs, culture and economic stability in balance with natural resources. All actions will comply with existing laws and regulations. However, changes to existing laws and regulations will be recommended as needed to attain our common vision and avoid one-size-fits-all solutions

Recognizing the significance of the roles of limiting factors outside of the watershed and natural events within the watershed, the long-term goal is to have the Entiat River's existing and future habitats contribute to the recovery of listed species and to eventually provide harvestable and sustainable populations of fishes and other aquatic resources.

Since 1993, landowner members of the CRMP Group/EWPU have always insisted that good science be applied to the collection and interpretation of information for all resource elements of concern. They hope that through the continued use of good science, the mission and goals of the group will be met, and with landowner cooperation during implementation, regulating agencies may not find it necessary to apply one-size-fits-all regulations to achieve their management objectives for the Entiat subbasin (CCCD 2004).

2.4 Subbasin Planning Goals and Ecological Objectives

As stated above, the Entiat Planning Units vision is to implement a subbasin management plan that will reflect a balance between existing natural resources and human uses and will capitalize on opportunities to improve these values. Listed below are specific goals adopted for the purposes of subbasin planning. Accompanying each of these goals are ecological objectives. Progress in achieving these objectives will be monitored to ensure accomplishment of the Planning Units overall Vision.

Goal 1. Maintain existing high quality habitat and the native fish and wildlife populations inhabiting these areas

Goal 2. Enhance or restore degraded areas, and return natural ecosystem functions to the subbasin

- Maintain, enhance, or restore the distribution, diversity, and complexity of watershed and landscape scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted
- Maintain, enhance, or restore biological diversity associated with native species and ecosystems
- Maintain, enhance, or restore sustainable and productive range and upland vegetative communities so as to promote watershed health and native ecological diversity
- Maintain, enhance, or restore significant culturally related natural resources
- Maintain, enhance, or restore unique habitats associated with riparian corridors along streams and in the upland environments
- Maintain, enhance, or restore the spatial and temporal connectivity within and between watersheds. Included are the drainage network connections, floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia
- Maintain, enhance, or restore natural stream flow regimes per temporal and spatial patterns
- Maintain, enhance, or restore habitat to support well-distributed populations of native plant, and riparian-dependent species, including habitat necessary for sustaining salmonids at critical life history stages of spawning, rearing and migration
- Maintain, enhance, or restore properly functioning floodplain and riparian conditions
- Maintain, enhance, or restore the water quality necessary to support healthy riparian, aquatic, and wetland ecosystems

Goal 3. Restore, maintain, or enhance fish and wildlife populations to sustainable and harvestable levels, while protecting biological integrity and the genetic diversity of the species

- Maintain or increase abundance of native fish and wildlife species to a level where populations can be harvested and can be sustained through natural reproduction and productivity

- Maintain or rebuild distribution of native fish and wildlife populations to perpetuate spatial structure, life history diversity and genetic diversity
- Maintain and/or restore performance (productivity, abundance and life history diversity) of wild, indigenous populations in a manner that maintains or enhances genetic similarity to naturally producing populations (Artificial propagation is considered a relatively short term measure and is not intended to replace naturally producing populations over the longer term.)

Goal 4. Increase public involvement, knowledge and appreciation for the protection, restoration and enhancement of fish and wildlife resources

- Provide scientific basis for protecting aquatic ecosystems and enhance open, public planning processes for sustainable resource management
- Develop tools and processes to increase greater public involvement in accurately assessing the responses in fish and wildlife populations and their habitats to specific strategies recommended and undertaken
- Assess current and future water supply and community needs and develop a long-term strategy for sustainable community growth and efficient water conservation
- Inform, educate and involve landowners, recreationists and the general public about the need to protect, restore and enhance fish and wildlife resources

Goal 5. Improve fish and wildlife management, regulation and enforcement, public involvement and government incentives and funding to maintain and restore natural ecosystems and the species they support

- Increase effectiveness of decision-making and management of fish and wildlife populations and their habitats
- Make decision-making about and management of fish, wildlife populations and their habitats populations more effective
- Strengthen plans and regulations to restore and maintain habitat that supports healthy, harvestable populations of fish
- Use incentives and government funding to support the protection and restoration of fish, wildlife and their habitats
- Build citizen support and involvement in restoration, conservation and enhancement of fish and wildlife habitat

Goal 6. Improve coordination for long-term monitoring of fish and wildlife population and habitat and develop the required institutional infrastructure to better insure consistency and efficiency with other local, tribal, state and federal monitoring protocols

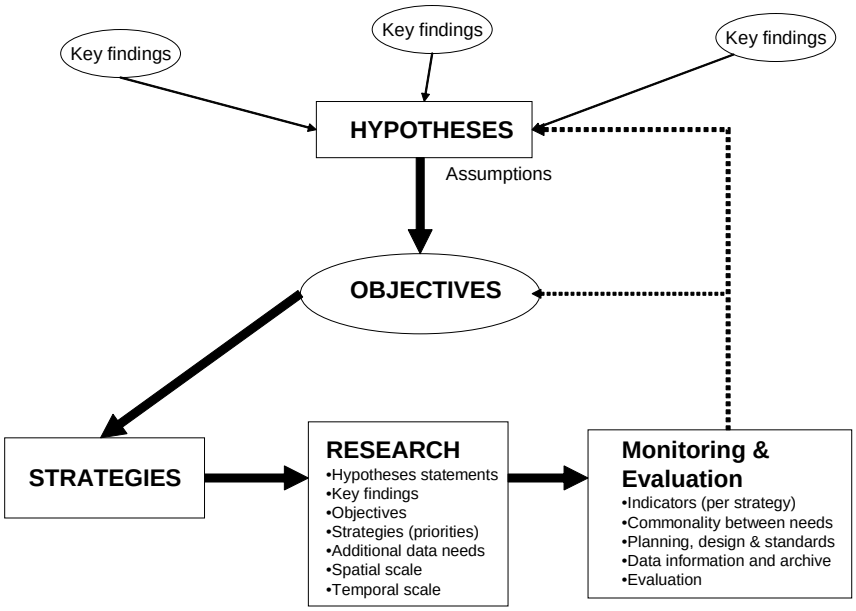
- Develop and employ a trend monitoring program based on remotely-sensed data obtained from sources such as aerial photography or satellite imagery

- Develop and implement a long-term statistically-based monitoring program to evaluate the status of fish populations and habitat (This requires probability-based statistical site selection procedures and establishment of standard protocols and data collection methods.)
- Implement experimental research monitoring at selected locations to establish the underlying causes for the changes in habitat and population indicators

2.5 Logic Path and Documentation of the Subbasin Plan

Of primary interest to the Entiat Subbasin Plan is the logic, or rational that supports the recommendations of the Management Plan. The fundamental premise in the development of this Plan is to identify 1) what habitat conditions have been most effected by developments in the last 200 years, 2) how have important species responded to these changes, and 3) what can local resource managers and citizens do to maintain and enhance these and other important terrestrial and aquatic populations and ecosystems (Figure 1).

Figure 1. Logic diagram



There are six sections contained within this subbasin plan. All sections are closely related but can be read and understood independent of the others. Below is a brief summary of the content and intent behind each of the six sections.

2.5.1 Subbasin Overview

The subbasin overview provides a coarse overview of the subbasin with respect to the Columbia Cascade Province and with the key environmental features within the Entiat Subbasin. This information is simply descriptive in nature and is meant to help orient the unfamiliar reader with the subbasin. This section also provides a Scientific Conceptual Foundation, which describes the underlying premises of how Subbasin Planners view and interpret ecologic health and population

responses within the subbasin and relevant to the larger Columbia Basin region as a whole. This information provides the framework of how Assessment information is interpreted and Management Recommendations are developed.

2.5.2 Assessment

The Assessment is descriptive information that addresses Terrestrial and Aquatic considerations separately. Essentially all of the information used in the Assessment exists in published literature, or was derived from Technical Subcommittee meetings, assembled periodically for the development of this subbasin plan.

The terrestrial assessment is based upon focal habitats. These habitats are considered sensitive and/or vulnerable to changes in environmental conditions, especially from rural or urban developments. Representative species that have a direct association are identified for each of the focal habitats.

For aquatic considerations, focal species were selected based upon a) cultural significance, b) fulfillment of a critical ecologic function, c) serves as an indicator to environmental health, d) are locally significant, and/or e) are a federally listed species. Focal species are seen as a "canary in the coal mine", such that their populations' health is a cumulative result of many environmental attributes. If these populations remain healthy, it is reasonable to conclude that the overall environmental condition and function is reasonably healthy. Focal species are described with an emphasis on their life history strategies, their relationship to various habitats, and their population characteristics and status.

A significant component of the Assessment is a description of habitat and ecologic conditions within the Entiat Subbasin. For the purposes of this document, the subbasin was dissected into four separate "Assessment Units", based primarily upon major watersheds contained within the subbasin. Each Assessment Unit is described with regards to its overall Watershed Condition, Riparian and Floodplain Condition, Stream Channel Condition, Water Quality, Water Quantity (flow) and Ecological Condition. These topics are inclusive to key and measurable habitat attributes important to survival and productivity of the focal species. Specific habitat attributes are evaluated and summarized in the Ecosystem Diagnosis and Treatment which primarily focused on streams available for anadromous fish use. The EDT model was used to evaluate habitat conditions for spring and late-run chinook salmon. Evaluation of other streams and focal populations was based upon existing Biologic Assessments developed by the US Forest Service for federal projects on publicly managed lands, and approved by the US Fish and Wildlife Service and NOAA Fisheries.

Each discussion of the Assessment Unit concludes with a brief discussion about important Environmental/Population Relationships, Areas of Special Interest, Limiting Factors (for focal species production) and key Data Gaps. These topics provide a synthesis of the Assessment Unit and highlight habitat conditions and functional relationships that are considered in the determination of recommended Management Strategies.

2.5.3 Inventory

The Inventory is a list of on-the-ground projects that have been implemented in the recent past, using the last five-years as a guideline. The simple purpose of the Inventory is to indicate if recently implemented projects are consistent with the needs identified by the Subbasin

Assessment. Comparing the projects from the Inventory with the habitat needs is a "Gap Analysis" which serves as the conclusion to this section.

2.5.4 Synthesis and Interpretation

The Synthesis and Interpretation focuses primarily upon aquatic resources and is the most complex section within the Subbasin Plan. The key elements within section are the 1) Key Habitat /Population Relationships, 2) Determination of Restoration Priorities, 3) Key Findings 4) Hypothesis Statements 5) Reference Conditions 6) Near-term Opportunities and 7) Determination of Restoration Priorities.

Key Habitat and Population Relationships provides a brief synthesis of the environment from the eyes of the focal fish species. This material identifies general types of actions that should be considered to enhance the productivity of these populations.

Determination of Restoration Priorities is taken from the Biologic Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region (2004) developed by the Regional Technical Team and adopted by the Upper Columbia Salmon Recovery Board. This information describes the basic criteria for determining priorities in species distribution across the landscape, and provides guidance in prioritization of protection and restoration activities. Important to note here is that this logic does not specifically prioritize or discount any potential project or activity to benefit fish and wildlife resources, rather it provides guidance in overall funding considerations.

The Key Findings and Hypothesis Statements are organized in a similar manner as the Assessment. Key habitat attributes that limit focal species production within the subbasin and an identification of attributes that remain in good ecological condition are summarized. This summary is a synthesis of the Assessment for each of the key habitat attributes. Hypothesis statements are provided for those habitat attributes that are considered to be impaired and are particularly important to the overall ecology of the subbasin. Statements are provided that estimate species response if these conditions could be improved to a natural range of variation (or the desired future condition, as discussed in the Management Plan). These discussions provide the basis for establishing priority actions within the Management Plan and Monitoring strategy.

Reference Conditions are provided that relate the presumed past, existing and potential future environmental conditions to potential fish performance. A reference condition is a benchmark from which habitat changes and/or population performance can be compared over time. Reference conditions are qualitative in nature and intended to provide context for identifying potential policy considerations over a relatively large time (year 2050) and geographic (subbasin) scale.

Near-Term Opportunities are identified in this section. The management actions recommended here could be implemented and/or could be substantially advanced within a 10-year time period if managers are successful in developing an aggressive implementation strategy and secure appropriate funding. Because these actions are generally feasible within the foreseeable future, it is appropriate to identify a measurable level of accomplishment that would signal a highly successful implementation program.

2.5.5 Management Plan

There are five key areas discussed within the Management Plan, the 1) Vision, 2) Objectives, 3) Management Strategies, 4) Consistency with the Endangered Species and Act and Clean Water Act and future 5) Research needs. For consistency and ease of use, the Objectives, Management Strategies and Research needs all are organized in a similar manner as the Subbasin Assessment.

The Vision provides the basic context and direction for the Management Plan. The Vision statement is provided from the Entiat Planning Unit, assembled under the direction of the Washington State Watershed Planning Act.

The Objectives describe the fundamental elements for habitat improvements in a quantifiable manner. Each of the Objective statements is organized by Assessment Unit and key environmental attribute, consistent with the Assessment.

Following the Objectives, specific Management Strategies are recommended for each of the key habitat attributes. These recommendation provide general direction that should be considered when identifying specific habitat enhancement or restoration activities for each of the Assessment Units

A brief statement is included here addressing the relationship between the Management Plan and the Endangered Species Act and the Clean Water Act. The Management Plan, consistent with the goals and objectives of this Subbasin Plan is designed to support the intent of each of these federal Acts.

Concluding the Management Plan, information is provided designed to guide future Research activities within the Subbasin. These statements carefully integrate the biologic objectives, key findings and hypothesis statements described in other portions of this document.

2.5.6 Monitoring and Adaptive Management

Over the past two years, the Regional Technical Team of the Upper Columbia Region has been actively involved in the development of a large scale, long-term monitoring strategy. To date, the Monitoring Strategy is based upon efforts at the Columbia Cascade Provincial scale. Provided appropriate funding levels, it is envisioned that monitoring will be implemented as described, consistent with other subbasin within the Province.

This monitoring strategy is designed to be consistent with ongoing Federal and State direction and will focus considerable attention to three key levels of monitoring: implementation, effectiveness and validation. Consistent with the ISAB (2003) recommendations, the Entiat Monitoring Strategy will (with an appropriate level of funding) 1) contain a trend monitoring program based upon remotely-sensed data obtained from sources such as aerial photography and/or satellite imagery, 2) develop and implement a long-term statistical monitoring program to evaluate the status of fish populations and habitat (his requires probabilistic (statistical) site selection procedures and establishment of common (standard) protocols and data collection methods), and 3) implement experimental research monitoring at selected locations to establish the underlying causes for the changes in habitat and population indicators.

2.6 Synopsis of Key Findings

Key Findings are concise statements/determinations about environmental attributes found to have a relatively high importance to the focal species existence within the Assessment Unit. These statements describe habitat conditions that are functioning properly as well as those that have been altered or degraded to the point that they limit the ability for the focal species to thrive or exist within the Assessment Unit. Key Findings are first described for Terrestrial and then for Aquatic considerations.

2.6.1 Summary of Key Findings: Terrestrial

The terrestrial assessment viewed the subbasin from a perspective of key and major vegetative communities. Three community types were chosen as focal habitat for this evaluation, ponderosa pine, shrub steppe and riparian ecosystems. Within each of these focal habitats, representative species that are directly associated with these vegetative communities are identified and will be monitored.

Factors Affecting Ponderosa Pine Habitat

- Timber harvesting has reduced the amount of old growth forest and associated large diameter trees and snags.
- Urban and residential development has contributed to loss and degradation of properly functioning ecosystems.
- Fire suppression/exclusion has contributed towards habitat degradation, particularly declines in characteristic herbaceous and shrub understory from increased density of small shade-tolerant trees. High risk of loss of remaining ponderosa pine overstories from stand-replacing fires due to high fuel loads in densely stocked understories.
- Overgrazing has resulted in lack of recruitment of sapling trees, particularly pines.
- Invasion of exotic plants has altered understory conditions and increased fuel loads.
- Fragmentation of remaining tracts has negatively impacted species with large area requirements.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and may be subject to high levels of human disturbance.

Factors Affecting Shrubsteppe Habitat

- Degradation of habitat from intensive grazing and invasion of exotic plant species.
- Fire management, either suppression or over-use, and wildfires.
- Invasion and seeding of crested wheatgrass and other introduced plant species which reduces wildlife habitat quality and/or availability.

- Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrub-steppe/grassland communities.
- Human disturbance during breeding/nesting season, parasitism.

Factors Affecting Riparian Wetland Habitat

- Habitat degradation from livestock overgrazing which can widen channels, raise water temperatures, reduce understory cover, etc.
- Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird), exotic nest competitors (European starling), and domestic predators (cats), and be subject to high levels of human disturbance.

2.6.2 Summary of Key Findings: Aquatic

Spring chinook

Spring chinook production in the Entiat River could increase if habitat problems within the lower basin were rectified. Preservation of quality spawning and rearing habitat in the Middle Entiat AU is important to maintain naturally reproducing populations. Increases of off channel habitat and riparian areas in the lower Entiat River would increase potential rearing habitat and life history diversity. Creating or restoring habitat will increase spring chinook productivity by a modest degree, and increase the spatial and potential life history diversity within the Entiat River.

Late-run chinook

Late-run chinook production in the Entiat River could increase if habitat problems within the lower river were corrected. Increases of off channel habitat and riparian areas in the lower Entiat River would increase productivity by increasing potential rearing, adult holding habitat, and genetic, spatial, and life history diversity.

Steelhead trout

Steelhead production in the Entiat River could increase if habitat problems within the lower basin were rectified. Preservation of quality spawning and rearing habitat in the Mad and Middle Entiat AU is important to maintain naturally reproducing populations. Increases of off channel habitat and riparian areas in the lower Entiat River would increase potential rearing habitat and life history diversity. Creating or restoring habitat will increase steelhead productivity by a modest degree, and increase the spatial and potential life history diversity within the Entiat River.

Bull trout

Bull trout production in the Entiat River Basin could increase if habitat problems were rectified. Increases of off channel habitat and riparian areas in the lower Entiat River, would increase potential rearing and adult holding habitat and life history diversity. While creating or restoring habitat may not increase overall bull trout production by a significant degree, it does increase the spatial and potential genetic diversity of bull trout in the Entiat River.

Bull trout are more sensitive than other species to habitat degradation. Water quality requirements for bull trout require the preservation and restoration of high functioning habitat. Processes that affect temperature, sediment load and connectivity from lower quality (feeding areas) to higher quality (spawning and initial rearing areas) should all be considered when trying to increase overall production of bull trout.

Westslope cutthroat trout

Westslope cutthroat trout are known to exist throughout most of the high elevation streams within the Entiat subbasin. There are concerns about the status of this species due to genetic introgression (especially with introduced rainbow trout), competition with non-native species (brook trout), depressed and fragmented populations or stocks, and loss of migratory life histories. Information addressing population abundance, trend and distribution is lacking.

Pacific lamprey

Pacific lamprey still exist in the Entiat system, but the abundance and distribution is mostly unknown. Due to the declining status of this species, and the lack of information a relatively high level of effort to monitor and enhance these populations are recommended.

Coho salmon

Coho salmon were extirpated from the Entiat River. Coho re-introduction into the Entiat River is being considered by fishery co-managers. Implemented of this work would likely proceed with relatively low levels of artificial production during a feasibility phase. Feasibility investigations would occur over several generations of returning fish (approximately 10-years).

2.7 Summary of Restoration and Conservation Measures: Terrestrial

2.7.1 Ponderosa Pine

Goal: Provide sufficient quantity and quality ponderosa pine habitats to support the diversity of wildlife as represented by sustainable focal species populations.

Habitat Objective 1: Determine the necessary amount, quality, and juxtaposition of ponderosa pine habitats by the year 2008.

Habitat Objective 2: Based on findings of Objective 1, provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Habitat Objective 3: Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving silvicultural practices, fire management, weed control, livestock grazing practices, and road management in existing and restored ponderosa pine habitat.

Biological Objective 1: Determine population status of white-headed woodpecker, flammulated owl, and pygmy nuthatch by 2008.

Biological Objective 2: Within the framework of the focal species population status determinations, inventory other ponderosa pine obligate populations to test assumption of the umbrella species concept for conservation of other ponderosa pine obligates.

2.7.2 Shrubsteppe

Goal: Provide sufficient quantity and quality shrub-steppe habitat to support the diversity of wildlife as represented by sustainable focal species populations.

Habitat Objective 1: Determine the necessary amount, quality, and juxtaposition of shrub steppe by the year 2008.

Habitat Objective 2: Based on findings of Objective 1, identify and provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Habitat Objective 3: Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving agricultural practices, fire management, weed control, livestock grazing practices, and road management on existing shrub steppe.

Biological Objective 1: Determine population status of Brewer's sparrow by 2008.

Biological Objective 2: Within the framework of the Brewer's sparrow population status determination, inventory other shrub-steppe obligate populations to test assumption of the umbrella species concept for conservation of other shrub-steppe obligates.

Biological Objective 3: Maintain and enhance mule deer populations consistent with state/tribal herd management objectives.

2.7.3 Riparian Wetlands

Goal: Provide sufficient quantity and quality riparian wetlands to support the diversity of wildlife as represented by sustainable focal species populations.

Habitat Objective 1: Determine the necessary amount, quality, and connectivity of riparian wetlands by the year 2008.

Habitat Objective 2: Based on findings of Habitat Objective 1, provide biological and social conservation measures to sustain focal species populations and habitats by 2010.

Habitat Objective 3: Enhance beaver habitat where appropriate to increase the quantity and quality of riparian wetlands for focal species by 2009.

Habitat Objective 4: Enhance beaver populations to benefit habitat for threatened/endangered fish species

Habitat Objective 5: Maintain and/or enhance habitat function (i.e., focal habitat attributes) by improving silviculture and agricultural practices, fire management, weed control, livestock grazing practices, and road construction and maintenance on and adjacent to existing riparian wetlands.

Biological Objective 1: Determine population status of red-eyed vireo yellow-breasted chat by 2008.

Biological Objective 2: Within the framework of the focal species population status determinations, inventory other riparian wetlands obligate populations to test assumption of the umbrella species concept for conservation of other riparian wetlands obligates.

2.8 Summary of Restoration and Conservation Measures: Aquatic

2.8.1 Lower Entiat Assessment Unit

Water Quality

- Improve elevated water temperatures and excessive fine sediments
- Reduce the levels of toxic materials and contaminants entering into the stream system

Water Quantity

- Increase efficiency of water withdrawal
- Decrease severity of high flow events by increasing in-channel structural diversity and restoring geo-fluvial processes

Riparian/Floodplain Conditions

- Reestablish riparian vegetation corridors and associated stream canopies
- Increase the number of large trees and complex riparian communities
- Minimize affects of development on channel migration zones within the riparian and floodplain, and increase stream sinuosity through active restoration when feasible
- Increase, or reconnect floodplain (off-channel) habitats, where feasible
- Maintain and enhance wetland complexes and enhance ground water recharge
- Where feasible, relocate roads from the valley bottoms

In-Channel Conditions

- Increase in-stream structural diversity and complexity to provide refuge to juveniles
- Increase/restore habitat diversity by increasing off-channel habitat, backwaters with cover and low energy refugia
- Evaluate the use of irrigation ditches as a means to increase rearing
- Increase large woody debris and provide adequate sources for future recruitment
- Increase quality and quantities of pool habitat

Barriers to Fish Passage

- Maintain passage in the mainstem and improve fish passage in the tributary streams

Ecological Conditions

- Reduce harassment to spawning and pre-spawning adult salmonids
- Evaluate Pacific Lamprey populations and habitat suitability

Minimize fish and bird predation on salmonids

- Improve nutrient base using salmon carcasses or suitable analog
- Minimize hatchery contribution of pathogens
- Minimize negative impacts of hatchery operations
- Enhance the nutrient base using salmon carcasses or analog materials

2.8.2 Middle Entiat Assessment Unit

Water Quality

- Decrease fine sediment and maintain trend

Water Quantity

- Moderate severity of high flow events by enhancing floodplain conditions and in-channel complexity

Riparian/Floodplain Conditions

- Improve riparian vegetation corridors and associated stream canopies
- Increase/maintain the number of large trees and complex riparian communities that will eventually increase the natural recruitment of large wood
- Reduce impacts from development and livestock management within the riparian area
- Reduce road density in riparian areas
- Minimize affects of development on channel migration zones within the riparian and floodplain, and increase stream sinuosity in tributary streams
- Increase, or reconnect floodplain (off-channel) habitats, where feasible
- Maintain and enhance wetland complexes, enhance ground water recharge
- Protect/enhance geo-fluvial processes and floodplain function

In-Channel Conditions

- Maintain and enhance in-stream structural diversity and complexity to provide refuge to juveniles
- Protect and increase in-stream structures (complex log structures)
- Increase stream bank stability
- Increase large woody debris and restore large wood complexes and provide adequate sources for recruitment
- Increase pool quality and quantity

Barriers to Fish Passage

- Allow unimpeded access of fish passage throughout the tributaries

Ecological Conditions

- Reduce or eliminate harassment and poaching to spawning and pre-spawning adult salmonids
- Evaluate Pacific Lamprey populations and habitat suitability
- Eliminate or reduce impacts of eastern brook trout and hatchery rainbow trout
- Maintain bull trout fishing closure and continue tracking bull trout and cutthroat trout populations
- Evaluate feasibility of coho reintroduction and begin implementation as appropriate
- Improve nutrient base using salmon carcasses or suitable analog

2.8.3 Upper Entiat and Mad River Assessment Units

Water Quality

- Maintain water temperature and decreasing trend in sediment loads

Water Quantity

- Maintain the natural hydrology of these areas and continue to improve conditions in some tributary streams

Riparian/Floodplain Conditions

- Maintain existing conditions throughout much of these areas; improve localized conditions in some tributaries

In-Channel Conditions

- Maintain good conditions and improve structural diversity in some areas in the lower Mad River and Tillicum Creek

Barriers to Fish Passage

- Maintain unimpeded access to fish passage throughout these areas and improve access in lower Tillicum Creek

Ecological Conditions

- Reduce or eliminate harassment and poaching to spawning and pre-spawning adult salmonids
- Evaluate Pacific Lamprey populations and habitat suitability
- Eliminate or reduce impacts of eastern brook trout and hatchery rainbow trout
- Maintain bull trout fishing closure and continue tracking bull trout and cutthroat trout populations

- Improve nutrient base using salmon carcasses or suitable analog

2.9 Summary of Monitoring and Infrastructure Needs: Terrestrial

Recommended monitoring and evaluation strategies summarized below for each focal habitat type are derived from national standards. Deer and elk sampling methodology follow standard protocols established by the Washington Department of Fish and Wildlife. Protocols for specific vegetation monitoring/sampling methodologies are drawn from USDA Habitat Evaluation Procedure standards. A common thread in the monitoring strategies contained in this Subbasin Plan is the establishment of permanent census stations to monitor bird populations and habitat changes.

Wildlife managers will include statically rigorous sampling methods to establish links between habitat enhancement prescriptions, changes in habitat conditions, and target wildlife population responses.

Specific methodology for selection of Monitoring and Evaluation (M&E) sites within all focal habitat types follows a probabilistic (statistical) sampling procedure, allowing for statistical inferences to be made within the area of interest. Protocols identified in this document describe how M&E sites will be selected. The following summarizes the basic concepts of the Wildlife Monitoring Strategy.

2.9.1 Ponderosa Pine

Focal Species

Flammulated owl, white-headed woodpecker, and pygmy nuthatch.

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Ponderosa pine sites to monitor focal species population and habitat changes and evaluate success of efforts.

Focal Habitat Monitoring

Factors affecting habitat:

- Direct loss old growth forest and associated large diameter trees and snags
- Fragmentation of remaining Ponderosa pine habitat
- Agricultural and sub-urban development and disturbance
- Hostile landscapes which may have high densities of nest parasites, exotic nest competitors, and domestic predators
- Fire suppression/wildfire
- Overgrazing
- Noxious weeds
- Silvicultural practices
- Insecticide use

2.9.2 Shrubsteppe

Focal Species

Sharp-tailed Grouse, Brewer's sparrow, and mule deer.

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed shrub-steppe sites to monitor focal species population and habitat changes and evaluate success of efforts.

Focal Habitat Monitoring

Factors affecting habitat:

- Direct loss shrub steppe due to conversion to agriculture, residential, urban and recreation developments
- Fragmentation of remaining shrub-steppe habitat, with resultant increase in nest parasites
- Fire Management, either suppression or over-use, and wildfires
- Invasion of exotic vegetation
- Habitat degradation due to overgrazing, and invasion of exotic plant species
- Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrub-steppe/grassland communities

2.9.3 Riparian Wetlands

Focal Species

Red-eyed vireo, yellow-breasted chat, and American beaver

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Riparian Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts

Overall Habitat and Species Monitoring Strategy: Establish permanent census stations to monitor bird population and habitat changes

Focal Habitat Monitoring

Factors affecting habitat:

- Direct loss of riparian deciduous and shrub understory
- Fragmentation of wetland habitat
- Flooding and dewatering of areas by beaver
- Agricultural and sub-urban development and disturbance
- Reduction in water quality

- Organochlorines such as dieldrin or DDE may cause thinning in egg shells which results in reproductive failure

2.10 Summary of Monitoring and Infrastructure Needs: Aquatic

The monitoring plan draws from the existing regional strategies (Independent Scientific Advisory Board, Action Agencies/NOAA Fisheries, and Washington Salmon Recovery Funding Board) and outlines an approach specific to the Entiat Basin. The plan addresses the following basic questions:

What are the current habitat conditions and abundance, distribution, life-stage survival, and age-composition of ESA-listed fish in the Entiat Basin (status monitoring)?

How do these factors change over time (trend monitoring)?

What effects do tributary habitat actions have on fish populations and habitat conditions (effectiveness monitoring)?

The monitoring plan is designed to address these questions and at the same time eliminate duplication of work, reduce costs, and increase monitoring efficiency. The implementation of valid statistical designs, probabilistic sampling designs, standardized data collection protocols, consistent data reporting methods, and selection of sensitive indicators will increase monitoring efficiency. For this plan to be successful, all organizations involved must be willing to cooperate and freely share information. Cooperation includes sharing monitoring responsibilities, adjusting or changing sampling methods to comport with standardized protocols, and adhering to statistical design criteria. In those cases where the standardized method for measuring an indicator is different from what was used in the past, it may be necessary to measure the indicator with both methods for a few years so that a relationship can be developed between the two methods. Measurements generated with a former method could then be adjusted to correct for any bias.

The monitoring report is divided into seven major parts. The first part (Section 2) identifies valid statistical designs for status/trend and effectiveness monitoring. Section 3 discusses issues associated with sampling design, emphasizing how one selects a sample and how to minimize measurement error. Section 4 examines how sampling should occur at different spatial scales. Section 5 describes the importance of classification and identifies a suite of classification variables. Section 6 identifies and describes biological and physical/environmental indicators, while Section 7 identifies methods for measuring each indicator variable. These six sections provide the foundation for implementing an efficient monitoring plan in the Entiat Basin. The last section deals with how the program will be implemented. Section 8 provides a checklist of questions that need to be addressed in order to implement a valid plan.

At this time entities that collect information relevant to fish and wildlife interests in the Entiat subbasin do not have a centralized location to store or retrieve critical or timely information. Key questions yet to be addressed at the subbasin and Regional level concerns data management, data interpretation and data presentation. One of the significant challenges yet to be resolved is in describing the organizational and cooperative manner in which agencies and entities can integrate the regular collection and interpretation of natural resource information and provide this information to the public in a manner that allows full involvement in future decision making processes.

3 Subbasin Overview

3.1 Entiat Subbasin in Regional Context

3.1.1 Introduction and Objectives

The Northwest Power and Conservation Council (NPCC) is responsible for implementing the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) and the Fish and Wildlife Program mandated by the act. For planning purposes, the NPCC divided the more than 50 subbasins comprising the Columbia River Basin south of the Canadian border into 11 ecoregions.

Each of the 11 ecological provinces will develop its own vision, biological objectives, and strategies consistent with those adopted at the subbasin level. NPCC's intent is to amend these Subbasin plans into the 2000 Fish and Wildlife Program during later rulemaking. The biological objectives at the province scale will then guide development of the program at the subbasin scale.

3.1.2 Columbia Cascade Province

The Columbia Cascade Ecological Province extends over an area of 14,333 sq. mi. It is defined as the Columbia River from Wanapum Dam to the limit of anadromous fish passage at Chief Joseph Dam and is situated in north central Washington. Tributary subbasins are, for the most part, high gradient streams that begin in the North Cascade Mountains and drain directly to the Columbia River. The province also includes a few smaller streams that drain smaller watershed adjacent to the Columbia as well as a number of gulches that arise from the channeled scablands to the east. The province is divided into 6 subbasins: the Entiat, Entiat, Lake Chelan, Methow, Okanogan, and Upper Middle Mainstem Columbia River.

The Entiat subbasin lies entirely within Chelan County. The subbasin comprises 3.2% of the Columbia Cascade Province and consists of approximately 298,000 acres (466 mi^2), as referenced in Table 1.

Table 1. Entiat subbasin in provincial context

Subbasin	Size		Percent of Province	Percent of State
	Acres	Mi^2		
Entiat	**298,363**	**466**	**4.9**	**.7**
Lake Chelan	599,925	937	**10**	1.4
Wenatchee	851,894	1,333	**14,1**	2.0
Methow	1,167,795	1,825	**19.4**	2.8
Okanogan	1,490,079	2,328	**24.8**	3.5
Upper Middle Mainstem Columbia River	1,607,740	2,512	**26.7**	3.8
Total (Columbia Cascade Province)	**6,015,796**	**9401**	**100**	**14.2**

Ashley and Stovall 2004

Note: Values may be somewhat inconsistent with other tables in this document due to differing sources of information. Values may be revised as significant errors are discovered and time is available.

Approximately 83% of the subbasin is in federal (primarily USFS) and state ownership. The remaining 17% of the lands in the subbasin is in private ownership as referenced inTable 2, below.

Table 2. Land ownership of the Columbia Cascade Province

Subbasin	Federal Lands (acres)	Tribal Lands (acres)	State Lands (acres)	Private Lands (acres)	Total (Subbasin) (acres)
Entiat	**247,064**	**0**	**13,629**	**37,670**	298,363
Lake Chelan	517,883	0	3,549	78,493	599,925
Wenatchee	682,295	0	11,836	159,182	853,313
Methow	985,234	0	55,836	126,724	1,167,794
Okanogan	400,496	311,826	261,598	516,159	1,490,079
Upper Middle Mainstem Columbia River	124,492	29,507	284,996	1,168,744	1,607,739
Total (Province)	**2,957,464**	**341,333**	**631,444**	**2,086,972**	**6,017,213**

Ashley and Stovall 2004

Note: Values may be somewhat inconsistent with other tables in this document due to differing sources of information. Values may be revised as significant errors are discovered and time is available.

Native American Tribes

Native people traditionally lived, hunted, gathered and fished within the Columbia Cascade Ecological Province. The province includes land ceded by the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) under the Treaty of 1855 to the United States. Members of the Yakama Nation and the Confederated Tribes of the Colville Reservation continue to exercise their hunting, gathering, and fishing rights within the province.

3.1.3 Terrestrial/Wildlife Context

For the most part, the Columbia Cascade Ecological Province shares many of the same problems and opportunities for fish and wildlife habitat conditions as other Provinces within the interior Columbia Basin. The upper watersheds are primarily forested and have undergone substantial management activities. Lower reaches of the principal streams within each of the subbasin are almost completely privately owned and primarily managed through agricultural practices. In all cases, habitat conditions range from pristine to severely altered.

3.1.4 Aquatic/Fish Context

Construction of Grand Coulee Dam in 1934 blocked over 1,000 miles of habitat in the Upper Columbia River Basin upstream of the Columbia Cascade Province. Another 52 miles of habitat was blocked, in 1961, by the completion of the Chief Joseph Dam. In addition, there are six hydroelectric projects downstream of this Province: Wanapum Dam and Priest Rapids Dam, and four federally owned projects, McNary Dam, John Day Dam, The Dalles Dam and Bonneville Dam.

To mitigate for the loss of anadromous salmonid production by the federally built projects, the federal government built and continues to operate the Leavenworth National Fish Hatchery in the Wenatchee subbasin and later the Entiat and Winthrop National Fish Hatcheries in the Entiat and Methow subbasins, respectively. No federal mitigation facility was constructed in the Okanogan subbasin.

With the construction of each of the privately owned Mid-Columbia hydroelectric projects, additional production/hatchery facilities were developed in the Columbia Cascade Province. The recent Habitat Conservation Plan (initiated by Chelan and Douglas Public Utility Districts (PUDs) for ESA Section 10 consultation) identified the mitigation obligation of the PUDs and provides the groundwork for future changes in facility production goals and operations. Details of these changes in hatchery production will be resolved over the next few years.

In spite of past mitigation efforts, declining salmonid populations in the Columbia Cascade Province have resulted in listings of spring chinook (Oncorhyncus tshawytscha) (endangered March 1999), summer steelhead (O. mykiss) (endangered August 1997) and bull trout (Salvelius confluentus , June 1998) under the ESA. Upper Columbia late-run chinook and Lake Wenatchee sockeye (O. nerka) were also petitioned (March 1998) but were determined not warranted for listing. Recent years have shown improved salmonid runs to the Province, consistent with findings throughout the Columbia Basin.

3.1.5 Subbasin Planning and the Regulatory Context

Federal

The USFS manages approximately 83% of the Entiat subbasin. Other federal land mangers include the BLM and the USFWS, which is responsible for the operation and management of the Entiat National Fish Hatchery. Actions on USFS, BLM and USFWS lands within the Entiat subbasin result from the execution of various federal laws and regulations. Some of the major federal laws governing agency practices that were considered during the development of this plan are described in this section.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 mandates that all federal agencies "utilize a systematic, interdisciplinary approach that will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making, which may have an impact on man's environment." NEPA integrates with a wide variety of existing environmental legislation, including the: Clean Air Act (CAA), Clean Water Act (CWA), Coastal Zone Management Act (CZMA), National Historic Preservation Act (NHPA), Marine Protection, Research and Sanctuaries Act (MPRSA), Pollution Prevention Act (PPA), and the Endangered Species Act (ESA). NEPA further requires a detailed statement on the environmental impact of major federal actions that significantly affect the environment be included in every recommendation or report on proposals for legislation.

Endangered Species Act

The Endangered Species Act (ESA) of 1973 applies to the management of fish, wildlife and plant species that are in danger of or threatened with extinction. The purpose of the ESA is to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and to provide a program for the conservation of such threatened and endangered species. All federal departments and agencies must seek to conserve threatened and endangered species and utilize their authorities to further the purposes of the ESA. Federal agencies are also required to cooperate with state and local agencies to resolve water resource issues in concert with conservation of endangered species.

In addition to mandating specific federal management actions, the ESA also applies to the actions of any person subject to the jurisdiction of the United States. It prohibits the harm or “take” of species listed as threatened or endangered under the ESA. Significant consideration is given to the ESA when any type of activity within the Entiat subbasin is proposed or undertaken, as threatened and endangered species exist within the management area on lands under both public and private management. Proposed habitat recommendations in this plan have been designed to help protect and restore threatened bull trout and endangered steelhead and spring chinook habitat on private lands within the subbasin.

Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended in 1977, is commonly known as the Clean Water Act (CWA). The CWA established a basic structure to regulate discharge of pollutants into U.S. waters, and gave the U.S. Environmental Protection Agency (EPA) the authority to implement pollution control programs. The EPA set federal water quality standards,

and delegated authority to the WDOE to monitor whether state surface waters are meeting federal water quality standards. The state is also required to maintain a list of impaired streams. The water quality recommendations in this plan have been designed to help address these concerns within the Entiat subbasin.

Federal Land Policy and Management Act

The Federal Land Policy and Management Act (FLPMA) requires the BLM to develop land use plans. In order to meet this requirement the BLM developed the Spokane Resource Management Plan, which includes lands within the Entiat subbasin. BLM administered lands in the subbasin are designated as Scattered Tracts, and allow most resource activities including recreation, timber harvest, and grazing. These lands have high value as wildlife winter range.

National Forest Management Act and Northwest Forest Plan

The National Forest Management Act (NFMA) is significant law affecting the management and decisions of Forest Service land managers. The NFMA directs the USFS to develop a Resource Management Plan (RMP) for each national forest. The 1990 Entiat Forest Plan contains management direction for the forest in the form of forest-wide standards and guidelines and management prescriptions for specific management areas (USFS Entiat NF 1990). The various management areas emphasize certain key values and indicate what practices will and/or will not occur within each management area.

The Northwest Forest Plan amended the Entiat Forest Plan in April 1994. This amendment modified the Entiat Forest Plan management designations and created Late Successional and Riparian Reserves. The Northwest Forest Plan also provides numerous standards and guidelines directing management practices on federal lands. Table 3 summarizes the resulting NFS land allocations by acreage within the Entiat subbasin and describes permitted management actions.

Table 3. USFS land allocations, acreages, and management emphasis

LAND ALLOCATION	ACRES[+]	MANAGEMENT EMPHASIS
Congressionally Withdrawn Areas	25,554.37	Part of the Glacier Peak Wilderness Area. Managed for primitive recreation and research in a primitive setting. No timber harvest.
Late-Successional Reserves	60,139.33	Managed to protect and enhance habitat for late-successional and old-growth related species. No scheduled timber harvest, but allows some tree thinning to enhance desired late successional/old-growth habitat.
Administratively Withdrawn	34,834.61	Entiat Forest Plan: Unroaded Dispersed Recreation. No timber harvest.
Riparian Reserves*		Emphasizes protection along all streams, wetlands, ponds and lakes. No scheduled timber harvest but some silvicultural treatments are permitted when they benefit riparian resources.
Matrix*	130,822.96	Lands outside of reserves and managed under prescriptions described in The Entiat Forest Plan land allocations. Approximately 65% or 62,958 acres are available for regularly scheduled timber harvest.
Forest Service Pending	3531.31	Lands acquired through exchange or purchase that do not have a Forest Plan allocation assigned to them yet.

CCCD 2004

In addition to creating reserves and prescribing standards and guidelines, the Northwest Forest Plan identified “key watersheds" in Washington, Oregon and Northern California as part of the Aquatic Conservation Strategy. Key watersheds provide habitat critical for the maintenance and recovery of anadromous salmonids and resident fish species.

The Northwest Forest Plan requires that watershed assessments be completed before federal land managers proceed with most activities within key watersheds. Each of these plans has been completed in the Entiat Subbasin and is incorporated into this document.

A key product of the watershed assessment process was the description of existing resource conditions, identification of desired ecological conditions, and the development of management strategies that would move elements in the watershed toward the desired future condition.

State

Many Washington state laws that regulate actions on private lands within the Entiat subbasin and that direct state and local agency decision-making about projects were also considered while developing this plan. Some of these pertinent state laws include, but are not limited to:

Salmon Recovery Act of 1998 (Chapter 75.46 RCW) and Watershed Planning (Chapter 90.82 RCW)

Additional detail about the Salmon Recovery Act (SRA) is provided below because of the close link between SRA and the State Watershed Planning Act. For more information about these and other state laws, see the following link: http://www.leg.wa.gov/rcw/index.cfm

The Salmon Recovery Act authorizes a Lead Entity to coordinate the development of locally-directed Habitat Restoration Project Lists and salmon recovery plans. The Lead Entity for salmon recovery activities occurring in Chelan County is the county. If a planning unit opts to include the habitat component in its plan, and restoration activities are already being developed under the Salmon Recovery Act, the planning unit is required to rely upon those activities as "the primary non-regulatory habitat component" of their plan.

The habitat restoration actions put forth in this plan were developed using the Critical Pathways Methodology identified in the Salmon Recovery Act, and are the result of a locally-directed, collaborative effort among federal, tribal, state, local, and other stakeholder interests.

Various State legislative actions have provided guidance to natural resource management. Several of the more important regulatory Acts are listed below:

- Shoreline Management Act of 1971 (Chapter 90.58 RCW)
- Water Resources Act o f 1971 (Chapter 90.54 RCW)
- Growth Management Act of 1990 (Chapter 36.70A RCW)
- Forestry Practices Act of 1974 (Chapter 76.09 RCW)
- State Environmental Policy Act of 1971 (Chapter 42.21C RCW)

Regional/Local

Regional Salmon Recovery Planning

It is anticipated that information contained in this document pertinent to habitat restoration and salmon recovery in the Entiat subbasin will contribute to the regional recovery strategy being developed for the Columbia Cascade Province.

Tribal Recovery Planning; Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon)

Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon) is the Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs and Yakama Tribes developed with the Columbia River Inter-Tribal Fish Commission (CRITFC). One of the plan's long-term objectives is to restore salmon populations to a level that will support tribal ceremonial, subsistence, and commercial harvests. For more information on Tribal Recovery, refer to the following link: http://www.critfc.org/text/water_action.html

Chelan County Comprehensive Land Use Planning

Planning units are required to consider city and county planning activities during the development of their watershed plan. The Entiat Planning Unit has given particular attention to local planning being done under the Growth Management Act (GMA). GMA is quite significant in that it mandates cities and counties to plan for land use and development; designate and protect critical areas including wetlands, aquifer recharge areas, frequently flooded areas, and fish and wildlife habitat conservation areas. GMA also guides the development of comprehensive plans using other goals such as enhancing water quality and water availability, promoting new businesses, and involving citizen participation in the planning process. Actions recommended in this plan were designed in consideration of the goals used to guide planning

under GMA, and to provide local input to Chelan County during the update of its Comprehensive Plan, which is scheduled for completion by December 1, 2006. To access Chelan County Comprehensive Plan documents, refer to: http://www.co.chelan.wa.us/bl/bl4.htm

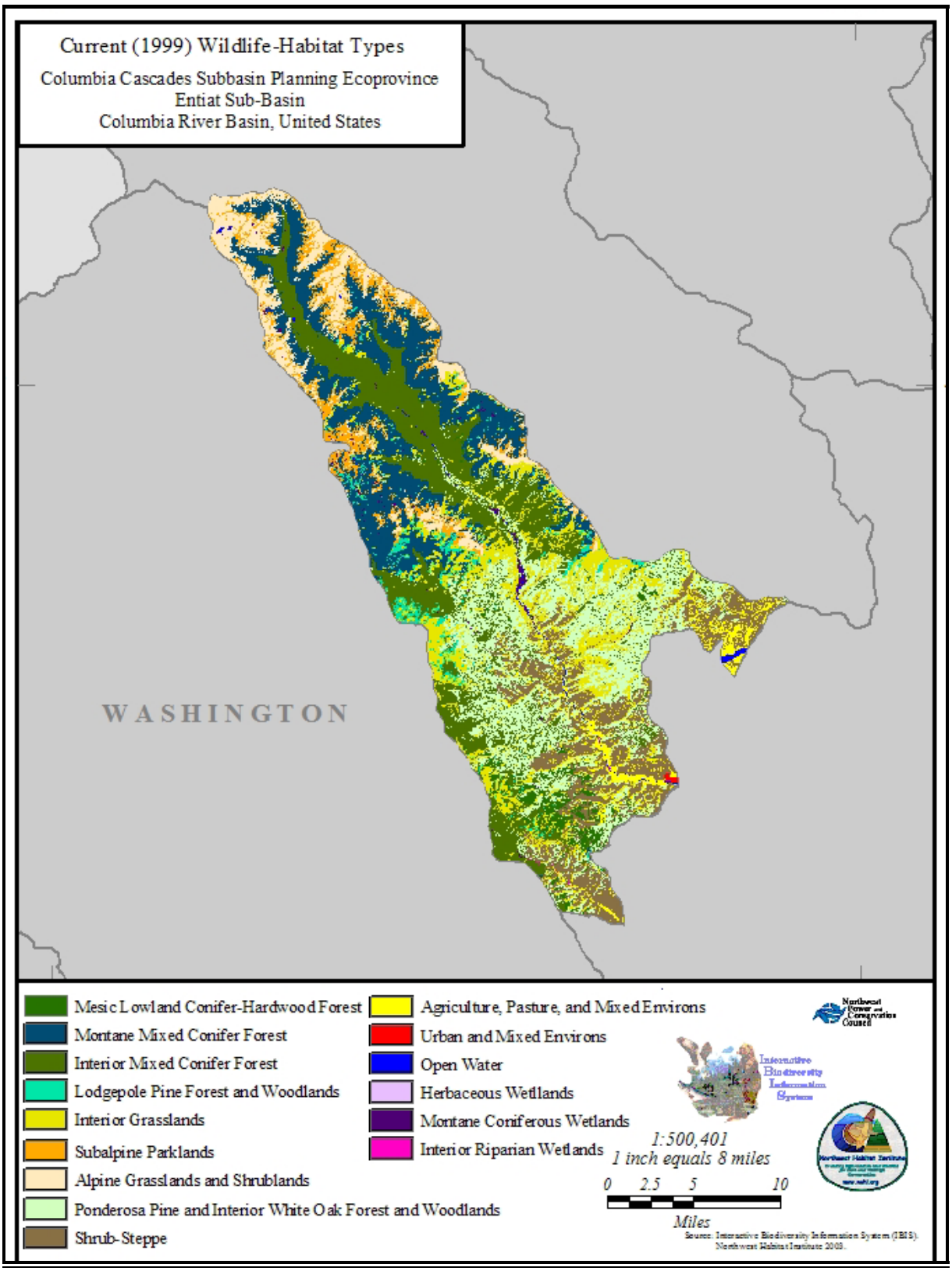


Figure 2. Major vegetation and wildlife habitat types in the Entiat subbasin

3.2 Subbasin Description

3.2.1 Location

The Entiat subbasin is located along the eastern slopes of the Cascade Mountains in north-central Washington State, Chelan County. It comprises the Entiat and Mad River watersheds, collectively known as the Entiat subbasin, as well as some minor Columbia River tributary drainages. The subbasin is approximately 305,641 acres and bounded on the northeast by the Chelan Mountains and the Lake Chelan drainage; to the southwest are the Entiat Mountains and the Entiat River subbasin.

3.2.2 Topography and Climate

Most of the large-scale topographic features are the result of alpine glaciation, which significantly affected the upper half of the Entiat subbasin. During the neo-glaciation period a valley glacier nearly 25 miles long extended from its source at the headwall of the Entiat watershed to just below Potato Creek, which is marked by a terminal moraine indicating the furthest downstream influence of the glacier on channel geomorphology and bed material. Above the terminal moraine the Entiat valley has a characteristic U-shaped appearance and is covered with glacial till. Glaciation resulted in hanging valleys and a moderately broad floodplain in the mid Entiat River that contains water-stratified silt, sand, gravel and cobbles (CCCD 2004).

Climate in the Entiat subbasin is strongly influenced by its association with the Cascade Mountains. Climate is discussed below in averages for winter and summer; however, fluctuations outside of average are very common, and extremes may best describe the local climate. Examples of such extremes include temperatures in the 90s and 100s, which may last for several weeks at a time during the summer, and single digit and sub-zero temperatures (occasionally double digit) for short periods during many winters.

Mean annual precipitation can range up to 90 inches in the headwater areas near the Cascade crest to less than 10 inches along the Columbia River. Approximately 50% of the mean annual precipitation falls from October through January, and 75% falls from October through March. Most winter precipitation falls as snow; however, rain is not unusual at some mid- and lower elevations. Cumulative snow depths range from less than 24 inches in lower elevations to nearly 400 inches. Precipitation in July and August, the two driest months, is 5-10% of the annual mean. High intensity, short duration thunderstorms frequently develop over the mountains in the summer, resulting in heavy downpours of short duration. Occasionally these heavy rains produce flash floods. Records from 1949 to1992 from climatological stations in the surrounding area do not show any definitive increasing or decreasing trend in annual precipitation (Kirk et al. 1995).

Average daily summer temperatures in the mid-elevations range between 60 and 70°F, decreasing to the 50s at higher elevations. High temperatures in the 90s frequently occur in the lower valley during July and August. In winter, storm systems moving east from the Pacific, as well as outbreaks of cold air from the north produce frequent weather changes. During an average winter, temperatures range from the teens to the 40s depending on elevation. The frost-free season is generally mid-May through early October; however, frost in the lower valley has occurred as late as the first week in June. The first frost of the fall is likely to occur about October 1. The average growing season in the agricultural area of the subbasin averages 150

days; the upper valley experiences a shorter growing season due to increased elevation and later departure/earlier onset of frost (CCCD 2004).

3.2.3 Land Ownership and Land Use

Ownership patterns in the Entiat subbasin result from public domain, railroad land grants, homestead and timber entries, and subsequent land sales and exchanges. The majority of privately owned land is located within one mile of the mainstem Entiat River in a band that extends 26 miles upriver. The settlement pattern along the valley bottom is a result of accessibility and the land's agricultural suitability. There are some privately held sections intermingled with national forest lands outside of the valley bottom area in the eastern portion of the watershed. This checkerboard ownership pattern is a result of railroad land grants.

Ownership within the subbasin is predominantly public, with slightly less than nine percent of the land in private ownership. The US Forest Service (USFS) manages approximately 83% of lands within the subbasin. Other notable federal land owners include the Bureau of Land Management (BLM) and the US Fish and Wildlife Service (USFWS). Almost all state lands are managed by either the Washington Department of Fish and Wildlife (WDFW) or the Washington Department of Natural Resources (WDNR). Table 4 provides an overview and depiction of primary land ownership in the Entiat subbasin (CCCD 2004).

Table 4. Land ownership in the Entiat subbasin by acreage and percentage

Owner	Approximate Acreage*	Percentage of Subbasin
Federal	258,477	84.6%
BLM	4424	
USFWS	798	
USFS	253,255	
State	17,467	5.7%
WDFW	7525	
WDNR	9930	
Other	12	
County/City/Local	361	0.1%
Chelan County	2	
City of Entiat	68	
City of Seattle	261	
Districts (Fire, Cemetery, Irrigation, School)	30	
Private	26,720	8.8%
NCW Museum	36	
Chelan-Douglas Land Trust	415	
Longview Fiber Company	9878	
Chelan County PUD	543	
Boat Club	32	
Other	15,816	
Columbia River	2436	0.8%
TOTAL	**305,641**	**100%**

* GIS analysis of USFS ownership, Chelan County parcel, and WDOE WRIA information

Historic Land Use

This overview is based on information taken from the Entiat Draft Watershed Plan (2004).

The Entiat valley has been shaped in large part by a long history of natural disturbance events such as wildfire, flooding, earthquakes, landslides, glaciation, and volcanic eruptions. Wildfire and flooding are very common events in the subbasin, as evidenced by the past 50 years; wildfires in 1970, 1976, 1988, and in 1994 affected over 60% of the subbasin. The most significant flood recorded occurred in 1948. Other significant floods occurred in 1972, twice in 1977, and in 1989 following wildfire events.

Native Americans used the Entiat valley for hunting and gathering prior to its use by trappers and settlers of European origin. Bitterroot was gathered on the lower valley hillsides, and is still relatively common in some locations today. Native Americans also harvested game from the forests and grasslands, and fish and other water dependent species from the river and its tributaries. The Yakama Nation, under the 1855 Treaty with the Yakama, maintains rights for hunting and gathering in the subbasin.

Trapping in the 1880s was the first non-Native American activity to occur in the Entiat subbasin. Trapping continued through the 1980s and into the 1990s as a source of revenue for some current residents' ancestors.

Sheep grazing also began about 1880, and was one of the most extensive earlier uses of the valley. Various sources indicate that more than 13,000 (13,000 to 16,000) sheep grazed the valley in the late 1800s and early 1900s. The Plummer report indicated that in 1902 there were upwards of 60,000 sheep along the head of Mad River (USDI Geologic Survey 1902). In the 1940s sheep grazing on federal lands in the Entiat was cut back from two to three bands (1,000 sheep/band) to one band annually, the number allowed to graze for 1-2 months annually or semi-annually today.

Cattle and horses also used the valley, although not as heavily or extensively as sheep. In the early 1900s, wild horses were rounded up and brought to the railroad stockyard at Entiat. Hogs and dairy cows were grazed in a few locations. The number of cattle now grazing on federal lands is less than 200 head, with approximately another 100 head using private lands for part of the year.

Between 1885 and 1910 gold and other minerals were prospected for and mined in the valley. Most of this activity was concentrated around Crum Canyon. Pumice was taken out of open pit mines between Stormy Creek and Cottonwood in the late 1940s, and commercial pumice was mined in Stormy Creek up until 1956.

Logging within the valley has had a rich and varied history. In 1892 the first log mill was established near the mouth of the Entiat River. Logging began to increase early in the twentieth century in response to home construction and the apple box industry. Other mills were built near the mouth of the river and in some of the lower river tributaries, including Mills Canyon, Crum Canyon, and Muddy Creek (Mud Creek). Small portable mills were also located within the valley.

Most of the road network that exists within the subbasin today was constructed by 1980 for access to timber sales. Timber harvest reached its peak in the valley just after the 1970 Entiat

Fires; between 1972 and 1977 almost 50 million board feet of fire salvage timber was sold from national forest lands.

The Entiat River had a varied history of impoundment between the late 1880s and the first half of the 1900s. A holding dam associated with the Harris-Cannon sawmill was constructed near the mouth of the river in 1898. In 1904 Gray built an electric power plant at the site of the dam; the plant experienced winter closure due to low water levels from 1905-1906. A log-holding dam was also built in 1904, in association with a sawmill constructed in Mills Canyon. In 1909, C.A. Harris constructed a dam and power plant about 1.5 miles up the river, near the present day Keystone Bridge. In some years only a little water remained in the channel below the Harris dam. In 1932 the Harris mill moved from Mud Creek to the mouth of the Mad River at Ardenvoir (RM 10.5) and some remnants of the 13.5 foot high log storage dam constructed to serve the mill are still evident just upstream of Cooper's store. U.S. Bureau of Fisheries surveys in 1934, 1935 and 1936 noted that three dams still remained on the Entiat River (Bryant and Parkhurst 1950). Of the three, the last to remain was the Ardenvoir Mill dam, which was washed out in the 1948 flood and never rebuilt.

Fruit production has always been very important to the local economy. The first orchard irrigation ditch, built in 1887, was the Hanan-Detwiler ditch. In 1888 a small peach orchard was planted near the mouth of the river; a ditch used prior to that time for placer mining, was the irrigation source. By 1889-90 almost every homesteader had some fruit trees for subsistence, and the growing conditions in the lower valley were favorable. The Entiat Improvement Co. Ranch constructed a ditch in 1894 that ran from four miles upriver downstream to the mouth and Ribbon Cliff. The Knapp-Wham ditch was filed for in 1903 and was furnishing water to three and one-half miles of land on the south side of the Entiat River between Roaring Creek and Keystone Canyon by 1905. Several other ditches exist today for both orchard and/or hay and pasture irrigation.

Valley residents and others have enjoyed hunting and fishing in the Entiat valley for many years. Hunting mule deer and fishing for local trout were important recreational and subsistence activities for local residents. They feel that deer numbers may be higher now than in the past, and remember a significant winterkill in 1943. Senior lifelong residents recall that when they were younger it was relatively easy to catch a 20 fish limit, and that there were at least two bull trout in the limit. They feel that this fishery has declined significantly since in the 1940's. Residents do not recall significant salmon runs but have heard stories from earlier residents of significant steelhead spawning activity in the Mad River. Early Bureau of Fisheries surveys of the Entiat River from the 1930s showed that it was virtually devoid of salmon (Bryant and Parkhurst 1950).

Current Land Use

Current land uses within the Entiat WRIA include agriculture, primarily pear and apple orchards; livestock production and grazing; timber harvest; residential housing; and recreation.

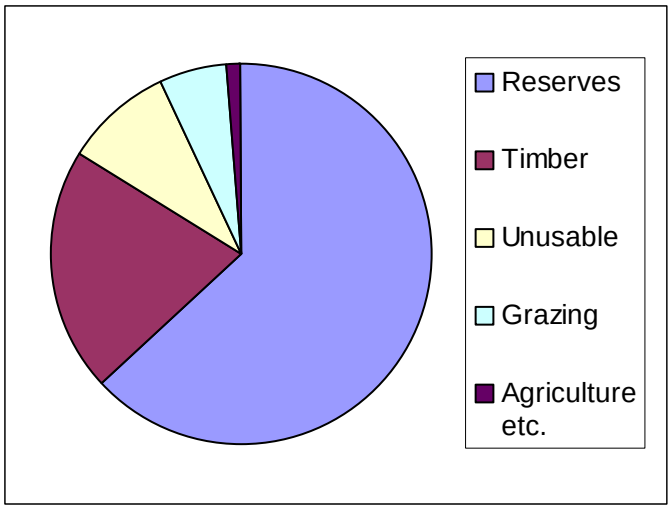


Figure 3. Aproximate land use percentages in the Entiat subbasin

Figure 3 approximates the percentage of various land use areas within the Entiat subbasin. Wilderness, old growth reserves, wildlife and riparian reserves comprise 63% of the USFS reserves land designation, which includes some areas in the lower valley that currently do not fall within the other land use categories. Reserve areas are primarily used by wildlife, but are not specifically designated for wildlife use. The unusable category is land intermingled with designated timber and/or grazing lands that is unsuitable for these uses due to topography or productivity, or is inaccessible for other reasons such as rock or cliff formations. Irrigated agriculture land area comprises 0.4% of the watershed, and with developed recreation areas (including trails) and residential areas, makes up approximately 1% of the total land area. For a more comprehensive discussion of the existing land uses, refer to the Entiat WRIA 46 Management Plan (2004).

3.2.4 Hydrology

Climate and topography create a wide range in annual precipitation. The capture, storage and release of precipitation control many of the Entiat subbasin's physical and biological processes. A large portion of the annual precipitation falls as snow and accumulates to form the winter snowpack. Warm spring temperatures and rain release water accumulated in snowpack as runoff. Thus, snowmelt is the dominant source of streamflow and groundwater in the subbasin. Occasional, large frontal and convective storms in the spring, summer and fall may increase flow or cause flooding.

Annual water yield from the Entiat subbasin varies considerably from year to year. Steep topography, relatively short drainage length, pinnate drainage structure, and other factors promote a rapid mainstem flow response time to runoff and a wide range between peak flows and low flows in the lower Entiat River. Mean volume produced from 1951-1958 by the Entiat subbasin (419 sq. mile drainage area), as recorded at the mouth by the Entiat at Entiat gage, was 367,379 acre-feet. Mean annual volume recorded at the same site for the period 1970-1976 was 528,275 acre-feet, indicating a 44% increase in yield during the period following the 1970 fires (USDA 1979). Mean annual runoff recorded upstream at the Entiat near Ardenvoir gage (203 sq.

mile drainage area) for the period 1957-1999 was 283,527 acre-feet, with an annual high of 451,140 acre-feet in 1972 and a low of 178,970 acre-feet in 1973.

Mean monthly runoff data for the Entiat subbasin are indicative of a snowmelt dominated system, and the alluvial and glacially derived sediments in the valley bottoms are the primary storage for groundwater in the Entiat subbasin. A pattern of high elevation snowmelt, aquifer recharge, and the gradual release of groundwater defines stream flows in the Entiat subbasin. Snowmelt influences on peak flows in lower elevation tributaries (e.g., Mud Creek) can begin as early as February; however, the vast majority of the annual runoff typically occurs during the period between early May and mid-July when mid to upper elevation snowmelt reaches its peak. Groundwater movement into the Entiat River and its tributaries from late summer through the winter helps sustain stream flows for the remainder of the year. This exchange of water between sub-surface and surface flows is a function of the height of the water table in relation to the channel.

High flows in the Entiat subbasin commonly result from either rapid spring snowmelt; large storms (1948 and 1972), including warm rain-on-snow events; or high intensity convective storms. Post-fire flooding triggered by one of these mechanisms is a frequent disturbance process. Since 1970, flooding has followed most major fires in the subbasin. The 1972 flood was a drainage-wide event resulting from a large frontal storm combined with the late melt of a record snow pack. The Preston Creek debris torrent that occurred during this event originated from lands burned in 1970. The Crum/Ringsted/Byrd Canyon floods of 1977, the Dinkelman/Mills/Roaring flood of 1989, and the Potato Creek and Oklahoma Gulch floods of 1997 were all post-fire responses triggered by short duration, high intensity convective storms (CCCD 2004).

Water Quality

In the Entiat subbasin, all surface waters within the Entiat NF, including the Entiat River from its headwaters to the Entiat NF boundary (river mile 20.5), are classified as Class AA (extraordinary) waters. The remaining portion of the Entiat River and all tributaries feeding into it, from the Entiat NF boundary to the confluence with the Columbia River, are classified as class A (excellent) water (Andonaequi 1999).

Typically, late summer water temperatures are not a serious problem in the lower Entiat River. However, temperature and pH have exceeded state standards and the lower Entiat has been on Washington State's 303(d) list since 1992. Maximum temperatures are typically less than 15^{o} C., which is tolerable for rearing juveniles. The 1974-1986 stream temperature record for Entiat National Fish Hatchery (NFH) has a mean July-September water temperature of 13.6^{o} C. Temperature standards are periodically exceeded in the lower Mad River. At times, the pH readings at some sites reached 8.5, which exceed the WDOE standard, but the causes are not known and are assumed to be partly of natural conditions. Existing data indicate that summer water temperatures in the lower Entiat (downstream from Burns Creek) and lower Mad rivers often exceed 16^{o} C (CCPUD 1998). A study conducted by the USFS (1999) concludes that the natural geology and hydrology of the Mad River resulted in exceedences of State water quality standards without a factor of human influence. Winter anchor ice is noted in the Entiat below Ardenvoir and in the Mad River (CCPUD 1998).

Sediment levels, especially fine sediments, are affecting aquatic habitat and irrigation. These sediments are derived from both natural and human-caused (accelerated) sources (CCPUD 1998). The natural range of variability of fine sediment loading in the Entiat River subbasin is unknown; but data from sediment core sampling indicates that it may be very broad. The level of fine sediment loading is above or at the upper limit of the natural range of variability in the lower Entiat, lower Mad, Stormy-Potato, Roaring-Tamarach, lower mid-Entiat, Mud Creek, Brennegan-Preston, and Mills-Dinkleman fish productions units (Andonaegui 1999).

In some locations, failing or sub-standard septic systems and/or surface runoff from home sites may be carrying a variety of nonpoint source pollutants (e.g., pathogens, sediment, nutrients, etc.) that threaten water quality. Orchard management involves use of a number of agricultural chemicals (sprays and fertilizers) that pose a potential risk to water quality (CCPUD 1998).

Impoundments and Irrigation Projects

There are no reservoirs in the Entiat watershed although the lowest 0.5 miles of the Entiat River and floodplain is influenced by the backwatering effects of Lake Entiat, which serves as the pool for the Rocky Reach Dam Hydroelectric Facility on the Columbia River. No artificial ponds have been identified (Andonaegui 1999).

The Entiat River Subbasin Salmon and Steelhead Production Plan identified water withdrawals, both agricultural and domestic, as an issue of concern relative to their potential to exacerbate normal low flows of late summer in the Entiat River. At that time, at issue was a need to set minimum instream flows at levels that would protect not only existing fish production, but also potential fish production, where appropriate. In 1997 the WDFW Yakima Screen Shop completed their most recent ground survey inventory of irrigation structures in the Entiat valley and identified two of the six ditch diversions and eight of the 45 pump diversions that were inadequately screened. Further, two private culverts on Stormy Creek have been identified as fish passage barriers that need to be replaced (Andonaegui 1999).

3.2.5 Terrestrial/Wildlife

There are an estimated 336 wildlife species that occur in the subbasin. Of these species, 102 (30%) are closely associated with riparian and wetland habitat and 77 consume salmonids during some portion of their life cycle. Seventeen wildlife species are non-native. Five wildlife species that occur in the subbasin are listed federally and 42 species are listed in Washington and Idaho as threatened, endangered, or candidate species. A total of 98 bird species are listed as Washington or Idaho State Partners in Flight priority and focal species. A total of 57 wildlife species are managed as game species in Washington.

Ninety-two percent of the wildlife species that occur in the Province occur in the Subbasin. In addition, 65% of the amphibian species and 84 percent of the reptile species that occur in the Province occur in the subbasin.

Table 5. Species richness and associations for the Entiat subbasin

Class	Entiat	% of Total	Total (Province)
Amphibians	11	65	**17**
Birds	218	93	**234**
Mammals	91	94	**97**
Reptiles	16	84	**19**
Total	**336**	**92**	**367**

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Table 6. Threatened and endangered species in the Entiat subbasin

	Common Name	Scientific Name	State Status		Federal Status
Amphibians					
	Dunn's Salamander	*Plethodon dunni*	WA	Candidate Species	
	Western Toad	*Bufo boreas*	WA	Candidate Species	
	Columbia Spotted Frog	*Rana luteiventris*	WA	Candidate Species	
	Northern Leopard Frog	*Rana pipiens*	WA	Endangered	
		Total Listed Amphibians: 4			
Birds					
	Common Loon	*Gavia immer*	WA	Sensitive	
	Western Grebe	*Aechmophorus occidentalis*	WA	Candidate Species	
	Northern Goshawk	*Accipiter gentilis*	WA	Candidate Species	
	Ferruginous Hawk	*Buteo regalis*	WA	Threatened	
	Golden Eagle	*Aquila chrysaetos*	WA	Candidate Species	
	Sage Grouse	*Centrocercus urophasianus*	WA	Threatened	Anticipated Candidate
	Sharp-tailed Grouse	*Tympanuchus phasianellus*	WA	Threatened	
	Marbled Murrelet	*Brachyramphus marmoratus*	WA	Threatened	Threatened
	Flammulated Owl	*Otus flammeolus*	WA	Candidate Species	
	Burrowing Owl	*Athene cunicularia*	WA	Candidate Species	
	Spotted Owl	*Strix occidentalis*	WA	Endangered	Threatened
	Vaux's Swift	*Chaetura vauxi*	WA	Candidate Species	
	Lewis's Woodpecker	*Melanerpes lewis*	WA	Candidate Species	
	White-headed	*Picoides albolarvatus*	WA	Candidate Species	

	Common Name	Scientific Name	State Status		Federal Status
	Woodpecker				
	Black-backed Woodpecker	*Picoides arcticus*	WA	Candidate Species	
	Pileated Woodpecker	*Dryocopus pileatus*	WA	Candidate Species	
	Loggerhead Shrike	*Lanius ludovicianus*	WA	Candidate Species	
	White-breasted Nuthatch	*Sitta carolinensis*	WA	Candidate Species	
	Sage Thrasher	*Oreoscoptes montanus*	WA	Candidate Species	
	Vesper Sparrow	*Pooecetes gramineus*	WA	Candidate Species	
	Sage Sparrow	*Amphispiza belli*	WA	Candidate Species	
		Total Listed Birds: 22			
Mammals					
	Merriam's Shrew	*Sorex merriami*	WA	Candidate Species	
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	WA	Candidate Species	
	White-tailed Jackrabbit	*Lepus townsendii*	WA	Candidate Species	
	Black-tailed Jackrabbit	*Lepus californicus*	WA	Candidate Species	
	Western Gray Squirrel	*Sciurus griseus*	WA	Threatened	
	Northern Pocket Gopher	*Thomomys talpoides*	WA	Candidate Species	
	Gray Wolf	*Canis lupus*	WA	Endangered	Endangered
	Grizzly Bear	*Ursus arctos*	WA	Endangered	Threatened
	Fisher	*Martes pennanti*	WA	Endangered	
	Wolverine	*Gulo gulo*	WA	Candidate Species	
	Lynx	*Lynx canadensis*	WA	Threatened	Threatened
		Total Listed Mammals14			
Reptiles					
	Sharptail Snake	*Contia tenuis*	WA	Candidate Species	
	Striped Whipsnake	*Masticophis taeniatus*	WA	Candidate Species	
		Total Listed Reptiles: 2			
		Total Listed Species: 42			

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Vegetative Groups

Vegetation in the Entiat subbasin (Figure 2) has been described over the years using a variety of methods. For example, one characterization emphasized vegetation important to grazing animals

and identification of suitable range areas for range management analyses, while another characterization emphasized timber management interests by identifying stands with high commercial value.

The USFS identified vegetative groups on federal lands in the subbasin that had similar disturbance regimes. An approach comparable to that taken by Agee (1994) was used to delineate vegetation groups based on structure, general characteristics of the vegetation, tree species presence and tree canopy density. Designations also reflected a similarity in fire frequency and, to some extent, fire intensities and soil characteristics. The vegetative groups identified in the Watershed Assessment Entiat Analysis Area (USFS WNF 1996) are summarized below and in Table 7.

Table 7. Wildlife habitat types within the Entiat subbasin

Habitat Type	Brief Description
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snowpack; several species of conifer; understory typically shrub-dominated.
Eastside (Interior) Mixed Conifer Forest	Coniferous forests and woodlands; Douglas-fir commonly present, up to 8 other conifer species present; understory shrub and grass/forb layers typical; mid-montane.
Lodgepole Pine Forest and Woodlands	Lodgepole pine dominated woodlands and forests; understory various; mid- to high elevations.
Ponderosa Pine and Interior White Oak Forest and Woodland	Ponderosa pine dominated woodland or savannah, often with Douglas-fir; shrub, forb, or grass understory; lower elevation forest above steppe, shrubsteppe.
Subalpine Parkland	Coniferous forest of subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*) and lodgepole pine (*Pinus contorta*).
Alpine Grasslands and Shrublands	This habitat is dominated by grassland, dwarf-shrubland (mostly evergreen microphyllous), or forbs.
Eastside (Interior) Grasslands	Dominated by short to medium height native bunchgrass with forbs, cryptogam crust.
Shrubsteppe	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogam crust.
Agriculture, Pasture, and Mixed Environs	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban and Mixed Environs	High, medium, and low (10-29 percent impervious ground) density development.
Open Water – Lakes, Rivers, and Streams	Lakes, are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin Eastside Riparian Wetlands and Herbaceous Wetlands
Montane Coniferous Wetlands	Forest or woodland dominated by evergreen conifers; deciduous trees may be co-dominant; understory dominated by shrubs, forbs, or graminoids; mid- to upper montane.
Eastside (Interior) Riparian Wetlands	Shrublands, woodlands and forest, less commonly grasslands; often multi-layered canopy with shrubs, graminoids, forbs below.

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Shrubsteppe

This dry plant community is dominated by shrubs, grasses, or both. Tree canopy cover is less than 10 percent and tree species are ponderosa pine or sometimes Douglas-fir. Common and dominant shrubs are bitterbrush and sagebrush. Common grasses are bluebunch wheatgrass,

junegrass, Sandberg's bluegrass, and bottlebrush squirreltail. In the Entiat, this group is found below the forest margin or on drier sites within forested areas at elevations of less than 4,500 feet.

Open Forest

This group is found mostly at lower elevations on relatively dry sites, commonly with grass or shrub understories similar to the Shrubsteppe Group. Typical tree canopy cover is 10-50% with grass/shrub cover of 10-90%. Ponderosa pine and Douglas-fir are the dominant tree species, with grand fir on some sites. These stands are essentially a transition between the shrubsteppe below and the closed forest above at elevations of less than 4,500 feet.

Closed Forest

Closed forest communities exhibit tree canopy covers of over 50%, with various understory species. This group is typically found at elevations between 1,500 and 4,000 feet; it may occur on north slopes at lower elevations and southerly aspects in the subalpine zone. Climax tree species are either Douglas-fir or grand fir; however, ponderosa pine and to a lesser extent lodgepole pine may temporally dominate some areas as a result of fire occurrence and frequency. This group combines fairly dry stands with relatively low site productivity and moist closed forest with fairly high site productivity.

Closed Subalpine

This group is typified by more than 50% tree canopy cover and various understory species. Communities are found between 4,500-6,000 feet, although this group can be found at lower elevations in cold air drainage areas and on north slopes. The predominant climax tree species in this group in the Entiat is subalpine fir. Lodgepole pine is the typical seral tree stand dominant.

Open Subalpine/Alpine

Open forest/park land interspersed with subalpine and alpine meadows typifies this group. Stands are generally open (canopy <50 percent) except in small clumps. Understory composition is commonly low shrubs, forbs, and graminoids. Conditions are often cold and snowy at the typical elevation range of this group (4,500-7,500 feet, with most over 6,000 feet). Common trees are subalpine fir, Englemann spruce, whitebark pine, and subalpine larch. Mountain hemlock may be present, but has limited distribution in the Entiat.

Table 8. Summary of vegetative groups found within the USFS Entiat Ranger District

Vegetation Type	Acres	Percent
Shrubsteppe	36,777	13.7
Open Forest	48,925	18.3
Closed Forest	109,936	41.0
Subalpine Forest	20,966	7.8
Open Subalpine	49,941	18.7
Non-vegetation (rock and/or water)	1,190	0.5
Total	267,735	100

Noxious Weeds

Several species of noxious weeds are found on both public and private lands within the Entiat subbasin. The most common noxious weeds include Dalmatian Toadflax, Canada thistle and Knapweeds, which are abundant in several locations throughout the subbasin. Knapweeds are especially prevalent along roads and other disturbed areas such as construction sites, gravel pits, utility and transportation corridors, as well as previously cultivated and/or semi-abandoned croplands and pastures. Some livestock pastures are heavily infested.

Proposed, Threatened, Endangered and Sensitive Plants

State and federal agencies maintain lists of proposed, threatened, endangered and sensitive plant species that occur or may occur within the Entiat subbasin. It is estimated that less than 50% of the subbasin has been surveyed, thus it is likely the lists are incomplete.

Wetlands

The USFWS National Wetlands Inventory (NWI) is the best existing information on wetlands in the Entiat subbasin. Table 9 provides a summary of the primary wetland systems and subsystems found within the subbasin. NWI data do not include all forested or seasonal wetlands, due to the mapping method used (high altitude aerial photography analysis). Wetlands are also dynamic, with plant communities and boundaries changing over time due to natural and human disturbances; thus, the accuracy of NWI data is limited.

An accurate assessment of historic and current wetlands distribution within the subbasin is difficult due a lack field data. The NRCS has collected some on the ground data during wetlands surveys, and the WDOE's Shorelands Environmental Assistance program staff also collects wetlands data within the subbasin. Information from the NRCS and WDOE will eventually be used to update the digital NWI wetland maps and data layers. A comprehensive, detailed inventory of wetland resources in the Entiat subbasin would provide information about the location of various wetland habitats and help identify potential restoration/enhancement areas.

Table 9. Primary wetland systems and subsystems found within Entiat subbasin

Definition	Approximate Acreage[+]
Lacustrine, limnetic, open water	2412
Lacustrine, littoral, unconsolidated bottom	23
Lacustrine, littoral, unconsolidated shore	6
Palustrine, emergent	514
Palustrine, forested	334
Palustrine, open water	71
Palustrine, shrub-scrub	546
Palustrine, unconsolidated shore	4
Riverine, upper perennial, open water	414
Riverine, upper perennial, unconsolidated shore	93
Upland	301,223
Total	305,640

CCCD 2004; USFWS NWI GIS data

3.2.6 Aquatic/Fish Resources

Many species of anadromous and non-anadromous fish utilize the aquatic habitat of the Entiat and Mad River watersheds. Some fish found in the subbasin are currently listed under the Endangered Species Act. Table 10 provides a summary of fish known and likely to occur in the subbasin, along with federally listed fish designations and candidate species which may be proposed for listing by the USFWS and/or NOAA Fisheries. The Washington Department of Fish and Wildlife maintains a state "Species of Concern" (SOC) list, which includes all *state* designated endangered, threatened, sensitive, and candidate species; state SOC list designations assigned to federally listed species are also provided.

Table 10.Summary of known and expected fish in the Entiat subbasin, and federal and state status

Species	Scientific Name	Federal ESA Listing and Date	State SOC Listing
Upper Columbia River late-run (summer) Chinook salmon	(Oncorhynchus tshawytscha)	---	---
Upper Columbia River spring Chinook salmon	(O. tshawytscha)	Endangered March 24, 1999	Candidate
Upper Columbia River summer steelhead	(O. mykiss)	Endangered August 18, 1997	Candidate
Sockeye salmon	(O. nerka)	---	---
Coho salmon	(O. kisutch)	---	---
Columbia River bull trout	(Salvelinus confluentus)	Threatened June 10, 1998	Candidate
Westslope cutthroat trout	(O. clarki lewisi)	Species of Concern	---
Redband trout[+]	(O. mykiss gardiner)	---	---
Brook trout	(S. fontinalis)	---	---
Mountain whitefish	(Prosopium williamsoni)	---	---
Longnose dace[+]	(Rhinichthys cataractae)	---	---
Mottled sculpin[+]	(Cottus bairdi)	---	---
Torrent sculpin	(C. rhotheus)	---	---
Largescale sucker	(Catostomus macrochelius)	---	---
Bridgelip sucker	(C. columbianus)	---	---
Pacific lamprey	(Entosphenus tridentatus)	Species of Concern	---
Northern pikeminnow	(Ptychocheilus oregonensis)	---	---
Redside shiner	(Richardsonius balteatus)	---	---

Note: Indicates expected presence based on information contained in the USFWS Entiat NFH Hatchery Genetic Management Plan and Mullan et al. 1992

In September 1994, NOAA Fisheries initiated a status review of late-run Chinook, sockeye, and Coho salmon to determine if listing was warranted. Although it was determined at that time that listing was not warranted, these three species should also be considered Candidate ESA species.

Anadromous Fish

Several populations of economically and culturally important anadromous fish species reside within the Entiat subbasin. The Entiat and Mad Rivers currently support runs of steelhead and bull trout, and spring and late-run Chinook salmon. Coho salmon were once present in the Entiat watershed (Mullan et al. 1992), but are now considered extinct (Nehlsen et al. 1991), however limited numbers of coho salmon reintroduced to the Wenatchee and Methow sub-basins, seem to be spawning in the Entiat River. The coho reintroduction efforts in the Wenatchee and Methow basin will likey expand to include the Entiat River in 2005. Coho reintroduction to the Enitat River is identified as a priority in the Wy-Kan-Ush-Mi-Wa-Kish-Wit document (Tribal Restoration Plan). Reintroduction methods would likely be similar to efforts in the Wenatchee and Methow sub-basins (Yakama Nation et. al. 2002). Sockeye salmon were also introduced into the Entiat River at one point. Notably, both Coho and Sockeye have recently been found utilizing the Entiat River (Hamstreet and Carie 2002, 2003). Upper Columbia River (UCR) spring Chinook salmon and summer steelhead trout are listed as endangered and Columbia River bull trout are listed as threatened under the Federal Endangered Species Act (ESA).

Dams constructed near the mouth of the Entiat River beginning in 1889 blocked salmon from returning to the Entiat to spawn. Barriers erected on Entiat River persisted through the mid-1930s, and probably contributed to the Coho's extinction (Craig and Suomela 1941). A Bureau of Fisheries survey of the Entiat in 1934, 1935 and 1936 showed the river was virtually devoid of salmon (Bryant and Parkhurst 1950) and salmon runs in general were essentially nonexistent by the time Grand Coulee Dam was built in 1939 (Craig and Suomela 1941).

As part of the Grand Coulee Fish Maintenance Project (GCFMP), all returning adult salmon were trapped at Rock Island Dam from 1939 to 1943. A total of 3,015 adult late-run Chinook were collected from commingled upper river stocks and placed in upper Entiat River spawning areas; only an estimated 1,308 of these survived to spawn (Fish and Hanavan 1948). Shorty Long recalls that fish were planted in two locations above the terminal moraine, at Burns Creek and Decker's near Gray Canyon. A weir was constructed at the terminal moraine to keep the adult salmon from migrating downstream to the Columbia River before spawning. Fish were also planted into Nason Creek and the Methow River, or spawned in hatcheries, including the Leavenworth, Winthrop and Entiat National Fish Hatcheries (NFH) (Fish and Hanavan 1948).

3.3 Scientific Conceptual Foundation

3.3.1 Definition and Overview of a Scientific Conceptual Foundation

A conceptual foundation is a set of scientific theories, principles and assumptions, which in aggregate describe how a system functions. The conceptual foundation determines how information is interpreted, what problems are identified and, as a consequence, it also determines the range of appropriate solutions (ISG 1996) to achieve desired management goals. It is through the conceptual foundation that management goals are translated into the conditions within the system that are needed to achieve those goals; and management strategies which could achieve the appropriate or desired conditions (NPPC 1997). The importance of the conceptual foundation is emphasized in the above citations, and most thoroughly discussed in "A Conceptual Foundation for the Management of Native Salmonids in the Deschutes River" (Lichatowich 1998). The latter forms the basis for much of the conceptual foundation of this Entiat Subbasin Plan.

3.3.2 Purpose and Scope

The conceptual foundation plays a powerful, albeit often unrecognized, role in natural resource management and restoration programs. It forms the premise and framework from which management goals and actions are based. Management goals should be achievable within the logical framework of the conceptual foundation and conditions within the ecosystem should relate to each other in ways which are specified in the logical framework. Managers need to recognize and clearly describe the implications of strategies derived from our conceptual foundation.

Laws and policies typically form the basis for many management plans. Often, these are based on a set of theories, premises or simply ideas which in whole define a conceptual foundation. Although these theories or premises guide the development and implementation of a program, rarely are they explicitly stated. As long as the conceptual foundation remains unstated it cannot be reviewed, evaluated and debated in open forums. False assumptions, outdated science, unsupported principles and unintended consequences in the conceptual foundation cannot be identified and corrected unless they are explicitly stated and publicly discussed.

A conceptual foundation must address ecosystems at various scales. Clear definitions of ecosystems are always problematic because ecosystem function occurs at various temporal and spatial scales simultaneously. For example, organisms are a product of their native environment, but just as importantly, many environments are products of certain species and populations. Species like anadromous salmonids use many ecosystems and are very sensitive to environmental changes. Changes in one ecosystem, such as the ocean can change salmonid abundance in the freshwater environments, which in turn can alter environmental conditions for other organisms.

The focus and organization of the assessment, inventory, and management strategies of a subbasin plan should directly reflect the conceptual foundation. The foundation should also consider the increasingly broader geographic scales within which other fish and wildlife management plans or actions operate. For example, in the Columbia Basin, this means that the way the conceptual foundation views events at the smallest scale—the individual fish and its surrounding habitat—should be consistent with and mirror how the fish communities and habitat

characteristics are viewed at the river reach scale, subbasin tributary, entire subbasin, multiple subbasins or regional scale (e.g., Evolutionary Significant Unit (ESU) scale), and aggregate Columbia basin anadromous fish stocks in the estuary and ocean environments. Ensuring conceptual consistency across multiple geographic scales in the management and recovery of fish, wildlife, and their habitats is a daunting challenge which has yet to be fully realized—primarily because the conceptual foundation at each geographic level is not explicitly stated and there has not been adequate communication and coordination regarding scientific principles and assumptions between the ever increasing numbers of management entities and governmental boundaries (i.e., local, state, and national) as geographic scale increases.

The conceptual foundation is defined at the largest geographic scale applicable to a planning effort. In this case, the Columbia Basin will usually be the largest geographic scale, although other out of basin scales may be appropriate for some migratory birds and the saltwater life stage of anadromous fish. As the plan focuses with increasing detail on management strategies for smaller geographic areas, subbasin planners should then continue to check for conceptual consistency. The only current examples of an explicitly stated conceptual foundation are the "alternative conceptual foundations" of *Return to the River* and the NPCC's An Integrated Framework for Fish and Wildlife Management in the Columbia Basin (NPPC 1997), which are reviewed and synthesized in Lichatowich (1998).

3.3.3 Guiding Principles

Four sets of guiding principles, in bold and shaded derived from Lichatowich's (1998) synthesis in the Columbia Basin Conceptual Foundation introduce principles and corollaries relevant to the Entiat subbasin. These four guiding principles have been modified to make them applicable to both fish and wildlife. Following them are principles pertaining to the Entiat Subbasin Conceptual Foundation.

The Columbia River is a natural-cultural system characterized by natural environmental variability and fluctuation in production. Salmon restoration and management must consider the whole ecosystem, natural as well as cultural, in the freshwater, estuary, and ocean. Suitable ecosystem attributes can be achieved by managing human interference in the natural habitat forming processes and by use of technology to support those processes. The use of technology to circumvent natural ecological processes should be avoided, if possible.

Principle 1. Strategies for recovery or maintenance of viable populations need to be evaluated within the context of the entire life history of the populations.

The Entiat Subbasin Plan can only identify, evaluate and prioritize alternative strategies for anadromous and migrating species recovery that can be fully implemented within the subbasin by authorized local, state, federal and tribal managers. The subbasin plan addresses strategies that can be implemented locally and that effect life stages that subbasin managers can influence or control through their decisions. However, planning and implementing actions for fish and wildlife within the Entiat subbasin must also consider out of basin affects, which will influence the success or failure of population recovery.

Ideally, populations should be tracked or accounted for throughout the geographical range of their life history to ensure that differential survival/mortality rates specific to that population can be evaluated in preparation of management or recovery strategies.

For species whose entire life history is confined to the Entiat Subbasin, it is possible to make informed and logical decisions regarding all strategies necessary for management. For fish and wildlife species that spend a portion of their life history outside of the subbasin boundaries, management goals, the desired ecosystem attributes, and restoration strategies should generally be universal and integrated across the subbasin, eco-region (ESU), Columbia Basin, and full life history including estuary and marine scales to be successful. Where differing parts of a population's life history or habitat are managed by different entities, those populations and their interactions with the environment, with other populations, and their responses to management actions should be monitored and communicated in a common language. The broader and more inclusive the management planning process becomes, the greater the potential that these common and integrated goals, attributes, strategies will be successful in recovering far-ranging migratory species.

Principle 2. The Entiat Subbasin contains an evolving, natural-cultural system that will continue to change into the future.

The Entiat subbasin's natural and cultural elements must be considered in any management planning. Unless a balance between the needs and constraints of the natural and cultural components of the ecosystem is achieved, the status of many of the native fish and wildlife populations in the basin will continue to decline. To move toward a balance, science and resource managers need to present the values and benefits of the natural elements and must show when their benefits outweigh the costs of protection and recovery. In addition, it must be made clear that healthy natural and cultural elements are not mutually exclusive.

Principle 3. Important environmental attributes that determine the distribution and productivity of fish and wildlife populations have been influenced by human activity in and outside the subbasin.

Cultural impacts have occurred at different rates and to varying degrees throughout the subbasin. For example the transportation system along the mainstem Entiat River, agricultural land use practices and channel modifications for flood control have directly altered floodplain, riparian, and in-channel characteristics to a large degree. These changes undoubtedly have affected habitat use and the relationship many of these species once had to these effected areas.

Many habitat attributes, now out of synch or timing with the life history strategies that fish and wildlife populations had evolved prior to those alterations, may be lethal to fish or wildlife for part of the year, or have directly resulted in habitat loss. These alterations have resulted in decreased abundance and productivity, and changes in the distribution of native fish and wildlife populations.

Fish and wildlife productivity requires a network of complex, interconnected habitats that are created, altered, and maintained by natural physical processes in terrestrial, freshwater, estuary, and ocean areas. Management and restoration goals depend on achieving suitable ecosystem attributes.

Principle 4. Viable native fish and wildlife populations are dependent upon the natural environment and the natural processes that sustain them.

Discovering which of the natural processes most influence various populations is fundamental to management direction. Usually the original conditions represent the best models we will ever

have. Subbasin planners and managers must avoid a common tendency to become excessively or exclusively species-centric in developing management strategies. Instead, focusing on restoring terrestrial and aquatic/riparian ecosystem health and function will provide habitat attributes that will enable holistic management or recovery for larger assemblages of native biota.

Principle 5. Changes to the physical characteristics and connectivity of the Entiat subbasin have contributed to the decline of native fish and wildlife populations.

Understanding the pre-development conditions, the current conditions, the trend in these conditions, and their effect on ecosystem attributes is crucial to formulation of recovery strategies. Throughout much of the Entiat subbasin, management and recovery of fish and wildlife productivity requires an emphasis on restoration of the natural range of hydrological attributes and fluvial processes, reconnection of isolated physical habitat, and protection or reintroduction of populations once reconnection has been achieved.

Principle 6. Changes to the physical characteristics of the alluvial valley and floodplains of the Entiat River have resulted in changes in ecosystem attributes.

Changes to the physical characteristics of the alluvial valley and floodplains of the Entiat River have resulted in changes in relatively large-scale ecosystem attributes. Some of these changes are reversible from a societal perspective; some are not. Floodplain management and restoration where possible is a key to successful recovery of physical and biological characteristics that support native fish and wildlife species.

Principle 7. The historical distribution of fish and wildlife populations and species in the Entiat Subbasin was controlled by relatively abrupt changes in physical attributes, i.e. steep environmental gradients.

In the Entiat subbasin, examples of environmental gradients existed at:

- Mouths of the lakes (thermal control or feeding stations for bull trout)
- Presence of lakes (refuge for cutthroat)
- Stream temperature (segregation of species)
- Stream gradients (slope) (provision to habitat types more conducive to certain species or life stages)
- Aspect, elevation or precipitation-based changes in vegetation zones (such as the forest/shrub steppe interface)

Changes to or elimination of the environmental gradients are expected to affect the presence and distribution of species or populations. Not all species respond in the same way to a similar gradient. Increasing the summer water temperature and lowering the winter temperature would have a powerful effect on aquatic species distribution and life history. Similarly, reducing the quality and quantity of "edge effects" from vegetative interfaces can significantly reduce habitat diversity required for many species to thrive.

Species diversity and the biotic community are a reflection of the ecosystem attributes. The co-evolved assemblage of species share requirements for similar ecosystem attributes and those attributes can be estimated by intensive study of focal or indicator species.

Principle 8. For aquatic and fish related interests, selection of a broad range of focal species provide a basis for developing holistic management strategies. For terrestrial and wildlife related interests, the selection of focal habitats and related focal species provide a basis for developing holistic management strategies.

Bull trout, cutthroat trout, spring chinook, late-run chinook, steelhead, and Pacific lamprey are the aquatic focal species for the Entiat subbasin. Through evaluating and planning for these species we assume that viable and sustainable ecosystem function and processes occurs in most geographic areas for important floodplain and riverine associated habitats.

In the case of terrestrial wildlife, focal habitat types can often be characterized by vegetation patterns. By maintaining adequate quality, quantity and connectivity of key vegetative communities we assume that viable and sustainable habitats are available and ecosystem function occurs over a wide range of the focal species. Ponderosa pine forests and woodlands, shrub-steppe and riparian habitats are the terrestrial focal habitats which cover most of the mid and low elevation areas within the subbasin.

Viability, a key concept in the context of conservation planning, refers to the ability of a species or a community/ecological system referred to in this document as focal habitats to persist over some specified time period. Species viability at the population level is affected by chance events that may dictate whether a species remains viable or goes extinct. Three general factors characterize community or ecological systems viability:

- demography of component species populations
- internal processes and structures among these component species
- landscape level processes that sustain the community or system

These factors are often referred to as size, condition, and landscape context.

Principle 9. The scientific concept of environmental stress is a legitimate means to evaluate the degree to which a threat to an environment by natural or human induced stressors may result in significant and undesired ecologic changes or the vulnerability of an environment to those stressors.

Environmental stressors such as an altered fire regime, rapid spread of invasive species or pathogens or altered habitat composition can affect environmental conditions at relatively small and large scales. Environmental stressors operate on habitat size and condition as well as landscape-scale attributes. The sources of these stresses are both natural and human-caused. Understanding the causes and likelihood of environmental stressors provides for long-term perspective of how future environmental conditions may relate to long-term management goals. The combination of stresses and sources provides a deeper analysis of potential viability impairment, thus forming a basis for management strategies.

Principle 10. Fish and wildlife are components of their own environment.

Inter and intra-specific competition are the drivers for species abundance, fitness and life history diversity within a given species assemblage. Restoration of individual populations may not be possible without restoration of other fish or wildlife populations with which they co-evolved. Beyond direct relationships between various populations, fish and wildlife alter key habitat

characteristics (e.g., nutrients, cleaned spawning beds, beaver ponds, forest understory, etc.) which can directly and indirectly affect other species/populations by changing important environmental characteristics.

Life history, genetic diversity, and metapopulation organization are ways that fish and wildlife adapt to their habitat. Diversity and population structure are how fish and wildlife species cope with spatial and temporal environmental variations. Such diversity promotes production and long-term persistence at the species level.

Principle 11. Most native fish and wildlife populations are linked across large areas which decrease the possibilities for extinctions or extirpations. An important component for recovery of depressed populations is to work within this framework and maintain or recreate large-scale spatial diversity.

Attempting to maintain or restore populations outside a framework of large-scale spatial diversity will be difficult or impossible. Management of Entiat subbasin fish and wildlife populations in the wild and in the hatchery environment should include strategies to maintain a close connection to the ecosystem attributes that influence and shape the population (i.e., environmental selective pressures), while also allowing for gene flow across populations. Any program to restore fish and wildlife to the Entiat subbasin must be capable of detecting and monitoring new, locally adapted life histories, if and when they occur in unique habitats.

Reintroduction or supplementation programs for fish or wildlife should concentrate on specific environments within the basin, selection of an appropriate stock for reintroduction to that environment or locally adapting a donor stock where a local stock no longer exists. When supplementing native populations, the facilities and programs should mimic the native environment as closely as possible. For example, in the hatchery environment, this includes maintenance of life history diversity such as spawn timing, matching hatchery incubation temperatures to the natural incubation environment, and simulating the natural rearing environment in the hatchery to the extent feasible.

Population management using supplementation must consider habitat quality and quantity to determine if existing habitat has the carrying capacity to support the number of fish or wildlife needed for genetic expression and to meet population goals.

Principle 12. Populations with the least amount of change from their historic spatial diversity are the easiest to protect and restore, and will have the best response to restoration actions.

The ability to predict population responses to changes in the environment is highest for those populations that are closest to their pre-settlement population structure. At some point along the scale from intact populations to former populations that have had entire metapopulation (groups of related populations that share genes at low rates over time) extirpated from the basin and adjacent basins, emphasis on recovery actions is better focused on rebuilding population structure than on habitat restoration. If the goal of cost- effective restoration is to be achieved, subbasin planners need to assess the optimal mix of habitat restoration and population structure restoration to achieve biological goals.

Populations that have multiple life histories (e.g., multiple locations or times where rearing takes place, multiple ages/times of year when out-migration occurs, multiple ages at sexual maturity,

multiple spawning areas) minimize risk to the population as a whole. These life history strategies are linked to population structure and genetics.

Principle 13. All else being equal, small populations are at greater risk of extinction than large populations, primarily because several processes that affect population dynamics operate differently in small populations than they do in large populations.

In some cases, small populations will need measures in addition to habitat protection and/or restoration if they are to survive into the future. Such measures may include specific forms of artificial production (broodstock collection programs for supplemented salmonid populations), artificial introduction from outside the population, or special consideration where habitat alterations or restoration modifies the only known sites where a particular life history is expressed.

3.3.4 Foundations for Current Understanding

The topography and drainage pattern of the Entiat River sub-basins were formed by volcanism, glaciation and uplift. Thus, much of the stream channel matrix consists of massive bedrock outcroppings, rock fall, and materials left over from glaciation too large to be moved by natural stream flows of today. Streambed materials consists mainly of sand, gravel and cobble from the glaciated upper valley, and angular stones and silty-clay from tributary basins and valley walls in the lower valley. In general, streams within the Entiat sub-basin are classified as non-erodible, and relatively high gradient and/or entrenched (Rosgen F, B and A channel types). A notable exception to the general classification is the Stillwater reach of the middle-Entiat River which passes through a terminal moraine. The moraine provides a large supply of sand, gravel and small cobble which can be transported by natural stream flows of today. The Entiat River within the Stillwater area is a low gradient, meandering stream with erodible banks (Rosgen C channel type) and currently supplies the primary spawning and rearing areas for anadromous salmonids.

During the past few hundred years, erosional processes associated with climate, wild fire and activities of Euro-Americans have had the primary influence on watershed and stream corridor conditions. Climate is the primary factor causing rock fall, highly variable streamflow and wild fire. Wild fire and floods cause episodic sediment and debris loading of the stream system. Development within the past 100 years have increased background erosion rates in portions of the watershed, and confined, simplified and straightened much of the lower river channel.

Floods following wild fire are common natural events in the Entiat sub-basin that deliver large volumes of sediment and debris to the stream system. Debris fans are common at the mouths of tributary streams. It appears that an adequate supply of material is being delivered to the stream system to support natural channel building processes within the lower ten to fifteen miles of the Entiat River. However, active processes are only observed in the lower mile.

Because of the watersheds climate, topography, and limited degree of development, natural physical processes are dominant at the watershed scale. Floods, wild fires and natural erosion remain the primary disturbance factors even though much of the lower Entiat valley is occupied by orchards and rural residential farms.

At a stream segment scale, the legacy of Euro-American resource extraction activity constrains the proper functioning of natural river processes and directly effects the biological characteristics of specific locations in the stream system. These activities include trapping of beaver, grazing,

road construction, logging, water impoundment, and river channel modification for flood control. Present day activities (water diversion, rural residential and agricultural development) effect flood plain and river terrace vegetation, but have little effect on stream channel characteristics.

The most pronounced influence of Euro-American activities occurs along the lower ten miles of the Entiat River and lower mile of the Mad River. The lower ten miles of the Entiat River was channelized and diked in response to 1948 flooding. The lower mile of the Mad River has been confined by a former lumber mill and work camp.

In both locations the stream channel is relatively straight, has a uniform slope and cross section, and is disconnected from its former flood plain. As a result, streambed shear stress is higher and more uniform over the streambed than would naturally occur. Little opportunity exists today for sand or gravel to be deposited within the activity channel, and the streambed is well armored. In a natural state, channel alignment would be more sinuous and depth of flow would be more variable. In some locations over bank flow during flood events would be common. The natural channel geometry would result in a non-uniform distribution of streambed shear force and local deposition of sand and gravel. Woody debris jams would also be expected.

The removal of large wood and debris jams from the Entiat River has affected gravel deposition and streambed topography between River mile 10 and 17. United States Bureau of Fisheries surveys during the 1930's report several debris jams pools in this reach. Today this reach is void of channel complexity being classified as a long, continuous run or riffle.

Today, the good land stewardship being practiced by many private land owners along the lower Entiat River and the large degree to which natural processes function throughout the watershed provide a solid foundation for undertaking stream restoration work in the lower ten to seventeen miles of the Entiat River. The spring and summer run chinook and steelhead would benefit from well focused stream channel enhancements and in some cases restoration.

The primary focus of this restoration work should be on increasing the complexity of streambed topography, developing depositional sites for spawning gravel, and reconnecting the river to its flood plain and over flow channels. Collectively these actions will provide more diversity in depth of flow and streambed shear. Existing natural river processes will work with the restored channel features to provide transient gravel deposits, a more defined thalweg, low velocity zones and off channel habitats. Both adult and juvenile life phases are expected to benefit from the envisioned stream restoration work.