

**FISHERY WHITE PAPER  
ENTIAT RIVER WATERSHED  
CHELAN COUNTY, WA**

**JUNE 26, 2007**

**FOR  
ENTIAT WATERSHED PLANNING UNIT**

**Fishery White Paper for the Entiat River  
Watershed  
File No. 15850-001-00**

**June 26, 2007**

**Prepared for:**

**Entiat Watershed Planning Unit (EWPU)  
Chelan County Conservation District  
301 Yakima Street, Room 307  
Wenatchee, WA 98801**

**Attention: Sarah Walker, EWPU Coordinator**

**Prepared by:**

**GeoEngineers, Inc.  
600 Dupont Street  
Bellingham, Washington 98225  
(360) 647-1510**

  
\_\_\_\_\_  
**John T. Monahan, Project Fisheries Scientist**

  
\_\_\_\_\_  
**Wayne S. Wright, Principal**

Copyright© 2007 by GeoEngineers, Inc. All rights reserved.

# TABLE OF CONTENTS

	<u>Page No.</u>
INTRODUCTION.....	1
BACKGROUND.....	1
GENERAL OVERVIEW OF FISH SPECIES.....	4
ANADROMOUS SPECIES .....	4
Salmonids.....	4
Non-Salmonids .....	11
RESIDENT SPECIES .....	12
Resident Salmonids.....	12
Other non-salmonid species present but not addressed.....	18
HISTORICAL INFORMATION .....	19
FISH AND FISHING IN THE ENTIAT – PRE-1900 ERA .....	20
Species composition.....	20
Subsistence and recreational fishing.....	20
Types of species and quantities harvested .....	21
Changes to habitat conditions .....	22
FISH AND FISHING IN THE ENTIAT – 1900 TO 1939 – RECREATIONAL FISHING AND TIMBER MANAGEMENT.....	23
Species composition.....	23
Species composition.....	24
Subsistence and recreational fishing.....	24
Types of species and quantities harvested .....	25
Changes to habitat conditions .....	25
Stocking.....	26
Regulations.....	28
FISH AND FISHING IN THE ENTIAT – 1940 TO 1990’S – GRAND COULEE FISH MAINTENANCE PROJECT ERA .....	29
Species composition.....	29
Subsistence and recreational fishing.....	30
Types of species and quantities harvested .....	31
Changes to habitat conditions .....	33
Stocking.....	34
Regulations.....	37
PRESENT-DAY DISTRIBUTION, ABUNDANCE, AND POPULATION TRENDS OF FISH SPECIES .....	38
CONTEMPORARY FISHERIES .....	38
ENDANGERED SPECIES ACT AND FISH LISTINGS IN THE ENTIAT RIVER WATERSHED.....	39
Endangered Species Act.....	39
Salmonid Listings in the Entiat River Watershed .....	41
STOCKING SUMMARY .....	42

# TABLE OF CONTENTS (CONTINUED)

Page No.

THE FISHERY PERMITTING PROCESS .....	45
Treaty Tribes and Fisheries Co-Management Authority .....	45
Non-treaty Tribes, Recreational/Commercial Fisheries and the North of Falcon Process.....	45
Section 10 Permits and Salmon/Steelhead Management Authority .....	46
Bull Trout Management Authority .....	46
THE FISHERY PERMIT APPLICATION AND AUTHORIZATION PROCESS.....	46
FISHERY POLICIES, RECOVERY PLANS, AND GOALS.....	47
Upper Columbia Salmon Recovery Board .....	47
Governor's Salmon Recovery Office .....	48
National Marine Fisheries Service (NMFS) .....	49
USFWS.....	49
Tribes.....	50
Washington Department of Fish and Wildlife (WDFW) .....	50
Other Resource Agencies and Organizations .....	51
THE SCIENCE OF FISHERIES MANAGEMENT .....	52
SPECIES INTERACTIONS.....	52
Commensalism.....	52
Competition.....	52
Predation .....	53
Disease.....	53
Genetic Introgression (Hybridization) .....	56
HOOKING MORTALITY.....	57
DATA GAPS.....	58
SUMMARY OF ONGOING ACTIVITIES/PROJECTS DESIGNED TO IMPROVE FISH POPULATIONS.....	59
Stream Habitat Enhancement Efforts .....	59
Stream Fish Population and Habitat Monitoring Efforts .....	60
FISHERY MANAGEMENT TOOLS.....	61
RECOMMENDATIONS.....	64
EXISTING FISHERIES .....	64
FUTURE FISHERIES.....	64
Near-Term Fisheries Opportunities .....	64
Long-Term Sustainable Fishery Opportunities.....	67
Nutrient Supplementation as a Salmonid Recovery Tool in the Entiat River .....	68
LIMITATIONS.....	70
REFERENCES.....	71

## List of Tables

Table 1 – Recent Awards to the Entiat Watershed Planning Unit.....	2
--	---

# TABLE OF CONTENTS (CONTINUED)

Page No.

Table 2. Summary of non-game species known or expected to inhabit the Entiat River watershed.....	18
Table 3 – Species names used in documents characterizing pre-1900 fisheries.....	20
Table 4 - Species names used in documents characterizing fisheries between 1900 and 1939.....	24
Table 5 - Species names used in documents characterizing fisheries between 1940 and 1990.....	30
Table 6 – Returns of spring Chinook salmon to the Entiat National Fish Hatchery.....	32
Table 7 – Returns of summer Steelhead to the Entiat River and harvest rates between 1978 and 1990..	33
Table 7. Summary of selected hooking mortality estimates for various salmonid species.....	58

## List of Figures

Figure 1 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1933-1940)...	28
Figure 2 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1940-1990)...	37
Figure 3 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1933-2006*).	44

## APPENDICES

Appendix A – Chronology of Trout and Steelhead Stocking in the Entiat River Watershed .....	A-1
Appendix B – USFWS – Endangered Species Act On-Line Glossary of Terms .....	B-1
Appendix C – WDFW 2007 Fishing Regulations Entiat Excerpt.....	C-1
Appendix D – Chronology of Fishing Regulations in the Entiat River Watershed .....	D-1
Appendix E – WDFW Application for Entiat Salmon Fishery.....	E-1
Appendix F – NMFS Federal Register Notice Regarding Proposed Entiat Salmon Fishery .....	F-1

# FISHERY WHITE PAPER FOR THE ENTIAT RIVER WATERSHED PREPARED FOR THE ENTIAT WATERSHED PLANNING UNIT

## INTRODUCTION

### BACKGROUND

Natural resource management has grown in magnitude and complexity as human populations expand, and we place ever increasing pressure on goods, services, and quality of life furnished by the environment. Our understanding of interrelationships between the natural environment, economics, social and political systems has grown such that we now understand that we cannot consider management of any one natural resource independent from the others.

This Entiat River Fishery White Paper (Paper) is the result of local, landowner-led interest in comprehensive and collaborative natural resource management in the Entiat River watershed. Citizens in the Entiat River valley have been involved in collaborative natural resource management and planning for over 13 years. The mission/vision and goals of the group have remained largely unchanged since their establishment in 1994. The current vision and goals statement, adopted on April 19, 2000, are as follows:

*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 Water Resource Inventory Area (WRIA 46). Our strategy is to complete a science based watershed management plan using watershed specific information ultimately leading towards compliance with the Federal Endangered Species and Clean Water Acts. Our end products will reflect a balance between existing natural resources and human uses and will capitalize on opportunities to improve these values.*

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

- 1. Optimize quantity and quality of water to achieve a balance between natural resources and human use both current and projected.*
- 2. Provide for coexistence of people, fish and wildlife while sustaining lifestyles through planned community growth, and maintaining and/or improving habitats.*
- 3. No avoidable human-caused mortality of State and Federal Threatened, Endangered and Candidate species.*
- 4. 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.*
- 5. 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. (Emphasis added)*

Implementation of the vision and goals has resulted in such great success that the Entiat River watershed effort is widely regarded as a “model” and benchmark for effective watershed planning and implementation. The Entiat Watershed Planning Unit (EWPU) has successfully completed a number of natural resource planning documents (CCCD 2006, 2004, 1998), a water resource management program (Chapter 173-546 WAC), and has supported the completion of salmon recovery plans (NPCC 2004, UCSRB 2006). Implementation of these programs has been recognized with awards and accolades, including those identified in Table 1.

**Table 1 – Recent Awards to the Entiat Watershed Planning Unit**

<b>Awarding Organization</b>	<b>Award Name and Date</b>	<b>Reason Cited for Award</b>
USDA – Forest Service	<i>Spirit Award – 2002</i>	National leadership in rural community assistance.
Upper Columbia Salmon Recovery Board – Board of Directors	<i>Salmon Summit Award – 2002</i>	For outstanding achievement in, and contribution to scientific advancement in the Upper Columbia Region
Western Division – American Fisheries Society	<i>Watershed/Riparian Challenge Award – 2005</i>	Exemplary watershed and riparian restoration project planning and implementation by a non-governmental organization.

With successful completion and ongoing implementation of water resource, water quality, fish habitat and instream flow plans under the Watershed Planning Act (Chapter 90.82 RCW) and related processes, EWPU interest has shifted to developing a more coordinated and collaborative approach to fisheries resource management in the watershed. EWPU involvement is guided by Goals 3 and 5, above, and motivated by interest in restoring fish populations, fisheries, fishing and associated benefits in the Entiat River watershed.

The EWPU has sought the assistance of fishery management officials and fisheries scientists to develop a better understanding of Entiat River watershed fisheries; to explore opportunities to enhance fisheries in the watershed, within existing regulations and salmon recovery criteria; and to work to achieve its vision and goals as defined above. The EWPU found one partner in the Washington Department of Fish and Wildlife (WDFW), the state agency charged with proposing and helping to establish harvest opportunities. In its Strategic Goals and Objectives Statement, the WDFW is defined as serving Washington state citizens “by protecting, restoring, and enhancing fish and wildlife and their habitat, **while providing sustainable fish and wildlife-related recreational and commercial opportunities**” (emphasis added, WDFW 2006a). With the WDFW Mission Statement as guidance, Art Viola, Wenatchee Resident Fish Biologist and other WDFW staff have been working with EWPU members to achieve shared objectives in the watershed. The EWPU also found a partner with the National Marine Fisheries Service (NMFS), the federal agency responsible for analyzing and authorizing WDFW fisheries management requests if salmon species or steelhead trout are involved. NMFS representative Kristine Petersen and other fisheries management staff members have been helping the EWPU to explore potential fisheries options in the Entiat subbasin. USFWS staff members have also provided guidance and input with respect to bull trout management objectives and the role of the Entiat National Fish Hatchery.

EWPU collaboration with the WDFW, NMFS and other fishery management agencies has led to the formation of an Entiat Fisheries Management Discussion Group. Over the course of several Round-Table meetings the group developed a “Fishery Touch-Points” document to identify and track key topics and issues of interest to the EWPU; outcomes or next steps; timelines and milestones; and names of

individuals to be contacted for more information. The EWPU also identified the need for this Paper to provide a single, consolidated source of information, written in an easy-to-read and understandable fashion, which would provide a solid background of the history of fish populations and fishing in the Entiat and Mad River watersheds. The purpose of this paper is to enable Entiat landowners to use existing information to more fully engage in discussions of Entiat River fishes, recovery, and fishery management. An outline of content for such a Paper was initially developed as a collaborative effort between Sarah Walker, EWPU Coordinator, Phil Archibald, USFS Fish Biologist and Art Viola (Archibald et al. 2006). An expanded outline of the Paper was reviewed and approved by the EWPU. GeoEngineers was retained to draft the Paper. This paper is the first Draft of the Entiat River Fishery White Paper, following the outline provided.

We have attempted to minimize the use of jargon or technical terms. Where jargon or technical terms were necessary, we have endeavored to provide definitions (e.g. Appendix B). If there are any questions about a term used, please contact John Monahan at (360) 647-1510.

## GENERAL OVERVIEW OF FISH SPECIES

Fish are of interest to humans for many reasons. Fish provide food to millions worldwide, cultural sustenance, sport, other commercial products (e.g. animal food), as well as enjoyment for aesthetic reasons and as pets. The EWPU and fishery management agencies are primarily interested in those fish managed for food, sport, and tribal cultural purposes. In the Entiat River subbasin, these species can be ocean-going (e.g. anadromous) or resident in form, may have always occurred there naturally (native), or may exist today due to human introduction (introduced, non-native). The following overview of fish species identifies those of greatest interest to the EWPU and partners, provides means of identification, describes basic life cycle patterns, identifies general migratory patterns, and summarizes habitat needs.

### ANADROMOUS SPECIES

Anadromous species spawn (breed and lay eggs) in freshwater streams. Some time after eggs have hatched and young have emerged from the gravel, juvenile fish migrate to the ocean (salt water) to feed and grow. Mature anadromous species migrate back to the freshwater stream in which they were born to spawn, thereby completing the life cycle (Wydoski and Whitney 2003).

#### **Salmonids**

##### ***Summer Steelhead (Oncorhynchus mykiss)***

Status: Steelhead found in the Entiat River are presently protected as “endangered” under the U.S. Endangered Species Act (ESA). An “endangered” status means that the federal government, as administrator of the ESA, has determined that steelhead in the Entiat River and larger Upper Columbia region are in danger of extinction throughout all or a significant portion of its range.

Identification: Steelhead and resident rainbow trout are the same species - *Oncorhynchus mykiss*, and are difficult to tell apart through external features (color, shape) or internal features (e.g. genetics). The main external difference between steelhead and resident rainbow trout is size at adulthood. Steelhead are the anadromous (sea-run) form, meaning they travel to the salt water to feed and grow (typically to a large size, 20 inches or greater) and return to fresh water to spawn. Resident rainbow trout spend their entire life in freshwater streams, typically with slower growth rates (adult typically less than 20 inches) than the ocean-going form.



*Adult steelhead are large (typically larger than 20 inches) and develop pink or red gill covers and sides as spawning time approaches.*

The name “rainbow” comes from the red or pinkish streak typically found along the lateral line (side) of rainbow trout and steelhead. Steelhead and rainbow trout have spots or speckling entirely covering the dorsal (back) and caudal (tail) fins. As a result of their similarities, it is virtually impossible to use external markings to distinguish between juvenile rainbow trout and juvenile steelhead prior to smoltification (a physical transformation that prepares juvenile steelhead to live in salt water). The physical transformation includes external changes such as the loss of parr marks, the development of a chrome-silvery coloring to their sides, and a longer, more slender body shape. During ocean life,

steelhead have blue backs and chrome sides, but quickly darken when they move into fresh water, developing pink or red gill covers and sides and more pronounced black spots along their bodies.

Life Cycle: The steelhead life cycle is fairly predictable in a general sense: they spawn in freshwater streams, migrate to ocean as juveniles, grow, mature, and return to their home stream to spawn. For steelhead, the previous general description is where predictability ends. The timing and the amount of time spent during each phase of the life cycle can vary widely from stream to stream, population to population and potentially from individual fish to individual fish. Biologists, commercial fishers and sport-fishers often describe different steelhead and other anadromous species by the time that they move from the ocean environment to freshwater prior to spawning and the level of sexual maturity at the time of migration. Biologists describe steelhead as either summer-run or winter-run. Summer-run steelhead typically enter freshwater as sexually immature sub-adults between the months of April and October. By contrast, winter-run steelhead are those that enter freshwater as adults between the months of November and June (WDFW 2006b). Historical steelhead populations in the interior Columbia River Basin, including the Entiat River basin, have the summer-run life cycle.

Summer-run steelhead returning to the Entiat River typically enter the Columbia River in the months of March through October, usually during periods of high flow. Once they make it back upstream, pre-spawn holding occurs in the Entiat River from December through March. During their return travel time and holding time, the steelhead become sexually mature and ready to spawn. Peak steelhead spawning in the Entiat occurs in the months of March, April, and May; although spawning may begin as early as February, depending on conditions. Unlike salmon, some steelhead (typically females) live through the spawning period and return to the ocean to feed, regain energy, and repeat as spawners (Pauley et al. 1986). Adults returning to spawn a second time are often referred to a “2-salt” fish or kelts.

After a steelhead creates a redd (gravel nest), spawned eggs develop for 4 to 7 weeks. With spawning so prolonged, steelhead redds in the Entiat River may be active anywhere from March through August of each year, depending on the spawn timing and water temperatures. Young steelhead (fry) usually emerge from the gravel and move to rearing areas (colonize) during the months of June, July, and August. Most naturally produced juvenile steelhead rear in freshwater habitats for 2 or 3 years, although some may spend as little as 1 year or as many as 7 years (Peven 1990) in the river system. The extended period of time that steelhead juveniles spend rearing in the Entiat River before starting their trip to the ocean is an important consideration of fisheries managers. Many immature steelhead move out of the Entiat River and into the mainstem Columbia River adjacent the Entiat River during the months of September, October, November and sometimes December. Following this over-winter rearing period, steelhead of sufficient size migrate to the ocean between the months of April and June. Non-migrating steelhead may return to the Entiat River to rear, or continue to rear in the mainstem Columbia River. Most steelhead produced in Washington waters grow for 2 years in the ocean. Stocks originating from the Entiat River, however, grow for only 1 year in saltwater (Wydoski and Whitney 2003).

Habitat Requirements: Steelhead are often found in rivers and streams used by other salmonids (e.g. Chinook salmon, cutthroat trout), but steelhead use different habitats. As a result there is little competition and predation among different species within the same river system. Like most salmonids, steelhead need clear, cool, well oxygenated water to successfully spawn (Reiser and Bjornn 1979). Unlike other salmonids, spawning steelhead select river bottoms (substrate) composed of gravel and cobble between 0.5 inches and 4.5 inches in diameter in which to dig nests (redds), and prefer water depths between 1.0 and 1.6 feet and velocities of 2.0 to 3.25 ft/s (WDOE and WDFW 2004). Steelhead substrate, water depth and velocity “preferences” are generalized ranges based on observations of and measurements taken during spawning steelhead throughout Washington State. Biologists and ecologists hypothesize that steelhead prefer these spawning habitat conditions because they are most likely to result

in the successful development of eggs deposited in redds. Areas that meet “preferred” conditions often coincide with areas of groundwater upwelling, typically more oxygen-rich with moderate temperature as compared with flowing surface water.

When steelhead fry emerge from the nest, they typically move to deeper water with high amounts of cover to feed and grow. For steelhead fry cover can come in many forms, including: rocks, roots, overhanging vegetation, log jams, or surface water turbulence. As steelhead fry feed and grow into juveniles (parr), their habitat needs change. Juvenile steelhead trout are often found during summer months to prefer water between 2.0 and 3.5 feet deep with velocities between 0.9 and 2.6 ft/s (WDOE and WDFW 2004). As a result, juvenile steelhead trout often occupy faster-water habitats like riffles and pool tail outs in contrast to other salmonids species, including resident rainbow trout (Chapman 1989). During the summer months juvenile steelhead and rainbow trout prefer water temperatures less than 70°F but can survive in temperatures ranging from 32 to 80°F (Wydoski and Whitney 2003). Juvenile steelhead and other salmonids’ preference for woody cover and cooler water is one of the main reasons for trying to restore streamside vegetation and shade in the Entiat River valley. During the fall and winter, as food energy demands decrease with lower water temperatures, rearing steelhead shift to areas with less depth (0.5 and 1.5 ft) and lower velocities (0.0 and 0.5 ft/sec) than used during summer months.

***Spring Chinook salmon, “King”, Stream-Type (Oncorhynchus tshawytscha)***

Status: Wild spring Chinook in the Upper Columbia region and Entiat River are presently listed as “endangered” under the federal ESA. The “endangered” status means that the federal government, as administrator of the ESA, has determined that spring Chinook in the Entiat River and associated area are in danger of extinction throughout all or a significant portion of its range.



*Pre-spawn spring Chinook hold in deep water in the upper mainstem Columbia River.*

Non-native spring Chinook are produced in the Entiat National Fish Hatchery (ENFH) and released in the Entiat River by the US Fish and Wildlife Service. These stocked fish are not presently considered as contributing to the recovery of the endangered spring Chinook that spawn naturally in the Entiat River and other portions of the Upper Columbia region. Recently, the release of non-native spring Chinook by the ENFH was detrimental to be detrimental to the recovery of endangered Upper Columbia River steelhead (USFWS 2007a). Consequently, a potential future fishery on the hatchery spring Chinook that return to the Entiat River is currently under consideration.

Identification: Chinook salmon are often confused with coho salmon. Unlike coho, Chinook salmon have black gums around the teeth on the lower jaw and spots on both the upper and lower lobes of the tail (caudal) fin. Biologists, commercial fishers and sport-fishers often describe Chinook salmon by the time that they move from the ocean environment to freshwater prior to spawning. Chinook salmon migrating to the Entiat River are characterized as either spring (“stream-type”) or summer (late-run, “ocean type”) Chinook (Gilbert 1913). External markings and body shape of spring and summer Chinook in the Entiat River are very similar and not useful to differentiate the runs. The main differences between fish in these run are: fish size, run timing, and spawning location. Spring Chinook enter the Entiat River and migrate through the lower reaches of the river much earlier in the year than late-run Chinook. Spring Chinook are

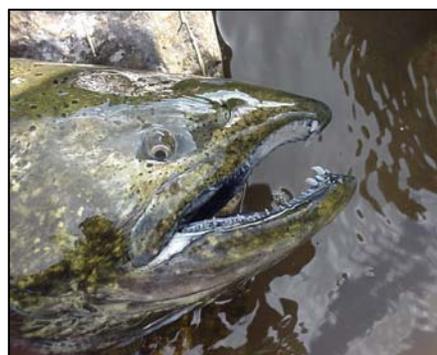
also smaller in size than summer Chinook, and tend to hold and spawn in the Entiat River above the confluence of the Entiat River and Potato Creek. In contrast, the larger and later-running summer Chinook tend to hold and spawn in the Entiat River downstream from the confluence of the Entiat River and Potato Creek, although some concentrated spawning occurs upstream to River Mile 18.7 (Hamstreet 2007).

Life Cycle: Prior to spawning, adult spring Chinook enter the Columbia River during the months of March, April, and May. They migrate to and hold in deep water in Lake Entiat, and also enter the Entiat River in May through September to hold in deep pools with abundant cover, low velocities, and cool water temperatures prior to spawning. Spring Chinook spawn in the Entiat River from late August through September, usually upstream from the confluence of the Entiat River and Potato Creek. In the Entiat River most spawning adults observed during 2006 surveys were 4 years of age (Hamstreet 2007). Spring Chinook fry emerge from redds during the months of February, March and April, and begin to rear as juveniles at the end of March and beginning of April. Spring Chinook rear in freshwater for over 1 year, and out-migrate to the ocean as yearling smolts where they will feed and grow for multiple years before returning as adults.

Habitat Requirements: During the fall spawning period spring Chinook move between holding areas and spawning areas. Chinook adults are found to prefer to hold in pools greater than 6 ft deep with velocities between 0.0 and 3.8 ft/sec, but spring Chinook are more difficult to determine in smaller systems like the Entiat River (Caldwell et al. 1987). Chinook seek out areas with clean gravel and cobble (larger substrate than other salmonids) with water velocities generally between 1.0 and 3.0 ft/s and water depths between 1.0 and 3.0 ft, although deeper areas and faster velocities are used in larger systems with suitable substrate (Healy 1991, WDOE and WDFW 2004, Wydoski and Whitney 2003). Juveniles typically utilize a variety of habitat types as they rear and grow. They have been found during warmer months to occupy habitat in proportion to body size, with larger juvenile spring Chinook in deeper water with higher velocities (Chapman 1989), generally in water greater than 1.5 ft deep and velocities between 0.45 and 1.25 ft/s. Optimal water temperature for juvenile spring Chinook is 54 to 55°F, with temperatures greater than 73°F being lethal (Wydoski and Whitney 2003). Optimal temperatures for spring Chinook are significantly cooler temperature than the 59 to 64°F considered optimal for juvenile fall Chinook (Wydoski and Whitney 2003).

***Late-run Chinook salmon, “King”, “Summers”, Ocean-Type (Oncorhynchus tshawytscha)***

Status: Summer Chinook are considered non-native in the Entiat River (Craig and Suomela 1941, Hamstreet 2007). Adult summer Chinook were stocked in the upper Entiat River in 1939 and 1940. Juvenile summer Chinook were stocked in the Entiat River from 1941 through 1964 and in 1976. Summer Chinook are presently reproducing naturally in the Entiat River at increasing levels, generally concentrated in areas below the confluence of Potato Creek and the Entiat River (Hamstreet 2007). Summer Chinook in the Entiat River and Upper Columbia region are not presently listed under the Endangered Species Act (ESA). Consequently, a potential fishery on summer Chinook near the mouth of the Entiat River, where potential impacts to ESA-listed species within the Entiat River could be minimized, is currently being considered.



*Chinook salmon are identified by a back gum line on the lower jaw.*

Identification: Like spring Chinook, summer Chinook salmon have black gums around the teeth on the lower jaw and spots on both the upper and lower lobes of the tail (caudal) fin. Spring Chinook and late-

run Chinook are difficult to differentiate between in the Entiat River because they have the same markings and body shape and have overlapping habitat use. The main differences between the two runs are: size, run timing, and spawning location. Summer Chinook are larger in size and enter the Entiat River later than spring Chinook. Summer Chinook also tend to spawn the Entiat River downstream from the confluence of the Entiat River and Potato Creek, although some concentrated spawning occurs upstream to River Mile 18.7 (Hamstreet 2007).

**Life Cycle:** Summer Chinook salmon reach maturity and return to their home waters to spawn between the ages of 2 and 8 years of age (Wydoski and Whitney 2003). In 2006 most adult summer Chinook in the Entiat River were 5 years of age, with a small percentage age 2, 3, 4 or 6 years at maturity (Hamstreet 2007). Adults enter the Columbia River during June and July. They migrate to and rear in deep water in Lake Entiat and deep pools in the Entiat River with abundant cover, low velocities, and cool water temperatures. Late-run Chinook generally enter the Entiat River and spawn during the month of October, anywhere between the confluence of the Entiat and Columbia River upstream to RM 28.1. Greatest concentrations of redds are generally found between RM 0.3 and 1.5, and another concentration of redds are often located between RM 16.2 and 18.7. Late-run Chinook fry emerge during the months of March, April and May, and rear as juveniles in March through July. Late-run Chinook typically rear in freshwater for less than 1 year, and out-migrate to the ocean as age 0+ out migrants. Some sub yearling late-run Chinook may slowly migrate, rear and forage as they pass through the reservoir system, thereby delaying their arrival at the estuaries until they are yearlings and of a larger size (Andonaegui 1999).

**Habitat Requirements:** During the fall spawning period summer Chinook move between holding areas and spawning areas. Adult holding water habitat in rivers is preferably greater than 6 ft deep with velocities between 0.0 and 3.8 ft/sec, but is more difficult to determine in smaller systems like the Entiat River (Caldwell et al. 1987). Chinook seek out areas with clean gravel and cobble with water velocities generally between 1.0 and 3.0 ft/s and water depths between 1.0 and 3.0 ft, although deeper areas and faster velocities are used in larger systems with suitable substrate (Healy 1991, WDOE and WDFW 2004, Wydoski and Whitney 2003). Juveniles rearing in the Entiat River utilize a variety of habitat types to rear and grow. They have been found during warmer months to occupy habitat greater than 1.5 ft deep with velocities between 0.45 and 1.25 ft/s. Optimal water temperature for juvenile late-run Chinook is likely higher, as fall Chinook have optimal temperatures between 59 to 64°F (Wydoski and Whitney 2003), and biologists have found no genetic difference between fall and summer Chinook (Chapman et al. 1994 in Andonaegui 1999).

***Coho or “Silver” Salmon  
(Oncorhynchus kisutch)***

**Status:** Coho were historically native and relatively abundant in the Entiat River, but dams on the Entiat River prevented use of the river between the late 1800’s and early 1900’s. By 1941 the Entiat River coho run was “practically exterminated “(Craig and Suomela 1941). The Yakama Nation is currently attempting to re-introduce coho salmon to the Wenatchee and Methow River basins. Some coho have recently been observed in the Entiat River, and are thought to be strays from Yakama Nation programs. Although strays are occasionally



*Pre-spawn coho salmon have a dusky blue-green back, but are best distinguished from Chinook by the pale (white or gray) gums in the lower jaw.*

observed, sustainable populations of coho salmon do not

presently exist in the Entiat River basin. This species is included in this paper to document the historic fishery, and to consider the potential for a future coho salmon fishery in the Entiat River watershed.

**Identification:** Adult coho have pale (white or light gray) gums in the lower jaw (as distinct from Chinook that have black gums on the lower jaw). The ocean form of adults have steel-blue to greenish backs, silver sides, and black spots on back, upper sides, dorsal fin, and upper lobe of the caudal (tail) fin. Once coho enter fresh water, male acquire a darker, dusky blue-green back with a bright red stripe on dull sides and grey to black along the ventral (belly) surface. Juvenile coho are blue-green backed with silvery sides, 8 to 12 widely spaced parr marks (space between marks larger than width of parr marks), the lateral line bisecting each parr mark, a dark adipose fin and orange on the caudal (tail) often other fins.

**Life Cycle:** Most adult coho salmon weight between 8 and 12 pounds and have an average fork length between 21 and 30 inches when they return to spawn. Mature coho return to their home waters at 3 years of age (Wydoski and Whitney 2003). Adult coho return to the Columbia River during the months of August through November, with spawning peaking between October and December. Female coho may deposit eggs in three or four redds (nests). The length of time required for young to hatch depends on water temperature, with cold temperatures requiring longer development periods. Young generally hatch after approximately 6 to 8 weeks in the gravel, depending on water temperature (Wydoski and Whitney 2003). Coho emerge from the gravel approximately 2 to 3 weeks after hatching generally between the months of March and July. Fry often congregate as schools in pools adjacent or downstream from nests. Juvenile coho typically rear in freshwater for one full year and migrate to the ocean to mature.

**Habitat Requirements:** Adult coho typically enter rivers to spawn during daylight hours at all flows except peak floods. Coho typically spawn in small streams, but will also use large mainstem habitat if available. Coho prefer to spawn in areas with substrates ranging between medium gravel and small cobble and velocities between 0.75 and 1.8 feet per second (ft/sec) and depths between 1 and 2.5 feet (WDOE 2004), typically in riffle habitats with groundwater upwelling (Laufle et al. 1986). Newly emerged fry briefly live in shallow gravel areas, and then disperse upstream and downstream. Ideal rearing habitat for coho includes high habitat complexity with abundant pool and riffle areas, instream and stream bank cover, water temperatures between 50°F and 59°F through the summer with high dissolved oxygen and low fine sediment levels (Reiser and Bjornn 1979). Juvenile coho have been found to prefer areas ranging in depth from 1.5 to almost 4 feet, velocities between zero and 0.3 ft/sec (WDOE and WDFW 2004).

***Sockeye, “Bluebacks”, “Reds”  
(*Oncorhynchus nerka*)***

**Status:** Sockeye are not native to the Entiat River (Craig and Suomela 1941). Limited numbers of adults and juveniles are periodically detected in the Entiat River (Hamstreet 2007). Sockeye were twice stocked in the Entiat River (1943 and 1944) using fish from Lake Quinault and Lake Whatcom stocks (Mullan 1986 in Hamstreet and Carie 2004). Sockeye have been observed annually since 2003 during Chinook spawning ground surveys, and are most likely strays from the Lake Wenatchee or Lake Osoyoos populations. Sockeye are only



*Sockeye salmon have pale green heads and red or scarlet bodies during breeding time.*

included in this paper to document presence, but do not occur in sustainable number and are not anticipated to serve as a potential future fishery in the Entiat River watershed.

Identification: Ocean-going sockeye (bluebacks) have greenish-blue backs and chrome-bright sides with very fine back speckling on the back. Breeding males have a pale green head with a bright red body and fins. Breeding females also have a pale green head with a bright scarlet body. Juvenile sockeye have parr marks that are shorter than the diameter of the eye, oval in shape, and typically located above the lateral line.

Life Cycle: Sockeye salmon have a wide variety of life history patterns, including landlocked populations of kokanee which never enter saltwater. Sockeye are distinct from other salmon because most stocks require a lake environment as part of their life cycle. Columbia River sockeye are mostly limited to lakes Wenatchee (Wenatchee watershed) and Osoyoos (Okanogan watershed). Limited numbers of adults and juveniles are periodically detected however, in the Methow and Entiat Rivers and in isolated areas of the mid-Columbia River (Chapman et al. 1995, in Andonaegui 1999). Columbia River stocks of sockeye enter freshwater in mid-June through late September (Wydoski and Whitney 2003). Spawners are found in Wenatchee and Osoyoos Lakes during July through September (Mullan 1986). Spawning typically occurs in September, with activity peaking in the Wenatchee system about the third week of September (Howell et al. 1985). Lake Wenatchee sockeye will spawn in rivers upstream from the lake and on beaches, typically in areas of upwelling groundwater. Sockeye also spawn in side channels and spring-fed ponds. The egg incubation period depends upon water temperature, but usually lasts from 50 to 140 days (Pauley et al. 1989). After hatching, alevins remain in the redd for 3-5 weeks before emerging. Emergence typically occurs in April and May. Emergent fry typically disperse to low velocity areas (lakes) to feed and grow. Wenatchee River sockeye typically live in the lake environment for 1 year, although some reside for a second year. Out-migration typically occurs during the spring when surface water temperatures warm to as much as 44oF. Sockeye often remain in the ocean from 1 to 3 years with most returning to spawn after 2 years in the ocean (Andonaegui 1999).

Habitat Requirements: Resier and Bjornn (1979) identified optimum spawning temperatures of sockeye salmon as ranging between 51 and 54oF, and incubation as being between 40 and 56oF. Sockeye salmon eggs require dissolved oxygen levels of at least 5.0 mg/l. Spawning sockeye salmon typically select substrates with small to medium gravel (e.g. 0.5 to 4.0 inches, Reiser and Bjornn 1979), in water between 0.6 and 1.6 ft deep and velocities around 1.0 to 1.8 ft/s (WDOE and WDFW 2004). Young sockeye need cold, clear lakes to rear, feed, and grow prior to out-migration. Young sockeye live suspended in the lake's water column at depths between 30 to 60 feet, migrating vertically to feed on zooplankton (Pauley et al. 1989).

## **Non-Salmonids**

### ***Pacific Lamprey (Lamptera tridentata)***

**Status:** Pacific lamprey are native to the Columbia River basin and tributaries, including the Entiat River. Pacific lamprey populations in the Columbia River basin have been in decline (Wydoski and Whitney 2003), and the status of lamprey in the Entiat River is not known. Because of the importance of lamprey as a traditional food, Columbia River treaty tribes are involved in efforts to rebuild Pacific lamprey populations. In January of 2003 a petition was sent to the US Fish and Wildlife Service requesting that Pacific and three other species of lamprey were petitioned for listing as threatened or endangered under the ESA. In December of 2004 the US Fish and Wildlife Service issued a finding that there was insufficient information indicating that listing may be warranted.



*Adult Pacific lamprey can pass barriers like dams by clinging to and climbing them with the aid of their sucker-like mouths (Wydoski and Whitney 2003).*

**Identification:** Lamprey are rather distinct in body form from many fishes. Pacific lamprey have a eel-like body shape with seven gill openings appearing more like pin holes than gill slits. Adult pacific lamprey can be identified by the arrangement of teeth inside the sucker-like mouth. Adult pacific lamprey have a supra-oral (upper portion of mouth) lamina (thin plate or layer) with three cusps (teeth).

**Life Cycle:** Pacific lamprey migrate to fresh water between March and October, overwinter in deep pools, and spawn the following spring. Pacific lamprey typically spawn from April through July, with inland populations spawning later than those in coastal waters (Wydoski and Whitney 2003). Nests are depressions excavated in gravel substrates containing some small gravel and sand. Eggs hatch in approximately 2 to 3 weeks, depending on water temperature. Ammocoetes (larval lamprey) remain in fresh water as filter-feeders for between 4 and 7 years before metamorphosing into adults and migrating to the ocean. Lamprey out-migrate during March through July, following metamorphosis. Metamorphosis typically occurs during the months of October or November. Some recently metamorphosed lamprey become parasitic prior to maturing. Typically, mature lamprey that have migrated to the ocean are the parasitic life stage, feeding on the body fluids of various fish species, including salmon, steelhead, rockfish, lingcod, sablefish, halibut, and flounders (Wydoski and Whitney 2003). When adult pacific lamprey return to freshwater to spawn, they no longer feed. Like steelhead, many lamprey die after spawning, but some are able to return to the ocean to feed, grow and return to spawn.

**Habitat Requirements:** Lamprey are not well studied or understood, so information about habitat requirements is limited. Adult pacific lamprey are secretive at the onset of spawning, but have been found holding in large substrate (boulders) or in shade (Wydoski and Whitney 2003). Pacific lamprey spawning areas are concentrated in riffles and pool tailouts where velocities are generally between 1.6 and 3.3 ft/s in water depths between 1.3 and 3.3 feet (Wydoski and Whitney 2003). Ammocoetes rear in areas with fine silt and mud, generally in eddies, alcoves, and backwater areas of stream with velocities less than 1.0 ft/sec.

## RESIDENT SPECIES

Resident species live their entire life in fresh water. Adult spawning and juvenile rearing life stages may occur in different parts of the freshwater aquatic system. Adfluvial, fluvial, and stream-resident life history strategies are specific examples of the general, resident form. Definitions are provided here, as they are referenced in subsequent sections of this paper (source Wydoski and Whitney 2003):

- Adfluvial: Life history strategy of fish in which adults and subadults live in lakes or reservoirs but spawning by adults and rearing of juveniles occurs in streams or rivers.
- Fluvial: Life history strategy of fish in which spawning by adults and rearing of juveniles occurs in smaller tributary streams, but the subadults and adults occupy habitat in larger stream or mainstem rivers.
- Stream-Resident: Life history strategy in which the entire life cycle occurs in a river, stream, or creek.

### **Resident Salmonids**

**Bull Trout, “Dolly Varden”, “Dollies”,  
“Char”**  
(*Salvelinus confluentus*)

Note: Bull trout and Dolly Varden (*Salvelinus malma*) are currently classified as different species based on genetic analyses (Leary and Allendorf 1997, Crane et al. 1994).

Status: Bull trout are native to the Entiat and Mad Rivers. They are listed as threatened under the ESA. Spawning population levels monitored in the Mad River revealed an increase in the bull trout spawning population between 1992 and 2005, following the closure of the Entiat and Mad Rivers to fishing. Wydoski and Whitney (2003) report that over harvest of bull trout can occur because of ease of capture by anglers. The recent low in bull trout spawning numbers (Archibald and Johnson 2007), however, indicates that bull trout recovery is proving elusive, and the near-term restoration of a bull trout fishery in the Entiat River watershed is unlikely.



*Dolly Varden were named after a colorful character in the Charles Dickens story “Barnaby Rudge” described as wearing a green dress with pink dots. This “gaudy attire” is shared with the adult form of the closely related species, bull trout, shown above.*

Identification: Adult bull trout can be identified by their pale olive-green backs and their sides marked with spots about the size of the pupil of the fish eye, with ranging in color from cream to crimson (typically orange). Bull trout also typically have pronounced white line on the front side of each fin, offset by a black secondary bar flanking the white margin. Juvenile bull trout and brook trout are often confused. Brook trout, however, have the appearance of a mustache at the end of the snout.

Life Cycle: Bull trout have four life cycle types in waters of Washington State: anadromous, adfluvial, fluvial, and stream-resident (Wydoski and Whitney 2003). In the upper Columbia Basin, bull trout exhibit resident (stream) and migratory (fluvial/adfluvial) life-history strategies. Stream-resident bull

trout complete their entire life cycle without leaving the stream in which they were born. Migratory bull trout in the Entiat River are believed to use the mainstem Columbia River for overwinter rearing and foraging (UCSRB 2006). Most Entiat River bull trout are thought to be migratory, with stream-resident bull trout possibly using the upper Mad River.

Bull trout may reach sexual maturity in 4 years, are normally mature by 7 years and may live longer than 12 years or age. Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality (death) are not well documented (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996). Bull trout redds are found every fall in the Entiat River watershed, but individual bull trout may spawning every other year (Archibald 2007a). Bull trout typically spawn in the Mad and upper Entiat River in September and early October when water temperatures drop below 52°F. Egg development is dependant upon water temperature, with optimal incubation temperatures from 36 to 39°F. Eggs may hatch anywhere between 20 day and 200 days after spawning. Emergence from the streambed typically occurs in early spring. Juvenile bull trout usually remain in the stream for two or three years, and then migrate downstream to rivers (fluvial forms) and lakes (adfluvial forms). There is some debate about how to characterize bull trout leaving the Mad and Entiat River to rear in the Columbia River/Lake Entiat and other segments/pools of the upper Columbia River. Bull trout rear, feed, and grow in the Columbia River until sexually mature. When mature, bull trout return to spawn in the same segment of stream from which they hatched and emerged as young.

Habitat Requirements: Bull trout require very cold and very clean water in relatively pristine condition to thrive. Most field studies suggest that juvenile and adult bull trout are uncommon in rivers and streams where water temperatures exceed 59°F, although it is not unusual to observe water temperatures above this in the Columbia River. The combined effects of decreasing photoperiod and water temperature dropping below 52°F are thought to trigger bull trout spawning activity (Brown 1993). Bull trout spawning typically occurs when water temperatures decline from approximately 48°F to 41°F (Wydoski and Whitney 2003).

Bull trout generally spawn in the same stream reaches as previous years. These reaches often have strong groundwater influence and close proximity to cover. In the Entiat River watershed, spawning sites are often in low-gradient sections of high elevation tributary streams that provide the very cold very clean water they need, including sections of the Mad and Entiat Rivers. Sections of the Mad and Entiat Rivers most often used by bull trout have significantly lower water temperatures than other areas of watershed. The section of the Mad River most used by bull trout is significantly cooler than areas both upstream and downstream (Archibald 2007a). In 2004, bull trout were observed spawning in locations with substrate of medium gravel to small cobble (Monahan and Kohr 2004) with depths between 0.6 and 1.0 feet and velocities between 0.6 and 1.6 ft/s. Statewide suitability criteria, a majority of which was developed in the Entiat River and Wenatchee River watersheds, identifies preferred bull trout spawning habitat as having depths between 0.4 and 0.75 ft and velocities between 0.5 and 1.0 ft/s (EES 2005). Bull trout fry are usually found in shallow, backwater side-channels and eddies with low velocities and high abundance of cover. Sediment is an important factor determining juvenile bull trout rearing location. Juvenile and adult bull trout are closely associated with coarse substrates of large gravel, cobble, and boulder (Watson and Hillman 1997). Habitat suitability criteria developed for juvenile bull trout in the Wenatchee River watershed suggest that preferred depths between 1.45 and 2.05 feet with velocities between 0.05 and 0.3 ft/s (EES 2005).

***Westslope cutthroat trout, “cutthroat”, “cuts”,  
“Intermountain cutthroat”  
(*Oncorhynchus clarki lewisi*)***

Status: Cutthroat trout were petitioned for listing as threatened or endangered under the ESA. In 2003 the USFWS conducted a review of the status of Westslope cutthroat trout, throughout its known range. The USFWS found the species to be sufficiently abundant with stable, reproducing populations distributed throughout its historic range. The US Fish and Wildlife Service determined that protection under the Endangered Species Act was unnecessary. The status of Westslope cutthroat trout in the Entiat River watershed, however, is less certain. Native Westslope cutthroat trout are thought to still exist in the Entiat River basin, but may have interbred with introduced stocks (see Genetic Introgression section). Westslope cutthroat trout do naturally reproduce in the Entiat and Mad River watersheds. The feasibility of a Westslope cutthroat trout fishery in the Entiat River watershed is discussed in more detail later in this paper.



*Westslope cutthroat trout have an orange or pale red slash under the jaw and irregular shaped dark spots, mostly found above the lateral line and near the tail.*

**Identification:** The most readily recognized feature of a cutthroat trout is the presence of an orange or red slash (cut) on the underside of the lower jaw (throat). As Redband (native rainbow) trout also share this orange-slash feature, biologists look for the presence other indicators. The most common feature biologists use to identify cutthroat is the presence of hyoid (basibranchial) teeth, located on the floor of the mouth just forward of the gill arches. Externally, Westslope cutthroat trout have irregular shaped dark spots, mostly found above the lateral line and in highest numbers near the tail and fewer numbers near the head. The dorsal and adipose and caudal (tail) fins are typically spotted, but the anal fin is not spotted, or is only sparsely spotted. Young-of-the-year and yearling cutthroat trout do not have the above described features fully developed and are, therefore, very difficult to distinguish from rainbow trout or steelhead of the same size.

**Life Cycle:** Westslope cutthroat trout can have up to three life history forms: stream-resident, fluvial, and adfluvial (see section on bull trout for definition of these life history forms). Westslope cutthroat found in the Entiat River watershed are thought to be primarily stream-resident. Age at maturity varies considerably, but cutthroat are generally found to be mature at 4 to 6 years of age (Wydoski and Whitney 2003). The length of growing season and water temperature have strong influence on growth, spawn timing, timing for fry emergence, and length of time to sexual maturity (Wydoski and Whitney 2003). Westslope cutthroat spawn between the months of March and July in high-elevation reaches of the Entiat and Mad Rivers when water temperatures reach 50°F, and may also use smaller tributaries. Fry emerge from their gravel redds (nests) in the spring when they are about 1 inch long, and disperse to feed on zooplankton and aquatic insects and grow until reaching sexual maturity.

**Habitat Requirements:** Westslope cutthroat have not been extensively studied in the Entiat River or upper Columbia River watershed. In Montana streams, tributary to the Blackfoot River, Westslope cutthroat were found to spawn in areas with an average depth a little over 0.5 ft with velocities around 1.8 ft/s. Redds were found in pool tailouts and glides with mixed substrate of small, medium and large gravel as well as small cobble (Schmetterling 2000). Washington State suitability criteria identify general cutthroat spawning habitat as having preferred spawning habitat with depths of 0.3 to 0.8 ft, velocities between

0.45 and 1.5 ft/s. Juvenile habitat preferences include water depths between 1.85 and 2.65 ft with velocities between 0.35 and 1.05 ft/s (WDOE and WDFW 2004).

***Redband rainbow trout, “Redband rainbow”,  
“Redband trout”, “rainbow”, “Bow”  
(*Oncorhynchus mykiss gairdneri*)***



**Status:** Redband rainbow trout are native to the upper Columbia River and tributaries, including the Entiat River (Wydoski and Whitney 2003).

Widespread introductions of non-native rainbow trout and steelhead stocks in the upper Columbia River, including the Entiat River have potentially resulted in interbreeding with the native resident rainbow trout. Consequently, there is uncertainty about the abundance, distribution, and viability of native rainbow trout in the Entiat River watershed. In addition, the high level of similarity in appearance between Redband rainbow and threatened steelhead poses additional challenge managing this species for fishery purposes

*Redband rainbow trout have similar external markings as steelhead and introduced rainbow trout, but may have a trace of an orange “slash” on the underside of the lower jaw (Behnke 1992).*

**Identification:** “Redband” is the resident form of the native rainbow trout, once common throughout the Columbia River basin. Adult Redband rainbow trout have similar external markings as steelhead and introduced rainbow trout, but tend to have more robust spots, parr marks that tend to remain into adulthood, are more orange-red along the lateral line, have distinct white tips on the anal, dorsal, and pectoral fins, and may have a trace of an orange “slash” on the underside of the lower jaw (Behnke 1992). Also see the section on steelhead “Identification” for more details.

**Life Cycle:** Redband rainbow trout typically spawn in the spring between February and June, depending on the temperature and location. Redds are typically constructed in gravel areas of pool tailouts or at the heads of a riffle. Eggs remain in the gravel for 4 to 7 weeks, depending on water temperatures. Fry typically emerge in mid-late July. After emerging from the gravel, young-of-the-year feed, grow, and move into increasingly deeper water, typically feeding on benthic macroinvertebrates. Redband rainbow trout are usually mature after 3 years of growth, although times vary.

**Habitat Requirements:** Optimal Redband rainbow trout habitat is characterized by clear, cool water; a silt-free gravelly substrate in riffle-run habitat with a pool:riffle ratio of approximately 1:1. Areas of slow, deep water with well-vegetated streambank, abundant instream cover, and relatively stable streamflow and water temperature (Raleigh et al. 1984). Resident rainbow trout utilize a variety of habitats in Washington State. Composite habitat suitability information has been assembled by WDOE and WDFW (2004). Composite data indicate preferred spawning areas with depths between 0.6 and 1.2 ft and velocities between 1.5 and 2.7 ft/s. Resident juvenile and adult rainbow trout prefer depths between 2.7 and 4 ft with velocities between 0.75 and 1.25 ft/s for summertime holding and rearing purposes. During the winter resident rainbow trout prefer depths between 0.5 and 2.0 ft with velocities between 0.0 and 0.6 ft/s.

***Whitefish, mountain whitefish  
(Prosopium williamsoni)***

Status: Mountain whitefish are native to the upper Columbia River, including the Entiat River, are relatively abundant with self-sustaining populations in the Entiat River watershed, and are harvested throughout eastern Washington. Whitefish have gained in popularity as a sport species as other populations have declined and fishing opportunities have diminished.



*Whitefish are common throughout western North America. As other fisheries have closed, whitefish have grown in popularity as a sport species.*

Identification: All whitefish have small sub-terminal mouths (underside of the head just below the end of the snout) and large scales (Wydoski and Whitney 2003). Whitefish tend to have a uniform chrome or brassy in appearance. The mountain whitefish has a single flap between the nostrils and is generally larger and has more dorsal rays than the pygmy whitefish.

Life Cycle: Mountain whitefish live year-round in lakes, streams, and rivers throughout western North America. Mountain whitefish are typically mature at 3 to 4 years of age. Spawning usually occurs in the fall, generally between the months of September and December, when water temperatures reach between 40 and 45°F. Adhesive eggs attach to the clean substrate, prior to being buried by the female. Eggs often hatch after one month, under typical water temperature regimes, although lower water temperatures require longer periods of development. Following the hatch and further development, fry emerge from the gravel and drift downstream to nursery habitat in shallow, low-velocity backwaters and edge-habitat. Whitefish typically remain in the same stream, river, or lake through the 3 to 4 years of feeding, growth, and development prior to sexual maturity.

Habitat Requirements: Mountain whitefish are found in streams, rivers, and lakes throughout western North America. Adult and juvenile whitefish rearing in streams and rivers tend to prefer riffle habitat during summer months and slow-moving runs or large pools during the winter (Wydoski and Whitney 2003). Spawning usually occurs in gravel substrates in stream riffles. Young-of-the-year whitefish in the Yakima River basin were found in water with a mean depth of 1.2 inches and velocities of approximately 0.9 feet per second (Wydoski and Whitney 2003). Larger whitefish are found in deeper water with higher velocities. Composite habitat suitability information has been assembled by WDOE and WDFW (2004). Resident juvenile mountain whitefish prefer depths between 2 and 4.5 ft with velocities between 1.25 and 2.75 ft/s for rearing purposes. Resident adult mountain whitefish prefer depths greater than 2.5 feet and velocities between 1.5 and 3.25 ft/s.

***Eastern Brook Trout, Brook Trout, Brookies,  
Brook Char, Speckled Trout  
(Salvelinus fontinalis)***

Status: Brook trout are a non-native species introduced to the Entiat River and other watersheds in Washington State. Brook trout have established self-sustaining numbers in the upper Entiat River watershed, although they are not typically found below Entiat Falls at RM 34. Brook trout are a popular sport species when available in sufficient numbers of a large enough size. Although an introduced species, brook trout are presently and will likely remain a recreational sport fishery species in the Entiat River watershed. Brook trout are easy to catch, beautiful, and are considered excellent eating. As a result they are among the most popular game fishes in the United States (Wydoski and Whitney 2003). They can be, however, quite small (e.g. 2 to 8 inches total length). Wydoski and Whitney (2003) write: “In infertile high mountain lakes [e.g. Myrtle Lake], brook trout become overpopulated and their growth becomes stunted...[c]onsequently this species should not be planted in infertile waters.” Indeed, recent Entiat angler contacts indicate dissatisfaction with the brook trout fishery of the Entiat River above Entiat Falls and in Myrtle Lake for the very reasons previously stated by Wydoski and Whitney (2003). Opportunities to enhance the brook trout fishery resource in the Entiat River are discussed later in this paper.



*Brook trout are very colorful, often having crimson-red spots with blue “halos” (rings) around each spot, scattered along each side.*

Identification: The most distinguishing feature on a brook trout is the color. Brook trout are very colorful, often having crimson-red spots with blue “halos” (rings) around each spot, scattered along each side. Brook trout also have dark olive-green vermiculations (wavy markings) along the back and dorsal fin, lacking on most other trout. Juvenile brook trout also have dark green or black vermiculation (mustache) on the snout which distinguishes it from juvenile bull trout, which do not.

Life Cycle: Brook trout live year-round in cold, freshwater streams, lakes, ponds, and rivers, typically at high elevations. Brook trout may mature to adulthood in less than one year after hatch, but more typically require 2 to 5 years of growth before reaching maturity. Brook trout spawn in the fall, generally between the months of August and December when water temperatures fall below 50°F to around 40°F (Wydoski and Whitney 2003). Female brook trout dig redds in riffle areas of streams with gravel approximately 1.2 to 2.4 inches in diameter. Eggs may hatch after 144 days in water temperatures of 35°F (Wydoski and Whitney 2003), but hatch times vary with water temperature and time of spawning.

Habitat Requirements: Although fairly adaptive, brook trout prefer cold, clear, headwater brooks, creeks, streams, ponds and lakes. Brook trout prefer water temperatures between 55 and 66°F for summer rearing, and will seek out springs, upwelling areas, and coldwater tributary inflow areas. Warm water temperatures limit brook trout distribution and production (Raleigh 1982). Cover is also an important habitat component. The largest number and weights of brook trout were found in water with abundant cover, depths equal to or exceeding 6 ft, and velocities of approximately 0.5 ft/s (Raleigh 1982 in Wydoski and Whitney 2003). This habitat preference often results in overlap in habitat area between brook trout and bull trout.

### **Other non-salmonid species present but not addressed**

A variety of other fish species have been found to inhabit the Entiat River watershed. These species are not described in detail in this paper because they are generally regarded as not having sport, commercial, or food-fish value. These species are listed here, however, because their presence is part of what makes the Entiat River watershed unique. These species are only identified by common and scientific name.

**Table 2. Summary of non-game species known or expected to inhabit the Entiat River watershed (CCCD 2004)**

<b>Common Name</b>	<b>Scientific Name</b>
River Lamprey	<i>Lamptera ayresi</i>
Western Brook Lamprey	<i>Lamptera richardsoni</i>
Chiselmouth	<i>Acrocheilus alutaceus</i>
Peamouth	<i>Mylocheilus caurinus</i>
Northern pikeminnow	<i>Ptychocheilus oregonensis</i>
Longnose dace*	<i>Rhinichthys cataractae</i>
Dace sp.	<i>Rhinichthys spp.</i>
Redside Shiner	<i>Rhirdsonius balteatus</i>
Bridgelip sucker	<i>Catostomus columbianus</i>
Largescale sucker	<i>Catostomus macrocheilus</i>
Sucker sp.	<i>Catostomus spp.</i>
Mottled sculpin*	<i>Cottus bairdi</i>
Torrent sculpin	<i>Cottus rhotheus</i>
Sculpin sp.	<i>Cottus spp.</i>

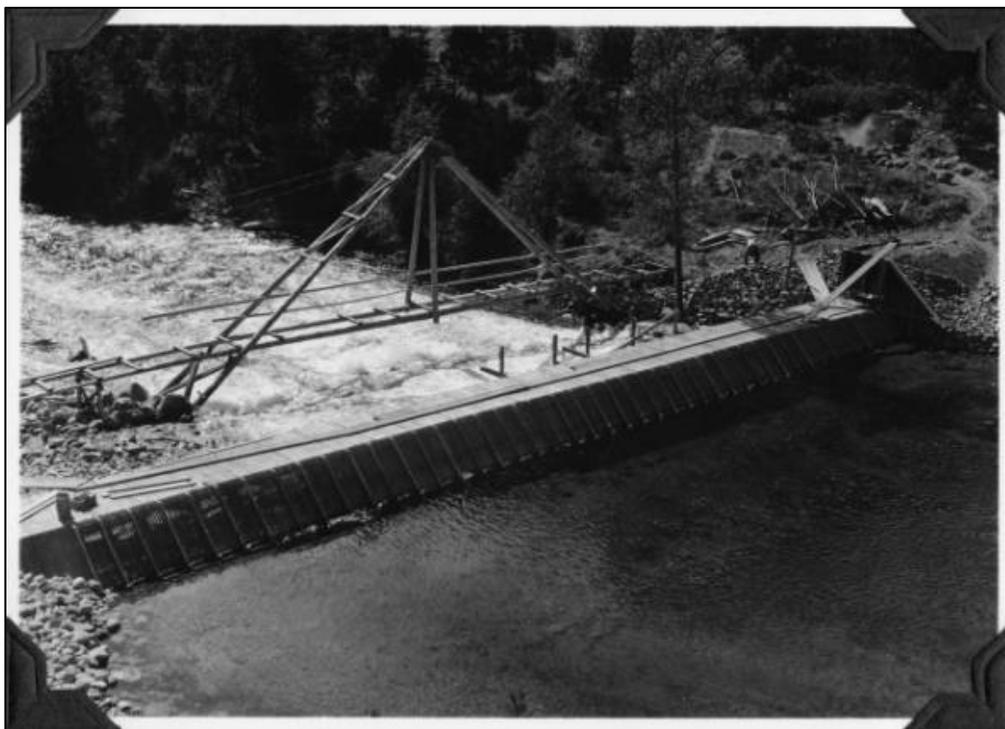
Notes: \* Indicates the expected presence based on Mullan et al. 1992 and other USFWS reports.

## HISTORICAL INFORMATION

Historical information about fish and fisheries in the Entiat River watershed is needed to provide context for discussions of current and future fisheries and related management issues. For the purpose of this paper we refer to historical fisheries as those occurring previous to the closure of the river to fishing as the result of protective listings of Upper Columbia River summer steelhead, bull trout, and spring Chinook under the U.S. Endangered Species Act (ESA). These listings occurred in 1997, 1998, and 1999 respectively. To better describe the fisheries practices and associated management over time, we have divided this section into three sub-periods and themes as follows:

- Pre-1900 Era – Early Tribal and Subsistence Fishing
- 1900 to 1939 Era – Recreational Fishing and Timber Management
- 1940 to 1990's Era – Grand Coulee Fish Maintenance Project (GCFMP)

Research findings and notes made by Phil Archibald and Art Viola (Archibald and Viola 2006) were invaluable in preparing this section of the Report. Information pertaining to Native American populations and fisheries in the Entiat area and the early history of contact with Euro-Caucasian settlers relied primarily on “Ethnohistory 1811-1855” (Smith 1983) and anecdotal information in news reports in local papers. Yakama Nation and Colville Confederated Tribe fisheries program staff members were contacted to provide additional information about historical use of the Entiat River by tribal fishers. Two large-scale fisheries and fish habitat assessments (Mullan et al. 1992, Bryant and Parkhurst 1950), and several contemporary fishery management documents (UCSRB 2006, WDFW 2006a, WDFW 2006b) were referenced in developing sub-sections B and C. This information was supplemented with other reports suggested by the CCCD, the USFS, and by agency reviewers.



*This 1939 Bureau of Fisheries photograph shows the Entiat National Fish Hatchery (ENFH) weir under construction. Photograph provided courtesy of Oregon State University (OSU) Archives (2007).*

## FISH AND FISHING IN THE ENTIAT – PRE-1900 ERA

Information about fish and fishing in the Entiat River watershed prior to 1900 is very limited. Some anecdotal evidence of subsistence fishing by Native Americans and early settlers of the Entiat River valley is provided in this section. The available record suggests that fisheries were solely comprised of native stocks, with sustainable populations maintained by the natural habitat.

### **Species composition**

A variety of species descriptions were used prior to 1900, and in literature referencing pre-1900 fishing and fisheries. Table 3 provides a list of fish identified in historical texts as present or captured in the Entiat River watershed prior to 1900.

**Table 3 – Species names used in documents characterizing pre-1900 fisheries.**

Name used in Historical Text	Most Likely Species (scientific name)	Most Likely Species Common Name
Salmon	<i>Oncorhynchus spp.</i>	Chinook and Coho salmon
Salmon Trout	<i>Oncorhynchus mykiss</i>	Steelhead
Whitefish	<i>Prosopium williamsoni</i>	Mountain whitefish
Mountain trout	<i>Oncorhynchus clarki lewisi</i>	Westslope cutthroat trout
Silver Salmon, Coho	<i>Oncorhynchus kisutch</i>	Coho salmon
White Salmon, Chinook	<i>Oncorhynchus tshawytscha</i>	Chinook Salmon
Steelhead	<i>Oncorhynchus mykiss</i>	Steelhead
25-pound salmon	<i>Oncorhynchus tshawytscha</i>	Chinook Salmon

Notes: GeoEngineers collaborated with local biologists to associate colloquialisms describing fish species in historic documents with scientific name and common name, using best professional judgment.

### **Subsistence and recreational fishing**

The first settlers arrived in the Entiat valley in 1887 (Kerr 1980, in Mullan et al. 1992). The earliest documented accounts of settlers fishing in the Entiat were recorded by Emma Mead (Entiat Valley resident from 1888 to 1900) in her unpublished book titled *The Valley of the Entiat, Washington in Territorial Days: A Plain and Humble Life* and by Edson Dow (1963) in *Passes to the North – History of the Wenatchee Mountains*. The following excerpts from these texts provide corroborating evidence of early fisheries utilized by settlers of the Entiat River valley.

Ms. Mead identifies a neighbor in the Entiat River valley, Mr. Bonar, as the consummate sportsman and provider. In Chapter 4 of *The Valley of the Entiat, Washington in Territorial Days: A Plain and Humble Life*, she writes:

“Mr. Bonar was our first visitor and he came often. The Entiat River swarmed with salmon, salmon trout, whitefish and mountain trout which ran up from the Columbia to reach the cold headwaters in the glaciers.

Mr. Bonar was a famous hunter and near his cabin he had planted brush in an eddy in the river close by an old beaver dam, inside of which the water was comparatively quiet, the swift current being on the other side. Fish coming up the stream would stop to rest under these bushes in the still water and fell easy prey to the waiting sportsman.

Mr. Bonar was very liberal in distributing his catch among the settlers. One silver salmon that fell victim to his spear weighed 40 pounds, but the common size was from seven to 10 pounds. We never lacked fish of the finest quality while Mr. Bonar lived...

The closing statement that the settlers “never lacked fish of the finest quality while Mr. Bonar lived” implies that the fishery was as much for subsistence as for sport. In Ms. Mead’s book, the duration of this fishery, the number of fish caught, and the species caught are not well documented. Edson Dow, on the other hand, provides more detail regarding species and quantities caught.

The identity and activities of Mr. Bonar were further documented by Edson Dow. Mr. James C. Bonar was identified as the second settler in the Entiat, and kept a diary. Portions of Mr. Bonar’s diary were reprinted in Edson Dow’s (1963) *Passes to the North: History of the Wenatchee Mountains*. Mr. Bonar was 58 years old in 1887, the year he arrived in the Entiat River valley. Mr. Bonar’s diary, as published in Dow (1963) reads that on April 11, 1887 he “took claim on the Entiat” at the present location of Keystone Ranch. His diary of 1887 was also quoted as stating that on “July 30..... put fish net in the river.... October 10...Made fish trap.” Continuing in 1888, on June 29; “speared salmon”, June 30 “Get salmon”, August 4 “killed a 25-pound salmon”, August 6 “just learned how to catch trout”, August 7 “caught 30 trout”, and June 10, 1889 “killed 35 white salmon”.

In Appendix J of Monograph I, Mullan et al. (1992) substantiate the diary of Mr. Bonar that salmon used the Entiat River. Mullan et al. (1992) further explain that salmon runs in the Entiat River were practically exterminated in the Entiat River during the late 1800’s and early 1900’s, due to the construction of dams on the river that had inadequate ladders or no fish ladders at all.

### ***Types of species and quantities harvested***

Mullan et al. (1992) attempted to reconstruct the historical tribal fisheries of the mid-Columbia River region including the Entiat River. They noted that data relating to the Entiat are meager. “This may be because they never were a numerous people and because they appear to have begun to dissolve as a cohesive entity early in the post-contact period (Smith 1983b).”

Mullan et al. (1992) write: “The single winter village and all four summer camps of the Entiat tribe were located on or near the banks of the Columbia River. About 125 persons occupied their one winter village at the mouth of the Entiat River (Smith 1983b). Ray (1936, 1974) reported the Entiat caught fish in the Entiat River, but that this stream was of no great importance as a fish source because of its small size. The small summer fishing camp above the mouth and adjacent to winter quarters described in the Wilkes expedition (1845) would seem to verify this.”

“In 1881, Symons and Downing (1882, in Smith 1983) carried out a mapping survey of the Columbia River. Symon’s narrative of October 6 reads:

‘There is quite an Indian village on...[the] banks [of the Entiat River], and several of the Indians were engaged in spearing salmon from canoes, paddled and poled along the shallows by assistants. Just below the mouth of the Entiat-qua River there are a number of bar islands, and the river is very shallow. We apparently went in the main channel, and I found only three feet of water over the bar... This is the shallowest water met with yet. At the lower end of the bar is quite a strong little rapid.’

“Symons does not make it clear whether the spearing “shallows” were in the Entiat River at its mouth or were those he described in detail in the Columbia itself. However, it is of interest that these natives were spearing salmon in early October – either coho or Chinook” (Mullan et al. 1992).

Mullan et al. (1992) developed a population estimate of 140 Indians for the Entiat River tribe in the mid-19<sup>th</sup> century. “It is probable that the Entiat Indians relied on fish primarily from the Columbia River, though we assume that 50% of their catch came from the Entiat River.” Mullan et al. (1992) used reasonable estimates of population, daily per capita consumption of salmon and salmon trading to arrive at an estimated aboriginal catch of 31,938 pounds of salmon per year from the Entiat River. Mullan et al. (1992) continued their analysis to convert the annual aboriginal maximum catch weight to estimated numbers of fish. For the Entiat River this conversion resulted in an estimate of 170 steelhead, 1,513 coho salmon, and 1,141 Chinook salmon.

### ***Changes to habitat conditions***

Soon after arrival in the Entiat River valley, settlers began to make changes to the landscape and river. Construction was started in 1888 on the first dam across the Entiat River, as described in the diary of Mr. Bonar. A mill was constructed the following year (1889) near the mouth of the river (Long 2001). Initially, it was operated by T.J. Cannon, then later traded to C.A. Harris, and eventually sold to



George H. Gray and son (Long 2001) and is generally referred to as Gray’s Mill.

*The first dam across the Entiat River was built in 1888, located approximately one mile upstream from the confluence of the Entiat and Columbia Rivers.*

The Bureau of Fisheries (BOF 1936) recognized the significance of this structure and provided this information about the dam’s effects on fish passage: “The following information was received from Mr. George Wolf, a resident of Entiat since 1895. ‘In May and June a very excellent run of salmon entered the Entiat in the early years. In [1889] a dam was built at a saw-mill site about 1 mile above the mouth of the river, which partially stopped salmon from ascending to their spawning grounds. A crude fish ladder was built in the dam to allow fish to pass upstream. A new dam was built shortly thereafter, constructed of logs, which entirely cut-off the free passage of fish upstream. In 1904 the last good run of [C]hinooks entered the Entiat, and following that year a rapid decline took place until only a few [C]hinooks appeared in the stream. The same conditions exist today [1935]. No information is available as to when the dam was removed.’”

## FISH AND FISHING IN THE ENTIAT – 1900 TO 1939 – RECREATIONAL FISHING AND TIMBER MANAGEMENT

A review of the literature produced a modest published record of fish and fishing in the Entiat River watershed between 1900 and the 1939. The record illustrates a period of transition in the quantity, quality, and composition of catch. In the very early 1900's, fisheries were predominantly for native salmon, trout, and steelhead. As early as 1919 the river was closed to the taking of salmon, and by 1933 the river, tributary streams, and lakes in the Entiat River watershed were being heavily stocked with both trout and steelhead. Eastern brook trout, rainbow trout, and cutthroat trout were planted in large quantities in both lakes and streams in the watershed (see Appendix A). Between 1900 and 1939 subsistence fishing was largely replaced with a culture of recreational sport-fishing which emerged in the Entiat River, like other river systems in Washington State. The sport-fishery was supported mainly by methods used to artificially enhance trout and steelhead population levels with stocking of hatchery fish.

Habitat changes were also taking place in the Entiat River watershed. By the year 1925 runs of Chinook salmon and steelhead were practically exterminated by the construction of small dams and other habitat altering activities in the watershed (Bryant and Parkhurst 1950, Mullan et al. 1992). For example, Gray's dam and another dam built across the Entiat River at the Kellogg Mill site in 1913 posed barriers to fish passage through at least 1932 (BOF 1936), precluding salmon and steelhead passage and use of the Entiat River for three decades.

The combined effects of harvest, habitat alteration, and mass stocking of native and non-native salmonid species significantly changed the composition of fish populations and sustainable fishing opportunities in the Entiat River watershed between 1900 and 1939.



*This 1939 Bureau of Fisheries photograph show salmon congregate near there release point. Photograph provided courtesy of Oregon State University (OSU) Archives (2007).*

### **Species composition**

The composition of fish caught in the Entiat River between 1900 and 1939 changed significantly from capture of predominantly native trout and salmon between 1900 and 1920 to capture primarily of stocked trout between 1920 and 1939. Table 4 provides a list of fish identified in the literature as present or captured in the Entiat River watershed between 1900 and 1939.

**Table 4 - Species names used in documents characterizing fisheries between 1900 and 1939.**

<b>Name used in Historical Text</b>	<b>Most Likely Species</b>	<b>Species Common Name</b>
Salmon (in June)	<i>Oncorhynchus</i>	Salmon
Dolly Varden	<i>Salvelinus confluentus</i>	Bull trout
Cutthroat trout	<i>Oncorhynchus clarki lewisi</i>	Westslope cutthroat trout
Speckled beauties	<i>unknown</i>	may be bull, brook, cutthroat or rainbow trout
Eastern brook trout	<i>Salvelinus fontinalis</i>	Eastern brook trout
Steelhead trout	<i>Oncorhynchus mykiss</i>	Steelhead

Notes: Best professional judgment was used to identify species by scientific name and common name based on colloquialisms and common names used in historical documents. Salmon captured in June were assumed to be spring Chinook.

### **Subsistence and recreational fishing**

A comprehensive history of the first 25 years of development in the Entiat River Watershed was published by the Wenatchee Daily World. The record included testimony to healthy salmon and trout habitat and populations in the Entiat River. The October 27, 1911 issue stated that: “The stream was alive with salmon during the season and the upper river and side streams serve as trout preserves.” This situation persisted for several years, as recorded in the June 12, 1913 issue of The Entiat Times. The Times reported that “Several fine salmon were taken from the Entiat by lucky fishermen during the past week. Ed Gurnsey caught a 7-pound Dolly Varden trout in the Entiat below Gray’s mill Tuesday.”

As mentioned earlier, the abundance of native salmon and trout stocks began to change noticeably and the decline in these populations led to official closures. By 1919 salmon could no longer be legally captured and retained in the Entiat River. A public notice published in the June 2, 1919 issue of the Wenatchee Daily World stated:

“ENTIAT RIVER CLOSED FOR TWO YEARS.

No Food Fish to Be Taken From Stream During That Time. The State game warden’s office has promulgated an order that no food fish be taken from the Entiat River for two years beginning Jun 1, 1919 and ending Jun 21, 1921. According to the usual interpretation of the term ‘food fish’, this means that game fish may be caught but no salmon, halibut, sturgeon, and other fish of that class. There may not be any of those other in the Entiat except the salmon, but these are the fish mentioned as ‘food fish’.”

Consistent with provision for the continued capture of game fish, records indicate that sportfishing continued through the summer of 1919. In an article entitled “Playground of the Entiat Described”, the August 20, 1919 issue of the Wenatchee Daily World reported that a Mr. Potter of the Entiat Camp caught “five speckled beauties that averaged from one and a half to two pounds” from Box Canyon.

### ***Types of species and quantities harvested***

Aside from anecdotal records of salmon captures in the Entiat River in 1911 and 1913, no documentation of salmon fisheries or salmon harvest rates could be found for the Entiat River. In 1934 the Bureau of Fisheries (BOF 1936) reported finding “fair numbers” of rainbow trout, Eastern brook trout, and Dolly Varden [bull trout], while cutthroat trout and steelhead were found to be scarce. The BOF (1936) report further stated that “Steelhead are reported to be taken occasionally as far upstream as Silver Creek. The run of steelhead in the river is exceedingly light with the best catches probably below the Harris mill dam.” They reported no fish species as either “abundant” or “very abundant”. Lastly they reported that catches of Dolly Varden [bull trout] ranged in size between 8 to 10 inches, with the maximum range of rainbows trout being 12 inches and Eastern brook trout being 11 inches, citing as the source of these remarks an interview on 11/13/1934 with a Mr. Scofield, ex-county game warden.

The BOF (1936) concluded that “Fishing in the Entiat is generally regarded as good, although on the decline .... A number of sports fishermen were questioned relative to the run of [C]hinooks in the Entiat in recent years. They claim that in the past ten years [mid-1920s to mid-1930s] this species has not been noted in the river.” An exception to this was the statement of claim of one individual who claimed that a “few [C]hinooks spawned in the area known as the Stillwater in 1934. No [C]hinooks were observed in the river during the survey in 1935.... Local sportsmen consider Mad River as the principal steelhead stream in the Entiat system, though even here the fish have become exceedingly scarce.” (BOF 1936)

### ***Changes to habitat conditions***

Mullan et al. (1992) reviewed factors associated with settlement in the Upper Columbia River basin that could potentially have affected salmonid production and habitat, including: mining, grazing, logging and roads, wildfire, sedimentation, stream stability and riparian vegetation, stream alteration, agriculture/irrigation, contaminants, dams and diversions, impoundments, predation, genetic alternation and loss, and hatcheries. For more information about the potential effects of these actions on habitat in the Entiat River watershed, see Chapter 6 in Mullan et al. (1992).

Mullan et al. (1992) were emphatic, however, about the negative effects of dams and diversions on salmon and steelhead habitat and populations, stating that “[t]urn-of-the-century sawmill, hydroelectric, and



*The McKenzie irrigation diversion on the Entiat River located near the confluence of the Entiat River and Potato Creek, approximately river mile 16. 1939 photograph courtesy of OSU Archives (2007).*

irrigation diversion dams devastated salmon (Appendix H; Fish and Hanavan 1948; Bryant and Parkhurst 1950).” They clarified, though, that “[i]rrigation diversions have been screened since the 1940s, and early ‘light bulb’ plant and sawmill dams disappeared before 1940”. Observations made by the BOF (1936) of the effects of dams across the Entiat River at the Harris Mill site and Kellogg Mill sites substantiate the claims made by Mullan et al. (1992).

#### Harris Mill site:

The BOF (1936) observed that “[c]oncrete fish ladder at [Harris Mill] dam [built in 1930] inefficient for passage of fish. Greatest attraction for ascending fish is middle and west portion of river where spillway of dam is located. Very little attraction at fish ladder located on east side of dam.” During a visit on 5/5/1937 the BOF noted that “[d]uring low water, the water in ladder is reported to fall on bare rock, making it practically impossible for fish to enter. It is also reported that no attempt is made to keep the ladder clean...A few steelhead are said to ascend over the dam. On the date of observation the dam was virtually an impassable barrier.”

#### Kellogg Mill site:

The BOF (1936) observed that “[t]his [Kellogg Mill] dam was built in 1913, burned 1917” and that “[t]he remains of this dam serve as a definite barrier to migrating salmonids. On the date of observation, the high water made it possible for steelhead to pass over with difficulty.” The BOF then explain that “[s]portsmen at Entiat, WA, have [in 1932] dynamited a passage way in the east side of [Kellogg Mill] dam for anadromous fish. Further work is necessary to make passage more accessible for ascending fishes. West side of dam proves an obstacle for free passage of fishes.”

Logging activity and associated road development began in the lower Entiat River watershed in the early 1900s, with Mills Canyon and Mud Creek being two of the first major tributaries to be developed (USFS-WNF 1996).

### **Stocking**

The State of Washington got into the hatchery business in 1903 with the opening of a hatchery on Lake Chelan (Trotter 2001). Initial source of eggs included Westslope cutthroat trout from Lake Chelan and the Stehekin River.

The June 12, 1913 issue of The Entiat Times reported that 250,000 trout from the Spokane fish hatchery were deposited in the Entiat River. The report indicated that fish were planted in the Kellogg Lumber Co. mill pond and other “bits of still water up the river.” In historical notes, Gib Roundy recalled that in 1914, Charlie Duncan packed cutthroat trout from Mad Lake and put them in Two Little Lakes [in the headwaters of Tommy Creek] and word of this never got out until 1924 by which time the fish were 16 inches. On Jan 29, 1915 the Entiat Times report that the Entiat River was planted with 310,000 trout from a Seattle hatchery. On March 3, 1920, The Wenatchee Daily World published an article titled “MILLIONS OF TROUT PLACED IN CHELAN COUNTY STREAMS” which included 10,000 eastern brook trout and 150,000 steelhead trout in the Entiat River and 10,000 steelhead trout in the North Fork Entiat River.

Trotter (2001) also noted that trout were stocked in the mainstem Entiat River in 1915. State funded hatcheries provided a mix of rainbow, cutthroat and brook trout to be stocked into the Entiat River in most years from 1915 until 1933, and annually thereafter until well past 1940. Trotter (2001) further

explained that the Entiat River was stocked quite extensively, including being one of the release streams for steelhead and salmon displaced by the construction of Grand Coulee Dam.

### Mainstem Entiat River

The following releases were found listed in various sources consulted:

- Westslope cutthroat trout (non-native Twin Lakes strain) were stock stocked in the Entiat River in 1915, 1917, 1918, 1934 through 1936 and dates thereafter detailed later in this report.
- Non-native rainbow trout were released annually beginning in 1933 through 1996.
- Non-native brook trout were annually stocked in the Entiat River from 1933 through 1938.
- Non-native summer-run steelhead were also stocked in the Entiat River in 1936, 1937, and dates thereafter, detailed later in this report.

### Mad River

The following releases in the Mad River are listed in Trotter (2001), including Mad River tributaries Indian (Tillicum) Creek and Cougar Creek:

- one release to the mainstem Mad River of Westslope cutthroat trout (non-native Twin Lakes strain) in 1915,
- releases into Indian (Tillicum) Creek of Westslope cutthroat trout (non-native Twin Lakes strain) in 1918 and dates thereafter identified later in this report, and
- one release in Cougar Creek of Westslope cutthroat trout (non-native Twin Lakes strain) in 1939.

### North Fork Entiat River

Eleven releases in the mainstem North Fork River are listed in Trotter (2001), including:

- Westslope cutthroat trout (non-native Twin Lakes strain) in 1918, 1936 and dates thereafter identified later in this report, and
- Rainbow trout in 1933, 1934, 1938, and dates thereafter identified later in this report.

No stocking records were found for South Pyramid or Grouse creeks, but Fern Lake was stocked with rainbow trout in years later than 1940, identified later in this report. Edson Dow (1963) wrote that in 1919 or 1920 "...fish were planted in [South] Pyramid Creek at the present trail ford...they were packed in by pack string over the old Pyramid Mountain trail...and on down a sheep drive way to the ford." State stocking records do not account for the efforts of such "bucket biologists" who stocked fish in the watershed. There is, therefore, no means to determine the potential effects of these actions on fish, fishing, and fisheries. This is the only written record we have found for a fish stocking practice that was widespread and may continue to the present day.

Figure 1 provides a summary of total trout and steelhead stocking activities in the Entiat River watershed between 1933 and 1939. Over 400,000 trout were stocked in the Entiat River in 1934, and between 75,000 and 200,000 trout and steelhead were stocked annually in the watershed in 1933, and 1935

through 1939. See also Appendix A for more details about the stocking of trout and steelhead in the Entiat River watershed.

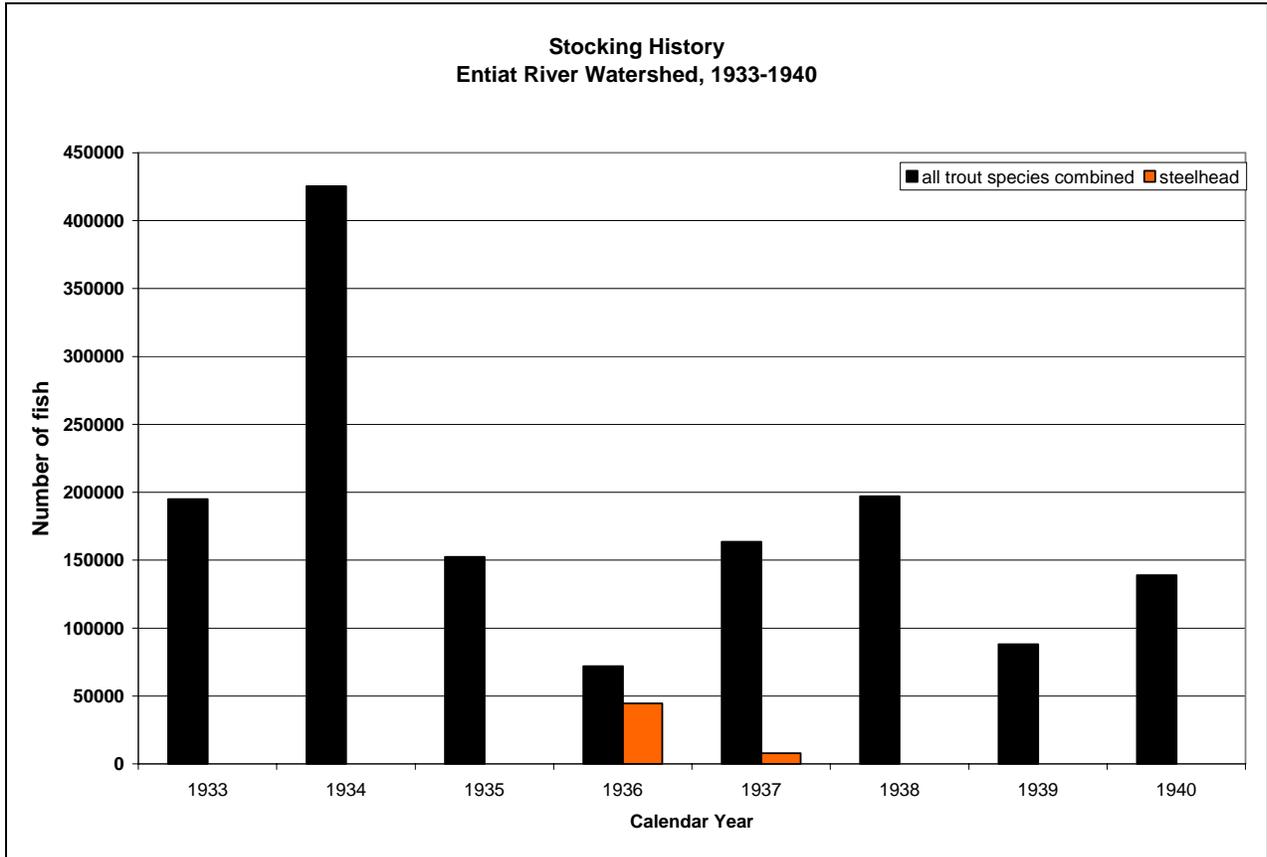


Figure 1 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1933-1940).

### Regulations

Record of fishing regulations is not readily available for the 1900 to 1939 period. The only record found of Entiat River fisheries regulation during this period was the previously mentioned 1919 state closure of salmon “food fish” fisheries.

## FISH AND FISHING IN THE ENTIAT – 1940 TO 1990’S – GRAND COULEE FISH MAINTENANCE PROJECT ERA

The construction of Rock Island Dam in 1933, Bonneville Dam in 1937, and Grand Coulee Dam in 1939 were significant events in the history of Columbia River and its tributary anadromous fisheries. The development of Rock Island and Bonneville dams in the 1930’s were significant because they ushered in an era of hydroelectric power development, impounding the free-flowing Columbia River and dramatically changing habitat and passage conditions for anadromous species. These structures, however, provided for the passage of anadromous species, whereas the Grand Coulee Dam did not. With the completion of construction in 1939 and opening of Grand Coulee Dam in 1942, salmon, steelhead and other migratory species



*King Weber analyzing Entiat River water chemistry during the early years of the Grand Coulee fish maintenance project. Photograph provided courtesy of OSU Archives (2007)*

lost access to over 1000 miles of the Upper Columbia River and numerous tributary streams, significantly changing species composition and fishery management programs throughout the Columbia River basin.

Recognizing the losses caused by Grand Coulee dam, Federal authorities created the Grand Coulee Fish Maintenance Project (GCFMP), with the goal of maintaining production of salmon and steelhead in the Wenatchee, Entiat, Methow and Okanogan Rivers. In 1942 the Entiat National Fish Hatchery was constructed by the US Bureau of Reclamation to mitigate for lost fish production above Grand Coulee dam. The hatchery is located on the Entiat River near its confluence with Roaring Creek. Artificial fish production at ENFH began in 1942; between 1940 and 1990 the Entiat River was stocked with salmon and steelhead produced at the hatchery and other facilities supporting GCFMP objectives. GCFMP efforts, combined with ongoing steelhead and trout stocking programs designed to enhance recreational sportfishing, resulted in significant introductions of non-native fish stocks in the Entiat River watershed.

Between 1940 to 1990 fisheries in the Entiat River continued to transition from remnant, native trout, salmon and steelhead species sustained by natural habitat and reproduction to fisheries targeting artificially enhanced populations of non-native species, primarily produced either at the ENFH or released out planted into the Entiat River from other hatcheries. Changes in habitat quantity and quality also continued in the Entiat River watershed, often associated with significant events such as fire and flooding, but also occurring gradually as development by humans occurred.

### **Species composition**

The composition of fish caught in the Entiat River between 1940 and 1990 included mostly anadromous salmonids (spring Chinook salmon and steelhead from both naturally reproducing and hatchery origin stocks) and trout (e.g. rainbow, cutthroat, bull, and brook trout) and whitefish captured by recreational sportfishers. Coho salmon were once relatively abundant in the Entiat River watershed, but by 1941 the Entiat River coho run was “practically exterminated” (Craig and Suomela 1941). Eastern brook trout,

rainbow trout, cutthroat trout, and steelhead were stocked and fished in the Entiat River throughout the 1940s. After this time, catchable-sized rainbow and steelhead were the primary species stocked annually and targeted by recreational sportfishers through 1990. Sufficient spring Chinook returns resulted in fisheries on this species beginning in 1986. Bull trout were likely over harvested as a result of elevated trout fishing pressure in the Entiat and Mad Rivers, caused by the stocking of trout and steelhead in the watershed (WDFW 2004).

**Table 5 - Species names used in documents characterizing fisheries between 1940 and 1990.**

Species	Species Common Name
<i>Oncorhynchus tshawytscha</i>	spring Chinook
<i>Oncorhynchus mykiss</i>	Steelhead
<i>Oncorhynchus mykiss</i>	Rainbow trout
<i>Oncorhynchus clarki lewisi</i>	Westslope cutthroat trout
<i>Salvelinus confluentus</i>	Bull trout (char)
<i>Salvelinus fontinalis</i>	Eastern brook trout (char)

Please see pages 7-11 through 7-33 of the Entiat WRIA Management Plan (CCCD 2004) for more information on fish and fish habitat in the Entiat subbasin. The WRIA 46 Management Plan provides additional details about salmonid population levels, and changes in habitat and species composition from 1940 to present (see CCCD 2004).

### **Subsistence and recreational fishing**

By 1940 subsistence fisheries in the Entiat River watershed had ended. Recreational sportfishing flourished in the Entiat River watershed between 1940 and 1990 due largely to annual stocking efforts. Salmon and steelhead were fished in the mainstem Entiat River and trout were fished throughout the watershed, including high-elevation lakes.

Ralph Holtby, a Wenatchee National Forest Entiat Ranger District biologist, conducted an Entiat River Fisheries Survey (USFS-WNF 1968) and concluded: “Characteristically, this type of a stream is a low producer capable of perpetuating a very limited number of ‘native’ fish. Because of the increase in fishing pressure during the last 40 years, the native fish once found in the bag limit has diminished to less than five percent of the total catch. The remaining 95 percent of today’s catch is made up of planted trout placed in the river by the Washington Game Department for a ‘put and take fishery’. About 30,000 legal rainbow are planted in this stream annually.” and “The Entiat River fishery will be maintained by a ‘put and take’ planting program”. Holtby (in USFS-WNF 1972) was convinced that increased fishing pressure over the last 25 to 30 years (post-World War II to 1970) necessitated an annual planting program.

The recreational fishery of the late 1960s through early 1970s was described by Holtby as follows: “Rainbow trout 8”-9” in length are planted in the Entiat River. The yearly quantity has been about 20,000 rainbow for the Entiat River and 5,000 rainbow for the Mad River. It is unlikely that this quantity will be increased over the next 15 years unless fishing pressure rises considerably. Present pressure on the Entiat River as compared with other local rivers is light for winter steel-heading and moderate for other sport fishing.”

It appears that demand was increasing for recreational fishing in the early 1970s. Holtby (in USFS-WNF 1972) surveyed 11 sites in the Entiat Valley between Mud Creek and Cottonwood with an interest in

potential expansion of recreational fishing opportunities. Holtby (in USFS-WNF 1972) reported: “The Washington State Game Department has been actively acquiring stream bank easements along the Entiat River [map included]... Most of the easements are 25’ wide with varying length from a few hundred feet to two miles. The Albert Long easement is a notable one as it is nearly two miles long.”

### ***Types of species and quantities harvested***

Brook, rainbow, cutthroat, and steelhead were stocked and fished in the Entiat River through the 1940s, after which time catchable-sized rainbow and steelhead were the primary species stocked and fished. Bull trout were likely over harvested as a result of elevated trout fishing pressure in the Entiat and Mad Rivers, caused by the stocking of trout and steelhead in the watershed (WDFW 2004).

Numbers of species caught are not generally available for Entiat River fisheries, as creel surveys were not routinely conducted; however, some bits and pieces of catch info have been found: “...good catches of Eastern brook and a few rainbow trout have been reported by trail crew members at the mouth of Ice Creek and up to the first falls in the gorge. As far as is known, fish have never been caught above the gorge” (A. Johnson in USFS-WNF 1967). “Because of a lack of access to the river, they [WA Dept. of Game] have to dump their fish in just a few select places” (R. Holtby in USFS -WNF 1972).

Eldred (1975) reported that the average Entiat River steelhead catch was 108 fish per year for the period 1964-74 and represented approximately 500 angler-days of recreational fishing per year. The maximum catch (284 steelhead) reported for that time period occurred in 1971 and represented approximately 1,300 angler-days of fishing. Eldred (1975) attributed these steelhead catches to the steelhead smolt stocking program instituted in the Entiat in 1964.

Eldred (1975) also reported that the annual plants of approximately 25,000 catchable trout in the Entiat and Mad Rivers provided 2,500 angler-days of recreation. In the mid-1960s this changed due to a reduction in the number of fish stocked by Chelan PUD-funded mitigation programs. The number of rainbow trout stocked was lowered to approximately 10,000 rainbow trout per year which yielded approximately 1,000 angler-days of recreational fishing. Eldred (1975) noted that “the attractive size of the [planted] fish sustains a disproportionate angling interest, at a lower catch/angler-day rate, even though far fewer fish are planted” [since 1964].



*Fish biologists (Holland and Frey) rescue out-migrant Chinook from Entiat River “side pockets” in 1940. Photo provided courtesy of OSU Archives (2007).*

The Columbia River Fish Runs and Fisheries Status Report: 1938-1999 (ODFW and WDFW 2000) provides an accounting of anadromous species returning to the Columbia River and Entiat National Fish Hatchery. Spring Chinook returns to the Entiat National Fish Hatchery are provided in Table 6. Another fisheries management document, The Entiat River Subbasin Salmon and Steelhead Production Plan (WDF 1990), summarizes hatchery releases and harvest of spring Chinook, steelhead from the 1970s to 1990. Please note in Table 6 that run sizes are similar for most years, but are not reported as the same in the two documents. Please also note that harvest of spring Chinook in the Entiat River is not recorded for years prior to 1986, because returns of spring Chinook prior to this year were insufficient for a fishery.

**Table 6 – Returns of spring Chinook salmon to the Entiat National Fish Hatchery and harvest between 1980 and 1990.**

Year	Adult returns <sup>1</sup>	Jack Returns <sup>1</sup>	Total Returns <sup>1</sup>	Hatchery Returns <sup>2</sup>	In-River Harvest <sup>2</sup>
1980	279	26	305	305	0
1981	247	0	247	247	0
1982	236	11	247	247	0
1983	660	0	660	242	0
1984	753	55	808	660	0
1985	912	0	912	793	0
1986	955	14	969	959 <sup>3</sup>	100
1987	813	0	813	n.a.	n.a.
1988	662	27	689	n.a.	n.a.
1989	669	0	669	n.a.	n.a.
1990	581	2	583	n.a.	n.a.

<sup>1</sup> Source - ODFW and WDFW 2000), <sup>2</sup> – Source WDF 1990 (no data provided for 1987 through 1990), <sup>3</sup> – Run size only represents estimate of hatchery production for 1986.

The WDFW (2006) published *Oncorhynchus mykiss: Assessment of Washington State’s Anadromous Populations and Programs*. The report includes a summary of Entiat River summer steelhead run size and sport harvest between 1978 and 2006. Table 7 provides a summary of summer Steelhead run size and harvest between 1978 and 1990, based on figures in WDFW (2006).

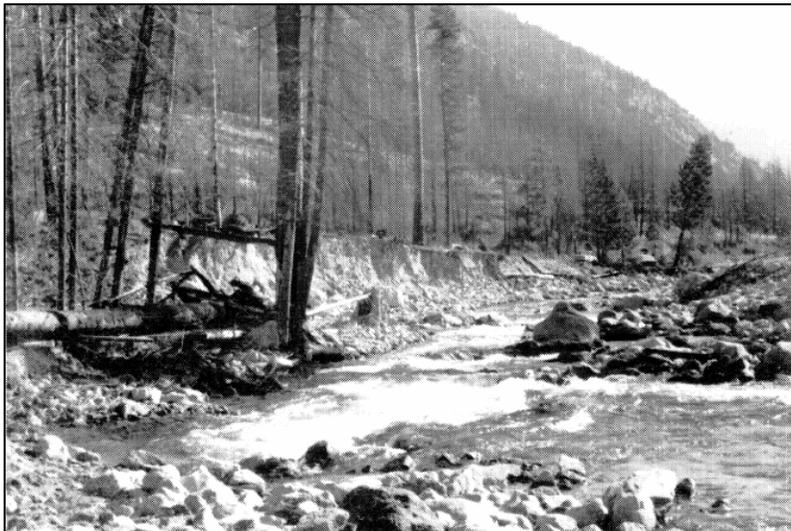
**Table 7 – Returns of summer Steelhead to the Entiat River and harvest rates between 1978 and 1990.**

Year	Hatchery Fish Returns	Wild Fish Returns	Total Returns	In-River Harvest
1978			786	8
1979			1463	64
1980			888	43
1981			1641	88
1982			1843	69
1983			1190	174
1984			1038	120
1985			3002	183
1986	1904	88	1992	118
1987	1745	343	2088	44
1988	1122	150	1272	114
1989	1304	183	1487	24
1990	1098	106	1204	19

**Changes to habitat conditions**

Changes in habitat quantity and quality between 1940 and 1990 continued in the Entiat River watershed as the result of significant, catastrophic events such as fire and flooding as well as gradual, incremental changes associated with development by humans.

On June 8, 1948 the flood of record (~10,800 cfs) swept through the Entiat River valley. The flood washed out the last remaining dam on the Entiat River (Ardenvoir Mill dam), and damaged steambanks and levee systems along the river (CCCD 2004). In 1949 the USACE repaired some of the damaged levees (CCCD 2004). In subsequent years the USACE performed



*Entiat River downstream from Fox Creek, 1972. Note heavy streambank erosion from Entiat River flooding and debris flows from Fox Creek. Photo provided courtesy of USFS-Wenatchee National Forest (1972).*

additional work to address flooding in the lower 10 miles of the Entiat River, resulting in the further simplification of channel shape and habitat conditions throughout the lower river. Additional flooding, erosion and mass-wasting events occurred in 1972, twice in 1977, and 1989 following the 1970 Entiat Fires, the Crum Canyon Fire of 1976, and the Dinkelman Canyon Fire of 1988. These natural events,

combined with stream clean-outs such as the removal of 10 miles of river debris by the USACE in April 1971 (CCCD 2004), caused pool in-filling and greater stream habitat simplification.

In 1968 Wenatchee National Forest staff characterized habitat as follows:

“To place the Entiat River fishery on a more sustained yield basis (producing native fish) would not be economical at this time [1968]. A habitat improvement program aimed at providing the planted trout with more holding pools would be the logical approach to enhancing the Entiat River. Increasing the number of pools per mile of riffle would provide the planted fish with better habitat in which to survive and also offer the fisherman a more appealing type of trout stream to fish. At present, the stream has few pools for holding trout and the fisherman must fish low quality trout habitat.” (WNF 1968)

The WNF (1968), therefore, recommended more fish “holding” water be created by deflectors, boulder retards, anchored logs, and other stream improvement devices. In 1972 WNF biologists further identified habitat attributes that would need to be restored to protect and restore Entiat River salmon fisheries:

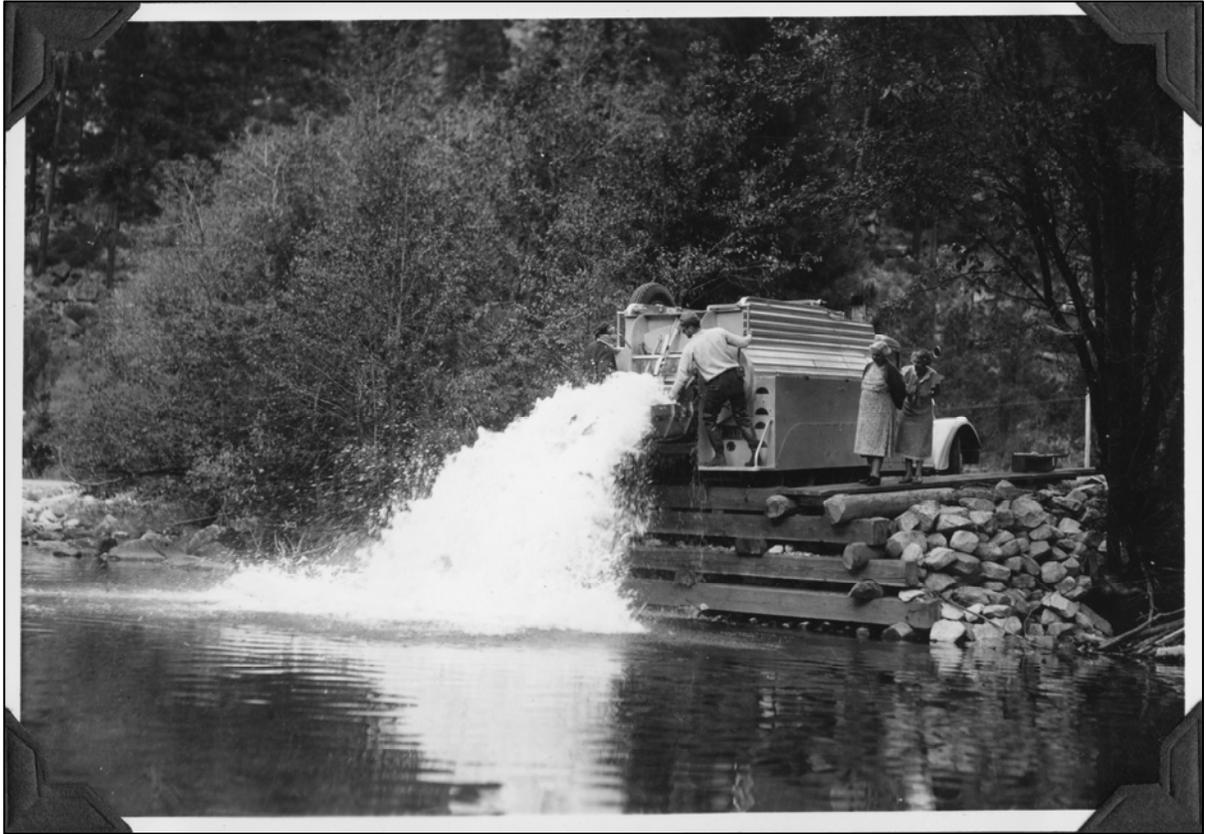
“During the spring of 1972, a tremendous amount of silt was deposited in the river which has virtually rendered useless stretches of the river that were once prime Chinook spawning areas. Most of the spawning gravel has been buried by one to two feet of silt. Unless silt can be removed from these areas, the Entiat River will loose [sic] its spring Chinook salmon run” (Holtby in USFS-WNF 1972).

In 1995 the Natural Resource Conservation Service (NRCS) Stream Team surveyed the Entiat River between River Mile (RM) zero (0) and RM 20.2. When compared with surveys of the Entiat River completed in the 1930’s (BOF surveys), it was apparent that significant changes in geomorphology (channel shape and habitat forming processes) had occurred, resulting in habitat simplification. Between 60% and 90% of the primary pool habitat was lost in the Entiat River (CCCD 2004, 1998). Other changes in habitat quality and quantity such as loss of off-channel habitat, habitat complexity, and floodplain function are well documented in a number of habitat analysis reports (e.g. Andonaegui 1999, CCCD 2006, 2004, 1998; Erickson 2003, Moberg, Inc. 2003, UCSRB 2006). These findings seem to confirm earlier observation of the WNF, and suggest that little had been done to protect and restore fish habitat conditions between 1940 and 1990.

### **Stocking**

The State of Washington stocked hatchery raised trout in the Entiat River watershed continuously from 1940 through 1990. The Federal government joined in hatchery operations in the Entiat River watershed with the opening of the Entiat National Fish Hatchery (ENFH) in 1942. The ENFH began fish culture operations in 1942 and began to release fish to the Entiat River soon thereafter.

State funded hatcheries provided a mix of rainbow, cutthroat and brook trout to be stocked into the Entiat River annually until well past 1940. Trotter (2001) further explained that the Entiat River was stocked quite extensively, including being one of the release streams for steelhead and salmon displaced by the construction of Grand Coulee Dam.



*Salmon were captured at Columbia River dams and transplanted to the Entiat River (photo above) and other sites as part of the salmon reclamation portion of the Grams Coulee Fish Maintenance project. This 1939 photograph was provided courtesy of OSU Archives (2007).*

### Mainstem Entiat River

The following releases were found listed in various sources consulted:

- The ENFH first released summer Chinook to the mainstem Entiat River from 1942 to 1944. No spring Chinook were released to the Entiat between 1945 and 1975.
- The ENFH secured eggs for hatchery production from a variety of sources including:
  - Commingled upriver stocks (1939-1943)
  - Methow River (1944)
  - Carson National Fish Hatchery (1944)
  - Entiat River (1946-1964)
  - Spring Creek National Fish Hatchery (1964)
  - Wells Dam (1974)
- The ENFH began producing and releasing spring Chinook in the Entiat River in 1975, and have only reared and released spring Chinook to the Entiat River between 1976 and 1990 (and dates thereafter identified later in this paper).
- Spring Chinook egg sources at the ENFH included:

- Several lower Columbia River sources (USFWS 2002)
- Leavenworth National Fish Hatchery
- Winthrop National Fish Hatchery
- Westslope Cutthroat Trout (non-native Twin Lakes strain) were stock stocked in the Entiat River in 1941, 1944, 1945, 1947, and 1974.
- Non-native rainbow trout were released annually from 1940 through 1990 as well as dates thereafter identified later in this paper.
- Non-native summer-run steelhead were also stocked in the Entiat River in 1949, 1964, 1967 through 1972 and 1974 through 1990 as well as dates thereafter identified later in this paper.
- From 1964 - 1994 the Chelan PUD provided funding to rear rainbow trout for annual release into Entiat. After 1994 all trout stocking was ceased in the Entiat River (personal communication Art Viola 2006, WDFW area fish biologist).

#### Mad River

The following releases in the Mad River are listed in Trotter (2001), including Mad River tributaries Indian (Tillicum) Creek, Cougar Creek, and Mad Lake:

- Annual releases of rainbow trout into the Mad River from 1981 through 1984 and 1986 through 1990, as well as dates thereafter identified later in this paper,
- one release into Indian (Tillicum) Creek of Westslope Cutthroat Trout (non-native Twin Lakes strain) in 1973,
- releases of non-native rainbow trout into Indian (Tillicum) Creek in 1940 through 1944 and 1947,
- one release of non-native Eastern Brook Trout into Tillicum Creek in 1973, and
- two releases into Mad Lake of Westslope Cutthroat Trout (non-native Twin Lakes strain) in 1950 and 1973.

#### North Fork Entiat River

Eleven releases in the mainstem North Fork River are listed in Trotter (2001), including:

- one release of Westslope Cutthroat Trout (non-native Twin Lakes strain) in 1941,
- releases of non-native rainbow trout in 1941 through 1944 and 1948.
- Fern Lake, in the headwaters of the North Fork Entiat River, was stocked with non-native rainbow trout in 1948, and
- releases into Fern Lake of Westslope Cutthroat Trout in 1955 (non-native Tokul Creek Hatchery source), 1966 (non-native Twin Lake strain), and 1977 (non-native Twin Lake Strain). The 1955 stocking with Tokul Creek Hatchery fish may have been Twin Lakes strain or a strain specific to

the Tokkul Creek Hatchery. The record does not specify which of these strains was stocked in Fern Lake in 1955.

Figure 2 illustrates the total steelhead and trout stocking history between 1940 and 1990. Fish were continuously stocked during this period. Greater numbers of trout were stocked from 1940 to 1950 as compared with later decades. Also, please note that steelhead trout were stocked in the Entiat River on an annual basis beginning in 1964 (Eldred 1975), and continuing through 1990.

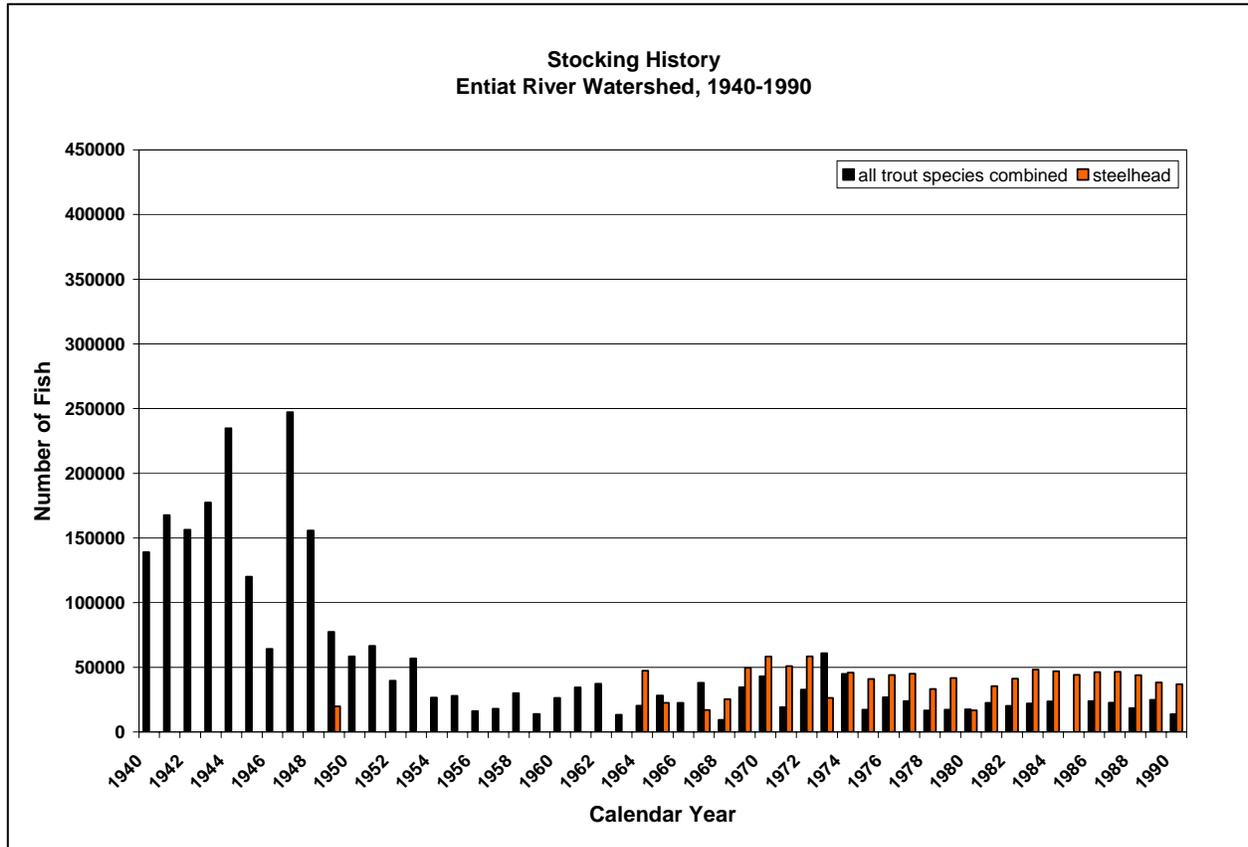


Figure 2 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1940-1990).

**Regulations**

Between 1940 and 1990 regulations did not significantly impair fishing and fisheries opportunities within the Entiat River watershed. Regulations such as bag limits, fishing seasons, gear restrictions were instituted to allow for a sustained fishery in the watershed. From 1940 to 1990 the Entiat River watershed generally had regular openings for fishing of spring Chinook, steelhead, trout (including bull trout), whitefish, and other species. However, closures and restrictions on anadromous salmonid commercial and sport fisheries in the Columbia River changed significantly between 1940 and 1990. See pages 103 through 107 of the *Columbia River Fish Runs and Fisheries Status Report: 1938-1999* (ODFW and WDFW 2000) for a chronology of significant Columbia River fishery management events.

## **PRESENT-DAY DISTRIBUTION, ABUNDANCE, AND POPULATION TRENDS OF FISH SPECIES**

The most current illustrations of the distribution of salmonid species of interest in the Entiat River watershed species are found on Pages N-1 through N-5 of Appendix N of the Entiat WRIA Management Plan (CCCD 2004). There are illustrations of the distribution of late-run (summer) Chinook, spring Chinook, Steelhead/rainbow trout, bull trout, and cutthroat trout. Brook trout remain relatively abundant in the upper Entiat River (above Entiat Falls) and in Myrtle Lake, but populations are dominated by stunted fish.

Abundance of certain species has declined, and commingling (mixing) of healthy populations with runs that have low population numbers has resulted in the closure of fishing in the watershed from RM 0 to RM 34 at Entiat Falls. The primary reason for closure of fisheries in the Entiat River is to protect naturally reproducing spring Chinook salmon, steelhead, and bull trout that were listed for protection under the U.S. Endangered Species Act in the late 1990's. Naturally reproducing spring Chinook salmon and steelhead populations that utilize the Entiat River are currently not showing significant improvements in population levels that would lead to delisting and re-opening of fisheries. In addition, because the ESA-listed fish that are found in the Entiat River are part of larger Upper Columbia region populations, improvements to overall fish population levels in the Upper Columbia – not just the Entiat River – must happen before species down-listing (e.g. change from endangered to threatened) or de-listing may occur. Mad River bull trout populations appear to have improved following the fishing closure, but the fishery is not expected to reopen in the near future due to the fact that they are part of the Columbia River population that is listed under the ESA.

### **CONTEMPORARY FISHERIES**

Contemporary fishery opportunities and challenges in the Entiat River watershed are many and varied. The lower Entiat River and the lower Mad River are currently closed to most fishing in order to protect salmonid species listed under the U.S. Endangered Species Act (ESA). It is necessary to address priority fishery management concerns of local citizens, tribes, and state and federal resource managers within existing regulatory frameworks in order to restore self-supporting, sustainable fisheries in the Entiat River watershed and the region.

This section of the report provides definitions for key terms including “species” and “take”, and describes regulatory and permitting considerations required to enable and operate fisheries when ESA-listed species are present in a stream. Legal processes and authorities used to establish fisheries, and the importance and function of ESA Section 10 permitting, escapement (run size) estimation, harvest allocation, monitoring and enforcement, and reporting are noted in this section as part of current-day fisheries management considerations. Summaries are offered of challenges caused by ESA listing on salmonid stocks, including effects on stocking activities, processes to open and manage a fishery, and policies and programs to recover the species and their habitat.

Executive summaries are also provided describing policies, plans, programs and goals of the fishery co-managers (Yakama Nation and WDFW) and regulatory and resource management agencies (e.g. NMFS, USFWS, WDFW) in their efforts to protect and recover threatened and endangered salmonids in the Entiat and Mad River watersheds. Information, reports and data referenced in this paper include reports of the USFS, USFWS and WDFW such as the Salmon and Steelhead Stock Inventory (SASSI), Salmon and Steelhead Habitat Limiting Factors (SSHLF) report, Bull Trout Recovery Plan, the Entiat Sub-Basin Plan, Upper Columbia Salmon Recovery Plan, and various products of the fisheries co-managers and Interior Columbia Technical Recovery Team (TRT). The intent of this section is to provide a solid

foundation of information about the complex regulatory and policy frameworks that exist and how they collectively define the fisheries management decisions that are made.

## **ENDANGERED SPECIES ACT AND FISH LISTINGS IN THE ENTIAT RIVER WATERSHED**

### ***Endangered Species Act***

The Endangered Species Act (ESA) of 1973 was created to protect fish, wildlife and plant species that are determined to be in danger of or threatened with extinction. The ESA is administered by the Department of the Interior's (DOI) U.S. Fish and Wildlife Service (USFWS) and the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS). The USFWS has primary responsibility for recovery of terrestrial and freshwater aquatic species, including bull trout, while NMFS has jurisdiction over marine species, including salmon and steelhead. The purpose of the ESA is to protect threatened or endangered (T&E) species and to provide a means for conservation of their ecosystems. Federal agencies are required to utilize their authorities to further the purposes of the ESA. They are also required to cooperate with State and local agencies to address other resource management issues in concert with conservation of T&E species. States, local governments, and individuals are also subject to the provisions of the ESA, including the prohibition of harm or "take" of T&E species.

Consequently, any efforts to restore fisheries in streams of the Entiat River watershed where spring Chinook, steelhead, or bull trout are present must be scrutinized for consistency with the ESA and recovery goals, because fisheries have the potential to affect these protected species.

### **Endangered Species Act Definitions (Source USFWS 2007b)**

The following definitions are provided to clarify the meaning of terms commonly used when discussing the Endangered Species Act. These terms and others (Appendix B), were made available over the web by the USFWS (2007b).

**Biological Assessment (BA)** - A document prepared for the Section 7 consultation process to determine whether a proposed major construction activity under the authority of a Federal action agency is likely to adversely affect listed species, proposed species, or designated critical habitat.

**Biological Opinion (BO)** - A document that is the product of formal consultation, stating the opinion of either NMFS or USFWS on whether or not a Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

**Consultation** - All Federal agencies must consult with the USFWS or NMFS when any activity permitted, funded, or conducted by that agency may affect a listed species or designated critical habitat, or is likely to jeopardize proposed species or adversely modify proposed critical habitat. There are two stages of consultation: informal and formal. See Section 7, Section 7 Consultation.

**Critical habitat** - Specific geographic areas, whether occupied by listed species or not, that are determined to be essential for the conservation and management of listed species, and that have been formally described in the Federal Register.

**Down-list** - The process of downgrading, e.g. changing from Endangered to Threatened) the status of an animal [fish] or plant on the list of Endangered and Threatened Wildlife and Plants.

**Delist** - The process of removing an animal or plant from the list of Endangered and Threatened Wildlife and Plants.

**Distinct Population Segment (DPS)** - If it satisfies the criteria specified in the February 7, 1996, Federal Register, pages 4722-4725, a portion of a vertebrate (i.e., animals with a backbone) species or subspecies can be listed. The criteria require it to be readily separable from the rest of its species and to be biologically and ecologically significant. Such a portion of a species or subspecies is called a distinct population segment. Within this paper, this term specifically applies only to bull trout management.

**Endangered** - The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

**Evolutionarily Significant Unit (ESU)** – is a term introduced by NMFS, similar to “distinct population segment” used by the USFWS, is used to define a population of salmonids that is considered to be distinct for the purposes of species recovery purposes. In general, unique attributes of an ESU include at least one of the following: (a) geographic separation from other populations, (b) genetic differentiation caused by the historic restriction of gene flow, and (c) locally adapted phenotypic (external physical) characteristics.

**Extinct species** - A species no longer in existence.

**Extirpated species** - A species no longer surviving in regions that were once part of their range.

**Habitat Conservation Plan (HCP)** - A plan which outlines ways of maintaining, enhancing, and protecting a given habitat type needed to protect species. The plan usually includes measures to minimize impacts, and might include provisions for permanently protecting land, restoring habitat, and relocating plants or animals to another area. An HCP is required before an incidental take permit may be issued.

**Harm** - An act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation when it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.

**Incidental take** - Take that results from, but is not the purpose of, carrying out an otherwise lawful activity. See section 10 of the ESA for details.

**Listed species** - A species, subspecies, or distinct vertebrate population segment that has been added to the Federal lists of Endangered and Threatened Wildlife and Plants as they appear in sections 17.11 and 17.12 of Title 50 of the Code of Federal Regulations (50 CFR §17).

**Recovery** - The process by which the decline of an endangered or threatened species is arrested or reversed, or threats to its survival neutralized so that its long-term survival in nature can be ensured.

**Recovery plan** - A document drafted by the Service or other knowledgeable individual or group that serves as a guide for activities to be undertaken by Federal, State, or private entities in helping to recover and conserve endangered or threatened species.

**Section 7** - The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the Service, to insure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.

**Section 7 consultation** - the various section 7 processes, including both consultation and conference if proposed species are involved. [50 CFR §402].

**Section 10** - The section of the Endangered Species Act that lays out the guidelines under which a permit may be issued to authorize activities prohibited by Section 9, such as take of endangered or threatened species.

**Species** - From Section 3(15) of the Federal Endangered Species Act: "The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." A population of individuals that are more or less alike, and that are able to breed and produce fertile offspring under natural conditions.

**Take** - From Section 3(18) of the Federal Endangered Species Act: "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." See section 10 of the ESA for details.

**Threatened** - The classification provided to an animal or plant likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

### ***Salmonid Listings in the Entiat River Watershed***

Three species of fish are listed as either threatened or endangered under the ESA: bull trout, spring Chinook salmon, and summer steelhead:

#### Bull trout (char)( *Salvelinus confluentus*):

Upper Columbia River bull trout (*Salvelinus confluentus*) were listed as threatened on June 12, 1998.

#### Spring Chinook (*Oncorhynchus tshawytscha*):

Upper Columbia River spring Chinook salmon (*Oncorhynchus tshawytscha*), listed as Endangered on March 16, 1999

#### Steelhead (*Oncorhynchus mykiss*):

Upper Columbia River steelhead (*O. mykiss*), were listed as endangered in October, 1997, were down-listed to threatened on January 5, 2006, but returned to endangered status on June 13, 2007 by order of Judge John C. Coughenour (2007).

Critical habitat for Upper Columbia River Spring Chinook salmon and upper Columbia River Steelhead was designated on September 2, 2005 (70 FR 52631) for the Entiat River. Critical habitat has been neither proposed nor designated for bull trout within Upper Columbia River Basin – Unit 21, which includes the Entiat River. The Entiat River provides Essential Fish Habitat (MSA 1996) for Chinook salmon. The lower Entiat River contains a steelhead minor spawning area and the entire river is designated a major spawning area for spring Chinook (UCSRB 2006).

A petition to list Westslope cutthroat trout (*O. clarki lewisi*) as threatened under the ESA was found to be “not warranted” by the USFWS in April 2000. However, on March 31, 2002 a US District Court remanded the “not warranted” listing decision and ordered the USFWS to initiate a new status review for Westslope cutthroat trout within the United States. The reconsidered 12-month finding for an amended petition to list Westslope cutthroat trout reaffirmed the “not warranted” listing (68 FR §46989). Westslope cutthroat trout continue to be a species of “concern” since they are in decline in the Entiat watershed and they are a Forest Service Regional Forester’s Sensitive Species.

## STOCKING SUMMARY

With the listing of salmon, steelhead, and bull trout as species protected by the Endangered Species Act, most stocking was discontinued in the Entiat River watershed. With the exception of limited stocking of cutthroat trout in high-elevation lakes, the State of Washington discontinued trout stocking in 1994.

Similarly, no steelhead have been stocked in the Entiat River since 1999. Outplanting of hatchery raised steelhead was stopped due to concerns about the harm (via genetic introgression and hybridization between hatchery-raised and naturally reproducing steelhead) continued stocking could cause to ESA listed steelhead in the Entiat subbasin. In addition, the decision to stop stocking steelhead in the Entiat was made by WDFW and other fisheries and hatchery production managers, i.e. the Chelan PUD, because discussion had begun about whether the Entiat River was suitable for use as a “Reference” stream to help evaluate the effects of hatchery stocking on Upper Columbia steelhead populations. As a “Reference”, the steelhead population in the Entiat River that was not stocked or “supplemented” would be compared against other populations in the Upper Columbia region that still receive steelhead supplementation.

The rationale for the potential designation of the Entiat River as a reference stream included a number of considerations, including the following: the number of steelhead outplanted to the Entiat subbasin was relatively small compared to what is outplanted in other Upper Columbia streams, e.g. the Wenatchee and the Methow; and the limited amount of streams/habitat used by steelhead in the Entiat subbasin would make population monitoring easier.

The Entiat River has not been formally designated as a “Reference” stream for steelhead. A high degree of genetic introgression between hatchery and naturally-reproducing steelhead populations in the Entiat has already been documented; therefore, the genetic makeup of the naturally-reproducing Entiat steelhead population may already be too altered to evaluate whether the Entiat summer steelhead population can survive without hatchery supplementation.

Additional data collection has been initiated to help determine whether the Entiat River would or would not be appropriate for use as a steelhead Reference stream. Regardless of whether or not it is designated as a Reference, the overall ability to develop and pursue the recreational fisheries opportunities listed in the recommendations section of this paper will not be affected. However, because all steelhead fisheries currently permitted in the Upper Columbia Region are designed to remove surplus hatchery (non-ESA listed) steelhead that are produced in or outplanted to streams like the Methow and Wenatchee, the near-term option for a fishery on hatchery produced steelhead in the Entiat was eliminated when stocking stopped.

Recent decisions about management of the Entiat National Fish Hatchery may bring to a close production and planting of Chinook salmon in the Entiat River watershed (USFWS 2007a). Non-native (Carson stock) spring Chinook have been released annually in the Entiat River by the Entiat National Fish Hatchery since 1976; Chinook and other species were released from 1945-1975. The current ENFH spring Chinook salmon program is intended to function as a mitigation-harvest program. The fish reared and released in the Entiat River by ENFH do not contribute to recovery goals and are not listed under the ESA.

The ENFH is operated as part of the overall Leavenworth Hatchery Complex. The Leavenworth Complex, including the ENFH production program, is currently under review as part of a larger evaluation of Columbia Basin hatcheries managed by the USFWS. Due to the fact that spring Chinook reared and released by the ENFH do not contribute to, and in fact pose a risk to the recovery of naturally-reproducing spring Chinook salmon (USFWS 2007a), recent discussions about the future direction of the

ENFH program have focused on discontinuing production of non-native (Carson stock) spring Chinook. Closing the ENFH facility is not part of current discussions; however, spring Chinook production will likely end in the next few years and be replaced with an alternate production program because “continuation of the current spring Chinook program was not considered a viable alternative” (USFWS 2007a).

The USFWS Columbia Basin Hatchery Review Team responsible for the ENFH review developed four alternatives involving fish propagation designed to increase benefits and/or reduce risks to recovery relative to the existing program at the ENFH. These include:

1. Integrated spring Chinook conservation program: Discontinue existing spring Chinook segregated harvest program and replace with an integrated conservation-recovery program derived from natural origin spring Chinook in the Entiat River [Naturally reproducing spring Chinook from the Entiat River would be captured and used to raise natural-origin spring Chinook].
2. Coho restoration central facility: Discontinue existing segregated spring Chinook program and convert Entiat NFH to a central rearing facility for coho salmon in support of mid-Columbia coho restoration program of the Yakama Nation.
3. Integrated summer Chinook harvest program: Discontinue existing...program and replace with an integrated summer Chinook harvest program derived from natural-origin adults trapped in the Entiat River [Capture Entiat River summer Chinook and use their eggs to raise summer Chinook].
4. Conservation facility for upriver stocks: Discontinue existing...program and use the ENFH for propagation of upper Columbia River basin species of high conservation concern, including – but not limited to – reintroduction of coho salmon in the Wenatchee and Methow Rivers (Yakama Nation’s master plan) and reintroduction of spring Chinook to the upper Columbia and Okanogan Rivers (Colville Tribe’s restoration plan), and restoration of upper Wenatchee River spring Chinook programs [Produce fish to meet conservation/restoration/recovery goals outside of the Entiat subbasin]

The recommendation from Entiat watershed stakeholders was to pursue Alternative 3, and in its draft recommendations the USFWS Review Team proposed replacing the existing program with an integrated summer Chinook harvest program (Alternative 3). However, after co-manager input on the draft recommendation, Alternative 4 was selected as the preferred alternative. No final agreement as to the future direction of the ENFH hatchery program has been reached; negotiations between the USFWS and NMFS, and the Yakama Nation via the ongoing US v. Oregon legal process are still underway.

To access the full USFWS Review Team final report – Leavenworth Complex Review (April 2007), go to: <http://www.fws.gov/pacific/fisheries/hatcheryreview/reports.html>

Figure 3 illustrates the history of trout and steelhead stocking in the Entiat River, from 1933 to present. This summary extends beyond the earlier “eras” considered in this report, but is provided to illustrate the continuous trout and steelhead stocking efforts in the Entiat River watershed.

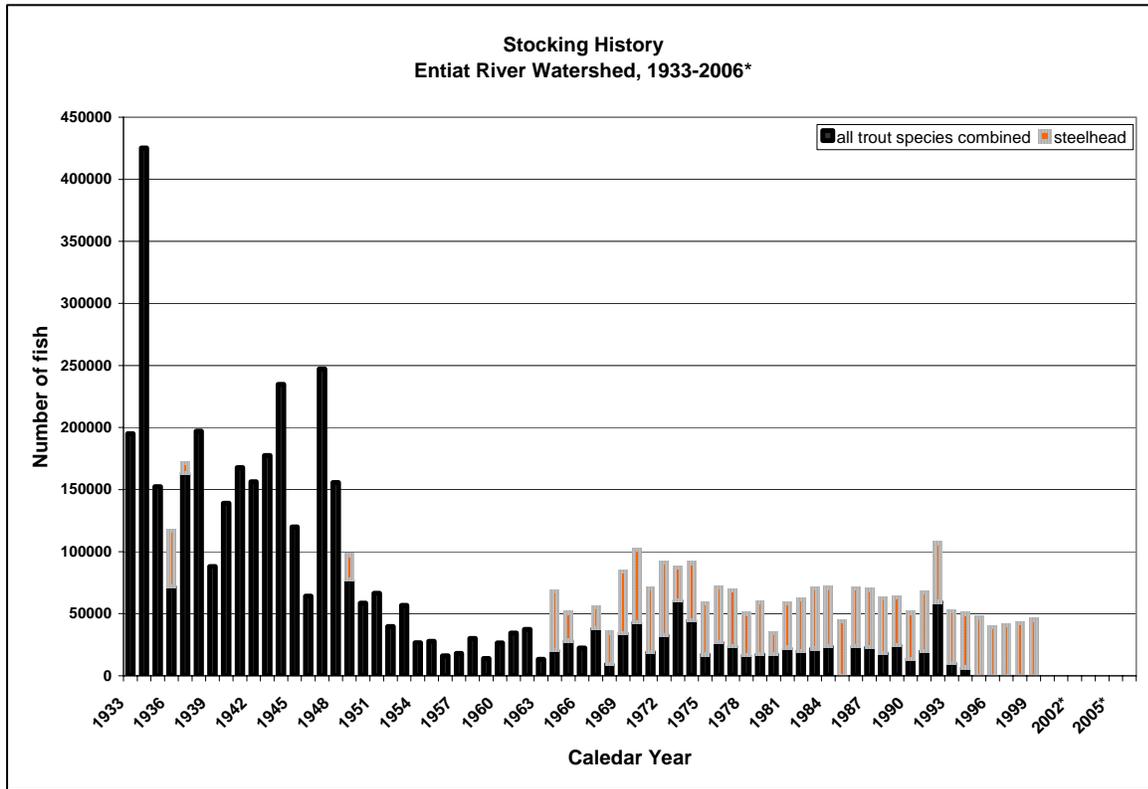


Figure 3 – Stocking history of the stream, lakes, and rivers of the Entiat River watershed (1933-2006\*).

## **THE FISHERY PERMITTING PROCESS**

The process of proposing and authorizing recreational and tribal fishery opportunities in the Upper Columbia region is scientifically complex when ESA listed species (spring Chinook, summer steelhead or bull trout) are present in the river system(s) where harvest is proposed. The fishery permitting process is also based on state, federal and tribal statutory authorities. This section focuses on the steps and interactions that are required between the WDFW, treaty and non-treaty tribes, NMFS, and potentially the USFWS during the fishery permitting process.

### ***Treaty Tribes and Fisheries Co-Management Authority***

In 1969, the supreme court US v Oregon case (Belloni decision; Defendants: States of WA, OR, ID; Plaintiffs - US, federal treaty tribes) acknowledged that four Columbia River treaty tribes (Nez Perce, Umatilla, Warm Springs, and Yakama tribes) reserved rights to fish in all “usual and accustomed” places whether on or off a reservation. The Yakama Nation holds federal treaty rights, granted under the 1855 “Treaty with the Yakima”, and claims portions of the Upper Columbia region as usual and accustomed places. The 1969 US v. Oregon decision also determined that the treaty tribes were entitled to a “fair and equitable share” of the resource. Currently, fishery objectives for Zones 1-6 (mouth of Columbia to McNary Dam) are established annually by the state, federal and tribal US v. Oregon parties.

The US v. Oregon decision is closely tied to US v Washington (1974 Boldt decision), which later defined a “fair and equitable share” as 50% of all fish destined for the tribes’ traditional fishing places. This ruling still holds today: whenever fishery activities are authorized, the tribes are entitled to 50% of the harvest. In addition to defining tribal harvest levels, the US v. Washington decision established the tribes and the State of Washington as “co-managers” of fishery resources. As it pertains to fisheries management decisions within the Upper Columbia Region and affecting the Entiat subbasin, the Yakama Nation and WDFW have co-management authority.

### ***Non-treaty Tribes, Recreational/Commercial Fisheries and the North of Falcon Process***

The Confederated Tribes and Bands of the Colville Nation (CCT) are a non-treaty tribe involved with fisheries management activities within the Upper Columbia Region. The CCT is formally recognized as a tribe, but do not hold treaty-reserved rights. Rather, the CCT is involved in fishery management discussions through the “North of Falcon” process. In this process state, federal and tribal fishery managers meet at least annually to review data and other information in order to plan the Northwest's recreational and commercial salmon fisheries. This process occurs in the spring (March, April) prior to the opening of the fishing season. The process includes public meetings involving federal, state, tribal, industry representatives and other concerned citizens. The primary annual planning meeting under the North of Falcon process is scheduled to occur at the same time as meetings of the Pacific Fishery Management Council (PFMC). The PFMC is the federal authority responsible for setting ocean salmon seasons in ocean waters located from three (3) to 200 miles off the Pacific coast (personal communication Heather Bartlett, WDFW fishery biologist).

In addition to the two PFMC meetings, the states of Washington and Oregon and the Treaty Tribes sponsor additional meetings to discuss alternative fishing seasons that meet conservation and allocation objectives. Fishery managers generally refer to the entire set of pre-season meetings, which begin in February as North of Falcon. The name refers to Cape Falcon in northern Oregon, which marks the southern border of active management for Washington salmon stocks.

### **Section 10 Permits and Salmon/Steelhead Management Authority**

Section 10 of the ESA authorizes NMFS to issue permits for direct take (10(a)(1)(A)) and “incidental take” (10(a)(1)(B)). Anyone planning to conduct any activity that may “take” a threatened or endangered species must obtain approval to perform that activity -- including authorizing/opening a fishery.

A Section 10 direct take permit allows the holder to take a listed species for scientific purposes or to enhance the propagation or survival of listed species. NMFS’ Northwest Region issues direct take/Section 10 permits on ESA-listed salmon and steelhead for scientific research and enhancement projects.

Fishery activities cannot be directed at ESA listed species. A Section 10 incidental take permit allows the holder to take a listed species when the action involved is incidental to, and not the purpose of, an otherwise lawful activity. The Northwest Region issues incidental take/Section 10 permits on ESA-listed salmon and steelhead for scientific research, habitat conservation plans, artificial propagation programs, and harvest management programs, e.g. fisheries.

When a recreational/tribal fishery is authorized, a Section 10 incidental take permit is issued to cover the potential harm/mortality to ESA listed species that may occur as a result of the fishery.

### **Bull Trout Management Authority**

The USFWS is the federal agency charged with management of bull trout. Therefore, whenever an activity that may affect bull trout through direct or indirect take is proposed, consultation with the USFWS must occur.

### **THE FISHERY PERMIT APPLICATION AND AUTHORIZATION PROCESS**

As a co-manager and the state agency responsible for “protecting, restoring, and enhancing fish and wildlife and their habitat, while providing sustainable fish and wildlife-related recreational and commercial opportunities”, WDFW prepares and submits permit applications (fishery proposals) to the NMFS for consideration.

Separate permits are requested/authorized for Upper Columbia River steelhead and Chinook fisheries activities; the Chinook application that WDFW prepares and submits covers both summer/late-run Chinook and spring Chinook fishery activities. Steelhead or Chinook fishery activities within entire the Upper Columbia Evolutionarily Significant Unit (ESU), which includes the mainstem Columbia River above Priest Rapids Dam and water bodies within Chelan, Douglas and Okanogan counties, are permitted as a package. A regional permit for steelhead or Chinook fisheries is requested by WDFW and authorized by NMFS because WDFW, NMFS and other fishery management agencies are charged with managing populations at a regional/population scale, particularly for the purposes of salmon recovery.

The regional nature of fishery permits is important to note because it relates to why requests for fisheries cannot be made or authorized on a watershed-by-watershed basis. For example, requests for fisheries within the Entiat watershed must be made as part of the regional permit application prepared and submitted by WDFW. In addition, because fishery requests must be made in balance with regional recovery goals, stated by WDFW as follows:

*“... only fisheries that will have no adverse effect on or will help with the recovery of ESA listed species may be proposed by WDFW or authorized by NMFS.”*

During development of fishery proposals for the Upper Columbia Region, WDFW is required to communicate with the other co-manager, the Yakama Nation. Communication with the NMFS also occurs during WDFW permit application development, in order to facilitate NMFS review of WDFW's permit request.

If threatened bull trout are present in the streams where WDFW proposes harvest activities, the WDFW must also consult with the USFWS regarding the potential impacts a fishery may have on bull trout populations. This step is required because the USFWS is charged with bull trout management; they have a Memorandum of Understanding with WDFW that outlines communication protocols regarding bull trout issues.

Once a permit application is submitted by WDFW to NMFS, they review it and publish it in the federal register for public review and comment. In addition, as a federal management agency, NMFS must prepare an Environmental Assessment of the proposed activities and issue a Biologic Opinion on the proposed activities. Only after all of these steps have been concluded may NMFS issue a Section 10 permit to WDFW authorizing incidental take associated with fishery activities. Due to the complexity and length of the permitting process, when a permit is issued by NMFS to WDFW, it is typically issued for a 5 or 10 year period.

After a fishery has been approved and authorized for an established period, the number of adults that return to the Entiat River and other streams covered by the permit must meet certain levels (escapement goals) and other conditions, such as the number of hatchery vs. natural origin adults that return, in order for the fishery to open. If incidental take authorizations were included as a condition to a fishery opening, the fishery will close as soon as incidental take limits are reached, regardless how long the fishery has been open.

## **FISHERY POLICIES, RECOVERY PLANS, AND GOALS**

The life cycle of anadromous salmonids originating in the Entiat River can involve migrations across several jurisdictional boundaries including two countries (United States and Canada), as many as three states (Washington, Oregon, and Alaska), at least three ecosystems (freshwater, estuary, ocean) and through numerous fisheries and resource management areas. As a result, management of anadromous fishery resources has developed into a complex process involving international, intergovernmental (tribal-federal, tribal-state), interstate, and interlocal agreements between nations, Tribes, federal agencies, state agencies, local governments and others with overlapping jurisdictions and regulatory responsibilities. In addition to myriad anadromous fishery management programs, non-migratory fish resources such as trout are typically managed by agencies and individuals that are not involved in anadromous fishery resource management. As a consequence, the maze of regulations, programs and plans are too numerous and complicated to concisely describe in this paper. The following, therefore, is provided only as an introduction to the organizations, policies, plans, and goals that presently have the greatest influence on fishery management in the Entiat River watershed.

### ***Upper Columbia Salmon Recovery Board***

The Upper Columbia Salmon Recovery Board (UCSRB) organized in response to the listing of salmonids under the Endangered Species Act, under the authority of the Salmon Recovery Planning Act (see Chapter 77.85 RCW). The UCSRB is responsible for developing a Salmon Recovery Plan for the Upper Columbia region, which includes the Entiat River watershed. UCSRB membership includes Chelan, Douglas and Okanogan counties, the Colville Confederated Tribes, and the Yakama Nation. The mission of the UCSRB is "to restore viable and sustainable populations of salmon, steelhead, and other at-risk species through the collaborative efforts, combined efforts, and wise resource management of the Upper

Columbia Region.” The vision of the UCSRB is to “[d]evelop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well being of the communities both within and outside the recovery region.”

The UCSRB recently completed a Proposed Upper Columbia Salmon Recovery Plan (Recovery Plan, UCSRB 2006), intended to achieve the mission and vision of the UCSRB by providing a comprehensive framework for the conservation and survival of endangered species and threatened species listed under to the Endangered Species Act. The Recovery Plan includes recommendations for research, monitoring and evaluation; actions and schedules for implementation; stakeholder involvement; and funding. The UCSRB acknowledges that the Recovery Plan implementation must be coordinated with numerous other conservation and watershed-based efforts to address or improve the viability of naturally produced spring Chinook, steelhead, and bull trout in the Upper Columbia Basin.

The UCSRB specifically mentions in the Recovery Plan that implementation must complement ongoing efforts including (UCSRB 2006):

- Mid-Columbia Habitat Conservation Plans (HCPs) for the operation of Wells, Rocky Reach, and Rock Island dams
- Biological Opinions on the mid-Columbia HCPs
- Federal Columbia River Power System Biological Opinion and Remand
- Biological Opinion on the operation of Priest Rapids and Wanapum dams
- Hatchery and Genetic Management Plans (HGMPs) for federal hatcheries
- Biological Opinions on the operation of state hatcheries (designed for PUD mitigation)
- the USFWS Bull Trout Draft Recovery Plan
- U.S. Forest Service Wenatchee National Forest Land and Resource Management Plan (1990) as amended by the Northwest Forest Plan (1994)
- Biological Opinions on Federal Actions (USFS/BLM land management activities)
- Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon), The Tribal Salmon Restoration Plan
- Washington State Forest and Fish Agreement
- Northwest Power and Conservation Council (NPCC) Subbasin Plans
- Watershed Planning under Chapter 90.82 RCW
- Lead Entity process under Chapter 77.85 RCW
- local comprehensive and shoreline management plans and their respective regulatory functions
- Natural Resource Conservation Service and Conservation District efforts

For more information, see: <http://okanogancounty.org/water/Salmon%20Recovery.htm>.

### ***Governor’s Salmon Recovery Office***

Along with the formation of regional salmon recovery boards, the Salmon Recovery Act (Chapter 77.85 RCW) created the Governor’s Salmon Recovery Office (GSRO) to manage the development of the statewide salmon recovery strategy, and to coordinate and assist with the development of recovery plans.

An Independent Science Panel was also created to provide technical review and support for the development of recovery plans and projects. For more information about the GSRO and statewide salmon recovery efforts, and relationships to local recovery efforts, go to:

<http://www.governor.wa.gov/gsro/default.asp>.

### **National Marine Fisheries Service (NMFS)**

NMFS has been providing funding and working with the UCSRB on the development of the Proposed Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan. NMFS published a notice of availability and request for comments on the Recovery Plan on September 29, 2006 (71 FR §57472). For a copy of the Draft Recovery Plan, see: <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm>.

NMFS is responsible for the administration of the ESA for the purpose of protecting threatened and endangered species, including the permitting of activities that may impact species listed under the act. The agency has a variety of tools including the issuance of permits, biological opinions, Section 4(d) rulemaking, approval of habitat conservation plans (HCP's), and scientific research authorizations. For more information about NMFS involvement with ESA see: <http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/index.cfm>.

NMFS has been administering the Pacific Coastal Salmon Recovery fund. This fund was established by congress to contribute to the restoration and conservation of Pacific salmon and steelhead populations and their habitats. Between 2000 and 2003, over \$ 170 million of the fund was spent on salmon habitat restoration projects (Roni 2005). The fund is intended to supplement state, tribal, and local programs to foster development of federal-state-tribal-local partnerships in salmon and steelhead recovery. For more information about the fund, its purpose, and its uses, see: <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm>.

NMFS is also involved in the administering of the Mitchell Act (16 USC §755; 52 Stat. 345), as amended by the Act of August 8, 1946, (60 Stat. 932). The Mitchell Act authorizes the Secretary of the Interior to carry on activities for conservation of fishery resources in the Columbia River Basin. The Mitchell Act directs the establishment of salmon hatcheries, conduct of engineering and biological surveys and experiments, and installing fish protective devices for the purpose of mitigating the impacts of development of Grand Coulee Dam and other hydroelectric facilities on the Columbia River. It also authorizes agreements with State fishery agencies and construction of facilities on State-owned lands. Federal activities in the Columbia River basin under the Mitchell Act are carried out by the Department of Commerce pursuant to Reorganization Plan No. 4 of 1970 (84 Stat. 2090). Actions under the Mitchell Act are presently focused on evaluating the potential effects of Mitchell Act-funded hatcheries on threatened and endangered species. For more details see - <http://www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Hatcheries/NEPA-Activities-Mitchell-Act-EIS.cfm>.

### **USFWS**

The USFWS, like NMFS, is involved in the administration of the ESA in the Columbia River Basin, in monitoring and other science-based fish population protection and restoration technical support, administration of funds to support recovery, and management of hatcheries built to mitigate the development of the Federal Columbia River Power System (FCRPS).

On September 26, 2005 the USFWS published the Final Rule for the designation of critical habitat for bull trout (70 FR §56212). In 2002 the USFWS released a draft Bull Trout Recovery Plan, including a chapter on bull trout in the Upper Columbia recovery unit (USFWS 2002). The recovery plan identifies actions believed to be necessary to recover and protect threatened bull trout in the Entiat River and elsewhere in the recovery unit and distinct population segment. Bull trout are the jurisdiction of the USFWS, but the NMFS Proposed Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan (UCSRB 2006) includes strategies and actions intended to complement the draft bull trout recovery plan published by the USFWS in the draft Bull Trout Recovery Plan. For more information about the draft Bull Trout Recovery Plan, see: <http://www.fws.gov/pacific/bulltrout/colkla/recovery/>.

### **Tribes**

The two tribes most involved in the Entiat River watershed are the Yakama Nation and the Confederated Tribes and Bands of the Colville Nation. The Yakama Nation holds co-management authority for fishery resources. The tribes are members of the Upper Columbia Salmon Recovery Board (UCSRB) working on salmon recovery efforts. The tribes are also involved in salmonid fishery enhancement projects including, but not limited to, supplementation of Chinook fisheries, the re-introduction of coho salmon in the Upper Columbia, salmon habitat restoration, monitoring, and other salmon and steelhead protection and restoration efforts.

For more information about the Confederated Tribes and Bands of the Colville Nation, see: <http://www.colvilletribes.com/default.htm>.

For more information about Yakama Nation fisheries, see: <http://host119.yakama.com/>.

In 1977 the Warm Springs, Yakama, Umatilla, and Nez Perce tribes joined together to renew a long-standing tradition of inter-tribal management of Columbia River fisheries, forming the Columbia River Inter-Tribal Fish Commission. The CRITFC commitment is: “unity of action in service of the salmon”. CRITFC provides intertribal representation in regional planning, policy, and decision-making. CRITFC planning and policy recommendation for the recovery of salmon is documented in the Tribal Salmon Restoration Plan, also known as Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon). One of the long-term objectives of the plan is to restore salmon populations to a level that will support Tribal ceremonial, subsistence, and commercial harvest objectives. For more information about CRITFC and Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon), The Tribal Salmon Restoration Plan see: <http://www.critfc.org/index.html>.

Please also see the section above entitled *Treaty Tribes and Fisheries Co-Management Authority*, above.

### **Washington Department of Fish and Wildlife (WDFW)**

WDFW is the agency in Washington State with the administrative authority, and mission to “serve the citizens of Washington State by protecting, restoring, enhancing fish and wildlife and their habitat, while providing sustainable fish and wildlife-related recreational and commercial opportunities”. The mission is based on a number of legislative directives regarding fish and wildlife management as well as resource and habitat protection and enhancement. Implementation of the mission by WDFW staff is guided by a set of principles, goals, and objectives identified at following web site: [http://wdfw.wa.gov/depinfo/strat\\_goals\\_obj.htm](http://wdfw.wa.gov/depinfo/strat_goals_obj.htm).

The WDFW is preparing anadromous salmonid management program plans specific to the Upper Columbia River and its tributaries. For more information, see the *Harvest Framework for Non-treaty Fisheries directed at Salmonids originating above Priest Rapids Dam*, at:

([http://wdfw.wa.gov/fish/papers/harvest\\_framework\\_salmonids\\_priest\\_rapids/draft2\\_harvest\\_framework\\_salmonids\\_priest\\_rapids.pdf](http://wdfw.wa.gov/fish/papers/harvest_framework_salmonids_priest_rapids/draft2_harvest_framework_salmonids_priest_rapids.pdf))

WDFW endeavors to ensure that WDFW activities and programs are consistent with local, state, and federal regulations that protect and recover fish, wildlife and their habitats. WDFW, as co-manager, shares salmon and steelhead management responsibilities with the Tribes, consistent with the 1974 Boldt decision. WDFW, in collaboration with tribes, has produced a number of programs and planning documents that guide fish and habitat recovery efforts. These documents include:

- Wild Salmonid Policy (<http://wdfw.wa.gov/fish/wsp/joint/final/fwsptoc.htm>)
- Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIA), see SalmonScape (<http://wdfw.wa.gov/mapping/salmonscape/>)

In addition to administration of salmon fisheries and salmon recovery programs, the WDFW serves as a permitting entity, conducts monitoring, is a source of science and technical assistance, and manages a network of hatcheries throughout the state to provide fish for recreational sportfishing and harvest. More recently, WDFW has been using hatcheries to assist with the conservation and restoration of wild salmonid populations. For more information, see: <http://wdfw.wa.gov/hat/hat-main.htm>.

### ***Other Resource Agencies and Organizations***

A wide variety of natural resource management agencies, organizations, and individuals are providing salmon, steelhead, bull trout, and other fish habitat restoration support. The USFS is the majority land manager in the Entiat River watershed and is, therefore, a significant contributor to habitat protection and restoration efforts. Chelan County Conservation District (CCCD) is the Entiat WRIA Planning Unit Lead Agency and resource management coordinator working more closely than any other entity with agencies and citizens in the Entiat watershed to implement restoration programs. For more information about the Entiat WRIA Planning Unit, implementing partners and watershed-based restoration activities please see: <http://www.chelancc.org/>.

## THE SCIENCE OF FISHERIES MANAGEMENT

*“A fishery is the complex of interaction within and between the population(s) of fish being harvested, the population(s) of fishermen, and the environment of each. Fishery management ranges from an individual fisherman’s concern to problems of international magnitude.”* Everhart and Youngs (1981)

Fishery biologists and managers face a wide variety of challenges while performing day-to-day duties. These challenges can be scientific, social, political, economic, or cultural in origin. The following discusses some of the typical scientific considerations in developing a fishery management program.

### SPECIES INTERACTIONS

Interactions among fish species can have a variety of effects on species involved. Interactions like mutualism and commensalism are positive, while interactions like competition and predation are negative (Krebs 1985). Mutualistic relationships are interactions that benefit both species involved, but are not commonly found in coldwater systems like the Entiat River. Commensalism is a relationship between two organisms where one species benefits, but the other is unaffected. Competition is a relationship defined as the act of striving against others for the purpose of achieving gain. Predation is a biological interaction where one organism (predator or parasite) feeds on another living organism (prey). Natural fish species interactions like competition and predation can be influenced by human behavior. Human management actions such as the stocking of non-native fish species can also harm native fish populations by introducing disease or causing the loss of genetic integrity (dilution of stronger, naturally occurring genes resulting in fish that do not perform or survive as well).

The following summarizes and provides examples of these types of interactions.

#### ***Commensalism***

Commensalism can occur in systems like the Entiat River in a number of ways. For example, salmon, steelhead and trout excavate areas (redds) in the stream bottom during spawning. During excavation, other fish have been observed downstream from the redd site, feeding on benthic (bottom-dwelling) organisms that are dislodged during redd construction. Similarly, stream-dwelling suckers (Catostomus sp.) have been observed turning over stones looking for food. Smaller fish (i.e. minnows, young salmonids) follow the sucker and feed on food items missed by the sucker. In each of these circumstances, fish positioned downstream benefit from the energy expended by the fish positioned upstream, while the upstream fish is not affected.

#### ***Competition***

Competition can occur in a variety of forms. Typically, competition is a situation where more than one organism demands the same resources at the same time, and these demands exceed the immediate supply (resource competition). Fish may compete for food, living space, or reproductive opportunity. Interactions between fish of the same or different species can result in reduced health, habitat displacement, reduced reproductive success or other effects at the individual, community, or population level. Although competition can take place without organisms seeing or hearing their competitors, when competing organisms meet, it can result in these organisms seeking to harm one another (interference competition).

While studying the ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, evidence was found that reddsiders and juvenile Chinook salmon used the physical space in the Wenatchee River (Hillman 1989). Hillman (1989) suggested that competitive success of a fish species in mid-order streams could be influenced by water temperature, with Chinook out-competing shiners in cold

water, and shiners out-competing salmon in warm water. In laboratory experiments it was determined that such interactions between reaside shiner and steelhead trout were, indeed, influenced by water temperature (Reeves et al. 1987).

Competition has also been observed between native and non-native species. In the interest of providing sport-fishing opportunities and mitigating for decreases in salmon, fisheries managers have stocked non-native trout species like brook and rainbow trout, steelhead and Chinook in the Entiat River. In similar river systems, biologists have documented competitive interactions between brook and rainbow trout species and native Westslope cutthroat trout, typically leading to the competitive exclusion of cutthroat from areas used prior to the introductions (e.g. McIntyre and Rieman 1995). The introduction of hatchery stocks like non-native spring Chinook can also lead to competition for spawning ground space between the “less strong” hatchery fish and naturally-reproducing Chinook salmon that use the Entiat River (Hamstreet 2007); the same competition principle applies to steelhead.

### **Predation**

Predation is a very direct form of fish species interaction that can be a powerful force limiting a fishery, and it can come in various forms. Fishery biologists are most concerned with carnivorous, cannibalistic, and parasitic types of predation. Carnivorous interactions are those where an individual from one species kills and consumes another. For example, large northern pikeminnow are known to consume other fish, including juvenile salmonids. Recognizing this fact, fishery managers offer cash rewards to anglers for the capture of northern pikeminnow in certain locations of the Columbia River ([www.pikeminnow.org/info.html](http://www.pikeminnow.org/info.html)). Similarly, fishery managers previously attempted to control predation of bull trout (now a threatened species) on other trout and salmon species by offering a bounty for bull trout captured and killed by fishermen. Brown (1993) noted that bull trout/dolly varden were “once condemned mightily as an eater of salmon eggs and fry, even to the point that bounties were paid for ‘dollie’ tails. However, in most situations, the damage to salmon stocks was found to be minimal as most eggs consumed were ‘floaters’, eggs washed out of the redd or dug up by subsequent spawners.”

Cannibalism can also have dramatic effects on fish populations and fisheries. Cannibalism is a unique form of predation where the predator and prey are of the same species, and can occur within species managed for fisheries. For example, in the Yakima River basin, large adult bull trout were observed cannibalizing their young (Polacek and James 2003). Biologists also found a relatively high degree of cannibalism by bull trout in the Walla Walla and Umatilla Rivers (Budy and Thiede 2003).

The most visible form of parasitism among species inhabiting the Entiat River is seen between lamprey and salmonids. The life history of the Pacific lamprey (*L. tridentata*) includes a parasitic adult life stage. Adult pacific lamprey use their sucker-like mouth to attach to other fish, including salmonids, rasping (biting) an opening in the side of the prey species and ingesting body fluids. This parasitism is not necessary lethal to the salmon, but has a negative effect on the health of the species.

### **Disease**

Like competition and predation, disease can also limit fish populations and complicate fishery management. In natural systems disease can be a necessary element balancing fish populations (Everhart and Youngs 1981). With the introduction of non-native species, however, native fish populations can suffer from elevated levels of disease because they are exposed to pathogens for which they have not developed resistance over time. For example, when biologists introduced non-native brown trout (*Salmo trutta*) to North American in the late 1950s a metazoan parasite, *Myxobolus cerebralis*, that invades the head and spinal tissue of juvenile salmonids was also introduced. Rapid development of the parasite in native trout species causes loss of equilibrium, resulting in erratic swimming (whirling), deformities, and

mortality (USDA 2007). This disease has significantly impaired native trout fisheries in states like Montana and Colorado. The pathogen causing whirling disease was recently discovered in eastern brook trout in Washington State (WDFW 2002). The potential for disease problems resulting from interactions between native trout and stocked eastern brook trout populations is one of the considerations affecting current fishery management decisions and actions in the Entiat River watershed.

Other diseases can be naturally occurring in North American waters, but frequency and severity of outbreaks may be worsened by fishery management actions. Bacterial kidney disease (BKD) is an infection in trout and salmon caused by the bacterium *Renibacterium salmoninarum*. This disease has been identified as the cause of high mortalities in both wild and hatchery trout and salmon populations (Bullock and Herman 2007). The following parasitic, fungal, bacterial, and viral diseases have been noted at the Entiat National Fish Hatchery (Evered 2006):

#### **Parasites:**

*Ichthyobodo* – This parasite has been observed occasionally on juvenile Chinook salmon. Hatchery managers use formalin treatments on the disease, following approved FDA and EPA guidelines.

*Trichodina* – This parasite has been observed occasionally on juvenile Chinook salmon. Hatchery managers use formalin treatments on the disease, following approved FDA and EPA guidelines.

*Epistylis* – This parasite is a common problem at hatcheries, but hatchery managers do not consider it to be a problem. Hatchery managers use formalin treatments on the disease, following approved FDA and EPA guidelines.

*Myxobolus spp.* – If river water is used for rearing, fish become infected with a neurotropic myxobolid parasite that has not been definitively identified, but is probably *M. neurobius*. No treatment is available, so avoiding the use of surface water is imperative. Currently, ENFH managers use water from groundwater (wells and springs) for rearing hatchery stock to avoid issues associated with this parasite.

*Ceratomyxa shasta* – Hatchery staff have made incidental findings of this parasite in the lower intestine of adult Chinook and Coho salmon. This parasite has also been detected in wild Chinook and Coho salmon throughout the Columbia River Basin. Hatchery staff suggest that no treatments are needed.

#### **Fungi:**

*Saprolegnia spp.* – This fungus has been occasionally observed on eggs, juveniles, and returning adult salmon. Hatchery managers suggest that these fungal infections are controlled by the use of formalin consistent with FDA and EPA recommendations, claiming that if control measures are used, no problems are encountered. Hatchery operators warn that if river water is used during rearing, there is more risk that fungus (“flag tail”) will occur, probably due to some other debilitating cause such as *Myxobolus spp.*

#### **Bacteria:**

*Renibacterium salmoninarum* – These bacteria are common in hatchery salmonid populations, and have been documented in wild salmonids throughout the Columbia River system. Signs of this disease in spring Chinook can develop, depending on the levels of bacterial kidney disease (BKD) bacteria in adult females, juvenile rearing densities, and other fish cultural activities. Hatcheries control *R. salmoninarum* in Chinook by injecting adult females with erythromycin about 30 and 60 days before they are spawned, by segregating or eliminating eggs from moderate and high risk BKD female carriers, and by reducing

stress in fish (e.g. fish crowding) as much as possible. Treatments are administered by hatchery personnel only if warranted by severity of the disease and include oral administration of erythromycin by an Investigational New Animal Drug (INAD) permit or veterinary extra-label prescription.

*Flavobacter psychrophilum* – These bacteria have been occasionally observed in small Chinook fry, but hatchery personnel generally do not consider it to be a problem. Hatchery personnel do not consider treatments to be necessary at this time.

*Aeromonas salmonicida* – These bacteria have been occasionally observed in returning adult salmon and, under certain conditions, may be associated with an increase in pre-spawn mortality. Hatchery personnel have not noted methods of treatment.

**Viruses:**

Infectious Hematopoietic Necrosis Virus (IHNV) – This virus has been isolated intermittently in adult Chinook and Coho salmon during the spawning stage. The virus has not been isolated by hatchery personnel, nor found to cause disease in progeny of infected adults.

Erythrocytic Inclusion Body Syndrome (EIBS) – This virus has been noted to have occurred historically, but has rarely been isolated in recent samples. Hatchery personnel suggest that the virus does not cause problems. Hatchery personnel hypothesize that the virus may be associated with disease symptom known as “flag-tail”. This virus has been detected in wild Chinook throughout the Columbia Basin.

Similar pathogens have been noted, and similar treatments have been used at the Leavenworth and Winthrop National Fish Hatcheries.



*Salmon transplanted to the Entiat River did not always spawn prior to death. This 1939 photograph shows a “green” (unspawned) Chinook salmon covered in fungus - an unsuccessful transfer attempt. Photograph provided courtesy of OSU Archives (2007).*

### ***Genetic Introgression (Hybridization)***

Genetic introgression (hybridization) is defined as the movement of hatchery-origin genetic material into a natural population through breeding between hatchery and natural-origin fish. Hybridization in trout and salmon populations is a growing concern of fish biologists for a number of reasons. Hybrid species have been found to have lower reproductive success (Chilcote 2003, Chilcote et al. 1986), reduced homing ability (Bams 1976), lower survival during later life stages (Busack and Currens 1995), and a higher susceptibility to disease (Currens et al. 1997). The recent protection of bull trout, steelhead, and spring Chinook under the U.S. Endangered Species Act has fisheries managers more carefully considering the role of hatcheries (and fish stocking) as part of fisheries management and the potential influence of hybridization on native salmonid populations (Sterne 1995).

WDFW reports that hybridization between wild steelhead and non-native steelhead stock has caused problems identifying historic populations. Risks to natural fish population fitness (strength, ability to survive) resulting from interbreeding with hatchery produced fish include: the reduction in genetic variability, genetic drift, selection and domestication (WDFW 2006b). Fishery managers have similar concerns about the genetic integrity of naturally reproducing salmon populations. A number of hatchery management guidelines have been developed to help hatchery managers minimize these risks (e.g. IHOT 1995, WDF 1991).

Howell and Spruell (2003) recently completed an analysis of genetic condition of trout in the Entiat River, Mad River and creeks and streams elsewhere in the Columbia River basin. They found that it is highly unlikely that cutthroat trout populations presently found in the North Fork Entiat and Mad River were the result of previous stocking (e.g. Twin Lakes Hatchery). Rather, the evidence presented by Howell and Spruell (2003) suggests that cutthroat trout found in the North Fork Entiat and Mad River basins are of native Westslope cutthroat trout stock. They did find, however, that the distribution of “pure” WSCT in these reaches can be limited to a few miles of river.

“Pure” cutthroat trout were not the only trout populations found in the Entiat and Mad River by Howell and Spruell (2003). Rainbow trout and rainbow-cutthroat hybrids were also found in the upper Entiat River, portions of the North Fork Entiat River and parts of the Mad River. Trout sampled in three reaches of the mainstem Entiat River above Entiat Falls were found to be primarily (over 90%) rainbow trout, but up to 7% of the genetic composition was characterized as Westslope cutthroat trout “hybrid swarm”. Similarly, three reaches of the mainstem Mad River were found to be primarily (over 90%) rainbow trout, but had up to 6% of genetic composition characterized as Westslope cutthroat trout “hybrid swarm”. Two other reaches of the Mad River were characterized as Westslope cutthroat trout “hybrid swarm, with a very low level of rainbow trout genetic composition. Three reaches of the North Fork Entiat River were characterized entirely as Westslope cutthroat trout “hybrid swarm”. This blending of genetic material (introgression) between Westslope cutthroat trout, rainbow trout and other species has created challenges for resident trout fisheries managers. Fish biologists have found poor survival rates of young (fry) produced from Westslope cutthroat trout-rainbow trout hybrids (Leary, et al. 1995; Allendorf et al. 2004). Protecting the remaining pure and native Westslope cutthroat trout populations found in the Entiat and Mad River watersheds from further hybridization is a priority for fisheries managers; this goal must always be considered during discussions about the potential for trout stocking in the Entiat subbasin.

Similar problems are faced by biologists and fishery managers working to protect and restore bull trout populations, while managing resident fisheries. Studies of bull trout and brook trout populations in Montana identified genetic introgression (hybridization) between these species (Kanda et al. 2002). Biologists found that not only would brook trout and bull trout hybridize, but offspring were found to be fertile. In addition, they found that typically hybrids were produced by female bull trout and male brook

trout, thus having a disproportionate impact on bull trout. Hybrids were found to reproduce, however, young from the hybrids were found to have very low survival rates, resulting in wasted reproductive effort (Kanda et al. 2002). Similar studies have not been completed in the Entiat River watershed, but are not considered necessary as the Upper Columbia Salmon Recovery Board has determined that among the limiting factors and threats to bull trout recovery, the introduction of brook trout threatens bull trout through hybridization, competition, and predation.

The above-described problems associated with genetic introgression (hybridization) are proving to be a significant challenge for fishery managers throughout North America. Unlike gardening, where a cross between two varieties of plants can produce hardier or more productive offspring (termed “hybrid vigor”), fishery biologists are finding that crosses between two varieties of fish are less hardy producing less productive offspring (termed “outbreeding depression”). The history of stocking non-native trout species as well as non-native anadromous salmon and steelhead stocks in the Entiat River watershed, and evidence of hybridization may, therefore, prove to be an impediment to restoring fisheries if local populations are suffering from outbreeding depression.

## **HOOKING MORTALITY**

Fishery managers must make decisions about whether a certain population of fish can sustain a fishery based on information about the size of a fish population (stock), the rate of change in the population (recruitment), and measures of mortality (exploitation). Biologists recognize that natural sources of mortality (e.g. predation, senescence) are best left to be “managed” by natural processes. Manageable sources of mortality resulting from direct human influence (e.g. harvest) or indirect causes (e.g. hooking mortality) can be successfully managed with the cooperation of the angling public. In order to make a decision to open a fishery, managers must make assumptions about mortality rates to predict the potential effects on the fish population. No estimates are easy to make, but uncertainly associated with values like hooking mortality can be especially complicated.

Hooking studies have been done in an effort to understand mortality rates associated with different hook types (treble, single, barbed, barbless), angling method (fly-fishing, spin-casting, still-fishing), hook sizes, bait types, water temperatures, species of fish et cetera (e.g. DuBois and Kuklinski 2004, Pauley and Thomas 1993). Scientists have reported a wide range of estimates of post-release mortality of fish from a low of 3% to a high of as much as 90%. Table 7 provides a summary of hooking mortality rate estimates developed for various salmonid species found in the Entiat River watershed.

The potential effects of hooking mortality, therefore, must be included in analyses of the impacts a fishery may have on a fish population.

Fishery managers must also consider the potential for hooking mortality or other causes of non-target species death if a fishery is opened in a body of water or reach of river that has more than one species present. This is especially important when considering the possibility of opening a fishery where threatened or endangered fish are present. The hooking and potential resultant indirect killing of a threatened or endangered species, even if accidental, is construed as a “take” under the Endangered Species Act (see above subsection entitled Endangered Species Act). In order to permit a fishery in a body of water containing threatened or endangered species, therefore, WDFW needs Section 10 incidental take authorization from NMFS and/or the U.S. Fish and Wildlife Service to cover the potential risk to ESA listed species.

**Table 8. Summary of selected hooking mortality estimates for various salmonid species published in the primary literature.**

Species	Mortality Estimate	Hook type, hook size, and/or hooking conditions	Reference
Salmonids	3%	Worm fishing in clear water, immediate hook set when strike was observed	Thompson (1946)
Salmonids	25%	Recommended as general estimated for baited hooks	Wydoski (1977)
Salmonids	21%	Deeply hooked, line cut	Schisler and Bergersen (1996)
Salmonids	55%	Deeply hooked, hook removed	Schisler and Bergersen (1996)
Trout species	30%	Recommended as general estimate in Washington State	Mongillo (1984)
Brook Trout	2-16%	Barbed and non-barbed, baited hooks. Little Brule River Wisconsin	Dubois and Kulinski (2004)
Brook Trout	26%	Deep Hooking	Dubois and Kulinski (2004)
Rainbow Trout	16%	Bait-caught, slack-line and tight-line methods	Schill (1996)
Hatchery Rainbow Trout	47%	Deep-hooked fish, line cut	Schill (1996)
Hatchery Rainbow Trout	74%	Deep-hooked fish, hook removed	Schill (1996)
Hatchery Rainbow Trout	34%	Baited hook, line cut and hook left in	Mason and Hunt (1967)
Hatchery Rainbow Trout	82%	Baited hook, hook removed with pliers	Mason and Hunt (1967)
Hatchery Rainbow Trout	95%	Baited hook, hook removed with fingers	Mason and Hunt (1967)
Cutthroat Trout	<1%	Fly-caught	Schill et al. (1986)
Cutthroat Trout	8%	not deeply hooked	Hunsacker et al. (1970)
Cutthroat Trout	73%	deeply hooked	Hunsacker et al. (1970)
Cutthroat Trout	39.5-58.1%	worm-baited hooks	Pauley and Thomas (1993)
Cutthroat Trout	10.5-23.8%	Lure (spinner)	Pauley and Thomas (1993)

## DATA GAPS

Thanks are extended to Phyllis Griffith, Art Viola, the Oregon State University Archives and especially Phil Archibald (US Forest Service-Entiat Ranger District fish biologist) for copies of historic records and photos, and assistance assembling anecdotal records. The search was not exhaustive, but was illuminating. It is expected that additional records would be found if a focused research effort were funded. It is recommended that a librarian/archivist work with local historian Phyllis Griffith to further search Entiat Historical Society, Chelan Mirror, Entiat Daily Record, Wenatchee World, U.S Forest Service, and WDFW records. The librarian/archivist should be sure to focus energy on the years 1940 through 1965. Additional searches could concentrate on:

- Tribal subsistence fisheries: Historical information of Tribal fisheries were included in this paper (e.g. Mullan et al. 1992). Additional historic subsistence fisheries information may be available directly from the Yakama Nation and the Colville Confederated Tribes (CCT).

- The status of lamprey in the Entiat River watershed is not known. Lamprey were at one time an important Tribal fishery (Rose 2006, personal communication)
- As part of the 1995 stream survey, the NRCS interviewed long-lived citizens in the Entiat Valley. An oral history was compiled on videotape (VHS) and is being archived by the CCCD). The oral history could be reviewed for fish, fishing, fisheries and habitat change information.
- There are a number of families residing in the Entiat River valley. Family photo albums, fishing journals, and other personal histories may contain information about fish, fishing, and fisheries (e.g. diary of Mr. Bonar). A review of these records could be completed if citizens were willing to share the personal records.
- There is not a definitive record of fish population, or meta-population records for Columbia River or for populations in the Entiat River. This uncertainty is confounding decisions of fisheries managers, and is a source of aggravation to those interested in fishing. Recent genetic analyses indicated “insufficient sample size” as the most significant limitation to the record (e.g. Ford et al. 2001). A sufficient sample size of spring Chinook and steelhead should be collected, and results published.
- WDFW should provide guidance to anglers about existing fishery opportunities in the Entiat River watershed. Regulations published by the WDFW cannot provide a sufficient level of detail about locations, target species, gear type, etc. to enable use of the sustainable fish and wildlife-related recreational and commercial opportunities presently available in the watershed. An outreach document, specific to the Entiat River watershed, could be developed to provide details that were not included in the regulation book.
- A study is needed to evaluate the effectiveness and feasibility of utilizing nutrient enrichment as a habitat enhancement technique. The study should evaluate the potential for improvements in condition and survival of salmonids rearing in a treated area as compared with a reference area where no treatment would occur.

## **SUMMARY OF ONGOING ACTIVITIES/PROJECTS DESIGNED TO IMPROVE FISH POPULATIONS**

Citizens of the Entiat River valley are to be commended for the sustained commitment to ongoing fish habitat enhancement and monitoring efforts. The following summarizes these ongoing efforts that could not be completed without the willingness of landowners to allow access to the stream or without the sustained interest and involvement of citizens in watershed and salmon recovery efforts.

### ***Stream Habitat Enhancement Efforts***

Generally stream habitat enhancement is focused on increasing habitat complexity. This includes creating more primary pools, side-channel habitat, reconnecting the Entiat River and tributaries to their flood plains, decreasing summer water temperatures and enhancing riparian areas. Efforts to decrease summertime water temperatures and increase summertime instream flows will also enhance stream habitat in the Entiat River. For more information about these efforts contact the Chelan County Conservation District (509-664-0271), <http://www.chelancc.org/watershed.htm>. Details are provided in the following documents:

Entiat Water Resource Inventory Area (WRIA) 46 Management Plan (CCCD 2004):  
[http://www.chelancc.org/WRIA46\\_Plan.htm](http://www.chelancc.org/WRIA46_Plan.htm)

Detailed Implementation Plan (CCCD 2006): <http://www.chelancd.org/DIP.htm>

Proposed Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout\* Recovery Plan (UCSRB 2006):[http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/Proposed\\_UC\\_Plan.pdf](http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/Proposed_UC_Plan.pdf)

### ***Stream Fish Population and Habitat Monitoring Efforts***

Ongoing monitoring efforts in the Entiat River watershed fall into two general categories: (a) Status and Trend monitoring and (b) Effectiveness monitoring.

Status and trend monitoring has been conducted in the watershed for many decades. The purpose of status and trend monitoring is to observe changes over time. Examples of status and trend monitoring data include streamflow (gauging), water temperature, sediment, water quality (e.g. DO, pH), and fish spawning (redd) surveys. For over 10 years the Entiat WRIA Planning Unit (EWPU) has been provided updates on status and trends in the data. Examples of status and trend reports include:

Sediment Surveys – (Archibald and Johnson 2006a)

Spawning Surveys – (Archibald and Johnson 2006b, Hamstreet 2007, Hamstreet 2006)

Streamflow – (USGS 2007, WDOE 2007)

Water Quality, see – [http://www.ecy.wa.gov/programs/eap/fw\\_riv/rv\\_main.html](http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html)

Effectiveness monitoring is a more recent effort of scientists to determine the effects of ongoing habitat enhancement efforts on fish production and habitat use in the subbasin. Effectiveness monitoring can include spawner surveys (redd counts), direct observation of fish (snorkel surveys), counts of fish at dams (dam counts), tagging and trapping of small fish (pit tagging, smolt trapping), and other studies to determine the number and type of fish, their distribution in the watershed, and general health of fish. Habitat surveys are also conducted to evaluate changes in the quantity and quality of fish habitat. A number of reports have been produced including:

Integrated Status and Effectiveness Monitoring Program (ISEMP) – (Terraqua, Inc. 2006)

Environmental Monitoring and Assessment Program (EMAP), See –

[http://www.ecy.wa.gov/programs/eap/fw\\_benth/emap-remap.html](http://www.ecy.wa.gov/programs/eap/fw_benth/emap-remap.html)

Data Access in Real Time (DART), see –<http://www.cbr.washington.edu/dart/help/>

An ultimate goal of the ongoing habitat enhancement and status, trend, and effectiveness monitoring in the Entiat River watershed is to document the restoration of fish populations and enable the re-opening of fisheries. Monitoring data can be used to illustrate existing healthy fish populations and habitat that can be exploited immediately. Monitoring information can also be used to track the status of less-healthy habitat and fish populations to determine when these populations have recovered to the point that a fishery could be re-opened. It is critical that status, trend, and effectiveness monitoring continue in the watershed to enable future decisions to re-open fisheries. Specific goals have been identified for the recovery of wild salmon, steelhead, and bull trout populations to warrant de-listing under the Endangered

Species act (see UCSRB 2006). Once monitoring shows that these goals have been reached, fishery managers will consider what tools might be used to enable a fishery for the recovered species.

## **FISHERY MANAGEMENT TOOLS**

Fishery biologists have a limited number of tools to use to manage how, when, where and how much of an effect fishers might have on a fish population. These tools include:

**bag limits:** A typical method of controlling the amount of harvest is to designate, in rules, the maximum number of fish that one person can keep, typically in 1-day's time.

**gear restrictions:** Another common method used to limit direct and indirect mortality rates on a fish population is to restrict gear types. By limiting the types of gear available, anglers catch fewer fish with the use of less effective methods and release fish with greater survival.

**license limitations:** Fisheries can be managed by controlling the number of individuals permitted to use a particular fishery.

**quotas:** These are limits on the number of fish that can be retained by an individual (see bag limit) or fishery (e.g. ocean commercial harvest). Quotas are established to ensure that the total catch does not exceed projected total harvest limits.

**seasons:** Time frames when a fishery is open or closed (season) is typically done to avoid the incidental catch of non-target species or life stages. For example, seasons when fish spawn are typically closed to fishing.

**Geographic closures:** Where a fishery takes place can be just as important as when a fishery is open. Typically fisheries are not open in locations where target species are known to spawn, or are otherwise excessively vulnerable (e.g. Mad River "Dolly Holes" and Entiat River Box Canyon pools).

**size limits:** Maximum and minimum size limits are often used to allow a fishery to be open, but protecting a sufficient number of adult fish to spawn and produce enough young to sustain the fishery over time. Specialized size limits (e.g. slot) can also be used to create specialized conditions like trophy fisheries.

**taxes and fees:** Fisheries managers use taxes and fees to pay for biologists to monitor fish, fisheries, and habitat, restore habitat, or improve access.

In order to determine whether or not there are enough excess adult fish to support a fishery, biologists must use various tools to make an annual harvest allocation: These tools include:

**Dam counts:** When dams were constructed on the Columbia River, viewing windows and other monitoring portals were constructed along fish ladders to enable biologists to count the number of fish passing upstream. These (dam) counts are used to estimate the number of fish returning to any one stream tributary to the Columbia River.

**Redd surveys:** As with dam counts, biologists estimate the number of adult fish returning to spawn in a particular stream by counting the number of nests (redd surveys) in

the river or stream. The total redd count is multiplied by a standardized value (between 2 and 4, depending on species and stream) representing the number of fish associated with a redd.

**Ocean census:** Counts are made of fish captured in ocean fisheries. These counts are sometimes used as an index of how large or small a population may be. These values are more difficult to apply to a particular river or stream.

In order to determine how many of a target species have been removed from a population as part of a fishery, biologists must use various tools to estimate harvest levels: These tools include:

**Creel census** In a creel census or survey (also known as angler survey) anglers are interviewed, fish are measured, the number of hours anglers fished are counted, number of boats are counted, and other such data are collected. When the data are analyzed, biologists are able to estimate the amount of effort, harvest rates, fish size and species distribution and other important population parameters can be estimated. Often an estimate of fishing quality and recreational fishing pressure can be determined, helping to shape future fishery management decisions.

**Catch cards** Indirect methods can be used to collect similar information as obtained with anglers surveys (e.g. catch cards). Catch cards are designed so that anglers can provide to fishery managers information similar to what might be obtained in an angler interview. Indirect methods are less expensive and time consuming, but often provide lower data quality.

Fishery biologists analyze data from each of the above sources to determine when, where, and how a fishery can be opened. The following three examples are offered illustrating use of this information to manage existing fisheries in the Entiat River watershed, and For example,,

Entiat River whitefish fishery- With the closure of trout fishing in the lower Entiat River (mouth to Entiat Falls), the only recent fishery on the mainstem Entiat River has been the winter whitefish season. The fishery is a good example of a fishery utilizing a combination of season restrictions (Dec 1-Mar 31) and gear restrictions (one single-point size #14 hook) developed by WDFW to avoid or minimize capture of ESA listed fish that may be present in the same waters as the target species. Gear restrictions such as no bait or single barbless hooks greatly increase the survival of released fish after they have been hooked (see hooking mortality section). Seasonal limitations were also imposed to avoid fishing in these sections of stream when listed species are spawning.

Upper Mad River cutthroat trout fishery – There is presently a year-round geographic closure of the Mad River from its confluence with the Entiat River up to Jimmy Creek. This is a good example of an area and seasonal-closure, intended to avoid the capture of three listed species (spring Chinook, steelhead, and bull trout) while allowing a summer fishery for cutthroat trout in the Mad River upstream from Jimmy Creek where ESA listed species are not present.

Upper Entiat River (geographic and specialized) trout fishery - The Entiat River above Entiat Falls is open to fishing from June 1 to October 31 for all species because ESA listed species are not present above the falls (a natural passage barrier). This timing restriction protects the spring spawning window of rainbow and cutthroat trout while encompassing the peak recreation season when national forest visitors are seeking stream angling opportunities. Selective gear rules apply to this fishing area. These rules

provide that “fish may be released until the daily limit is retained”. Survival of released fish is improved by the rule stipulations of “only unscented artificial flies or lures with one single-point barbless hook”...”up to a total of three artificial flies or lures containing single-point barbless hooks may be used.”... “bait is prohibited” and “if any fish has swallowed the hook or is hooked in the gill, eye, or tongue, it should be kept if legal to do so.”

## RECOMMENDATIONS

This recommendations section discusses efforts to enhance ongoing fisheries, near-term opportunities to open new fisheries and long-term actions needed to restore recreational and tribal fishing opportunities in the Entiat River watershed. It is a rather challenging endeavor to develop fisheries opportunities that cause no harm to ESA listed species found in the Entiat and Mad River watersheds; help obtain salmon, steelhead and bull trout recovery goals; do not lead to disease or genetic impacts to native populations of salmon and trout; and meet the management objectives of the tribes, state and federal management agencies.

Creative solutions that are already being pursued or implemented to enhance and expand opportunities in the Entiat River Watershed are described below. Potential long-term strategies to restoring sustainable fisheries in the Entiat River watershed are also offered, consistent with the vision and goals of the Entiat Watershed Planning Unit and the “stewardship” and “recreation” policy position of the WDFW.

### EXISTING FISHERIES

Existing fisheries in the Entiat River watershed could, and should be more fully exploited. Fishery managers could provide better guidance to anglers about existing sport-fishing opportunities that currently exist in the Entiat River watershed. Portions of the Entiat River and tributary streams are annually open to seasonal, recreational sportfishing. Seasonal trout fisheries are open on the Entiat River above Entiat Falls and the North Fork Entiat River. Tributary streams with seasonal trout fisheries include: Roaring Creek, Tillicum Creek, Potato Creek, Lake Creek, and Tommy Creek. A number of alpine lakes also have seasonal trout fisheries, including: Myrtle Lake, Larch Lakes, Ice Lakes, Fern Lake, Two Little Lakes (Louise and Ann), Mad Lake and Lost Lake. This last alpine lake (Lost Lake) is noteworthy for having large brook trout (Archibald 2007b). These waters are subject to the general fishing regulations (Appendix C). Also check with local biologists for more information about fishing conditions and recent regulation changes:

Art Viola, WDFW Region 2 Resident Fish Biologist – (509) 665-3337

Phil Archibald, USFS-Entiat Ranger District Fish Biologist – (509) 784-1511

### FUTURE FISHERIES

There are ongoing, near-term and proposed long-term opportunities to expand fisheries in the Entiat River watershed. Near-term opportunities are identified here as programs that may be implemented relatively soon to allow new or expanded fishing in the watershed. Long-term opportunities are identified here as programs and actions that will require time to implement and take effect, but could create fisheries that can be sustained indefinitely.

#### ***Near-Term Fisheries Opportunities***

Near-term opportunities include efforts that could be immediately implemented that will not impair recovery efforts. With the listing of spring Chinook, steelhead, and bull trout as protected under the ESA, fisheries opportunities must be designed to either have no effect or enhance efforts to recover threatened and endangered species.

#### **Anadromous**

Selective fisheries on both non-native Carson stock spring Chinook and summer Chinook salmon have recently been proposed for the Entiat River. These proposed programs, summarized below, were collaboratively developed by citizens of the Entiat River valley, state agencies, federal agencies, Tribal

agencies, local government, and non-governmental entities through ongoing “Fishery Round Table” discussions. For more information about the Fishery Round Table, please contact Sarah Walker, EWPU Coordinator (509) 664-0271. Appendix D is an example of the type of document required to demonstrate consistency with Endangered Species Act recovery efforts. Appendix E is an example of the formal public notification process required of federal agencies as part of the permitting process.

Spring Chinook – A fishery has been proposed that would open the Entiat River to the harvest of hatchery produced (non-native Carson stock) spring Chinook salmon in the Entiat River from RM 0 up to the Entiat National Fish Hatchery (ENFH). In most years, the return of hatchery-origin adults to the ENFH exceeds the hatchery’s requirements and capacity for brood stock; the hatchery spawns approximately 300 adults per year (USFWS 2007). From 1999-2003, an average of 1,235 surplus adults per year returned to the hatchery. These “surplus” fish were collected and made available to members of the CCT and other Columbia River tribes to satisfy their treaty entitlement to “ceremonial and subsistence” fish. The ENFH collects surplus hatchery fish beyond what they need for broodstock in an attempt to prevent them from spawning naturally in the Entiat River and minimize genetic intermingling and competition of the non-native hatchery fish with the naturally reproducing spring Chinook that spawn in the Entiat watershed (see previous section on “genetic introgression”).

Because of their genetic make-up, Carson stock (hatchery) spring Chinook do not contribute to the recovery of naturally reproducing spring Chinook populations in the Entiat or Upper Columbia region and are not protected by the ESA. Removal of surplus ENFH adults would provide a fishery opportunity while helping to meet recovery goals by eliminating the risk of further genetic introgression and competition on the spawning grounds with naturally reproducing spring Chinook stocks.

If authorized, the triggers required to open the fishery on hatchery spring Chinook would include escapement and run composition considerations. A minimum escapement (adult returns) of 100 natural and 800 Carson origin hatchery fish would be required to initiate a fishery. One hundred natural origin spawning adults represents a critical threshold escapement level for the basin and is 20% of the minimum viable threshold level (500 fish) for the Entiat River Basin (TRT 2005). The minimum of 800 Carson origin Chinook that would be needed to initiate a fishery is based upon the 400 fish required for broodstock collection at Entiat NFH and would leave an estimated 400 fish available for harvest.

A possible fishery would be selective in terms of:

1. timing – The opening of the fishery would likely occur in mid-May or June when the bulk of the hatchery spring Chinook were returning to their “spawning grounds” (the ENFH), and the potential for incidental take of other listed species in the mainstem Entiat River was at its lowest;
2. location – The fishery could be opened from the mouth of the Entiat River to just downstream of the ENFH where these fish would be concentrated and most available to anglers; and,
3. target species – The fishery would target hatchery spring Chinook. Hatchery fish would need to carry a visible “mark” to enable anglers and managers to determine that only hatchery-origin fish were being captured and retained. The most commonly used visible “mark” is a clipped adipose fin with a healed scar.
4. gear restrictions – Gear and bait restrictions would likely be used to minimize the potential for incidental take (adverse effects) on ESA protected steelhead and bull trout.

Potential drawbacks to this fishery include limited public access on the lower six miles of river and spring high flows which typically occur during May and June. These factors could diminish angler satisfaction. Also, the month of May encompasses the end of the steelhead spawning season and the beginning of the bull trout spawning migration. Restrictions on the type of gear and bait would likely be required to avoid or minimize incidental hooking of these two ESA-listed species.

This proposal is a new request that was recently written into the WDFW permit application for Chinook fisheries within the Upper Columbia region; the permit application is currently under review by NMFS. For more information about progress towards opening this potential fishery, please contact the Chelan County Conservation District at (509) 664-0271.

Summer Chinook – WDFW worked directly with landowner steering committee and technical members of the EWPU, County staff, and NMFS staff through Fishery Round Table discussions to identify the potential for the harvest of summer Chinook salmon in the Entiat River from RM 0 up to the Entiat City Limit Sign. During most years (including 2007), the Columbia River between Rocky Reach Dam and Wells Dam is open to salmon fishing from July 1 to October 15. The timing of this fishery targets summer (late run) Chinook salmon and avoids or minimizes incidental capture of steelhead, spring Chinook salmon, and bull trout. Summer Chinook are not protected under the ESA. An expansion of the existing Columbia River fishery boundary into the lower Entiat River has been and is presently moving through the permitting process. The proposed fishery would not expand Columbia River harvest numbers but would extend the boundary for the late-run Chinook fishery into the Entiat River up to the Entiat City Limits sign, an easily recognizable landmark. Public access in this area is very good although no sanitation facilities are presently available.

This possible fishery would be selective in terms of:

1. timing – The fishery would likely be opened between July 1 and October 15, concurrent with the mainstem Columbia River fishery, when the bulk of summer Chinook are returning to their spawning grounds;
2. location – The fishery would be opened from the mouth of the Entiat River to the Entiat City Limit sign, where the fish would be most available to anglers; and,
3. target species – The fishery would be for summer Chinook.

Potential drawbacks to this fishery include a perceived difficulty of capturing summer Chinook by angling in fresh water. Further, any temptation for anglers to run their boats up the lower Entiat River, which is closed to motorized craft upstream from the Highway 97A Bridge, should be avoided. The popularity of this segment of the Entiat River among swimmers and paddlers on hot days in August and September may also create challenges if there is competition for use of this space for different recreational activities. These factors could diminish angler satisfaction. For more information about progress towards opening this potential fishery, please contact the Chelan County Conservation District at (509) 664-0271.

### **Resident Fisheries**

Selective fisheries for Westslope cutthroat trout, rainbow trout, and brook trout could potentially be developed in the Entiat River between the Forest Service Boundary (RM 26) and Entiat Falls. The purpose of these fisheries would be to provide recreational sport-fishing opportunities to campers and other anglers in the mainstem Entiat River adjacent to three campgrounds managed by the USFS-Entiat Ranger District: Fox Creek, Lake Creek and Silver Falls.

These fisheries would be selective in terms of:

1. timing – The proposed fishery would need to minimize the risk of incidental hooking of ESA-protected bull trout or steelhead trout, and would therefore need to be limited to the months of July and August or possibly June and July if incidental hooking of bull trout is found to be a problem;
2. location – The proposed fisheries would be limited to sections of water known to have non-native rainbow trout, brook trout, and rainbow-cutthroat hybrids generally being between RM 26 and 34;
3. target species – The fisheries would need to target non-native rainbow trout, brook trout, and rainbow-cutthroat hybrids. Any incidental catch of steelhead or bull trout would likely cause an immediate closure were such a fishery opened; and,
4. gear restrictions – Gear, hook, and bait limitations would likely be required. A selective, fly-only catch and release fishery might be more likely to gain support from fishery managers.

The most significant drawback to such fisheries would be the potential effects on bull trout. The Entiat River between RM 26 and 34 is used by bull trout for spawning and rearing. If such fisheries were opened, very close monitoring by fishery managers and agencies responsible for bull recovery would be required to ensure that the fisheries did not impair recovery efforts. Such a restrictive and heavily regulated fishery could require additional fishery management agency staff and resources; however, self-policing fisheries have been successfully developed in cooperation with fly-fishing groups in other portions of the Upper Columbia region, i.e. the Methow valley. The need to heavily regulate the fisheries could diminish angler satisfaction. This potential future fishing opportunity between RM 26 and 34 is strictly conceptual, and has yet to be proposed. Further exploration and potential development of the concept will require numerous discussions with WDFW, NMFS and USFWS staff members.

### ***Long-Term Sustainable Fishery Opportunities***

The following have been identified as possible future Entiat River fishery opportunities, provided that sufficient time is taken to implement all the actions required to produce sustainable fish populations. Improvements must occur across all 4 “H”s currently affecting listed fish populations: Harvest, Hatcheries, Hydropower, and Habitat. The level of effort required to achieve self-sustaining populations and associated long-term fishery objectives should not be taken lightly. The amount of time estimated to downlist spring Chinook and steelhead is 5-15 years (UCSRB 2006). It is estimated that recovery (delisting) of spring Chinook and steelhead could occur within 10-30 years, while the estimated amount of time for bull trout recovery is 15-25 years (UCSRB 2006). Estimates of costs to recover salmon, steelhead and bull trout vary greatly depending on the source. The USFWS estimates that it will cost approximately \$15 million to recover bull trout in the Upper Columbia River basin (USFWS 2002). The UCSRB (2006) estimates that it will cost at least \$154 million to recovery spring Chinook, steelhead, and bull trout in the Upper Columbia River basin. The UCSRB (2006) further clarifies that its number is an underestimate, as it assumes that actions will also be implemented based on Habitat Conservation Plan and settlement agreement requirements of mainstem Columbia River Public Utility Districts (PUDs). PUDs are anticipated to contribute in excess of \$100 million towards recovery actions. Efforts to restore the lower Columbia River, the Columbia River estuary, and facilities associated with the Federal Columbia River Power System will add even more costs and time. For more details see the Proposed Upper Columbia Salmon Recovery plan (UCSRB 2006):

Persons interested in the restoration of fisheries for spring Chinook, steelhead, and bull trout in the Entiat River watershed should continue to implement ongoing habitat restoration and monitoring programs. Ongoing collaborative efforts to develop these fisheries should also continue through Fishery Roundtable discussions. Fishery management agencies and salmon recovery leadership should also make regular progress reports to the EWPU at quarterly meetings. Cooperating parties should consider implementing an accelerated salmon recovery project implementation schedule.

Long-term programs to enhance resident fisheries should include an effort to better manage brook trout populations in the Entiat River watershed. Brook trout are “believed by some anglers to be the easiest of all trout to catch. It readily takes bait, artificial flies, and spinners. Because of its beauty, excellent flavor, and vulnerability, it is one of the most popular game fishes in the United States, despite its relatively small size” (Wydoski and Whitney 2003). However, “In infertile high mountain lakes [e.g. Myrtle Lake], brook trout become overpopulated and their growth becomes stunted...[c]onsequently this species should not be planted in infertile waters” (Wydoski and Whitney 2003). Indeed, recent Entiat angler contacts indicate dissatisfaction with the brook trout fishery of the Entiat River above Entiat Falls and in Myrtle Lake for the very reasons previously stated by Wydoski and Whitney (2003). In response, beginning in 2007, WDFW “liberalized” the fishing regulations for eastern brook trout above Entiat Falls to: No minimum size, daily limit 10, and bag limits that encourage anglers to release other trout species so that they may continue to fish longer for brook trout. This regulation has not been in effect long enough to determine its effectiveness in reducing the population of brook trout, increasing their size, and satisfying angler preference/demand.

The self-sustaining brook trout population of Myrtle Lake poses another problem for fishery managers – it serves as a source of recruitment to the Entiat River (fish escape from Myrtle Lake and make it into the Entiat River). For several years fishery biologists from WDFW and USFS have been formulating a strategy to remove the brook trout and replace them with Westslope cutthroat trout. The shift to Westslope cutthroat trout would accomplish 3 goals: (1) reduce the population of an ecologically undesirable introduced species (brook trout), (2) bolster the recovery of a native resident trout species that is in decline (Westslope cutthroat), and (3) provide a more satisfactory recreational fishery in Myrtle Lake and the upper Entiat River. This strategy would most likely involve the use of a toxicant such as rotenone or antimycin to kill brook trout and could be controversial.

### ***Nutrient Supplementation as a Salmonid Recovery Tool in the Entiat River***

Salmon provide a crucial link in the flow of marine derived nutrients to the freshwater environments in which they spawn (Cederholm et al. 1999). It has been estimated that only 6-7% of historically available marine derived nutrients are reaching watersheds in the Pacific Northwest. A growing body of evidence suggests that this annual pulse of nutrients released from decaying post-spawn adults provides substantial benefits in both aquatic and terrestrial ecosystems through a variety of pathways (Bilby et al. 2001) possibly aiding the recovery of weak or ESA-listed stocks (Wipfli 1999, 1998).

In recognition of these benefits, a nutrient enhancement program was established in 2000 to outplant post-spawn spring Chinook carcasses from Leavenworth Complex hatcheries in the Wenatchee, Entiat and Methow River basins. Carcasses were sanitized through freezing and the tail was removed prior to outplanting to distinguish outplants from naturally spawned carcasses. Carcass distribution targeted known spring Chinook spawning areas in each basin. During the course of the project, decisions were made to eliminate female broodstock because they are injected with erythromycin prior to spawning to combat bacterial kidney disease. Additionally, any MS-222 treatment (fish sedative) of adults required a

one month (living) withdrawal period or the subsequent carcass was not useable for outplant. In 2003, spawning practices changed to the extent that few suitable carcasses were available for outplant (use of MS-222 at both ENFH and LNFH). In an effort to continue nutrient supplementation, an alternative method was employed. In 2003, carcass analogs were purchased from the fish feed manufacturer Bio-Oregon based on favorable findings about the ability of this product to mimic natural salmon carcass nutrient contribution. The carcass analog is composed primarily of post-spawn hatchery Chinook salmon and binder that is pasteurized through heating and desiccation into pellet form for distribution. Carcass analogs were outplanted under guidelines from Bio-Oregon that suggested three pounds of dried analog provides the nutrient equivalent to one fifteen pound Chinook carcass. A total of 959 salmon carcasses (or analog carcass equivalents) were outplanted in the Entiat River during the years 2000-2003. Due to the limited availability of useable carcasses for outplanting, complications with other studies, and the costs associated with the use of analogs, the nutrient enhancement program was discontinued in 2004.

## LIMITATIONS

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

## REFERENCES

- Allendorf F.W., R.F. Leary, N.P. Hitt, K.L. Knudsen, L.L. Lundquist, P.Spruell. 2004. Intercrosses and the U.S. Endangered Species Act: Should hybridized populations be included as westslope cutthroat trout? *Conservation Biology* 18(5): 1203-1213.
- Andonaegui, C. 1999. Salmon and steelhead habitat limiting factors report for the Entiat Watershed Water Resource Inventory Area (WRIA) 46, Version 3. Washington State Conservation Commission, Headquarters Office, Olympia, Washington. 77 pp.
- Archibald, P. 2007a. Personal communication regarding bull trout in the Entiat River watershed.
- Archibald, P. 2007b. Personal communication regarding brook trout fisheries in the Entiat River watershed.
- Archibald, P. and E. Johnson. 2007. Mad River Bull Trout Spawning Survey – 2006. 11 pp.
- Archibald, P. and E. Johnson. 2006a. 2005 Sediment Monitoring Report: Entait River, Mad River. USFS Wenatchee National Forest, Entait Ranger District: Entiat WA.
- Archibald, P. and E. Johnson. 2006b. 2005 Spring Spawning Surveys for Rainbow/Steelhead Trout Entiat Ranger District. USFS Wenatchee National Forest, Entait Ranger District, Entiat, WA.
- Archibald, P. and A. Viola. 2006. Draft Summary of Historical Fisheries in the Entiat River Watershed: Pre-1990 to 1930. Unpublished Draft Report to the Chelan County Conservation District, Wenatchee, Washington. 3 pp.
- Archibald, P. A. Viola, and S. Walker. 2006 Draft Fishery White Paper Table of Contents. Unpublished draft document.
- Bams, R. A. 1976. Survival and Propensity for Homing as Affected by Presence or Absence of Locally Adapted Paternal Genes in Two Transplanted Populations of Pink Salmon (*Oncorhynchus gorbuscha*). *Journal of the Fishereis Research Board of Canada* 33: 2716-2725.
- Behnke. R.J. 1992. Native Trout of Western North America. American Fisheries Society Monograph: No 6.
- Bilby, R.E., Fransen, B.R., Walter, J.K., Cederholm, C.J., and Scarlett, W.J. 2001. Preliminary Evaluation of the Use of Nitrogen Stable Isotope Ratios to Establish Escapement Levels for Pacific Salmon. *Fisheries* 26(1):6-14.
- Brown, L.G. 1993. Management Guide for the Bull Trout *Salvelinus confluentus* (Suckley) on the Wenatchee National Forest. USDA Forest Service, Wenatchee National Forest, Wenatchee, WA.
- Bryant, F.G. and Z.E. Parkhurst. 1950. Survey of the Columbia River and its Tributaries. No. 4 Area III, Washington Streams from the Klickitat and Snake Rivers to Grand coulee Dam, with Notes on the Columbia and its Tributaries Above Grand coulee Dam. U.S. Fish and Wildlife Service. Special Scientific Reports on Fisheries No. 37. 108 pp.

- Budy, P. and G.P. Thiede. 2003. Bull trout population assessment and life-history characteristics in association with habitat quality and land use: a template for recovery planning. Annual Progress Report for 2003. 62 pp.
- Bullock, G.L. and R.L. Herman. 2007. Bacterial Kidney Disease of Salmonid Fishes Caused by *Renibacterium salmonarium*. USFWS Fish Disease Leaflet 78. 2 pp.  
[www.aquatext.com/images/diseases/bkd.htm](http://www.aquatext.com/images/diseases/bkd.htm).
- Busack, C.A., Currens, K.P. 1995. Genetic Risks and Hazards in Hatchery Operations: Fundamental Concepts and Issues. American Fisheries Society Symposium 15: 71-80.
- Caldwell, J, B Caldwell and K Bruya. 1987. Documentation and rationale for preference curves for IFIM studies. Unpublished. State of Washington Department of Fisheries and State of Washington Department of Ecology.
- Chelan County conservation District (CCCD), Chelan County Conservation District. 2006. Detailed Implementation Plan, Entiat Water Resource Inventory Area (WRIA) 46. Prepared for the Entiat Watershed Planning Unit. Wenatchee, WA.
- CCCD. 2004. Entiat Water Resource Inventory Area (WRIA) 46 Management Plan. Prepared for the Entiat Watershed Planning Unit. Wenatchee, WA.
- CCCD. 1998. Entiat River Inventory and Analysis. Chelan County Conservation District, Wenatchee, WA. 55 pp. For more information, please see –  
[http://www.chelancd.org/WRIA46Plan/Reports/EntiatR\\_Inventory&Analysis.pdf](http://www.chelancd.org/WRIA46Plan/Reports/EntiatR_Inventory&Analysis.pdf)
- Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, B.G. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Percy, C.A. Simenstad, and P.C. Trotter. 2000. Pacific Salmon and Wildlife – Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report, Prepared for D.H. Johnson and T.A. O’Neil (Manag. Dirs.), Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia. 141 pp.
- CFR (50 CFR §17). Title 50: Wildlife and Fisheries. Part 17 of the Endangered Species Act – Endangered and Threatened Wildlife and Plants. Endangered and Threatened Wildlife.  
[http://www.access.gpo.gov/nara/cfr/waisidx\\_01/50cfr17\\_01.html](http://www.access.gpo.gov/nara/cfr/waisidx_01/50cfr17_01.html)
- CFR (50 CFR §402). Title 50: Wildlife and Fisheries. Part 402 of the Endangered Species Act – Interagency Cooperation—Endangered Species Act of 1973, as amended.  
[http://www.access.gpo.gov/nara/cfr/waisidx\\_02/50cfr402\\_02.html](http://www.access.gpo.gov/nara/cfr/waisidx_02/50cfr402_02.html)
- Chapman, D. and Associates. 1989. Summer and Winter Ecology of Juvenile Chinook Salmon and Steelhead Trout in the Wenatchee River, Washington. Final Report to the Chelan County Public Utility district. 301 pp.
- Chapman, D.W., C. Peven, A. Giorgi, T. Hillman, F. Utter, M. Hill, J. Stevenson, and M. Miller. 1995. Status of sockeye salmon in the Mid-Columbia Region. Report prepared for the Mid-Columbia PUDs by Don Chapman Consultants, Inc. Boise, ID. 245 p + appendices.

- Chapman, D.W., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B., Suzumoto, R. Klinge. 1994. Status of summer/fall Chinook salmon in the mid-Columbia Region. Don Chapman Consultants, Inc. Boise, ID, 411 p.
- Chapter 77.85 Revised Code of Washington (RCW). Salmon Recovery . For copies of this statute please see - <http://apps.leg.wa.gov/rcw/default.aspx?Cite=77>
- Chapter 90.82 Revised Code of Washington (RCW). Watershed Planning. For copies of this statute please see - <http://apps.leg.wa.gov/rcw/default.aspx?Cite=90>
- Chilcote, M.W. 2003. Relationship Between Natural Productivity and the Frequency of Wild Fish in Mixed Spawning Populations of Wild and Hatchery Steelhead (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences 60(9): 1057-1067.
- Chilcote, M.W., Leider, S.L, and J.J. Loch. Differential Reproductive Success of Hatchery and Wild Summer-Run Steelhead Under Natural conditions. Transactions of the American Fisheries Society 115(5) 726-735.
- Coughenour, J.C. June 13, 2007. Case No. CV05-1128-JCC, Order, Document 125. 31 pp.
- Craig, J.A. and A.J. Suomela. 1941. Time of appearance of the runs of salmon and steelhead native to the Wenatchee, Entiat, Methow and Okanogan rivers. Unpublished MS, USFWS. 35 pp. plus 18 affidavits and accompanying letter of corroboration. In Mullan et al. 1992, Appendix J.
- Crane, P.A., L.W. Seeb, and J. Seeb. 1994. Genetic relationships among *Salvelinus* species inferred from allozyme data. Canadian Journal of Fisheries and Aquatic Sciences 51 (No. 1 Supplement): 182-197
- Currens, K.P., A.R. Hemmingsen, R.A. French, D.V Buchanan, C.B. Schreck, and W.L. Hiram. 1997. Introgression and susceptibility to disease in a wild population of rainbow trout. North American Journal of Fisheries Management. 17: 1065-1078.
- Dow, Edson. 1963. *Passes to the North. History of the Wenatchee Mountains*
- DuBois, R.B. and K.E. Kuklinski. 2004. Effect of Hook Type on Mortality, Trauma, and Capture Efficiency of Wild, Stream-Resident Trout Caught by Active Baitfishing. North American Journal of Fisheries Management. 24: 617-623.
- EES Consulting. 2005. Bull Trout Habitat Suitability Data from the Upper Wenatchee River Basin. Prepared for Chelan county Natural Resources Department and WRIA 45 Watershed Planning Unit. 39 pp.
- Eldred, D.R. 1975. Letter from Washington Department of Game to Ralph Holtby, USFS, Entiat Ranger District. Entiat Ranger District files. Entiat, WA.
- Erickson, J. 2003. Historical changes in the lower Entiat River, Washington: Implications for Stream Restoration and Salmon Recovery. Master's Thesis. Central Washington University Geography and Land Studies Department, Ellensburg, WA.

Evered, Joy. May 1, 2006. Fish Health Documents for Leavenworth National Hatchery Complex: Leavenworth, Entiat, and Winthrop NFHs. Provided to U.S. Fish and Wildlife Service Hatchery Review Team. 13 pp. See:

<http://www.fws.gov/pacific/fisheries/hatcheryreview/documents/documents/MC--022LeavenworthComplexFishHealthdocuments.pdf>

Everhart, W.H. and W.D. Youngs. Principles of Fishery Science. Second Edition. Constock Publishing Associates, Cornell University Press, Ithaca, New York. 349 pp.

Federal Register (71 FR §57472). September 29, 2006. Notice Of Availability and Request for comments on Endangered and Threatened Species Recovery Plans. Federal Register Volume 71, Number 189, pages 57472-57476.

Federal Register (70 FR §56212). September 26, 2005. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Bull Trout – Final Rule. Federal Register Volume 70, Number 185, pages 56121-56311.

Federal Register (70 FR §52630). September 2, 2005. Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho. Pages 52630-52685.

Federal Register (68 FR §46989). August 7, 2003. Endangered and Threatened Wildlife and Plants: Reconsidered Finding for an Amended Petition to List the Westslope Cutthroat Trout as Threatened Throughout its Range. Pages 46989-47009.

Fish, F.F. and M.G. Hanavan. 1948. A Report on the Grand Coulee Fish Maintenance Project 1939-1947. U.S. Fish and Wildlife Service Special Report 55.

Ford, M., and 12 co-authors. 2001. Upper Columbia River steelhead and spring Chinook salmon population structure and biological requirements. Final report. NMFS, NWFSC, Seattle, WA. 64 p.

Fraleigh, J. and B. Shepard. 1989. Life History, Ecology and Population Status of Migratory Bull Trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63:133-143.

Gilbert, C.H. 1913. Age at maturity of the Pacific coast salmon of the genus *Oncorhynchus*. Bulletin of the U.S. Fish Commission (1894): 169-207.

Hamstreet, C.O. 2007. Spring and Summer Chinook Salmon Spawning Ground Surveys on the Entiat River, 2006. Leavenworth, WA. 14 pp.

Hamstreet, C.O. and D. Carie. 2004. Spring and Summer Chinook Salmon Spawning Ground Surveys on the Entiat River, 2003. Leavenworth, WA. 14 pp.

Healey, M. C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 313-393 In: C. Groot and L. Margolis, Editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, Canada.

- Hillman, T. 1987. Spatial interaction of juvenile Chinook salmon and the redbside shiner. *in* Summer and Winter Ecology of Juvenile Chinook Salmon and Steelehad trout in the Wenatchee River, Washington. Final Report to Chelan County Public Utility District. 301 pp.
- Howell, P. and P. Spruell. 2003. Information Regarding the Origin and Genetic Characteristics of Westslope Cutthroat Trout in Oregon and Central Washington. Unpublished report furnished by Phil Archibald. USFS – Wenatchee National Forest – Entiat Ranger District. 18 pp.
- Hunsacker, D., II, L.F. Marnell, and F.P. Sharpe. 1970. Hooking Mortality of Cutthroat Trout at Yellowstone Lake. *Progressive Fish Culturalist*. 32:231-235.
- Interior Columbia Basin Technical Recovery Team (TRT). 2005. Viability criteria for application to Interior Columbia Basin salmonid ESUs. NOAA Fisheries. Draft report. Seattle, WA.
- IHOT (Integrated Hatchery Operations Team). 1995. Policies and procedures for Columbia Basin anadromous salmonid hatcheries. Annual Report 1994. Bonneville Power Administration, Portland, OR. Project Number 92-043.
- Kanda, N., R.F. Leary, F.W. Allendorf. 2002. Evidence of introgressive hybridization between bull trout and brook trout. *Transaction of the American Fisheries Society* 131: 772-782.
- Kerr, C.C. 1980. *The World of the World: From Frontier to Community. The Wenatchee World*, Wenatchee, WA. 144pp.
- Leary, R.F and F.W. Allendorf. 1997. Genetic Confirmation of Sympatric Bull Trout and Dolly Varden in Western Washington. *Transaction of the American Fisheries Society* 126(4): 715-720.
- Leary, R.F., F.W. Allendorf, and G.K. Sage. 1995. Hybridization and introgression between introduced and native fish. *American Fisheries Society Symposium*. 15:91-101.
- Leathe, S.A. and P.J. Graham 1982. Flathead Lake fish food habits study, final report. Montana Dept. Fish, Wildl., and Parks, Kalispell.
- Laufle, J.C., G.B. Pauley, and M.F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--coho salmon. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.48). U.S. Army Corps of Engineers, TR EL-82-4. 18 pp.
- Long, A. "Shorty". 2001. *Under the Guard of Ole Tyee – a reflection of the early days in the Entiat Valley*. Published and edited by Wayne and Joanne Long, E. Wenatchee, WA.
- Mason, J.W. and R.L. Hunt. 1967. Mortality Rates of Deeply Hooked Rainbow Trout. *Progressive Fish Culturalist* 29: 87-91.
- McIntyre, J.D. and B.E. Rieman. 1995. Westslope cutthroat trout. Pages 1-15 in M.K. Young editor. Conservation assessment for inland cutthroat trout. General Technical Report RM-256. Fort Collins, Colorado, USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Mead, Emma. Unpublished Manuscript. *The Valley of the Entiat, Washington in Territorial Days: A Plain and Humble Life*.

- Mobrand Biometrics, Inc. February 2003. Entiat EDT Watershed Analysis. Final Report prepared for the Yakama Nation. 47 pp + Appendices.
- Monahan, J and J. Korr. 2004. Habitat suitability data for spawning bull trout in the Mad River, WA. Unpublished data.
- Mongillo, P.E. 1984. A Summary of Salmonid Hooking Mortality. Washington Department of Game, Fisheries Management Division, Olympia.
- Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, and J.D. McIntyre. 1992. Production and Habitat of salmonids in Mid-Columbia River Tributary Streams. U.S. Fish and Wildlife Service Monograph I: 1- 289. Leavenworth, WA.
- Mullan, J.W. 1986. Determinants of sockeye salmon abundance in the Columbia River, 1880s-1982: A review and synthesis. USFWS Biological Report 86 (12). Leavenworth, WA 136 pp.
- Northwest Power and Conservation Council (NPCC). 2004. Entiat Subbasin Plan. 298 pp. See also- <http://www.nwcouncil.org/fw/subbasinplanning/entiat/plan>
- Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW). 200. Status Report: Columbia River Fish Runs and Fisheries, 1938-1999. 309 pp.
- Oregon State University (OSU). 2007. Pacific Northwest stream Survey Photo Collection. <http://osulibrary.oregonstate.edu/digitalcollections/pacificNWstream/index.html>
- Pauley, G.B. and G.L. Thomas. 1993. Mortality of Anadromous Coastal Cutthroat Trout Caught with Artificial Lures and Natural Baits. North American Journal of Fisheries Management 13: 337-345.
- Pauley, G.B., R. Risher, and G.L. Thomas. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--sockeye salmon. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.116). U.S. Army Corps of Engineers, TR EL-82-4. 22 pp.
- Pauley, G.B., B.M. Bortz, and M.F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- steelhead trout. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.62). U.S. Army Corps of Engineers, TR EL-82-4. 24 pp.
- Peven, C. M. 1990. The life history of naturally produced steelhead trout from the mid-Columbia River Basin. MS thesis, University of Washington, Seattle.
- Polacek, M.C. and P.W. James. March 2003. Diel Microhabitat Use of Age-0 Bull Trout in Indian Creek, Washington. Ecology of Freshwater Fish. 12(1) 81-86.
- Pratt, K.L. 1992. A Review of Bull Trout Life History. Pages 5-9 in Howell and Buchannon (1992).
- Raleigh, R.F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U.S. Fish Wildl. Serv. FWS/OBS-82/10.60. 64 pp.
- Raleigh, R.F. 1982. Habitat suitability index models: Brook trout. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.24. 42 pp.

- Reeves, G.H., F.H. Everest, and J.D. Hall. 1987. Interactions Between Redside Shiner (*Richardsonius balteatus*) and the Steelhead Trout (*Salmo Gairdneri*) in Western Oregon: The Influence of Temperature. *Canadian Journal of Fisheries and Aquatic Sciences*. Vol. 44(9) 1603-1613.
- Reiser, D.W. and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. In: W.R. Meehan, ed. *Influence of forest and rangeland management on anadromous fish habitat in western North America*. U.S. For. Serv. Gen. Tech. Rept. PNW-96. 54p.
- Rieman, B. E., and J. D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. *N. Amer. J. Fish. Manage.* 16: 132-141.
- Roni, P. 2005. Overview and background. Pages 1-12 in P. Roni, editor. *Monitoring stream and watershed restoration*. American Fisheries Society, Bethesda, Maryland.
- Rose, B. 2006. Personal communication regarding historic fisheries of the Yakama Nation and their interest in Pacific Lamprey (*Lamptera tridentata*).
- Schiler, G.J. and E.P. Bergersen. 1996. Postrelease Hooking Mortality of Rainbow Trout Caught on Scented Artificial Baits. *North American Journal of Fisheries Management* 16(3): 570-578.
- Schill, D.J. 1996. Hooking Mortality of Bait-Caught Rainbow Trout in an Idaho Trout Stream and a Hatchery: Implications for Species Regulation Management. *North American Journal of Fisheries Management*. 13: 337-345.
- Schill, D.J. J.S. Griffith, and R.E. Gresswell. 1986. Hooking Mortality of Cutthroat Trout in a Catch-and-Release Segment of the Yellowstone River, Yellowstone National Park. *North American Journal of Fisheries Management*. 6: 226-232.
- Schmitterling, D.A. 2000. Seasonal movements of fluvial westslope cutthroat trout in the Blackfoot River drainage, Montana. *North American Journal of Fisheries Management*. 21: 507-520.
- Smith, A.H. 1983. Ethnohistory 1811-1855. pp. 25-234. In *Cultural Resources of the Rocky Reach of the Columbia River*, R.F. Schalk and R.R. Mierendorf (eds), Vol. 1, WA State University, Pullman.
- Sterne, J.K. 1995. Supplementation of Wild Salmon Stocks: A Cure for the Hatchery Problem or More Problem Hatcheries? *Coastal Management* 23: 123-152.
- Terraqua, Inc. December 9, 2006. A Review of the Integrated Status and Effectiveness Monitoring Program: 2003-2006. 298 pp.
- Thompson, F.A. 1946. Experiment Proves Small Fish Are Worth Saving. New Mexico Department of Game and Fish. Technical Report 11F, Albuguerque. (not seen, cited in DuBois and Kuklinski)
- Trotter, P.C. 2001a. Hatchery Stocking Histories in Watershed Sampled for Westslope Cutthroat/Rainbow Trout Genetics. Unpublished Report Prepared for the USDA Forest Service, Pacific Northwest Research Station, LaGrande, Oregon. 28 pp.
- United States Congress (USC). 1938. Mitchell Act. Volume 16, pages 755-757 Full citation. Mitchell Act (16 U.S.C. 755-757; 52 Stat. 345), as amended -- Abernathy, Washington (1957); Eagle Creek, Oregon (1953); Entiat, Washington (1940).

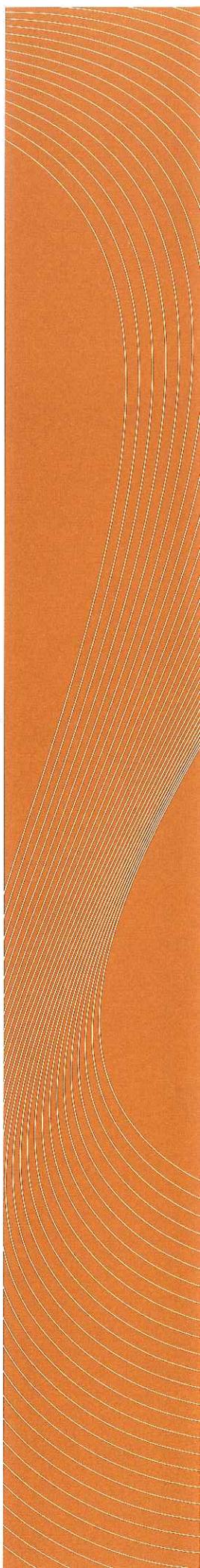
- UCSRB. 2006. Proposed Upper Columbia Spring Chinook Salmon, Steelhead and Bull Trout Recovery Plan. Upper Columbia Salmon Recovery Plan.
- U.S. Bureau of Fisheries (BOF). 1936. Physical stream surveys of the Entiat River and Mad River (1934, 1935, and 1936). Entiat Ranger District files.
- U.S. Department of Agriculture (USDA). 2007. National Agricultural Library – National Invasive Species Information Center. [www.invasivespeciesinfo.gov/microbes/whirling.shtml](http://www.invasivespeciesinfo.gov/microbes/whirling.shtml)
- U.S. Department of Agriculture Forest Service (USFS), Wenatchee National Forest (WNF). 1967. *Entiat River Stream Survey* by Art Johnson. Entiat Ranger District. Entiat, WA
- U.S. Department of Agriculture Forest Service (USFS), Wenatchee National Forest (WNF). 1968. *Entiat River Fisheries Survey*. Entiat Ranger District. Entiat, WA.
- U.S. Department of Agriculture Forest Service (USFS), Wenatchee National Forest (WNF). 1972. *Inventory of Potential Fishery Oriented Recreation Sites on the Entiat River* by Ralph Holtby. Entiat Ranger District. Entiat, WA.
- U.S. Department of Agriculture Forest Service (USFS), Wenatchee National Forest (WNF). 1990. Wenatchee National Forest Land and Resource Management Plan. 540 pp. <http://www.fs.fed.us/r6/wenatchee/projects/plans/wenatchee-forest-plan.pdf>
- U.S. Department of Agriculture Forest Service (USFS). 1994. Northwest Forest Plan. <http://www.fs.fed.us/r6/nwfp.htm>
- U.S. Department of Agriculture Forest Service (USFS), Wenatchee National Forest (WNF). 1996. *Watershed Assessment Entiat Analysis Area, Version 2.0*. Entiat Ranger District. Entiat, WA.
- U.S. Department of the Interior, Fish and Wildlife Service (USFWS). 2007a. Leavenworth, Entiat, and Winthrop National Fish Hatcheries – Assessment and Recommendations – Final Report. Columbia River Basin, Columbia Cascade Province, Wenatchee, Entiat and Methow River Watersheds. USFWS – Pacific Region, Columbia River Basin Hatchery Review Team. 158 pp. [http://www.fws.gov/pacific/fisheries/hatcheryreview/documents/LeavenworthComplexReview\\_19April2007\\_FINAL.pdf](http://www.fws.gov/pacific/fisheries/hatcheryreview/documents/LeavenworthComplexReview_19April2007_FINAL.pdf)
- U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2007b. Endangered Species on-line Glossary. <http://www.fws.gov/midwest/endangered/glossary/index.html>.
- U.S. Department of the Interior, Fish and Wildlife Service (USFWS) 2002. Bull trout (*Salvelinus confluentus*) draft recovery plan. U.S. Fish and Wildlife Service, Portland, OR.
- U.S. Geologic Survey (USGS). 2007. National Water Information System: USGS 12452800 Entiat River near Ardenvoir, WA. See- [http://waterdata.usgs.gov/wa/nwis/uv/?site\\_no=12452800&PARAMeter\\_cd=00060,00065](http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12452800&PARAMeter_cd=00060,00065)
- Viola, A. 2006. Personal communications with WDFW area fish biologist regarding trout stocking in the Entiat River Watershed.

- Washington Department of Ecology (WDOE). 2007. River and Stream Flow Monitoring. See: <https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=46A110>
- Washington Department of Ecology and Washington Department of Fish and Wildlife (WDOE and WDFW). April 5, 2004. Instream Flow Study Guidelines: Technical and Habitat Suitability Issues. Report Number 04-11-007. 64 pp.
- Washington Department of Fisheries (WDF). 1991. Stock Transfer Guidelines. Hatchery Program, Washington Department of Fisheries. Olympia, Wa.
- Washington Department of Fish and Wildlife (WDFW). Draft harvest framework for non-treaty fisheries directed at salmonids originating above Priest Rapids Dam. Washington Department of Fish and Wildlife, Olympia, WA.
- WDFW. 2004. Washington State Salmonid Stock Inventory: Bull Trout/Dolly Varden. 441 pp. See: <http://wdfw.wa.gov/fish/sassi/bulldolly.htm>
- WDFW. 2006a. Mission and Goals of the Washington Department of Fish and Wildlife. See: <http://wdfw.wa.gov/mission.htm>
- WDFW, July 21 2006b. *Oncorhynchus mykiss*: Assessment of Washington State's Anadromous Populations and Programs. Draft for Public review and Comment. Edited by James B. Scott, Jr. and William T. Gill. <http://wdfw.wa.gov/fish/papers/steelhead/>
- WDFW. January 16, 2002. News Release – Whirling disease agent found in northeast Washington trout. <http://wdfw.wa.gov/do/newreal/release.php?id=jan1602b>
- Watson, G. and T.W. Hillman. 1997. Factors Affecting the Distribution and Abundance of Bull Trout: An Investigation at Hierarchical Scales. *North American Journal of Fisheries Management* 17(2): 237-252.
- Wipfli, M.S., Hudson, J.P., and Caouette, J.P. 1998. Influence of Salmon Carcasses on Stream Productivity: Response of Biofilm And Benthic Macroinvertebrates in Southeastern Alaska. U.S.A., *Can. J. Fish. Aquat. Sci.* 55:1503-1511.
- Wipfli, M.S., Hudson, J.P., Chaloner, D.T., and Caouette, J.P. 1999. Influence of Salmon Spawner Densities on Stream Productivity in Southeast Alaska. *Can. J. Fish. Aquat. Sci.* 56:1600-1611.
- Wydoski, R.S. 1977. Relation of Hooking Mortality and Sublethal Hooking Stress to Quality Fishery Management. Pages 43-87 in R.A. Barnhart and T.D. Roelofs, editors. *Catch-and-release fishing as a management tool*. California Cooperative Fishery Research Unit, Humboldt State University, Arcata.
- Wydoski, R.S. and R.P. Whitney. 2003. *Inland Fishes of Washington*. Second Edition. University of Washington Press, Seattle, WA. 320 pp.



**APPENDIX A**  
***CHRONOLOGY OF TROUT AND STEELHEAD STOCKING  
IN THE ENTIAT RIVER WATERSHED***

---



The following table summarizes stocking information contained in the Washington Department of Fish and Wildlife (WDFW) Fish Stocking Database. Data were assembled by Phil Archibald, USFS WNF Entiat Ranger District Fisheries Biologist in December of 2003, and included in Appendix N of the Entiat WRIA Management Plan (CCCD 2004). Summary of information from WDFW Fish Stocking Database, prepared by Phil Archibald, USFS WNF Entiat Ranger District Fisheries Biologist, December 2003.

**Chronology of trout and steelhead stocking in the Entiat River watershed (1933- 1936).**

**(GT=golden trout, RB = rainbow, SS = summer steelhead, WCT=Westslope cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1933	EB	85000	ENTIAT RIVER
1933	RB	56000	ENTIAT RIVER
1933	RB	20000	NORTH FORK ENTIAT RIVER
1933	RB	15000	SILVER CREEK
1933	RB	4000	POPE CREEK
1933	RB	15000	LAKE CREEK
1934	RB	7500	NORTH FORK ENTIAT RIVER
1934	RB	219400	ENTIAT RIVER
1934	EB	2600	ENTIAT RIVER
1934	CT(B SPOT)	50000	ENTIAT RIVER
1934	CT	102100	ENTIAT RIVER
1934	CT	18750	MAD RIVER
1934	CT	8500	TWO LITTLE LAKES
1934	CT	4000	LOST LAKE
1934	RB	12500	LARCH CREEK
1935	EB	37000	ENTIAT RIVER
1935	RB	37500	ENTIAT RIVER
1935	CT	20000	ENTIAT RIVER
1935	RB	25000	SNOWBRUSHY CREEK
1935	EB	13000	MYRTLE LAKE
1935	CT	20000	SILVER CREEK
1936	EB	8000	ENTIAT RIVER
1936	RB	20000	ENTIAT RIVER
1936	CT	6000	ENTIAT RIVER
1936	SH	44675	ENTIAT RIVER
1936	CT	4000	NORTH FORK ENTIAT RIVER
1936	CT	3000	INDIAN CREEK
1936	RB	6000	INDIAN CREEK
1936	EB	25000	MYRTLE LAKE

**Chronology of trout and steelhead stocking in the Entiat River watershed (1937- 1940).**

**(EB= eastern brook trout, RB = rainbow, SH = general steelhead, CT= cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1937	SH	5000	ENTIAT RIVER
1937	EB	73950	ENTIAT RIVER
1937	RB	25050	ENTIAT RIVER
1937	RB	6000	INDIAN CREEK
1937	SH	3000	MAD RIVER
1937	RB	12000	MAD RIVER
1937	CT	15000	MAD RIVER
1937	EB	16500	MYRTLE LAKE
1937	EB	5000	MUD CREEK
1937	RB	5000	LAKE CREEK
1937	CT	5000	LAKE CREEK
1938	RB	14950	NORTH FORK ENTIAT RIVER
1938	EB	15000	ENTIAT RIVER
1938	RB	71080	ENTIAT RIVER
1938	CT	8000	MAD RIVER
1938	RB	53050	MAD RIVER
1938	RB	10075	SILVER CREEK
1938	RB	5000	PYRAMID CREEK
1938	RB	10075	POPE CREEK
1938	RB	9840	LAKE CREEK
1939	RB	38121	ENTIAT RIVER
1939	RB	4679	CORRAL CREEK
1939	CT	5000	CORRAL CREEK
1939	RB	3056	PYRAMID CREEK
1939	RB	3053	TOMMY CREEK
1939	RB	22945	MAD RIVER
1939	RB	2000	INDIAN CREEK
1939	CT	9200	COUGAR CREEK
1940	RB	50951	ENTIAT RIVER
1940	RB	4988	TWO LITTLE LAKES
1940	RB	9925	LAKE CREEK
1940	RB	3000	MUDDY CREEK
1940	RB	24897	MAD RIVER
1940	RB	20850	INDIAN CREEK
1940	RB	11950	COUGAR CREEK
1940	CT	12490	LOST LAKE

**Chronology of trout and steelhead stocking in the Entiat River watershed (1941- 1945).**

**(GT=golden trout, RB = rainbow, SS = summer steelhead, CT=Westslope cutthroat trout)**

<b>YEAR</b>	<b>SPECIES</b>	<b>NUMBER STOCKED</b>	<b>WATER BODY STOCKED</b>
1941	RB	44116	ENTIAT RIVER
1941	CT	9875	ENTIAT RIVER
1941	CT	52775	NORTH FORK ENTIAT RIVER
1941	RB	16000	COUGAR CREEK
1941	RB	1906	MAD RIVER
1941	RB	28491	INDIAN CREEK
1941	RB	14470	LAKE CREEK
1942	RB	59992	ENTIAT RIVER
1942	RB	5000	POTATO CREEK
1942	RB	21991	ROARING CREEK
1942	RB	7991	MUDDY CREEK
1942	RB	26480	INDIAN CREEK
1942	CT	19900	LOST LAKE
1942	CT	15000	LAKE CREEK
1943	RB	30500	NORTH FORK ENTIAT RIVER
1943	RB	61960	ENTIAT RIVER
1943	RB	39989	MAD RIVER
1943	RB	44973	INDIAN CREEK
1944	RB	11800	NORTH FORK ENTIAT RIVER
1944	RB	109000	ENTIAT RIVER
1944	CT	4400	ENTIAT RIVER
1944	RB	70000	MAD RIVER
1944	CT	4000	POPE CREEK
1944	RB	33600	INDIAN CREEK
1944	CT	2000	LOST LAKE
1945	RB	37500	ENTIAT RIVER
1945	CT	19990	ENTIAT RIVER
1945	CT	19990	MAD RIVER
1945	RB	19872	INDIAN CREEK
1945	CT	12580	LOST LAKE
1945	CT	10064	LAKE CREEK

**Chronology of trout and steelhead stocking in the Entiat River watershed (1946- 1950).**

**(EB= eastern brook trout, RB = rainbow, SH = general steelhead, CT=cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1946	RB	19996	ENTIAT RIVER
1946	CT	10240	TWO LITTLE LAKES
1946	RB	16000	INDIAN CREEK
1946	CT	18000	LAKE CREEK
1947	RB	71990	ENTIAT RIVER
1947	CT	17925	ENTIAT RIVER
1947	CT	4000	ICE CREEK
1947	CT	29800	TWO LITTLE LAKES
1947	RB	23950	SNOWBRUSHY CREEK
1947	RB	23375	LAKE CREEK
1947	RB	27042	MAD RIVER
1947	RB	49039	INDIAN CREEK
1948	RB	54522	ENTIAT RIVER
1948	RB	27900	NORTH FORK ENTIAT RIVER
1948	RB	13900	FERN LAKE
1948	CT	10100	LAKE CREEK
1948	EB	15000	ROARING CREEK
1948	EB	13500	MUDDY CREEK
1948	RB	15600	INDIAN CREEK
1948	RB	5200	MAD RIVER
1949	RB	22327	ENTIAT RIVER
1949	SH	19817	ENTIAT RIVER
1949	CT	20000	ICE LAKE
1949	EB	6400	MUD CREEK
1949	CT	25000	LOST LAKE
1949	RB	3590	MAD RIVER
1949	EB	1254	SWAKANE CREEK BEAVER POND
1950	RB	21054	ENTIAT RIVER
1950	CT	6800	TWO LITTLE LAKES
1950	RB	1060	ARDENVOIR MILL POND
1950	RB	3900	MUD CREEK
1950	EB	10150	MUD CREEK
1950	RB	4929	MAD RIVER
1950	CT	10600	MAD LAKE
1950	EB	4000	SWAKANE CREEK BEAVER POND

**Chronology of trout and steelhead stocking in the Entiat River watershed (1951- 1958).**

**(EB= eastern brook trout, RB = rainbow, CT=cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1951	RB	25610	ENTIAT RIVER
1951	CT	4032	TWO LITTLE LAKES
1951	RB	3295	ARDENVOIR MILL POND
1951	EB	15720	ROARING CREEK
1951	EB	9975	MUD CREEK
1951	CT	3900	LOST LAKE
1951	RB	4000	MAD RIVER
1952	RB	34106	ENTIAT RIVER
1952	RB	5500	MAD RIVER
1953	RB	24080	ENTIAT RIVER
1953	RB	2496	ARDENVOIR JUVENILE POND
1953	EB	14700	MUD CREEK
1953	CT	10000	LOST LAKE
1953	RB	5504	MAD RIVER
1954	RB	14600	ENTIAT RIVER
1954	CT	2000	INDIAN CREEK
1954	CT	10000	LOST LAKE
1954	EB	5200	SWAKANE CREEK BEAVER POND
1955	RB	15394	ENTIAT RIVER
1955	CT	5000	FERN LAKE
1955	CT	5000	LOST LAKE
1955	RB	2450	MAD RIVER
1956	RB	13553	ENTIAT RIVER
1956	RB	2520	MAD RIVER
1957	RB	13170	ENTIAT RIVER
1957	EB	4000	MUD CREEK
1957	RB	900	MAD RIVER
1958	RB	17422	ENTIAT RIVER
1958	EB	7680	MUDDY CREEK
1958	RB	4945	MAD RIVER
1958	EB	5760	SWAKANE CREEK BEAVER POND

**Chronology of trout and steelhead stocking in the Entiat River watershed (1959- 1967).**

**(EB= eastern brook trout, RB = rainbow, SS = summer steelhead, CT=cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1959	RB	14000	ENTIAT RIVER
1960	RB	21278	ENTIAT RIVER
1960	CT	3000	LOST LAKE
1960	RB	2139	MAD RIVER
1961	RB	30340	ENTIAT RIVER
1961	CT	2125	LOST LAKE
1961	RB	1950	MAD RIVER
1962	RB	35282	ENTIAT RIVER
1962	RB	2015	MAD RIVER
1962	EB	3060	SWAKANE CREEK BEAVER POND
1963	RB	11184	ENTIAT RIVER
1963	RB	2107	MAD RIVER
1964	RB	10887	ENTIAT RIVER
1964	SH	47353	ENTIAT RIVER
1964	CT	3485	LOST LAKE
1964	RB	6040	MAD RIVER
1965	SS	22494	ENTIAT RIVER
1965	RB	19916	ENTIAT RIVER
1965	CT	3200	ICE LAKE
1965	CT	2145	MAD LAKE
1965	RB	3000	MAD RIVER
1966	RB	12787	ENTIAT RIVER
1966	CT	2567	FERN LAKE
1966	CT	1963	TWO LITTLE LAKES
1966	RB	5179	MAD RIVER
1967	SS	17000	ENTIAT RIVER
1967	RB	30008	ENTIAT RIVER
1967	CT	2990	LOST LAKE
1967	RB	5004	MAD RIVER

**Chronology of trout and steelhead stocking in the Entiat River watershed (1968- 1974).**

**(EB= eastern brook trout, RB = rainbow, SS = summer steelhead, CT=cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1968	SS	25360	ENTIAT RIVER
1968	RB	6448	ENTIAT RIVER
1968	RB	3000	MAD RIVER
1969	SS	49625	ENTIAT RIVER
1969	RB	29634	ENTIAT RIVER
1969	RB	5000	MAD RIVER
1970	SS	58390	ENTIAT RIVER
1970	RB	36572	ENTIAT RIVER
1970	CT	4032	TWO LITTLE LAKES
1970	RB	2500	MAD RIVER
1970	EB	3955	SWAKANE CREEK BEAVER POND
1971	SS	50870	ENTIAT RIVER
1971	RB	13000	ENTIAT RIVER
1971	RB	5000	MUD CREEK
1971	CT	1216	LOST LAKE
1972	SS	58570	ENTIAT RIVER
1972	RB	30289	ENTIAT RIVER
1972	RB	2500	MAD RIVER
1973	SS	26319	ENTIAT RIVER
1973	RB	28985	ENTIAT RIVER
1973	EB	260	TILlicum CREEK
1973	CT	2000	INDIAN CREEK
1973	RB	3014	MAD RIVER
1973	EB	260	MAD RIVER
1974	SS	45905	ENTIAT RIVER
1974	RB	40049	ENTIAT RIVER
1974	CT	2000	ENTIAT RIVER
1974	CT	2000	LOST LAKE
1974	RB	810	MAD RIVER
1974	EB	3105	SWAKANE CREEK BEAVER POND

**Chronology of trout and steelhead stocking in the Entiat River watershed (1975- 1982).**  
**(GT=golden trout, RB = rainbow, SS = summer steelhead, WCT=Westslope cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1975	SS	40960	ENTIAT RIVER
1975	RB	15167	ENTIAT RIVER
1975	RB	2090	MAD RIVER
1976	SS	44122	ENTIAT RIVER
1976	RB	15431	ENTIAT RIVER
1976	CT	8012	ICE LAKE
1976	CT	2042	MYRTLE LAKE
1976	RB	1487	MAD RIVER
1977	SS	45011	ENTIAT RIVER
1977	RB	14828	ENTIAT RIVER
1977	CT(TWLKCUTT)	3040	MYRTLE LAKE
1977	CT(TWLK CUTT.)	160	CHORAL LAKE
1977	GT(G. TROUT)	1200	CHORAL LAKE
1977	CT	3040	FERN LAKE
1977	RB	1544	MAD RIVER
1978	SS	33264	ENTIAT RIVER
1978	RB	14543	ENTIAT RIVER
1978	RB	2026	MAD RIVER
1979	SS	41640	ENTIAT RIVER
1979	RB	14240	ENTIAT RIVER
1979	RB	3105	MAD RIVER
1980	SS	16780	ENTIAT RIVER
1980	RB	16053	ENTIAT RIVER
1980	RB	1511	MAD RIVER
1981	SS	35536	ENTIAT RIVER
1981	RB	17436	ENTIAT RIVER
1981	RB	5178	MAD RIVER
1982	SS	41254	ENTIAT RIVER
1982	RB	16701	ENTIAT
1982	RB	3470	MAD

**Chronology of trout and steelhead stocking in the Entiat River watershed (1983- 1990).  
(GT=golden trout, RB = rainbow, SS = summer steelhead, WCT=Westslope cutthroat trout)**

YEAR	SPECIES	NUMBER STOCKED	WATER BODY STOCKED
1983	WCT	3696	ICE LAKES (BOTH)
1983	SS	48328	ENTIAT
1983	RB	17159	ENTIAT
1983	RB	1100	MAD
1984	SS	47021	ENTIAT
1984	RB	22149	ENTIAT
1984	RB	1542	MAD
1985	SS	44280	ENTIAT
1986	SS	46185	ENTIAT
1986	RB	21440	ENTIAT
1986	RB	2520	MAD
1987	SS	46520	ENTIAT
1987	RB	20280	ENTIAT
1987	RB	2400	MAD
1988	SS	43960	ENTIAT
1988	RB	16365	ENTIAT
1988	RB	2055	MAD
1989	GT	90	CHORAL LAKE
1989	SS	38350	ENTIAT
1989	RB	23560	ENTIAT
1989	RB	1180	MAD
1990	SS	36915	ENTIAT RM 10
1990	RB	12540	ENTIAT
1990	WCT	200	UNNAMED LAKE
1990	RB	1010	MAD

**Chronology of trout and steelhead stocking in the Entiat River watershed (1991- 2000).**

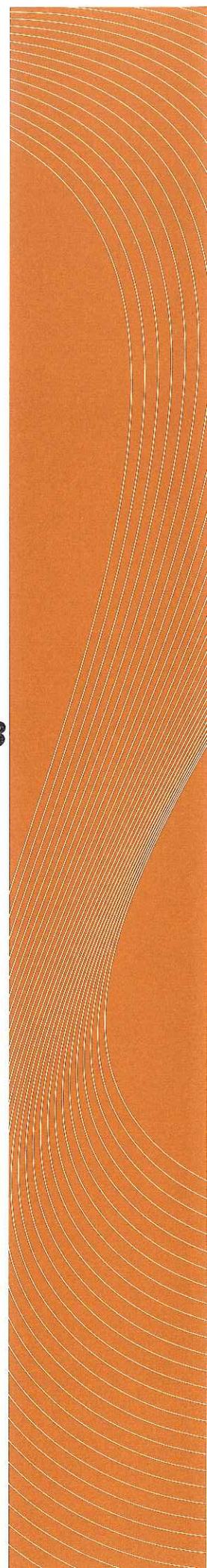
**(RB = rainbow, SS = summer steelhead)**

<b>YEAR</b>	<b>SPECIES</b>	<b>NUMBER STOCKED</b>	<b>WATER BODY STOCKED</b>
1991	SS	47360	ENTIAT RM 10
1991	RB	18772	ENTIAT
1991	RB	1050	MAD
1992	SS	47270	ENTIAT RM 10
1992	RB	11755	ENTIAT
1992	RB	680	MAD
1993	SS	41480	ENTIAT RM 10
1993	RB	9790	ENTIAT
1993	RB	510	MAD
1994	SS	43210	ENTIAT RM 10
1994	RB	6640	ENTIAT
1994	RB	60	LOST LAKE
1995	SS	46740	ENTIAT RM 10
1996	SS	39000	ENTIAT RM 10
1997	SS	40950	ENTIAT RM 10
1998	SS	42180	ENTIAT RM 10
1999	SS	45080	ENTIAT RM 10
2000	SS	0	ENTIAT SS STOCKING DISCONT'D.



**APPENDIX B**  
**USFWS - ENDANGERED SPECIES ACT ON-LINE**  
**GLOSSARY OF TERMS**

---



**Source:** <http://www.fws.gov/midwest/endangered/glossary/index.html>.

**Biodiversity** - The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur.

**Biological assessment** - A document prepared for the Section 7 process to determine whether a proposed major construction activity under the authority of a Federal action agency is likely to adversely affect listed species, proposed species, or designated critical habitat.

**Biological opinion** - A document that is the product of formal consultation, stating the opinion of the Service on whether or not a Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

**Candidate species** - Plants and animals that have been studied and the Service has concluded that they should be proposed for addition to the Federal endangered and threatened species list. These species have formerly been referred to as category 1 candidate species. From the February 28, 1996 Federal Register, page 7597: "those species for which the Service has on file sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list but issuance of the proposed rule is precluded."

**Category 1 candidate species** - A term no longer in use, having been replaced by the term "candidate species" which uses the same definition.

**Category 2 candidate species** - A term no longer in use. Previously referred to species for which the Service had some indication that listing as threatened or endangered might be warranted, but there were insufficient data available to justify a proposal to list them.

**Category 3 candidate species** - A term no longer in use. Previously referred to species which once were category 1 or 2 candidate species, but for which subsequent data indicated that listing as threatened or endangered was not appropriate.

**CITES** - The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, restricting international commerce between participating nations for plant and animal species believed to be harmed by trade.

**Common name** - The nonscientific name of an animal or plant most widely used and accepted by the scientific community.

**Conference** - The consultation process required for Federal actions that are likely to jeopardize the continued existence of a species proposed for listing or result in the destruction or adverse modification of proposed critical habitat.

**Conserve** - Carrying out actions to improve the health of a species so it no longer needs to be listed as threatened or endangered.

**Conservation** - From section 3(3) of the Federal Endangered Species Act: "The terms "conserve," "conserving," and "conservation" mean to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided under this Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law

enforcement, habitat acquisition and maintenance, propagation, live trapping, and transportation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking."

**Consultation** - All Federal agencies must consult with the U.S. Fish and Wildlife Service (or National Marine Fisheries Service) when any activity permitted, funded, or conducted by that agency may affect a listed species or designated critical habitat, or is likely to jeopardize proposed species or adversely modify proposed critical habitat. There are two stages of consultation: informal and formal.

**Critical habitat** - Specific geographic areas, whether occupied by listed species or not, that are determined to be essential for the conservation and management of listed species, and that have been formally described in the Federal Register.

**Delist** - The process of removing an animal or plant from the list of Endangered and Threatened Wildlife and Plants.

**Distinct population segment** - If it satisfies the criteria specified in the February 7, 1996, Federal Register, pages 4722-4725, a portion of a vertebrate (i.e., animals with a backbone) species or subspecies can be listed. The criteria require it to be readily separable from the rest of its species and to be biologically and ecologically significant. Such a portion of a species or subspecies is called a distinct population segment.

**Ecosystem** - Dynamic and interrelating complex of plant and animal communities and their associated nonliving (e.g. physical and chemical) environment.

**Ecosystem Approach** - Protecting or restoring the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated.

**Endangered** - The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

**Endangered Species Act of 1973, as amended** - Federal legislation intended to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, and provide programs for the conservation of those species, thus preventing extinction of native plants and animals.

**Endangered species permit** - A document issued by the Service under authority of Section 10 allowing an action otherwise prohibited under Section 9 of the Endangered Species Act.

**Endemic species** - A species native and confined to a certain region; having comparatively restricted distribution.

**Extinct species** - A species no longer in existence.

**Extirpated species** - A species no longer surviving in regions that were once part of their range.

**Federal action agency** - Any department or agency of the United States proposing to authorize, fund, or carry out an action under existing authorities.

**Formal consultation** - The consultation process conducted when a Federal agency determines its action may affect a listed species or its critical habitat, and is used to determine whether the proposed action may jeopardize the continued existence of listed species or adversely modify critical habitat. This determination is stated in the Service's biological opinion.

**Habitat** - The location where a particular taxon of plant or animal lives and its surroundings (both living and nonliving) and includes the presence of a group of particular environmental conditions surrounding an organism including air, water, soil, mineral elements, moisture, temperature, and topography.

**Habitat Conservation Plan (HCP)** - A plan which outlines ways of maintaining, enhancing, and protecting a given habitat type needed to protect species. The plan usually includes measures to minimize impacts, and might include provisions for permanently protecting land, restoring habitat, and relocating plants or animals to another area. An HCP is required before an incidental take permit may be issued.

**Harm** - An act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation when it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.

**Historic range** - Those geographic areas the species was known or believed to occupy in the past.

**Implementation schedule** - An outline of actions, with responsible parties, estimated costs and timeframes, for meeting the recovery objectives described in the species recovery plan.

**Incidental take** - Take that results from, but is not the purpose of, carrying out an otherwise lawful activity.

**Incidental take permit** - A permit issued under Section 10 of the Federal Endangered Species Act to private parties undertaking otherwise lawful projects that might result in the take of an endangered or threatened species. Application for an incidental take permit is subject to certain requirements, including preparation by the permit applicant of a conservation plan, generally known as a "Habitat Conservation Plan" or "HCP."

**Incidental take statement** - A term referring to that part of a biological opinion that exempts incidental take of a listed species from the Section 9 prohibitions.

**Informal consultation** - Informal consultation precedes formal consultation and includes any form of communication between the Federal action agency, applicant, or designated non Federal representative and the Service to determine if listed species may occur in the action area and what the effects of the action may be to such species. This phase is often used to develop project modifications or alternatives to avoid adverse effects to listed species, which would then preclude the need for formal consultation.

**Jeopardy biological opinion** - A Service Section 7 biological opinion that determines that a Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

**Lead region** - The Fish and Wildlife Service Region that is responsible for coordinating all actions taken to study, propose, list, conserve, and delist a species.

**Lead office** - The field office that has been given the responsibility for coordinating all or most actions taken to study, propose, list, conserve, and delist a species within the boundaries of Region 3. If Region 3

is the lead region for a particular species, the lead office has these responsibilities over the entire range of that species.

**Listed species** - A species, subspecies, or distinct vertebrate population segment that has been added to the Federal lists of Endangered and Threatened Wildlife and Plants as they appear in sections 17.11 and 17.12 of Title 50 of the Code of Federal Regulations (50 CFR 17.11 and 17.12).

**Listing** - The formal process through which the Service adds species to the Federal List of Endangered and Threatened Wildlife and Plants.

**Listing moratorium** - Public Law 104-6 "Emergency Supplemental Appropriations and Rescissions for the Department of Defense to Preserve and Enhance Military Readiness Act of 1995" specifically prohibited ". . . making a final determination that a species is threatened or endangered or that habitat constitutes critical habitat . . ." This measure was signed into law on April 10, 1995, and prohibits the listing of species as threatened or endangered or the designation of critical habitat.

**Listing priority** - A number from 1 to 12 indicating the relative urgency for listing plants or animals as threatened or endangered. The criteria used to assign this number reflect the magnitude and immediacy of threat to the species, as well as the relative distinctiveness or isolation of the genetic material they possess. This latter criterion is applied by giving a higher priority number to species which are the only remaining species in their genus, and a lower priority number to subspecies and varieties. These listing priorities are described in detail in the Federal Register on September 21, 1983, as pages 43098-43105.

**No jeopardy biological opinion** - A Service Section 7 biological opinion that determines that a Federal action is not likely to jeopardize the existence of a listed species or result in the destruction or adverse modification of critical habitat.

**Participation plan** - A plan describing the means to carry out one or more tasks outlined in the Implementation Schedule of a species recovery plan, minimizing the socioeconomic impacts of that action.

**Petition (Listing)** - A formal request, with the support of adequate biological data, suggesting that a species, with the support of adequate biological data, be listed, reclassified, or delisted, or that critical habitat be revised for a listed species. See also Region 3 Guidance for Potential Petitioners

**Propose** - The formal process of publishing a proposed Federal regulation in the Federal Register and establishing a comment period for public input into the decision-making process. Plants and animals must be proposed for listing as threatened or endangered species, and the resulting public comments must be analyzed, before the Service can make a final decision.

**Proposed species** - Any species of fish, wildlife, or plant that is proposed in the Federal Register to be listed under Section 4 of the Endangered Species Act.

**Range** - The geographic area a species is known or believed to occupy.

**Reauthorization** - A term referring to periodic action taken by Congress to reauthorize the Endangered Species Act. By reauthorizing an act, Congress extends it and may also amend it.

**Reclassify** - The process of changing a species' official threatened or endangered classification.

**Recovery** - The process by which the decline of an endangered or threatened species is arrested or reversed, or threats to its survival neutralized so that its long-term survival in nature can be ensured.

**Recovery outline** - The first Service recovery document provided for a listed species. While very brief, the document serves to direct recovery efforts pending the completion of the species' recovery plan.

**Recovery permit** - Permits issued under Section 10(a)(1)(A) of the Federal Endangered Species Act for scientific research and other activities benefiting the recovery of Federally listed species.

**Recovery plan** - A document drafted by the Service or other knowledgeable individual or group, that serves as a guide for activities to be undertaken by Federal, State, or private entities in helping to recover and conserve endangered or threatened species.

**Recovery priority** - A number, ranging from a high of 1C to a low of 18, whereby priorities to listed species and recovery tasks are assigned. The criteria on which the recovery priority number is based are degree of threat, recovery potential, taxonomic distinctiveness, and presence of an actual or imminent conflict between the species and development activities.

**Region 3** - The geographic unit of the Service that is composed of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.

**Scientific name** - A formal, Latinized name applied to a taxonomic group of animals or plants. A species' scientific name is a two-part combination consisting of the name of the genus, followed by a species name. For example, the scientific name of gray bat is *Myotis grisescens*. If a species has been further divided into subspecies, a third part is added to the scientific name. The Ozark big-eared bat is *Plecotus townsendii ingens*. "Ingens" distinguishes the Ozark subspecies from other subspecies of the big-eared bat.

**Scientific take permit** - A type of recovery permit authorized under Section 10 allowing for research pertaining to species recovery such as taking blood samples from a peregrine falcon for genetic analysis, or conducting surveys of freshwater mussel beds to determine species status and distribution.

**Section 4** - The section of the Endangered Species Act that deals with listing and recovery of species, and designation of critical habitat.

**Section 4(d) rule** - A special regulation developed by the Service under authority of Section 4(d) modifying the normal protective regulations for a particular threatened species when it is determined that such a rule is necessary and advisable to provide for the conservation of that species.

**Section 6** - The section of the Endangered Species Act that authorizes the Service to provide financial assistance to States through cooperative agreements supporting the conservation of endangered and threatened species.

**Section 7** - The section of the Endangered Species Act that requires all Federal agencies, in "consultation" with the Service, to insure that their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat.

**Section 9** - The section of the Endangered Species Act that deals with prohibited actions, including the import and export, take, possession of illegally taken species, transport, or sale of endangered or threatened species.

**Section 10** - The section of the Endangered Species Act that lays out the guidelines under which a permit may be issued to authorize activities prohibited by Section 9, such as take of endangered or threatened species.

**Species** - From Section 3(15) of the Federal Endangered Species Act: "The term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." A population of individuals that are more or less alike, and that are able to breed and produce fertile offspring under natural conditions.

**Species of Concern** - "Species of concern" is an informal term that refers to those species which Region 3 believes might be in need of concentrated conservation actions. Such conservation actions vary depending on the health of the populations and degree and types of threats. At one extreme, there may only need to be periodic monitoring of populations and threats to the species and its habitat. At the other extreme, a species may need to be listed as a Federal threatened or endangered species. Species of concern receive no legal protection and the use of the term does not necessarily mean that the species will eventually be proposed for listing as a threatened or endangered species.

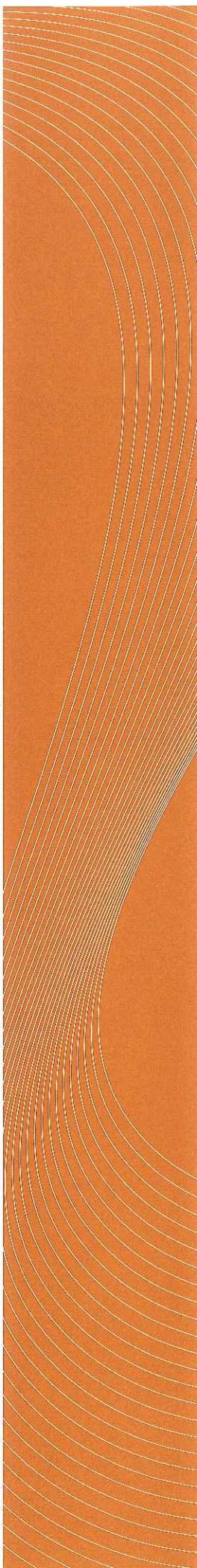
**Take** - From Section 3(18) of the Federal Endangered Species Act: "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

**Threatened** - The classification provided to an animal or plant likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

**Source:** <http://www.fws.gov/midwest/endangered/glossary/index.html>.



**APPENDIX C**  
**WDFW 2007 FISHING REGULATIONS ENTIAT EXCERPT**



### State-Wide General Rules:

Unless otherwise listed in the Special Rules, you must follow the Statewide Rules. For all game fish and salmon, the Special Rules show ALL of the fishing opportunities for each freshwater area listed. Freshwater areas are open 24 hours per day when open.

All FRESHWATER areas are CLOSED to fishing for SALMON, DOLLY VARDEN/BULL TROUT, Columbia River SMELT (EULACHON), and GRASS CARP unless listed as open in Special Rules. Fishing for COMMON CARP, WHITE STURGEON, SHAD, or forage fish other than Columbia River SMELT (unless specifically noted in Special Rules) is open only during open game fish or SALMON seasons.

### **Lakes, Ponds and Reservoirs:**

- Open year-round to fishing for game fish except DOLLY VARDEN/BULL TROUT and GRASS CARP.
- *There are no special rules for Lakes, Ponds and Reservoirs in the Entiat or Mad River Watersheds. All Entiat and Mad River watershed Lakes, Ponds and Reservoirs are open year-round to fishing for game fish (EXCEPT BULL TROUT and grass carp).*

### **Rivers, Streams and Beaver Ponds:**

- Open JUNE 1- OCTOBER 31 to fishing for game fish except DOLLY VARDEN/BULL TROUT and GRASS CARP.
- *There ARE special rules that override the state-wide rules in the Entiat and Mad River Watersheds –see below.*

### **SPECIAL RULES FOR THE ENTIAT AND MAD RIVER WATERSHEDS:**

- *Special rules that apply to the mainstem Entiat River*
  - The Entiat River from the mouth/Hwy 97 bridge up to Entiat Falls is CLOSED to fishing for all species except whitefish between December 1 and March 31 – see regulations excerpt p. 76 for more information.
  - Above Entiat Falls, the Entiat River is OPEN to fishing for all species – see regulations excerpt p. 78 for more information.
  - Tributaries to the mainstem Entiat River (EXCEPT the Mad River) are OPEN for fishing under state-wide general rules for rivers, streams and beaver ponds.
- *Special rules that apply to the Mad River*
  - The Mad River from the mouth to Jimmy Creek is CLOSED to fishing for all species – see regulations excerpt p. 80.
  - Tributaries to the Mad River above Jimmy Creek are OPEN to fishing under state-wide general rules for rivers, streams and beaver ponds.

An "open" listing does not authorize anglers to trespass on private property (which often includes the bed of the stream). Please respect private property boundaries by contacting the land owner before entering.

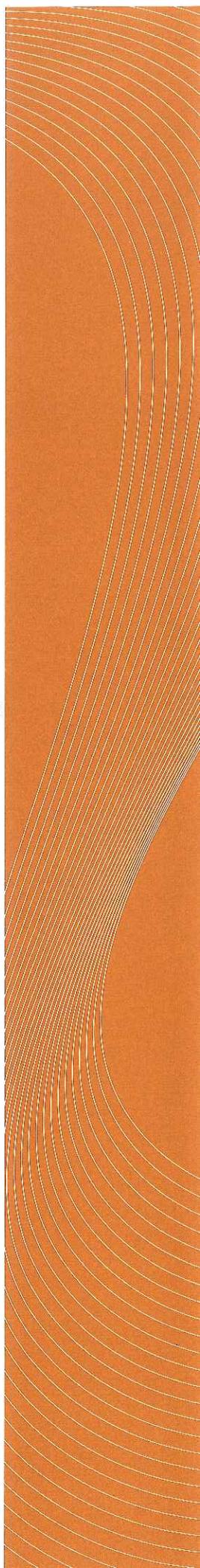
"**All Game Fish**" and "**Other Game Fish**" include the Game Fish species on the definitions pages, except DOLLY VARDEN/BULL TROUT and GRASS CARP.

"**Trout**" includes: **Steelhead, Brown, Cutthroat, Tiger, Rainbow, Lake, Golden, and Eastern brook trout; grayling, kokanee, and LANDLOCKED Atlantic, Coho and Chinook salmon.**



**APPENDIX D**  
**CHRONOLOGY OF FISHING REGULATIONS IN THE**  
**ENTIAAT RIVER WATERSHED**

---

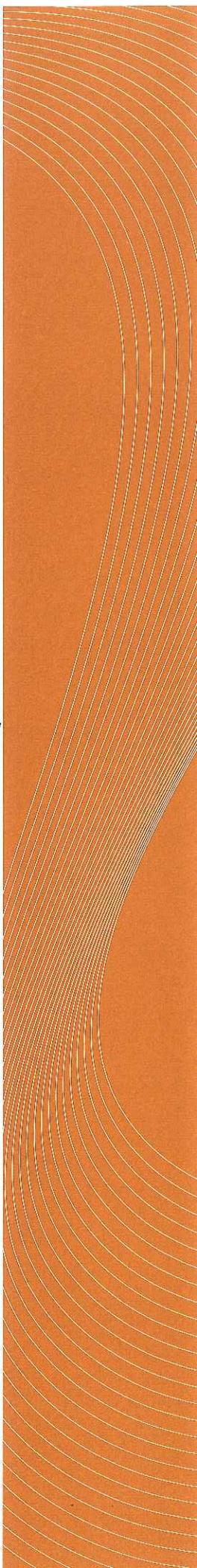


**Summary of Entiat River fishing regulations (1993-2006). Special restrictions for the Entiat River from its confluence with the Columbia River to Entiat Falls (RM 34).**

YEAR	Bull Trout Fishery	Steelhead Fishery	Salmon Fishery	Other Sport-fish Fishery
2005-2006	none	none	none	<b>Apr.1-Nov 30</b> Closed Waters <b>Dec 1-Mar 31</b> Open for Whitefish; single 3/16" or smaller hook, no min. size, daily limit of 15 whitefish
2004-2005	none	none	none	<b>Apr.1-Nov 30</b> Closed Waters <b>Dec 1-Mar 31</b> Open for Whitefish; single 3/16" or smaller hook, no min. size, daily limit of 15 whitefish
2003-2004				
2002-2003	none	none	none	<b>Apr.1-Nov 30</b> Closed Waters <b>Dec 1-Mar 31</b> Open for Whitefish w/ single 3/16" or smaller hook
2001-2002				
2000-2001	none	none	none	<b>Dec 1-Mar 31</b> open for Whitefish only with gear restrictions
1999-2000				
1998-1999	none	none	none	<b>June 1-Aug 31</b> All game fish except steelhead with selective gear rules. <b>Dec 1-Mar 31</b> Open for Whitefish with selective gear
1997-1998	none	Release Wild Steelhead, <b>June 1-Mar 31</b> , can take 2/5 Trout per day as Steelhead	none	<b>June 1-Mar 31</b> Trout season, limit 2 <b>June 1-Nov 30</b> All Other game fish, selective gear rules
1996-1997				
1995-1996	none	Release Wild Steelhead, <b>June 1-Nov 30</b> , can take 2/5 Trout per day as Steelhead	none	<b>June 1-Mar 1</b> Trout season, limit 2 <b>June 1-Nov 30</b> Other game fish, selective gear rules
1994-1995	none	Release Wild Steelhead, <b>June 1-Nov 30</b> , can take 2/5 Trout per day as Steelhead	none	<b>June 1-Nov 30</b> season, Trout limit 2, all other game fish, selective gear rules <b>Dec 1-Mar 31</b> season for Trout and all other game fish, no selective gear rules
1993-1994	none	<b>June 1-Mar 31</b> season, release wild steelhead, annual limit 30/year	none	<b>June 1-Mar 31</b> season, Trout limit 2, Bait prohibited <b>June 1-Nov 30</b>



**APPENDIX E**  
**WDFW APPLICATION FOR ENTIAT SALMON FISHERY**



**Application for a General Incidental Take Permit, under the Endangered Species Act of 1973, to authorize the incidental take of listed spring Chinook salmon, Snake River fall Chinook and steelhead by sport anglers in the Columbia River Hanford Reach and in the Columbia River and tributaries above Priest Rapids Dam**

**Date:** September 12, 2005

**Applicant:** Washington Department of Fish and Wildlife  
Jeff Koenings, Director  
600 Capitol Way North, Olympia, WA 98501-1091

**Staff Contacts:** Jim Uehara, Heather Bartlett, John Easterbrooks, Bruce Sanford, Bob Leland, Kirk Truscott, Bob Jateff, Art Viola, and Paul Hoffarth

**Submitted by:** Ross Fuller, Manager  
WDFW Fish Program  
Harvest Management Division  
600 Capitol Way North  
Olympia, WA 98501-1091  
360-902-2655  
fullerkf@dfw.wa.gov

**\*\*\*Entiat Excerpt\*\*\***

**Entiat River Spring Chinook Salmon Fishery**

Spring Chinook (Carson stock) released from the Entiat NFH are produced exclusively for sport and tribal fisheries. The stock is not included in the ESA listing of spring Chinook in the Upper Columbia River ESU. The target of this fishery is non-listed Carson stock spring Chinook. Recent spring Chinook adult escapements (1998-2004) reveal average escapements exceeding 1,000 fish, dominated by non-endemic Carson origin spring Chinook (Table 15). Although most of the Carson stock spring Chinook return to the Entiat NFH, some bypass the hatchery ladder and spawn in the natural environment. These strays onto the spawning ground may have negative impacts on the recovery of ESA-listed endemic spring Chinook. This fishery is intended to reduce the adverse impacts on the ESA-listed stock by removing Carson stock spring Chinook from the spawning population; thereby reducing hybridization with endemic spring Chinook stocks. The proposed fishery balances the negative impacts of incidental mortality from hooking and release of ESA-listed fish with the potential benefits of removing the stray non-ESA-listed fish from the spawning population.

On an annual basis, the in-season abundance of hatchery and natural origin fish would be estimated to determine if harvest of Carson stock spring Chinook is warranted. This analysis would generally occur in April. A minimum escapement of 100 natural and 800 Carson origin hatchery fish are required to initiate a fishery. One hundred natural origin spawning adults represents a critical threshold escapement level for the basin and is 20% of the minimum viable threshold level (500 fish) for the Entiat River Basin (ICTRT 2005). A minimum of 800 Carson origin Chinook are needed to initiate a fishery and is based upon a 400 fish escapement required for broodstock collection at Entiat NFH and an estimated 400 fish available for harvest.

An Entiat River spring Chinook fishery constitutes a “new” fishery, not previously authorized under ESA Section 10 Permit 1248. The Entiat River spring Chinook fishery would be regulated as a selective fishery requiring the use of barbless hooks, non-buoyant lure restriction, night closure and mandatory release of adipose present Chinook and all steelhead.

Because the fishery would be contingent upon a threshold number of natural origin fish and surplus Carson origin hatchery fish, appropriate methods to predict expected return of both natural and hatchery origin fish to the Entiat Basin would be required. Natural and hatchery origin adult escapement would be derived from smolt production estimates, hatchery smolt release numbers, SARs, and age-at-return data as well as in-season monitoring of Passive Integrated Transponder (PIT) tags. Currently, USFWS conducts juvenile emigration monitoring and spawning ground/carcass surveys in the Entiat Basin that provide estimates of annual smolt production from the Entiat Basin as well as age-at-return assessment; however, smolt production and adult monitoring data are insufficient at this time to establish SAR values for natural origin Entiat River spring Chinook. Robust SAR data does however exist for Chiwawa River spring Chinook, and with minor adjustments for expected mortalities associated with Rocky Reach Dam, may represent an acceptable surrogate for Entiat River fish.

As additional natural origin smolt production and adult return data are collected and analyzed, SAR values specific to the Entiat population will be developed and available to predict annual escapement of natural origin spring Chinook to the Entiat River. In addition to population specific SAR values, PIT tagging of natural and hatchery smolts emigrating from the Entiat River basin would provide additional precision in predicting adult escapement through in-season assessment of adult migration.

Although data exists that may be applicable to annual adult escapement projections, the precision of such projections are unknown; therefore, additional assessment is required. Sensitivity analysis of various predictive adult escapement methods has not been conducted. Prior to initiation of this fishery, the WDFW proposes a WDFW/NMFS/USFWS collaborative approach to the development of methods to predict adult escapement with sufficient precision to manage an Entiat River recreational spring Chinook fishery, consistent take provisions in this permit application.

#### **Anticipated dates and duration of activity**

If run escapement estimates (hatchery and natural origin) are sufficient to initiate a season and NMFS concurs with WDFW fishery recommendations, limits and gear restrictions will be announced in late April with the anticipated fishery directed on spring Chinook to occur from mid-May through July.

#### **Specific location of the activity**

Angling would be allowed from the Alternate Highway 97 Bridge (rkm .3) near the mouth of the Entiat River, upstream approximately 11 rkm to 152m downstream of the Entiat NFH Rack (rkm 11.2).

#### **Estimate of total level of activity expected**

Because this is a newly proposed fishery, no empirical data for effort or harvest exists; however, inferences may be made with the Icicle Creek fishery. Effort in the Icicle Creek fishery was estimated between 13,000 and 30,000 angler hours in 2000-2003 (Table 13). Because of the smaller return to the Entiat NFH (approximately 32% smaller in 2004), and public access limitations, lower effort is anticipated for a similar fishery targeting fish returning to the Entiat NFH than that observed at Icicle Creek. WDFW projects angler effort to range between 6,000-15,000 angler hours for this fishery.

## **Impact on Chinook**

### **Estimated number of animals of listed species impacted**

#### **Juvenile Spring Chinook-**

No Juvenile spring Chinook would be encountered in this fishery. Although juvenile spring Chinook occupy habitat within the proposed fishery area, gear targeting adult spring Chinook are generally too large to catch juvenile spring Chinook.

#### **Adult Spring Chinook**

An Entiat River sport fishery targeting non-listed Carson stock spring Chinook would be limited to the area from the Alternate Highway 97 bridge near the mouth of the River to just below the hatchery rack (approximately 11 river kilometers) will occur from mid-May through July. Natural and hatchery origin ESA-listed spring Chinook may be encountered in this fishery. The fishery will use an abundance-based sliding scale mortality rate schedule for determining permissible take of natural origin ESA-listed spring Chinook (Table 16). The estimated number of natural origin adult spring Chinook encountered in this fishery is calculated using a 15% encounter rate and assumes a 10% catch-and-release mortality rate. The sliding scale proportional take levels are provided in Table 15. Based on the above criteria, the Entiat River spring Chinook fishery may encounter between 20 and 400 natural origin spring Chinook at run escapement levels of 100 and 500, respectively (Table 16).

#### **Type of anticipated take**

No take of juvenile Chinook is anticipated, due to the type of gear used to target adult salmon. Take of adult ESA-listed natural-origin Chinook would be in the form of non-lethal catch and release and an assumed subsequent incidental mortality of 10% of the ESA-listed fish encountered.

#### **Effects of the take on the listed species - potential for mortality**

A 10% catch-and-release mortality is assumed for this fishery (Mongillo 1984). Based on the calculated encounter of natural origin spring Chinook at the critical and viable threshold population levels and the proposed proportional take, mortality is expected to range from 2 to 40 adult spring Chinook at the Critical and Viable threshold levels, respectively (Table 16).

**Table 15. Estimated spring Chinook spawning and run escapements to the Entiat River Basin, 1998-2004. (Data; USFWS spawning ground reports, 1998-2001 and Dave Carie, USFWS, Pers. comm.)**

Return Year	<u>Spawn Escapement</u>		<u>Hatchery Broodstock</u>		<u>Run Escapement</u>		
	Hatchery	Natural Origin	Hatchery	Natural Origin	Hatchery	Natural Origin	Total
1998	0	58	216	0	216	58	274
1999	0	65	724	0	724	65	789
2000	101	74	1,919	0	2,020	74	2,094
2001	192	260	2,666	0	2,858	260	3,118
2002	190	180	1,834	2	2,024	182	2,206
2003	84	175	883	1	967	176	1,143
2004 <sup>1/</sup>	121	181	759		880	181	1,061
GEOMEAN	130	122	998	1	1,065	123	1,209

<sup>1/</sup>- Spawn escapement origin determination is preliminary, pending scale analysis

**Table 16. Sliding scale of allowable sport angling produced mortality of ESA listed adult upper Columbia River spring chinook in the Entiat River Basin.**

Status Indicator Critical Threshold	Predicted Natural Origin Escapement	Maximum	Range of Potential Lethal Take	<sup>2/</sup>
		Percent Mortality		Range of Estimated Encounters
0% - 20% of Viable	≤ 100	0	0	0
20 - 40% of Viable	101 -200	2	2-4	20-40
40 - 60% of Viable	201 – 300	4	4-8	40-80
60 - 80% of Viable	301 – 400	6	18 - 16	160-180
80 - 100% of Viable	401 - 500 <sup>1/</sup>	8	32 - 40	320-400
> 100% Viable Threshold	501 - >500	10	50 - >50	500+

<sup>1/</sup>- ICTRT 2005.

<sup>2/</sup>- Encounters needed to achieve the lethal range take, assuming a 10% hooking-and-release mortality and the maximum mortality associated with critical and viable population threshold levels.

## Impact on Steelhead

### Estimated number of animals of listed species impacted

A fishery targeting Carson stock spring Chinook may encounter Upper Columbia River ESU steelhead. Summer steelhead spawn and rear in the lower- and mid-Entiat River, as well as Brennegan, Mud, Potato, Preston, Roaring, and Stormy creeks from mid-March until the end of May (CCCD). We expect that a delayed fishery opening, beginning in mid-May, will significantly reduce encounters of steelhead in the fishery, similar to observations in the Icicle Creek spring Chinook fishery.

### Adult Steelhead

The Entiat River Chinook fishery represents a “new” fishery; as such, no empirical data exists to provide insights regarding steelhead encounters. Due to the lack of empirical data, steelhead encounters observed in the Icicle Creek spring Chinook fishery will be utilized as a surrogate for the Entiat River fishery. During 2000-2003, the maximum estimated steelhead encounter in the Icicle Creek spring Chinook fishery was seven fish (Table 12). Steelhead spawning population abundance within the fishery area in the Entiat River is similar to Icicle Creek (Table 17); therefore, a similar fishery on the Entiat River may have steelhead encounters similar to those projected for the Icicle River fishery. Based on the Entiat and Icicle rivers fishery similarities and potential steelhead spawning populations within the fishery areas, WDFW anticipates ten or fewer adult steelhead encounters in this fishery.

<b>Table 17. Entiat River and Icicle Creek steelhead redd count surveys, 2002-2004.</b>				
	<u>Total Steelhead Redds <sup>1/</sup></u>		<u>Redds in Fishery Area <sup>2/</sup></u>	
<b>Year</b>	<b>Entiat</b>	<b>Icicle</b>	<b>Entiat</b>	<b>Icicle</b>
2004	69	23	28	23
2003	80	16	15	16
2002	NA	27	NA	27
<b>Average</b>	<b>74.5</b>	<b>22</b>	<b>21.5</b>	<b>22</b>
<sup>1/</sup> - Basin wide (WDFW and USFWS unpublished data). <sup>2/</sup> - redds that occur in the fishery area (WDFW and USFWS unpublished data).				

### Juvenile Steelhead

No catch of juvenile steelhead is expected because the gear utilized to target adult Chinook is generally too large to catch juvenile steelhead.

### Type of anticipated take

No juvenile steelhead take is expected. Take of adult steelhead will result from the incidental hooking and release of steelhead.

### **Effects of the take on the listed species - potential for mortality**

Applying a 10% hooking mortality rate (Mongillo 1984) to the anticipated number of released fish (10), provides an annual incidental mortality take estimate of one adult steelhead. No steelhead runs estimates to the Entiat River basin are available. Inter-dam count differences between Rocky Reach Dam

and Wells Dam cannot be used because the Wells Hatchery component comprises a large portion of the steelhead passing Rocky Reach Dam, and an unknown portion of the Wells Hatchery returning adults return to the hatchery volunteer channel or spawn in the Wells Dam tailrace, both located between Rocky Reach and Wells dams. Because of the uncertainties in providing Entiat River “run escapement” through inter-dam counts, WDFW used USFWS steelhead redd survey data from 2003 and 2004 to provide an estimated minimum spawning population (number of redds multiplied x two adults/redd). From Table 17, an average of 75 redds were observed in 2003 and 2004, inferring at least 150 spawning adults.

One adult mortality represents 0.67% of the minimum estimated steelhead spawning escapement to the Entiat River basin.

Monitoring Programs and Efforts to Reduce Impacts to Listed Fish during the Entiat River Spring Chinook Fishery

Annual smolt monitoring (USFWS) will continue through the next 5 years, providing necessary smolt production estimates to project natural origin adult returns. Adult projections, based on smolt estimates, provide greater precision than projections based upon adult spawning escapement. Because the allowable take is based on natural origin abundance, greater precision in adult escapement projections provide greater assurance that the fishery impacts are consistent with the abundance of the natural origin population.

Annual spring Chinook and steelhead spawning ground surveys in the Entiat River basin will continue. Spawning ground surveys will provide spring Chinook origin composition and spring Chinook and steelhead abundance assessment of the spawning population in the Entiat River basin. These assessments will allow WDFW to assess the abundance trend of natural origin fish and ability to modify the fishery or the expected take level should populations change over time. The spawning ground surveys will also provide valuable information to “truth” the precision of adult return projections based on smolt production estimates to further refine implementation of this fishery.

Creel surveys would also be conducted to assess encounters of natural origin spring Chinook and steelhead associated with this fishery. Surveys would mimic those conducted for the Icicle Creek fishery and included: (1) angler interviews; (2) biological data collection from Chinook retained in the fishery; (3) number of natural origin Chinook caught and released; (4) number of steelhead caught and released; and (5) angler effort counts. These data will allow WDFW to estimate the level of angler effort associated with this fishery, estimate the number of retained Chinook, and estimate the encounters and mortality of natural origin Chinook and steelhead. The WDFW will provide NMFS a bi-weekly summary of the fishery to facilitate compliance with take provisions for this fishery.

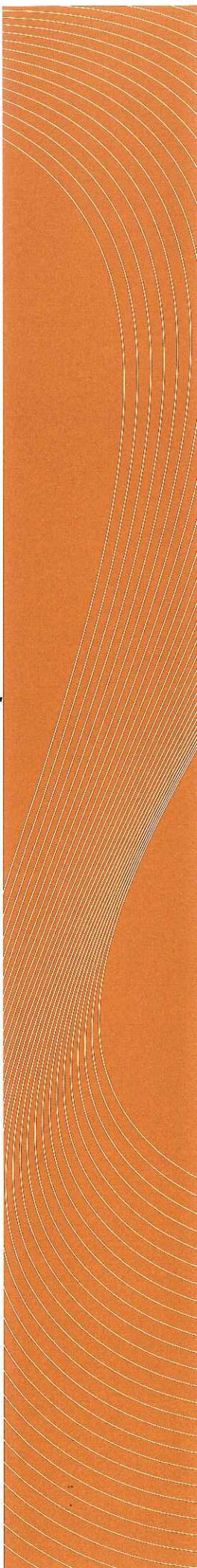
Sufficient WDFW enforcement presence will provide regulatory compliance. To document enforcement activity and compliance, enforcement staff will report the number of enforcement hours, the number of angler contacts, the number of violations and the nature of the violations.

Mandatory release of adipose-present Chinook and all steelhead would be required in this fishery, including regulations prohibiting the removal from the water of steelhead and salmon that are unlawful to retain, further reducing the expected mortality of non-target Chinook salmon and steelhead.



**APPENDIX F**  
**NMFS FEDERAL REGISTER NOTICE REGARDING**  
**PROPOSED ENTIAT SALMON FISHERY**

---



certificate regarding the reimbursement of antidumping duties prior to liquidation of the relevant entries during this review period. Failure to comply with this requirement could result in the Secretary's presumption that reimbursement of antidumping duties occurred and the subsequent assessment of doubled antidumping duties.

#### Notification Regarding Administrative Protective Orders

This notice also serves as a reminder to parties subject to Administrative Protective Order ("APO") of their responsibility concerning the return or destruction of proprietary information disclosed under APO in accordance with 19 CFR 351.305. Timely written notification of the return/destruction of APO materials or conversion to judicial protective order is hereby requested. Failure to comply with the regulations and terms of an APO is a violation which is subject to sanctions.

We are issuing and publishing these results and this notice in accordance with sections 751(a)(1) and 777(i)(1) of the Act.

Dated: November 18, 2005.

**Joseph A. Spetrini,**

*Acting Assistant Secretary for Import Administration.*

#### APPENDIX I

##### List of Comments in the Issues and Decision Memorandum

*Comment 1:* Certain Loss Related to General and Administrative Expenses (Cost Adjustment #1)

*Comment 2:* Changes in Inventory (Cost Adjustment #2)

*Comment 3:* Cost Adjustment #3

*Comment 4:* Financial Expenses

*Comment 5:* Technical Services Adjustment

*Comment 6:* Duty Drawback

*Comment 7:* Packing Costs

[FR Doc. 05-23281 Filed 11-23-05; 8:45 am]

BILLING CODE 3510-DS-S

#### DEPARTMENT OF COMMERCE

##### National Oceanic and Atmospheric Administration

[I.D. 111605E]

##### Receipt of an Application for Incidental Take Permit 1554

**AGENCY:** National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration, Commerce.

**ACTION:** Notice; application for permit.

**SUMMARY:** NMFS has received an application from the Washington Department of Fish and Wildlife (WDFW) for an incidental take permit pursuant to the Endangered Species Act of 1973, as amended (ESA). The duration of the proposed Permit is 10 years. NMFS is furnishing this notice in order to allow other agencies and the public an opportunity to review and comment on the document. All comments received will become part of the public record and will be available for review pursuant to the ESA.

**DATES:** Written comments from interested parties on the Permit application must be received at the appropriate address or fax number no later than 5 p.m. Pacific standard time on December 27, 2005.

**ADDRESSES:** Written comments on the application should be sent to Kristine Petersen, Salmon Recovery Division, NWR1, 1201 NE Lloyd Blvd., Suite 1100, Portland, OR 97232. Comments may also be sent via fax to (503) 872-2737. The mailbox address for providing e-mail comments is [UCRFisheries.nwr@noaa.gov](mailto:UCRFisheries.nwr@noaa.gov). Include in the subject line the following document identifier: "Upper Columbia fisheries". Requests for copies of the permit application should be directed to the Salmon Recovery Division, 1201 N.E. Lloyd Blvd., Suite 1100, Portland, OR 97232. The documents are also available on the Internet at [www.nwr.noaa.gov/1srd](http://www.nwr.noaa.gov/1srd). Comments received will be available for public inspection, by appointment, during normal business hours by calling (503) 230-5409.

**FOR FURTHER INFORMATION CONTACT:** Kristine Petersen, Portland, OR (ph: (503) 230-5409, fax: (503) 872-2737, e-mail: [kristine.petersen@noaa.gov](mailto:kristine.petersen@noaa.gov)).

**SUPPLEMENTARY INFORMATION:** Section 9 of the ESA and Federal regulations prohibit the "taking" of a species listed as endangered or threatened. The term "take" is defined under the ESA to mean harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NMFS may issue permits, under limited circumstances, to take listed species if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. NMFS regulations governing permits for threatened and endangered species are promulgated at 50 CFR 222.307.

##### Species Covered in this Notice

The following evolutionarily significant units (ESUs) are included in the Permit application:

Steelhead (*Oncorhynchus mykiss*): endangered Upper Columbia River (UCR).

Chinook salmon (*O. tshawytscha*): endangered Upper Columbia River spring-run and threatened Snake River spring/summer-run.

Application received:

On September 21, 2005, the WDFW submitted an application to NMFS for an ESA section 10(a)(1)(B) permit for the incidental take of ESA-listed anadromous fish species associated with recreational fisheries on non-ESA-listed fish species in the middle and upper Columbia River Basin in Washington State.

This notice is provided pursuant to section 10(c) of the ESA. NMFS will evaluate the application, associated documents, and comments submitted thereon to determine whether the application meets the requirements of section 10(a)(1)(B) of the ESA. If it is determined that the requirements are met, a permit will be issued to the WDFW for the purpose of carrying out the proposed fisheries. NMFS will publish a record of its final action in the **Federal Register**.

Dated: November 21, 2005.

**Angela Somma,**

*Chief, Endangered Species Division, Office of Protected Resources, National Marine Fisheries Service.*

[FR Doc. 05-23285 Filed 11-23-05; 8:45 am]

BILLING CODE 3510-22-S

#### DEPARTMENT OF COMMERCE

##### National Oceanic and Atmospheric Administration

[I.D. 102705A]

##### Marine Mammals; File No. 774-1649-03

**AGENCY:** National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

**ACTION:** Issuance of permit amendment.

**SUMMARY:** Notice is hereby given that Permit No. 774-1649-02 issued to the Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, California 92038 (Principle Investigator: Rennie Holt, Ph.D.) has been amended.

**ADDRESSES:** The permit and related documents are available for review upon written request or by appointment in the following office(s):

Permits and Documentation Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Room 13705, Silver Spring, MD 20910; phone (301)713-2289; fax (301)713-0376; and