

U.S. Fish & Wildlife Service

# SPRING AND SUMMER CHINOOK SALMON SPAWNING GROUND SURVEYS ON THE ENTIAT RIVER, 2011

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*On the cover: Spring Chinook salmon redd in the Entiat River located within reach 1 (rm 28.1-25.8) on August 29, 2011. USFWS photograph by Mathew R. Hall.*

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*Abstract*-The Mid-Columbia River Fishery Resource Office conducted spring and summer Chinook salmon, *Oncorhynchus tshawytscha*, spawning ground surveys on the Entiat River and tributary Mad River, from late August into mid-November 2011. A total of 248 spring Chinook salmon redds were identified. Using 2.4 fish per redd ratio, an estimated 595 spring Chinook salmon returned to spawn in the Entiat River. One hundred ninety-six summer Chinook salmon redds were identified during the 2011 spawning ground surveys. Using 2.4 fish per redd ratio, an estimated 470 summer Chinook salmon returned to spawn in the Entiat River. Surveyors also identified 35 sockeye salmon redds and 10 coho salmon redds, no bull trout redds were observed.

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## INTRODUCTION

From 1962 to 1994, spring Chinook salmon, *Oncorhynchus tshawytscha*, spawning was monitored by the Washington Department of Fish and Wildlife (WDFW) in a seven-mile section of the Entiat River known as the “index area” (river mile (rm) 28.1 to 21.3). From 1957 to 1991, Chelan County Public Utility District monitored summer Chinook salmon spawning in the lower ten miles (rm 10.4 to 0) of the Entiat River. In 1994, the United States Fish and Wildlife Service (USFWS), Mid-Columbia River Fishery Resource Office (MCRFRO), began monitoring spring and summer Chinook salmon spawning more intensely on the Entiat River. Efforts in 2011 mark the 18<sup>th</sup> year that MCRFRO has conducted the expanded spawning surveys.

The objectives of the spawning surveys are to:

Continue to assess the distribution of spring and summer Chinook salmon spawning throughout the index and expanded areas of the Entiat & Mad rivers and provide estimates of the respective spawning populations.

Evaluate possible straying of hatchery spring and summer Chinook salmon.

Search for and note presence and/or redds of other species, which may include sockeye salmon, *O. nerka*, coho salmon, *O. kisutch*, bull trout, *Salvelinus confluentus*, Pacific lamprey, *Entosphenus tridentatus*, and identify their spawning distribution in the survey sections.

## STUDY AREA

The Entiat River Basin is located in Chelan County, north-central Washington State. The river originates in a glaciated basin of the Cascade Mountains and flows southeasterly. Base flow is 385 cubic feet per second (Mullan et al. 1992) and the two major tributaries of the Entiat River are the North Fork (rm 34) and Mad River (rm 10.5). The upstream limit of anadromy is Entiat Falls (rm 33.8). See Appendix 1 for river mile locations of key tributaries and noted land marks in the Entiat River from the mouth of the Columbia River to Entiat Falls.

The Entiat system drains an area of about 416.5 square miles. The watershed is nearly 42 miles in length and varies in width from 5 to 14 miles. The basin's highest elevation is the 9,249 foot summit of Mt. Fernow and its lowest is about 700 feet at the confluence with the Columbia River (USDA 1979). The Entiat River enters the Columbia River at approximately river mile 484 and eight main stem hydroelectric dams above the Pacific Ocean.

Spring and summer Chinook salmon spawning ground surveys were conducted on the Entiat River between Fox Creek Campground (CG) (rm 28.1) and the McKenzie Diversion Dam (rm 16.2) (Figure 1). An additional spring Chinook spawning ground survey was conducted on the Mad River between rm 1.5 and Pine Flats CG (rm 3.5). An additional summer Chinook survey was conducted on the lower Entiat River between the river mouth (rm 0.3) and Entiat National Fish Hatchery (rm 6.8).

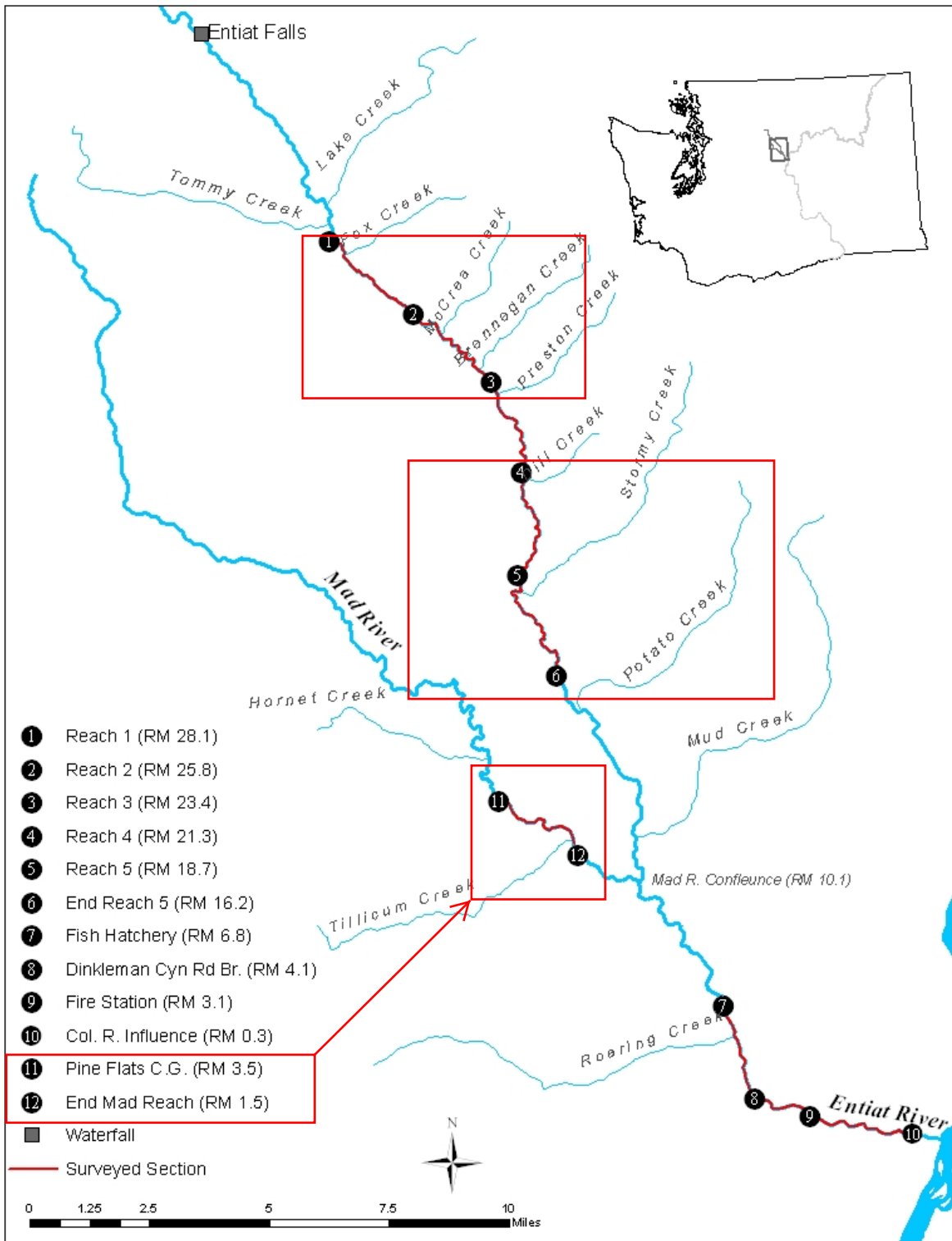


Figure 1. Overview of the Entiat River spawning ground survey areas.

## SALMON AND BULL TROUT POPULATIONS

The Entiat River has historically supported excellent salmon runs consisting of Chinook (probably spring Chinook salmon) and coho salmon (Craig and Suomela 1941). Construction of dams around the turn of the century near the mouth of the Entiat River blocked salmon from their spawning grounds, and salmon runs were essentially nonexistent by 1939 when Grand Coulee Dam was built (Craig and Suomela 1941). From 1939 to 1943, as part of the Grand Coulee Fish Maintenance Project mitigation effort, all ascending adult salmon, mainly summer and fall Chinook salmon, were trapped at Rock Island Dam and relocated to upstream tributary streams below Grand Coulee Dam, including the Entiat River, and to hatcheries, including Leavenworth, Entiat, and Winthrop National Fish Hatcheries (NFH) (Fish and Hanavan 1948). The goal of these efforts was to rebuild salmon runs in the tributary streams and mitigate for lost production above Grand Coulee Dam.

### Spring Chinook Salmon

In the initial years after Grand Coulee Dam was built, little effort was made to re-establish wild spring Chinook salmon runs in the Entiat River. From 1942 to 1944, Entiat NFH released a total of 1.3 million sub-yearlings and fewer than 50,000 yearling spring Chinook salmon that were offspring of the upriver stocks collected at Rock Island Dam (Mullan 1987). No spring Chinook salmon were released from Entiat NFH from 1945 to 1975. As early as 1956 and 1957, a wild spring Chinook salmon run was observed spawning in the area above Stormy Creek (rm 18.4) (French and Wahle 1960). Since 1962, spring Chinook salmon redds have been counted in an *index* area between river miles 28.1 and 21.3 where an established spring Chinook salmon run had been documented. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) and on the Mad River (rm 3.5-1.5) by foot since 1994. Entiat NFH resumed spring Chinook salmon production in 1974. Egg sources have included Cowlitz River (1974), Carson NFH (1975 to 1982), Little White Salmon NFH (1976, 1978, 1979, 1981), Leavenworth NFH (1979-1981, 1994), and Winthrop NFH (1988). Adults that voluntarily returned to the hatchery were the primary brood stock in 1980 and from 1983 to 2006, the last spring Chinook release into the Entiat River was in 2007, after which the program was terminated. The last returning age-class of Entiat NFH origin spring Chinook was completed in 2010.

### Summer Chinook Salmon

Although summer Chinook salmon are not believed to be endemic to the Entiat River (Craig and Suomela 1941), several efforts were made to establish summer Chinook salmon in the Entiat River following completion of Grand Coulee Dam. In 1939 and 1940, a total of 3,015 adult summer Chinook salmon, collected at Rock Island Dam from the commingled upriver stocks, were placed in upper Entiat River spawning areas. Only an estimated 1,308 of these survived to spawn (Fish and Hanavan 1948). Entiat NFH reared and released juvenile summer Chinook salmon into the Entiat River from 1941-1964, and 1976 (Mullan 1987). After cessation of spring Chinook program in 2006 a summer Chinook program was reinitiated in 2009 with the first release occurring in 2011. Entiat NFH summer Chinook egg sources have included commingled upriver stocks intercepted at Rock Island Dam (1939-1943), Methow River (1944), Carson NFH (1944), Entiat River (1946-1964), Spring Creek NFH (1964), and Wells Dam (1974, 2009-2010). Historically summer Chinook salmon spawning was monitored by aerial surveys in the lower 10.4 river miles from 1957 to 1991. Positive redd identification from the air is difficult at best; therefore aerial surveys likely underestimated actual redd numbers. Spawning numbers were never high, with a maximum of 55 redds in 1967. For years 1972-1991, aerial redd counts

averaged about five per year. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) by foot since 1994 and on the lower River (rm 6.8-0.3) by raft since 2006.

### **Sockeye and Coho Salmon**

Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941), and have only been stocked on two occasions (1943 and 1944) from Lake Quinault and Lake Whatcom stocks (Mullan 1986). A small run of sockeye salmon became established in the Entiat River and Entiat NFH collected sockeye salmon from 1944 to 1963, and their progeny were planted elsewhere (Mullan 1986).

Coho salmon runs had been largely extirpated in the Mid-Columbia River prior to 1941 (Mullan 1983). Propagation of coho salmon at the Mid-Columbia Federal hatcheries began in the 1940s and extended into the early 1970s. Chelan and Douglas County Public Utility Districts, in cooperation with WDFW, started propagation of coho salmon in the 1970's and continued until 1994. In 1996, the Yakama Nation initiated the Mid-Columbia Coho Restoration Program, which reintroduced the species into the Wenatchee and Methow sub-basins. Although no releases have occurred in the Entiat River, coho salmon have been observed in the Entiat River since 2001.

## **METHODS**

### **Spring and Summer Chinook Salmon Redd Surveys**

Redd surveys consisted of dividing the survey area into several reaches which were surveyed multiple times by walking or rafting downstream. Each encountered redd of both runs were numbered sequentially, number of live fish were recorded and redds were marked with colored flagging hung on nearby vegetation. Hand held Global Positioning System (GPS) units recorded latitude and longitude positions for each redd. Recovered carcasses were measured from snout tip to fork in tail (fork length) and post orbital to hypural plate (POH), gender identified, females were dissected and visually ranked (complete/partial/incomplete or unknown) for egg voidance and scale samples were collected when possible. Scales were viewed using a microfiche reader to determine age and origin (wild or hatchery). Carcasses were examined for external tags or marks and scanned for the presence of coded-wire tags (CWT) and passive integrated transponder (PIT) tags. Snouts were removed from carcasses with detected CWT's. The tags were later retrieved, de-coded and uploaded to the Regional Mark Processing Center with accessory information. Detected PIT tags were loaded into a portable transceiver and uploaded with accessory information to PTAGIS. Tissue samples were taken for future DNA analysis and the tail was removed to prevent re-counting.

### **Sockeye and Coho Salmon**

During Chinook salmon spawning ground surveys, sockeye and coho salmon adults as well as redds were recorded.

### **Estimating River Escapement by Fish/Redd Ratio**

Estimating escapement for spring Chinook salmon returning to the Entiat River was calculated by expanding redd counts using the expansion value of 2.4 fish per redd. Mullan (1990) used a spawner/redd ratio of 2.4 to account for pre-spawning mortality. To estimate return escapement for summer Chinook the expansion value of 2.4 fish/redd was also applied.

### **Scale Analysis and Age Designation**

Scales were used to identify fresh and salt water growth periods and to determine hatchery or wild origin. Wild spring-summer Chinook can exhibit one of three distinct freshwater life histories; (age 0) ocean-type juveniles which in their first year winter in the ocean, (age 1) stream-type juveniles which in their first year winter in the stream and (age 1) reservoir-type juveniles which in their first year winter in a reservoir (Healy 1991). Age designation in this report follows the Gilbert and Rich (1927) system, where total age is referenced by the first digit and age at the time of migration from freshwater is indicated by the subscript.

### **Estimating Coded-Wire Tag Expansions for Spring and Summer Chinook**

Recovered carcasses with a CWT generally only represent a portion of the population. In order to estimate the potential total number of adults represented by a particular recovered CWT, we expand by using the following two-step process. Step 1: Estimating the sampling rate for each species where  $S_R$  is the estimated sample rate,  $C_E$  is the number of examined carcasses and  $T_E$  is the estimated total return of adults to the river [ $S_R = C_E / T_E$ ]. Step 2: The equation [ $E_R = (N_R / S_R) / C_R$ ] is used to calculate the expanded CWT recoveries for each tag code recovered where  $E_R$  is the expanded coded-wire tag recoveries,  $N_R$  is the number of coded-wire tags recovered and  $C_R$  is the released group coded-wire tag percent.

### **Female Carcass Egg Voidance Determination**

Egg voidance from female carcasses was determined by visual estimation; complete (99% void of eggs), partial (98%-11% void of eggs), incomplete (10% or less void of eggs) and unknown (carcasses compromised).

## **RESULTS**

### **Spring Chinook Salmon Redd Counts**

A total of 248 spring Chinook salmon redds were identified during the 2011 spawning ground surveys (Table 1). This was 178% greater than the 10 year average of 139. The number of redds per reach in 2011 and the ten year running totals are found in Figure 2. One hundred eighty redds were counted in the old *index* area. Annual redd counts from the old *index* area are found in Appendix 2. Sixty-eight redds were found in the expanded survey area with no redds counted in the Mad River.

### **Spring Chinook Salmon Escapement**

The total spring Chinook salmon redd count was 248 and using the 2.4 fish per redd ratio, an estimated 595 spring Chinook salmon returned to spawn in the Entiat River.

### **Spring Chinook Salmon Sex Ratio and Spawning Success**

Of the 173 spring Chinook salmon carcasses recovered, sex was successfully determined on 168. Females comprised 49% (82) and males 51% (86). All 82 female carcasses were examined for spawning success; 82% (67) were fully voided, 2% (2) were incomplete, 2% (2) were partial voided and 14% (11) could not be determined because of decomposition. A total of 157 DNA samples were collected and sent to Abernathy Fish Technology Center for archival and future analyses.

Table 1. Spring Chinook salmon spawning ground survey results on the Entiat and Mad Rivers in 2011.

| Section                | River Mile | Date     | Redds                 | Live Fish | Carcasses             |
|------------------------|------------|----------|-----------------------|-----------|-----------------------|
| <b>Old Index Area</b>  |            |          |                       |           |                       |
| Reach 1                | 28.1-25.8  | 08/23/11 | 27                    | 12        | 1                     |
|                        |            | 08/29/11 | 20                    | 13        | 10                    |
|                        |            | 09/06/11 | 5                     | 1         | 12                    |
|                        |            | 09/12/11 | 1                     | 0         | 7                     |
|                        |            | 09/19/11 | <u>0</u>              | <u>1</u>  | <u>5</u>              |
| Cumulative Total Count |            | 53       | 27                    | 35        |                       |
| Reach 2                | 25.8-23.4  | 08/23/11 | 47                    | 56        | 5                     |
|                        |            | 08/30/11 | 19                    | 29        | 5                     |
|                        |            | 09/08/11 | 5                     | 4         | 20                    |
|                        |            | 09/13/11 | 5                     | 2         | 7                     |
|                        |            | 09/20/11 | <u>0</u>              | <u>0</u>  | <u>5</u>              |
| Cumulative Total Count |            | 76       | 91                    | 42        |                       |
| Reach 3                | 23.4-21.3  | 08/22/11 | 28                    | 40        | 1                     |
|                        |            | 08/29/11 | 0                     | 0         | 1                     |
|                        |            | 09/01/11 | 16                    | 8         | 13                    |
|                        |            | 09/09/11 | 3                     | 5         | 12                    |
|                        |            | 09/14/11 | 1                     | 1         | 2                     |
|                        |            | 09/21/11 | <u>3</u>              | <u>1</u>  | <u>0</u>              |
| Cumulative Total Count |            | 51       | 55                    | 29        |                       |
| <b>Old Index Total</b> |            |          | 180                   | 173       | 106                   |
| <b>Expanded Area</b>   |            |          |                       |           |                       |
| Reach 4                | 21.3-18.7  | 08/12/11 | 0                     | 0         | 1 <sup>a</sup>        |
|                        |            | 08/25/11 | 34                    | 45        | 5                     |
|                        |            | 09/01/11 | 7                     | 13        | 13                    |
|                        |            | 09/07/11 | 6                     | 6         | 20                    |
|                        |            | 09/12/11 | 4                     | 0         | 7                     |
|                        |            | 09/13/11 | <u>1</u> <sup>b</sup> | <u>0</u>  | <u>2</u> <sup>b</sup> |
| Cumulative Total Count |            | 52       | 64                    | 48        |                       |
| Reach 5                | 18.7-16.2  | 08/24/11 | 7                     | 9         | 0                     |
|                        |            | 09/01/11 | 0                     | 0         | 1 <sup>c</sup>        |
|                        |            | 09/02/11 | 4                     | 2         | 9                     |
|                        |            | 09/07/11 | 2                     | 8         | 4                     |
|                        |            | 09/16/11 | <u>3</u>              | <u>0</u>  | <u>4</u>              |
| Cumulative Total Count |            | 16       | 19                    | 18        |                       |
| Mad                    | 3.5-1.5    | 09/02/11 | 0                     | 0         | 0                     |
|                        |            | 09/15/11 | <u>0</u>              | <u>0</u>  | <u>1</u>              |
| Cumulative Total Count |            | 0        | 0                     | 1         |                       |
| Box Cyn.-Fox Cr. C.G.  | 29.1-28.1  | 09/22/11 | <u>0</u> <sup>d</sup> | <u>0</u>  | <u>0</u>              |
| Cumulative Total Count |            | 0        | 0                     | 0         |                       |
| <b>Expanded Total</b>  |            |          | 68                    | 83        | 67                    |
| <b>Index Total</b>     |            |          | 180                   | 173       | 106                   |
| <b>Total</b>           |            |          | 248                   | 256       | 173                   |

a) One carcasses recovered during redd imposition survey on 8/12. b) One redd observed and two carcasses recovered during redd imposition survey on 9/13. c) One carcasses recovered during redd imposition survey on 9/1. d) Bull trout spawning ground survey conducted on 9/22 observed no redds or carcasses.

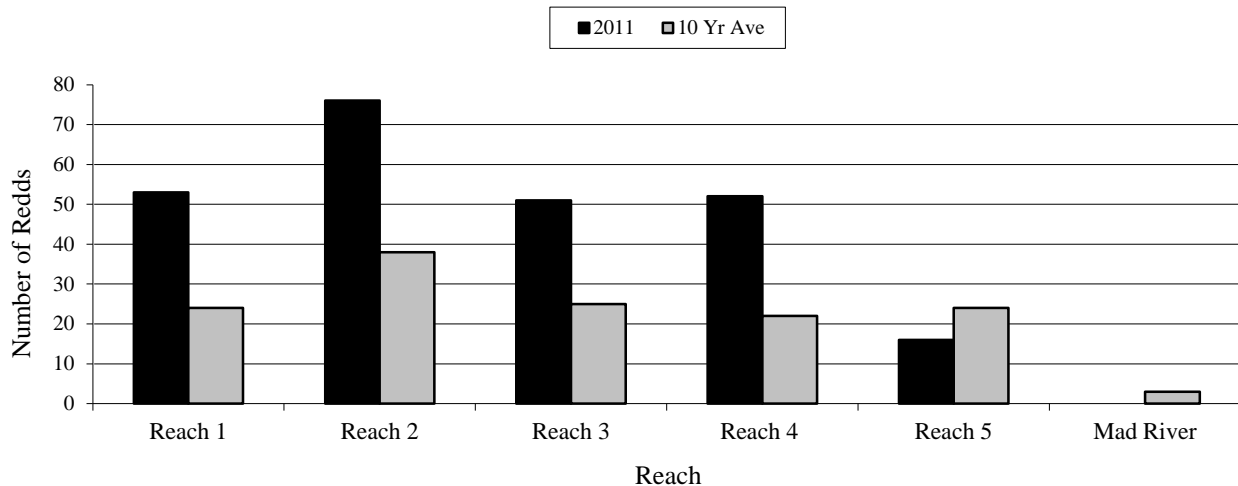


Figure 2. Entiat River spring Chinook salmon redd counts for Reaches 1-5 and Mad River for year 2011 and 10 year average.

Table 2. Age composition and origin for spring Chinook salmon sampled from the Entiat River in 2011.

| Origin   | Age | Male |     | Female |     | Total (N) | Total% |
|----------|-----|------|-----|--------|-----|-----------|--------|
|          |     | (N)  | (N) | (N)    | (N) |           |        |
| Hatchery | 2/2 | 1    |     | 0      |     | 1         |        |
|          | 3/2 | 40   |     | 1      |     | 41        |        |
|          | 4/2 | 6    |     | 20     |     | 26        |        |
|          | 5/2 | 1    |     | 1      |     | 2         |        |
|          |     | 48   |     | 22     |     | 70        | 46%    |
| Wild     | 3/2 | 6    |     | 0      |     | 6         |        |
|          | 4/2 | 14   |     | 31     |     | 45        |        |
|          | 5/2 | 7    |     | 23     |     | 30        |        |
|          |     | 27   |     | 54     |     | 81        | 54%    |
| Total    |     | 75   |     | 76     |     | 151       |        |

### Spring Chinook Salmon Age Composition and Origin

Of the 173 spring Chinook salmon carcasses recovered, age and origin were successfully determined for 151 (Table 2). Hatchery fish comprised 46% of the recovered carcasses compared to wild origin of 54%. The percent composition of hatchery vs. wild in the Entiat River for years 2002–2011 are found in Figure 3.

### Coded-Wire Tag Recoveries from Spring Chinook Salmon Carcasses

Of the 173 recovered carcasses from the Entiat River 154 were checked for missing adipose fins and scanned with a portable handheld wand detector for CWT's. Sixty (35%) were identified as having a missing adipose fin and 54 of these contained a CWT (Table 3). Note: Nineteen carcasses could not be identified as having an adipose fin present or missing.

### Passive Integrated Transponder Tag Recoveries from Spring Chinook Salmon Carcasses

Of the 173 recovered carcasses from the Entiat River, 148 were scanned with a portable transceiver for PIT tags. Five were identified as containing a PIT tag (Appendix 3).

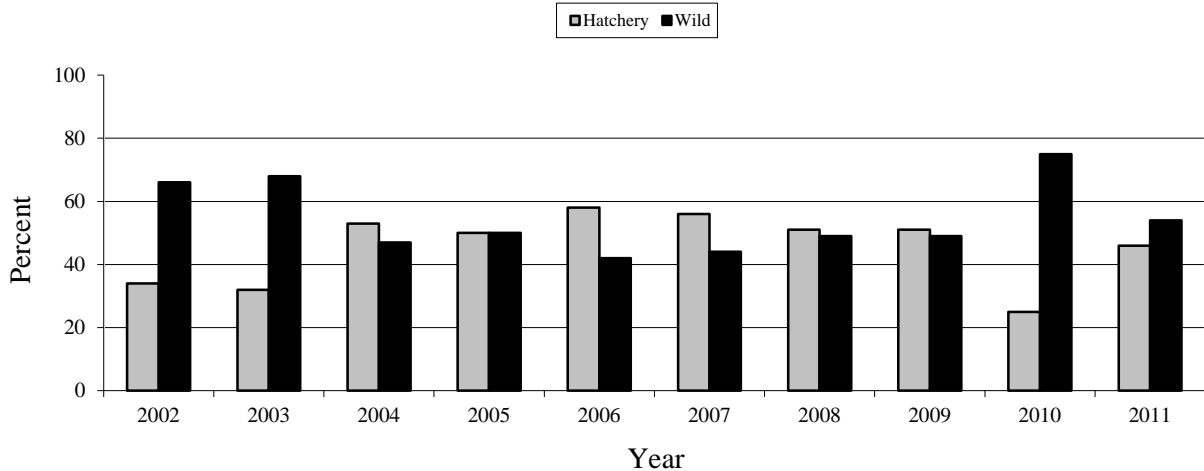


Figure 3. Estimated percent composition of hatchery and wild spring Chinook salmon escapement into the Entiat River, 2002-2011.

Table 3. Coded-wire tag recoveries collected from spring Chinook salmon carcasses on the Entiat River in 2011.

| Tag Code | Brood Year | Release Agency | Hatchery        | Recovered | Sample Rate % | % CWT'd at release | Expanded Recoveries |
|----------|------------|----------------|-----------------|-----------|---------------|--------------------|---------------------|
| 054709   | 08         | USFWS          | Leavenworth NFH | 1         | 25.9          | 19                 | 20                  |
| 054712   | 08         | USFWS          | Leavenworth NFH | 1         | 25.9          | 13                 | 30                  |
| 105181   | 07         | IDFG           | Clearwater FH   | 1         | 25.9          | 55                 | 7                   |
| 109182   | 08         | IDFG           | Clearwater FH   | 1         | 25.9          | 30                 | 13                  |
| 109782   | 08         | IDFG           | Clearwater FH   | 1         | 25.9          | 99                 | 4                   |
| 634290   | 07         | WDFW           | Chiwawa R.P.    | 8         | 25.9          | 99                 | 31                  |
| 634291   | 07         | WDFW           | Chiwawa R.P.    | 7         | 25.9          | 99                 | 27                  |
| 634292   | 07         | WDFW           | Chiwawa R.P.    | 2         | 25.9          | 99                 | 8                   |
| 634868   | 08         | WDFW           | Chiwawa R.P.    | 9         | 25.9          | 99                 | 35                  |
| 634869   | 08         | WDFW           | Chiwawa R.P.    | 10        | 25.9          | 99                 | 39                  |
| 635091   | 08         | WDFW           | Chiwawa R.P.    | 12        | 25.9          | 99                 | 47                  |
| 635374   | 09         | WDFW           | Chiwawa R.P.    | 1         | 25.9          | 99                 | 3                   |
| Total    |            |                |                 | 54        |               |                    | 248                 |

### Summer Chinook Salmon Redd Counts

A total of 196 summer Chinook salmon redds were identified during the 2011 spawning ground surveys (Table 5). This was 138% greater than the 5 year average of 142. The number of redds per reach in 2011 and the ten year running totals are found in Figure 4.

### Summer Chinook Salmon Escapement

The total summer Chinook salmon redd count was 196 and using the 2.4 fish per redd ratio an estimated 470 summer Chinook salmon returned to spawn in the Entiat River. This estimate should be considered a minimum since not all portions of the Entiat River were surveyed.



### **Summer Chinook Salmon Sex Ratio and Spawning Success**

Of the 136 summer Chinook salmon carcasses recovered, sex was successfully determined on 134. Females comprised 66% (89) and males 34% (45). All 89 female carcasses were examined for spawning success; 76% (68) were fully voided, 7% (6) incomplete, 2% (2) were partial voided and 15% (13) could not be determined because of decomposition. A total of 136 DNA samples were collected and sent to Abernathy Fish Technology Center for archival and future analyses.

### **Summer Chinook Salmon Age Composition and Origin**

Of the 136 summer Chinook salmon carcasses recovered, age and origin were successfully determined for 128 (Table 6). Hatchery origin fish comprised 8% of the recovered carcasses compared to wild origin of 92%. The percent composition of hatchery and wild in the Entiat River for years 2002–2011 are found in Figure 5. Estimated percent composition of hatchery and wild summer Chinook salmon spawning in the upper reaches (above rm 16.2) compared to the lower reaches (mainly below hatchery) in 2011 and the ten year average are found in Figure 6. Three juvenile life history types were identified for wild summer Chinook salmon, 76.1% migrated to saltwater at age 0, 23.1% over wintered in the reservoir and 0.8% over wintered in their natal stream. Both reservoir and stream type juveniles entered saltwater at age 1. Juvenile life history numbers and percentages for years 2006-2011 are found in Table 7.

### **Coded-Wire Tag Recoveries from Summer Chinook Salmon Carcasses**

Of the 136 recovered carcasses from the Entiat River, 130 were checked for missing adipose fins and scanned with a portable handheld wand detector for CWT's. Thirteen (10%) were identified as having a missing adipose fin and 10 of these contained a CWT (Table 8). Note: Six carcasses could not be identified as having an adipose fin present or missing.

### **Passive Integrated Transponder Tag Recoveries from Summer Salmon Carcasses**

Of the 136 recovered carcasses from the Entiat River, 130 were scanned with a portable transceiver for PIT tags. Four were identified as containing a PIT tag (Appendix 4).

### **Sockeye and Coho Salmon Redd, Live and Carcass Counts**

Surveyors identified, counted and/or recovered 35 sockeye salmon redds, 68 live, 7 carcasses and 10 coho redds, 15 live and 8 carcasses.

### **Coded-Wire Tag Recoveries from Sockeye and Coho Salmon Carcasses**

All recovered sockeye and coho salmon carcasses were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Seven sockeye carcasses were recovered of which five contained a coded-wire tag. Eight coho carcasses were recovered of which five contained a coded-wire tag. (Table 10).

### **Passive Integrated Transponder Tag Recoveries from Sockeye and Coho Salmon Carcasses**

All recovered carcasses from the Entiat River were scanned with a portable transceiver for PIT tags, none were identified as containing a PIT tag.

Table 4. Summer Chinook spawning ground survey results on the Entiat River in 2011.

| Section                                  | River Mile | Date     | Redds                 | Live Fish | Carcasses             |
|--|------------|----------|-----------------------|-----------|-----------------------|
| Reach 1                                  | 28.1-25.8  | 10/03/11 | 1                     | 1         | 0                     |
|  |            | 10/17/11 | <u>0</u>              | <u>0</u>  | <u>0</u>              |
| Cumulative Total Count                   |            |          | 1                     | 1         | 0                     |
| Reach 2                                  | 25.8-23.4  | 10/06/11 | 4                     | 4         | 0                     |
|  |            | 10/18/11 | <u>8</u>              | <u>5</u>  | <u>2</u>              |
| Cumulative Total Count                   |            |          | 12                    | 9         | 2                     |
| Reach 3                                  | 23.4-21.3  | 10/07/11 | 5                     | 2         | 0                     |
|  |            | 10/20/11 | <u>3</u>              | <u>1</u>  | <u>0</u>              |
| Cumulative Total Count                   |            |          | 8                     | 3         | 0                     |
| Reach 4                                  | 21.3-18.7  | 10/03/11 | 11                    | 19        | 0                     |
|  |            | 10/17/11 | 9                     | 7         | 4                     |
|  |            | 10/26/11 | <u>0</u>              | <u>0</u>  | <u>2</u> <sup>a</sup> |
| Cumulative Total Count                   |            |          | 20                    | 26        | 6                     |
| Reach 5                                  | 18.7—16.2  | 09/23/11 | 2 <sup>b</sup>        | 0         | 0                     |
|  |            | 10/08/11 | 86                    | 159       | 5                     |
|  |            | 10/21/11 | 22                    | 24        | 64                    |
|  |            | 10/27/11 | 0                     | 0         | 18                    |
|  |            | 11/02/11 | 2 <sup>c</sup>        | 0         | 0                     |
|  |            | 11/03/11 | <u>1</u> <sup>d</sup> | <u>0</u>  | <u>0</u>              |
| Cumulative Total Count                   |            |          | 113                   | 183       | 87                    |
| Upper River Total                        |            |          | 154                   | 222       | 95                    |
| Entiat NFH to Fire Station               | 6.8-3.1    | 10/20/11 | 15                    | 16        | 10                    |
|  |            | 11/03/11 | <u>3</u>              | <u>2</u>  | <u>8</u>              |
| Cumulative Total Count                   |            |          | 18                    | 18        | 18                    |
| Fire Station to Columbia River Influence | 3.1-0.3    | 10/21/11 | 18                    | 31        | 11                    |
|  |            | 11/04/11 | <u>6</u>              | <u>9</u>  | <u>13</u>             |
| Cumulative Total Count                   |            |          | 24                    | 40        | 24                    |
| Lower River Total                        |            |          | 42                    | 58        | 42                    |
| Upper River Total                        |            |          | 154                   | 222       | 95                    |
| TOTAL                                    |            |          | 196                   | 280       | 137                   |

a) Summer Chinook carcasses recovered during redd imposition survey on 10/26/11. b) Summer Chinook redds observed during redd imposition survey on 09/23/11. c) Summer Chinook redds observed during redd imposition survey on 11/02/11. d) Summer Chinook redd observed during redd imposition survey on 11/03/11.

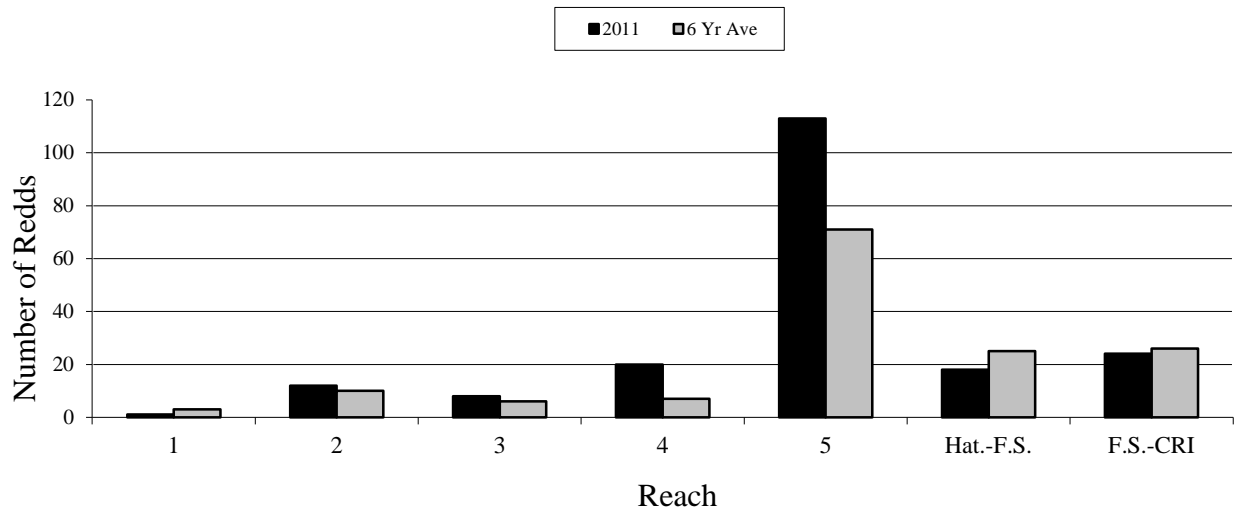


Figure 4. Entiat River summer Chinook salmon redd counts for Reaches 1-5, Entiat NFH to Fire Station and Fire Station to Columbia River influence for 2011 and 6 year average.

Table 5. Age composition and origin for summer Chinook salmon sampled from the Entiat River in 2011.

| Origin   | Age | Male |     |                  |                | Female |     |                  |                | Total (N) | Total % |
|----------|-----|------|-----|------------------|----------------|--------|-----|------------------|----------------|-----------|---------|
|          |     | (N)  | %   | Reservoir Reared | River Yearling | (N)    | %   | Reservoir Reared | River Yearling |           |         |
| Hatchery | 2/2 | 2    |     |                  |                | 0      |     |                  |                | 2         |         |
|          | 3/2 | 1    |     |                  |                | 0      |     |                  |                | 1         |         |
|          | 4/1 | 1    |     |                  |                | 1      |     |                  |                | 2         |         |
|          | 4/2 | 1    |     |                  |                | 0      |     |                  |                | 1         |         |
|          | 5/2 | 1    |     |                  |                | 3      |     |                  |                | 4         |         |
|          |     | 6    | 5%  |                  |                | 4      | 3%  |                  |                | 10        | 8%      |
| Wild     | 2/1 | 1    |     |                  |                | 0      |     |                  |                | 1         |         |
|          | 3/1 | 4    |     |                  |                | 0      |     |                  |                | 4         |         |
|          | 3/2 | 1    |     | 1                |                | 0      |     |                  |                | 1         |         |
|          | 4/1 | 14   |     |                  |                | 33     |     |                  |                | 47        |         |
|          | 4/2 | 3    |     | 3                |                | 4      |     | 4                |                | 7         |         |
|          | 5/1 | 12   |     |                  |                | 25     |     |                  | 1              | 37        |         |
|          | 5/2 | 2    |     | 2                |                | 18     |     | 17               | 1              | 20        |         |
|          |     | 37   | 29% |                  |                | 80     | 63% |                  |                | 117       | 92%     |
| Total    |     | 43   |     |                  |                | 84     |     |                  |                | 127       |         |

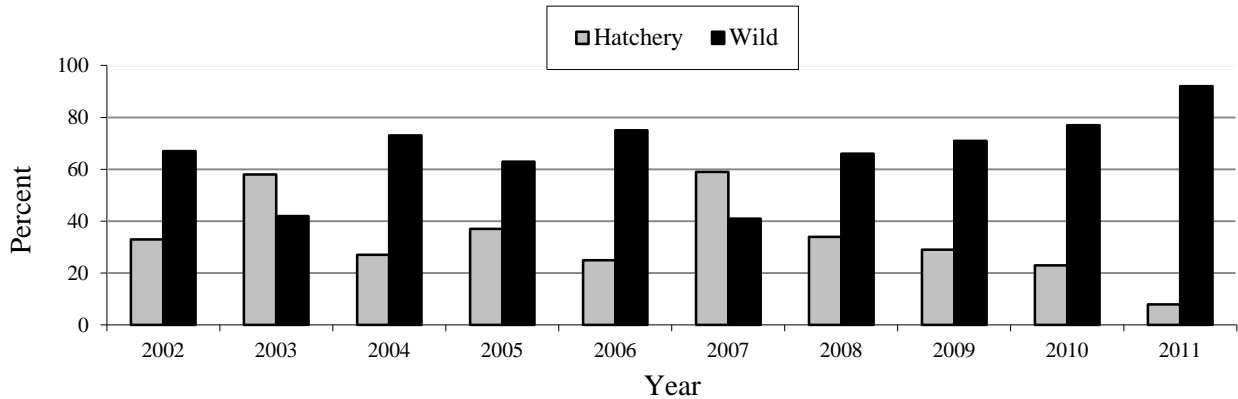


Figure 5. Estimated percent composition of hatchery and wild summer Chinook salmon escapement into the Entiat River, 2002-2011.

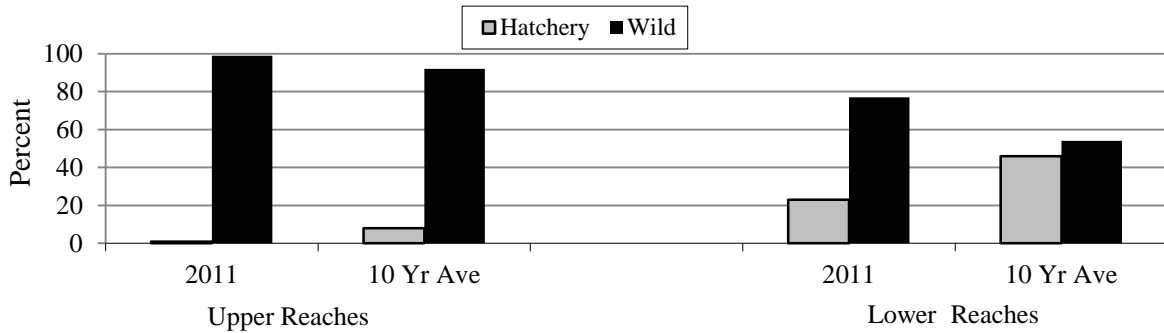


Figure 6. Estimated percent composition of hatchery and wild summer Chinook salmon spawning in the upper reaches (above rm 16.2) compared to the lower reaches (mainly below hatchery) in 2011 and the ten year average.

Table 6. Juvenile life history types and percentages for summer Chinook salmon sampled from the Entiat River in years 2006-2011.

| Year | Ocean # | %     | Reservoir # | %     | Stream # | %    |
|------|---------|-------|-------------|-------|----------|------|
| 2006 | 88      | 73.3% | 27          | 22.5% | 5        | 4.2% |
| 2007 | 24      | 68.6% | 10          | 28.6% | 1        | 2.9% |
| 2008 | 44      | 83.0% | 8           | 15.1% | 1        | 1.9% |
| 2009 | 46      | 82.1% | 10          | 17.9% | 0        | 0.0% |
| 2010 | 48      | 69.6% | 20          | 29.0% | 1        | 1.4% |
| 2011 | 89      | 76.1% | 27          | 23.1% | 1        | 0.8% |
| Ave. | 57      | 76.0% | 17          | 22.7% | 1        | 1.3% |

Table 7. Coded-wire tag recoveries collected from summer Chinook salmon carcasses on the Entiat River in 2011.

| Tag Code | Brood Year | Release Agency | Hatchery       | Recovered | Sample Rate % | % CWT'd at release | Expanded Recoveries |
|----------|------------|----------------|----------------|-----------|---------------|--------------------|---------------------|
| 053619   | 09         | USFWS          | Entiat NFH     | 1         | 27.7          | 99                 | 4                   |
| 633895   | 06         | WDFW           | Turtle Rock FH | 1         | 27.7          | 99                 | 4                   |
| 633896   | 07         | WDFW           | Turtle Rock FH | 2         | 27.7          | 99                 | 7                   |
| 634184   | 06         | WDFW           | East Bank FH   | 3         | 27.7          | 98                 | 11                  |
| 634693   | 07         | WDFW           | Chelan PUD FH  | 1         | 27.7          | 99                 | 4                   |
| 635164   | 08         | WDFW           | Turtle Rock FH | 1         | 27.7          | 99                 | 4                   |
| 635578   | 09         | WDFW           | Dryden Pond    | 1         | 27.7          | 98                 | 4                   |
| Total    |            |                |                | 10        |               |                    | 38                  |

Table 8. Coded-wire tag recoveries from sockeye and coho salmon carcasses on the Entiat River in 2011.

| Species | Tag Code | Brood Year | Release Agency | Hatchery     | Recovered |
|---------|----------|------------|----------------|--------------|-----------|
| Sockeye | 634265   | 07         | WDFW           | LK Wenatchee | 5         |
| Coho    | 190173   | 08         | YAKAMA         | Winthrop NFH | 3         |
| Coho    | 190180   | 08         | YAKAMA         | Winthrop NFH | 2         |
| Total   |          |            |                |              | 10        |

## SUMMARY

The total number of spring Chinook redds counted during the 2011 spawning ground surveys was 248 (Figure 7), which included 180 redds in the old index area and 68 redds found in the expanded section. Using the 2.4 fish per redd ratio and the total redd count of 248, an estimated 595 spring Chinook salmon returned to spawn in the Entiat River. One hundred seventy-three carcasses were recovered and examined, of these, 49% were females and 51% males. All 82 female carcasses were examined for spawning success, 82% (67) were fully voided, 2% (2) were incomplete, 2% (2) were partial voided and 14% (11) could not be determined because of carcass decomposition. Hatchery origin fish comprised 46% of the population compared to 54% wild origin. A total of 54 CWT's were recovered from carcasses, hatchery and release location from recovered CWT's are as follow; Leavenworth NFH/ Icicle Creek (2), Chiwawa Rearing Ponds/ Chiwawa River (49) and Clearwater Hatchery/ Powell Rearing Ponds (3). By expansion, this represents 20%, 70%, and 10% respectively of the known hatchery spawners.

The total number of summer Chinook redds counted during the 2011 spawning ground surveys was 196 (Figure 7), which included 154 redds in Reaches 1-5 and 42 located below river mile 16.2. Using the 2.4 fish per redd ratio and the total redd count of 196, an estimated 470 summer Chinook salmon returned to spawn in the Entiat River. One hundred thirty-six carcasses were recovered and examined, of these, 66% were females and 34% males. All 89 female carcasses were examined for spawning success; 76% (68) were fully voided, 7% (6) were incomplete, 2% (2) were partial voided and 15% (13) could not be determined because of carcass decomposition. Hatchery origin fish comprised 8% of the population compared to 92% wild origin. Scale analysis revealed wild summer Chinook had three distinctive freshwater life histories; 76% were

ocean-type juveniles migrants, 23% were reservoir-type juvenile migrants and 1% were stream-type juvenile migrants. A total of 10 CWT's were recovered from carcasses, hatchery and release location from recovered CWT's are as follows; Dryden Acclamation Pond/ Wenatchee River (1), Turtle Rock Hatchery/ Columbia River (4), East Bank Hatchery/ Wenatchee River (3), Entiat NFH/ Entiat River (1) and Chelan PUD/ Chelan River (1).

During the spring and summer Chinook spawning ground surveys, surveyors identified, counted and/or recovered 35 sockeye salmon redds, 68 live, 7 carcasses and 10 coho salmon redds, 15 live, 8 carcasses.

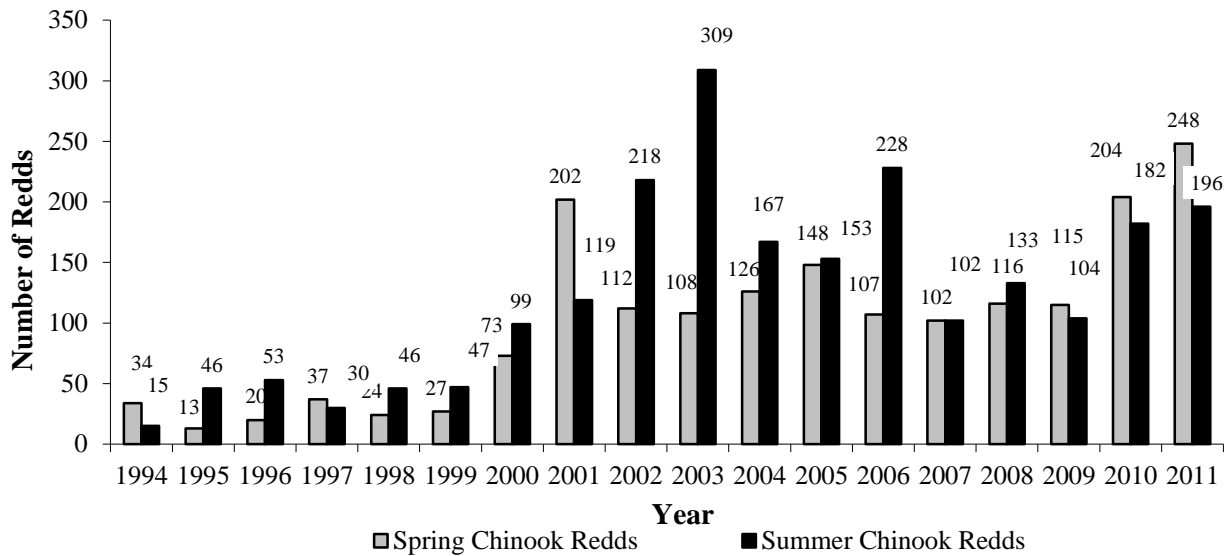


Figure 7. Spring and summer Chinook salmon redd counts for the Entiat River, 1994-2011.

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## APPENDIX 1

| River Mile | Description   |
|------------|---|
| 0.0        | Mouth of <u>Entiat River</u> at river-mile 483.7 on Columbia River    |
| 0.3        | Columbia River influence  |
| 1.5        | Keystone Bridge   |
| 3.1        | Entiat River Road Bridge (Fire Station Restoration Site)              |
| 4.1        | Dinkleman Canyon Road Bridge (Dinkleman Canyon Road Restoration Site) |
| 6.8        | Entiat National Fish Hatchery   |
| 10.1       | Mad River   |
| 15.2       | Potato Creek  |
| 16.2       | McKenzie Ditch and Diversion Dam (end of Reach 5)                     |
| 18.4       | Stormy Creek  |
| 21.2       | Dill Creek  |
| 23.1       | Preston Creek   |
| 23.4       | Brief Bridge  |
| 23.9       | Brennegan Creek   |
| 25.0       | McCrea Creek  |
| 25.5       | Burns Creek   |
| 27.7       | Fox Creek   |
| 28.1       | Fox Creek Campground (start of Reach 1)                               |
| 28.6       | Tommy Creek   |
| 28.9       | Lake Creek Campground   |
| 33.8       | Entiat Falls  |

mileage may not be exact

## APPENDIX 2

Entiat River spring Chinook salmon redd counts from annual surveys in old *index* area, Fox Creek C. G. to Dill Creek (RM 28 to 21), 1962-1993 (WDFW) and 1994-2011 (USFWS).

| YEAR | #of REDDS | YEAR | #of REDDS | YEAR | #of REDDS | YEAR | #of REDDS |
|------|-----------|------|-----------|------|-----------|------|-----------|
| 1962 | 115       | 1975 | 156       | 1988 | 67        | 2001 | 144       |
| 1963 | 145       | 1976 | 47        | 1989 | 37        | 2002 | 72        |
| 1964 | 384       | 1977 | 171       | 1990 | 83        | 2003 | 70        |
| 1965 | 104       | 1978 | 326       | 1991 | 32        | 2004 | 65        |
| 1966 | 307       | 1979 | NA        | 1992 | 42        | 2005 | 81        |
| 1967 | 252       | 1980 | 107       | 1993 | 100       | 2006 | 65        |
| 1968 | 252       | 1981 | 95        | 1994 | 24        | 2007 | 70        |
| 1969 | 83        | 1982 | 107       | 1995 | 1         | 2008 | 77        |
| 1970 | 70        | 1983 | 107       | 1996 | 8         | 2009 | 76        |
| 1971 | 136       | 1984 | 84        | 1997 | 20        | 2010 | 125       |
| 1972 | 61        | 1985 | 115       | 1998 | 15        | 2011 | 180       |
| 1973 | 229       | 1986 | 105       | 1999 | 6         |      |           |
| 1974 | 88        | 1987 | 64        | 2000 | 28        |      |           |



### APPENDIX 3

Passive Integrated Transponder Tag interrogations from spring Chinook salmon carcasses on the Entiat River in 2011.

| PIT Tag Code   | Sex | Release Site   | Release Date | Last Detection Site | Last Detection Date |
|----------------|-----|----------------|--------------|---------------------|---------------------|
| 3D9.1C2D6281D4 | M   | Wells Dam      | 06/27/11     | Entiat R. ENS       | 08/31/11            |
| 3D9.1C2C448CDF | M   | Entiat River   | 05/02/08     | Entiat R. ENS       | 08/31/11            |
| 3D9.1C2D628502 | M   | Wells Dam      | 06/28/11     | Entiat R. ENS       | 08/27/11            |
| 3D9.1BF27A6004 | M   | L. Granite Dam | 05/06/09     | Entiat R. ENF       | 08/08/11            |
| 3D9.1C2D8C149A | F   | Priest Rapid   | 06/06/11     | Entiat R. ENF       | 07/02/11            |

### APPENDIX 4

Passive Intergrated Transponder Tag interrogations from summer Chinook salmon carcasses on the Entiat River in 2011.

| PIT Tag Code   | Sex | Release Site | Release Date | Last Detection Site | Last Detection Date |
|----------------|-----|--------------|--------------|---------------------|---------------------|
| 3D9.1C2DB20C65 | F   | Bonn. Dam    | 07/06/11     | Entiat R. ENM       | 08/22/11            |
| 3D9.1C2DAC56E6 | M   | Bonn. Dam    | 06/16/11     | Entiat R. ENM       | 08/06/11            |
| 3D9.1C2D6BC045 | M   | Entiat NFH   | 04/15/11     | Entiat R. ENM       | 09/27/11            |
| 3D9.1C2D45FD8B | F   | Wells Dam    | 07/19/11     | Entiat R. ENL       | 08/21/11            |

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