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SPRING AND SUMMER CHINOOK SALMON SPAWNING GROUND SURVEYS ON THE ENTIAT RIVER, 2012

Charles O. Hamstreet

U. S. Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
Leavenworth, WA 98826

***On the cover**: Spring Chinook salmon redd in the Entiat River located within reach 1 (rm 28.1-25.8) on August 13, 2012. USFWS photograph by Matt Joki.*

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Prepared by:

Charles O. Hamstreet

U.S. Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
7501 Icicle Rd.
Leavenworth WA 98826

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7501 Icicle Rd.
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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 Mad River, from late August into mid-November 2012. A total of 236 spring Chinook salmon redds were identified. Using 2.4 fish per redd ratio, an estimated 566 spring Chinook salmon returned to spawn in the Entiat River. A total of 374 summer Chinook salmon redds were identified. Using 2.4 fish per redd ratio, an estimated 898 summer Chinook salmon returned to spawn in the Entiat River. Surveyors also identified 52 sockeye salmon redds and no coho salmon redds were observed.

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INTRODUCTION

Spring Chinook salmon, *Oncorhynchus tshawytscha*, spawning was monitored annually by foot, on one day after the peak spawning in a seven-mile section of the Entiat River known as the "index area" (river mile (rm) 28.1 to 21.3) by the Washington Department of Fish and Wildlife (WDFW) from 1962 to 1994. Additionally, Chelan County Public Utility District (CPUD) monitored summer Chinook salmon spawning in the lower ten miles (rm 10.1 to 0) of the Entiat River by aerial surveys from 1957 to 1991. From 1992 to 1993, no summer Chinook spawning surveys were conducted. Beginning in 1994, The United States Fish and Wildlife Service (USFWS), Mid-Columbia River Fishery Resource Office (MCRFRO) assisted WDFW monitoring of spring and re-initiated summer Chinook spawning surveys. Spring Chinook surveys included the index area and expanded to include additional reaches below the index area. Also in 1994, multiple summer Chinook salmon surveys were conducted between rm 28.3 to 16.2 and sections within rm 7.0 to 0.3. Starting in 1995, MCRFRO assumed all monitoring of spring and summer Chinook spawning surveys in the Entiat River with the addition of the Mad River (rm 3.1 to 1.5) for spring Chinook. Efforts in 2012 mark the 19th year that MCRFRO has conducted spawning ground surveys within the Entiat River.

The objectives of the spawning surveys are to:

Assess the distribution and estimate spawning population of spring and summer Chinook salmon throughout the index and expanded areas of the Entiat & Mad rivers.

Evaluate straying of hatchery spring and summer Chinook salmon.

Access the distribution of other spawning salmon species, which may include sockeye salmon, *O. nerka* and coho salmon, *O. kisutch*.

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 10.1). 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 basins 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 Pine Flats CG (rm 3.5) and (rm 1.5). An additional summer Chinook

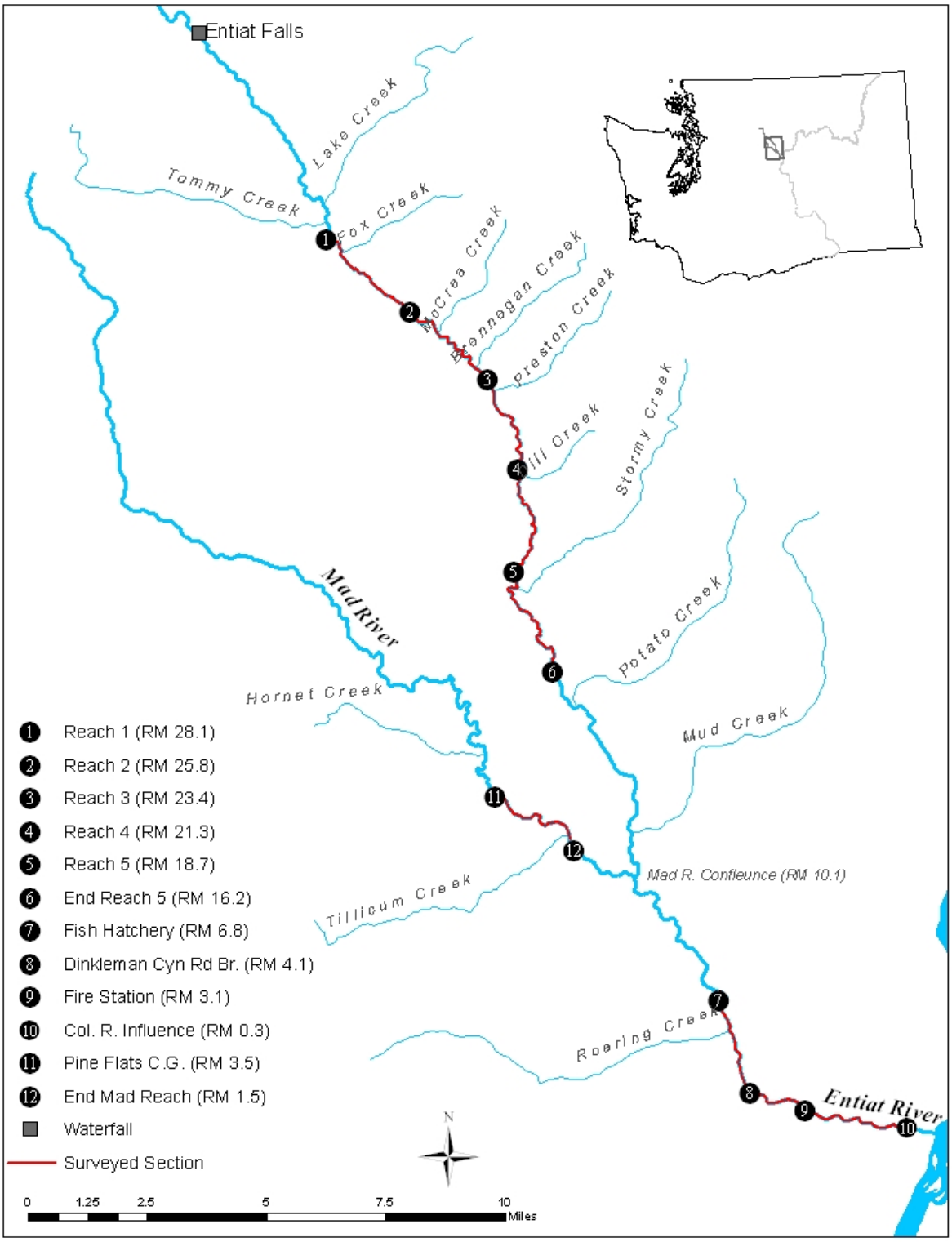

Figure 1. Overview of the Entiat River spawning ground survey areas.

survey was conducted on the lower Entiat River between Entiat National Fish Hatchery (rm 6.8) and the Columbia River influence (rm 0.3).

SALMON POPULATIONS

The Entiat River has historically supported 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. 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. 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). From 1962-1994, WDFW annually counted spring Chinook salmon redds, by foot, on one day after the peak spawning in an *index* area between river miles 28.1 and 21.3, where the established spring Chinook salmon run had been documented (MCRFRO assisted WDFW in 1994). In 1995, MCRFRO assumed all monitoring of spring Chinook redd surveys in the upper river (rm 28.1-16.2) and on the Mad River (rm 3.5-1.5) by multiple foot surveys.

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 2007 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 10.1 river miles from 1957 to 1991. Positive redd identification from the air is difficult at best; and likely underestimated actual redd numbers. No summer Chinook spawning surveys were conducted in the lower section for years 1992 and 1993. MCRFRO has conducted surveys in the upper river (rm 28.1-16.2) and sections of the lower river (rm 7.0-0.3) by foot since 1994 and by raft in the lower river only 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 reaches which were surveyed multiple times by walking or rafting downstream. Redds appear lighter in color than the surrounding gravel and typically are larger than 1.5 meters square with an excavated pit. Each encountered redd of both runs were numbered sequentially, 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.

Spring and Summer Chinook Salmon Carcass Recoveries

Data collected from recovered carcasses included; measurement from the snout tip to fork in tail (fork length) and post orbital to hypural plate (POH), gender, 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, origin (wild or hatchery) and freshwater rearing history. 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 (fin clips) were taken for future DNA analysis and tails were removed to prevent re-counting.

Sockeye and Coho Salmon Redd Surveys
During Chinook salmon spawning ground surveys, sockeye and coho salmon adults as well as redds were recorded. Coho and sockeye redds were determined by the presence of live adults and/or redds of generally less than 1.5 m^2 and in substrate < 5 cm. diameter. All recovered sockeye and coho salmon carcasses were scanned for CWT's and PIT tags using portable handheld wand detectors. No scales, genetics, or egg voidance was collected or documented.

Estimating River Escapement by Fish/Redd Ratio
Estimating escapement for both spring and summer 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.

Scale Analysis and Age Designation
Scales were used to identify fresh and salt water growth periods and hatchery or wild origin. Wild spring Chinook exhibit stream-type juveniles which spend their first year wintering in the stream and exit the following spring (age 1). Wild summer Chinook can exhibit one of three distinct freshwater life histories; (age 0) ocean-type juveniles which in their first year wintering in the ocean, (age 1) stream-type juveniles which spend their first year wintering in the stream and (age 1) reservoir-type juveniles which spend 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 (recovered carcass is defined as a non-compromised snout). 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
Throughout all surveyed areas a total of 236 spring Chinook salmon redds were identified during the 2012 spawning ground surveys (Table 1). This was 156% greater than the 10 year average of 151. The number of redds per reach in 2012 and the ten year running totals are found in Figure 2. One hundred seventy-two redds were counted in the old *index* area. Annual redd counts from the old *index* area are found in Appendix 2. Sixty-four redds were found in the expanded survey area with two redds counted in the Mad River.

Table 1. Spring Chinook salmon spawning ground survey results on the Entiat and Mad Rivers in 2012.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Old Index Area					
Reach 1	28.1-25.8	08/13/12	8	4	0
		08/20/12	11	19	0
		08/27/12	12	17	6
		09/05/12	22	24	11
		09/10/12	6	1	7
		09/17/12	2	1	4
		09/24/12	0	0	1
		Cumulative Total Count	61	66	29
Reach 2	25.8-23.4	08/14/12	4	24	0
		08/21/12	7	37	0
		08/28/12	20	24	5
		09/06/12	21	6	11
		09/12/12	7	1	10
		09/20/12	2	0	7
		09/25/12	2	0	1
		Cumulative Total Count	63	92	34
Reach 3	23.4-21.3	08/16/12	4	7	0
		08/23/12	11	10	2
		08/30/12	16	29	4
		09/07/12	10	11	8
		09/13/12	5	2	5
		09/21/12	2	0	2
		09/27/12	0	0	0
		Cumulative Total Count	48	59	21
Old Index Total			172	217	84
Expanded Area					
Reach 4	21.3-18.7	08/13/12	3	0	0
		08/20/12	3	7	0
		08/28/12	7	16	1
		09/04/12	15	24	7
		09/10/12	6	5	9
		09/17/12	1	1	3
		09/26/12	0	0	3
		Cumulative Total Count	35	53	23
Reach 5	18.7-16.2	08/16/12	0	0	0
		08/23/12	3	2	0
		08/30/12	8	11	0
		09/06/12	14	11	4
		09/13/12	2	3	10
		09/20/12	0	0	1
		09/27/12	0	0	1
		Cumulative Total Count	27	27	16
Mad River	3.5-1.5	08/17/12	0	0	0
		08/31/12	2	2	0
		09/14/12	0	0	1
		09/25/12	0	0	0
		Cumulative Total Count	2	2	1
Fire Station to Columbia River Influence	3.1-0.3	10/19/12	0	0	1[a]
Expanded Total			64	82	41
Index Total			172	217	84
Total			236	299	125

a) Carcass recovered during 10/19 lower river summer Chinook spawning ground survey.

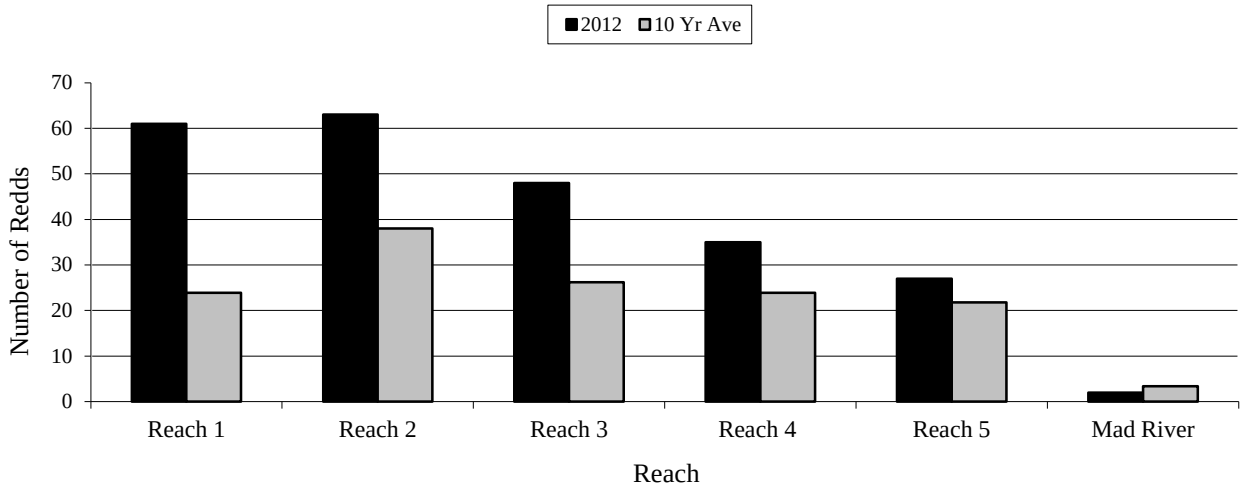

Figure 2. Entiat River spring Chinook salmon redd counts for Reaches 1-5 and Mad River for year 2012 and 10 year average.

Spring Chinook Salmon Escapement
The total spring Chinook salmon redd count was 236 and using the 2.4 fish per redd ratio, an estimated 566 spring 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.

Spring Chinook Salmon Sex Ratio and Spawning Success
Of the 125 spring Chinook salmon carcasses recovered, sex was successfully determined on 124. Females comprised 58% (72) and males 42% (52). All 72 female carcasses were examined for spawning success; 79% (57) were fully voided, 3% (2) were incomplete, 3% (2) were partial voided and 15% (11) could not be determined because of decomposition.

Spring Chinook Salmon Age Composition and Origin
Of the 125 spring Chinook salmon carcasses recovered, age and origin were successfully determined for 117 (Table 2). Hatchery fish comprised 34% of the recovered carcasses compared to wild origin of 66%. The percent composition of hatchery vs. wild in the Entiat River for years 2002–2012 are found in Figure 3.

Coded-Wire Tag Recoveries from Spring Chinook Salmon Carcasses
Of the 125 recovered carcasses from the Entiat River 119 were checked for missing adipose fins and scanned with a portable handheld wand detector for CWT's. Thirty-nine carcasses (33%) were identified as having a missing adipose fin and 30 of these contained a CWT (Table 3).

Passive Integrated Transponder Tag Recoveries from Spring Chinook Salmon Carcasses
Of the 125 recovered carcasses from the Entiat River, 118 were scanned with a portable transceiver for PIT tags. Six were identified as containing a PIT tag (Appendix 3).

Summer Chinook Salmon Redd Counts
A total of 374 summer Chinook salmon redds were identified during the 2012 spawning ground surveys (Table 4). This was 238% greater than the 6 year average of 156. The number of redds per reach in 2012 and the ten year running totals are found in Figure 4.

Table 2. Age composition and origin for spring Chinook salmon sampled from the Entiat River in 2012.

		Male	Female		
Origin	Age	(N)	(N)	Total (N)	Total%
Hatchery	2/2	0	0	0	
	3/2	7	0	7	
	4/2	10	22	32	
	5/2	1	0	1	
		18	22	40	34%
Wild	2/2	1	0	1	
	3/2	2	0	2	
	4/2	17	35	52	
	5/2	13	9	22	
		33	44	77	66%
Total		51	66	117	

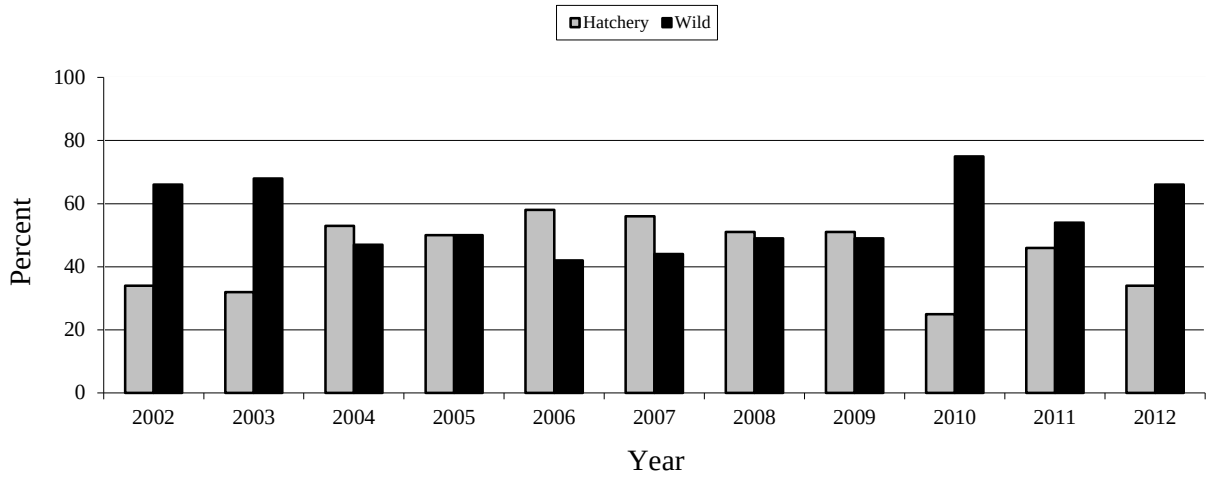

Figure 3. Estimated percent composition of hatchery and wild spring Chinook salmon escapement into the Entiat River, 2002-2012.

Table 3. Coded-wire tag recoveries collected from spring Chinook salmon carcasses on the Entiat River in 2012.

Tag Code	Brood Year	Release Agency	Hatchery	Rcvrd	Sample Rate %	% CWT'd at release	Expanded Recoveries	Est. % of Hatchery Escapement
053488	08	USFWS	Kooskia NFH	1	21.0	18	26	16
109782	08	IDFG	Clearwater FH	1	21.0	99	5	3
634290	07	WDFW	Chiwawa R.P.	1	21.0	99	5	
634868	08	WDFW	Chiwawa R.P.	8	21.0	99	38	
634869	08	WDFW	Chiwawa R.P.	8	21.0	99	38	81
635091	08	WDFW	Chiwawa R.P.	7	21.0	99	34	
635374	09	WDFW	Chiwawa R.P.	4	21.0	99	19	
Total				30			165	100

Table 4. Summer Chinook spawning ground survey results on the Entiat River in 2012.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	09/24/12	1	3	0
		10/09/12	4	0	0
		10/22/12	3	0	0
		Cumulative Total Count	8	3	0
Reach 2	25.8-23.4	09/25/12	3	33	0
		10/10/12	28	21	3
		10/23/12	14	10	2
		Cumulative Total Count	45	64	5
Reach 3	23.4-21.3	09/21/12	3	27	0
		09/27/12	8	32	0
		10/11/12	19	22	4
		10/25/12	2	3	5
		Cumulative Total Count	32	84	9
Reach 4	21.3-18.7	09/17/12	1[a]	2	0
		09/26/12	4	0	0
		10/09/12	16	18	1
		10/15/12	4	4	5
		10/22/12	0	4	2
		10/29/12	1	1	0
		Cumulative Total Count	26	29	8
Reach 5	18.7—16.2	09/20/12	2	168	0
		09/27/12	9	168	1
		10/12/12	165	319	20
		10/18/12	7	24	17
		10/20/12	18	46	41
		10/24/12	2	14	29
		10/29/12	1	5	28
		Cumulative Total Count	204	744	136
Upper River Total			315	924	158
Mad River Mouth	10.1	10/12/12	2	0	0
Entiat NFH	6.8-3.1	10/04/12	13[b]	85	0
to Fire Station		10/18/12	18	36	5
		10/29/12	1	3	13
		Cumulative Total Count	32	124	18
Fire Station to Columbia	3.1-0.3	10/05/12	1[c]	3	0
River Influence		10/19/12	20	23	15
		10/29/12	4	3	16
		Cumulative Total Count	25	29	31
Lower River Total			59	153	49
Upper River Total			315	924	158
TOTAL			374	1077	207

a) Summer Chinook redd observed during redd imposition survey on 09/17/12. b) Summer Chinook redds observed during raft orientation training on 10/04/12. c) Summer Chinook redd observed during raft orientation training on 10/05/12.

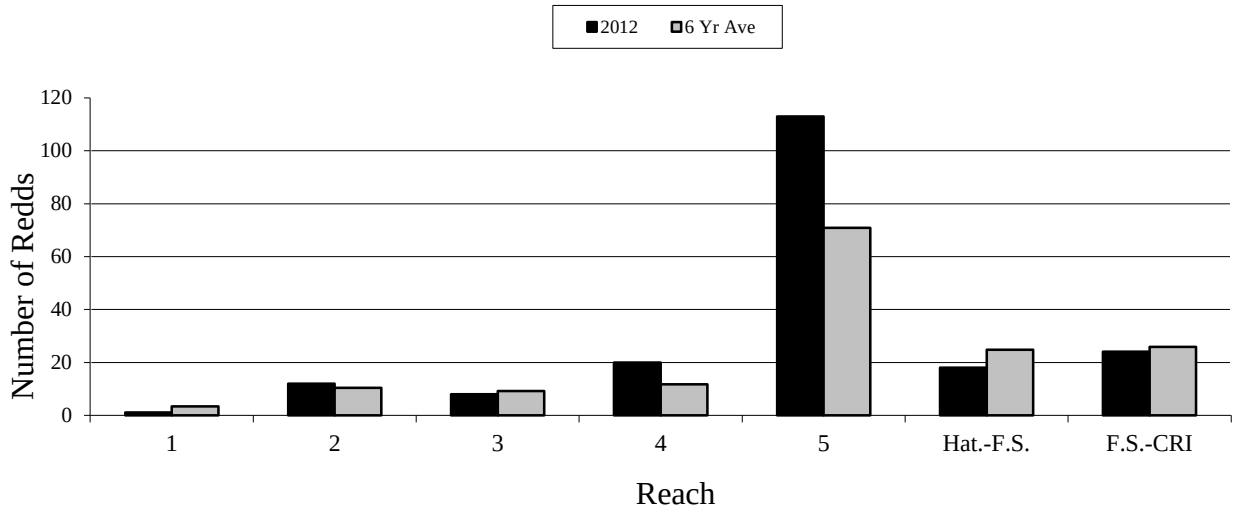

Figure 4. Entiat River summer Chinook salmon redd counts for Reaches 1-5, Entiat NFH to Fire Station and Fire Station to Columbia River Influence for 2012 and 6 year average.

Summer Chinook Salmon Escapement

The total summer Chinook salmon redd count was 374 and using the 2.4 fish per redd ratio an estimated 898 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 207 summer Chinook salmon carcasses recovered, sex was successfully determined on all 207. Females comprised 58% (120) and males 42% (87). All 120 female carcasses were examined for spawning success; 81% (97) were fully voided, 8% (10) incomplete, 1% (1) were partial voided and 10% (12) could not be determined because of decomposition.

Summer Chinook Salmon Age Composition and Origin

Of the 207 summer Chinook salmon carcasses recovered, age and origin were successfully determined for 199 (Table 5). Hatchery origin fish comprised 13% of the recovered carcasses compared to wild origin of 87%. The percent composition of hatchery and wild in the Entiat River for years 2002–2012 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 @ rm 6.8) in 2012 and the ten year average are found in Figure 6. Two juvenile life history types were identified for wild summer Chinook salmon, 74.6% migrated to saltwater at age 0 and 25.4% over wintered in the reservoir. None were identified as over wintering in their natal stream. All reservoir juveniles entered saltwater at age 1. Juvenile life history numbers and percentages for years 2006-2012 are found in Table 6.

Coded-Wire Tag Recoveries from Summer Chinook Salmon Carcasses

Of the 207 recovered carcasses from the Entiat River, 201 were checked for missing adipose fins and scanned with a portable handheld wand detector for CWT's. Twenty-four (12%) were identified as having a missing adipose fin and twenty-one of these contained a CWT (Table 7).

Table 5. Age composition and origin for summer Chinook salmon sampled from the Entiat River in 2012.

		Male				Female					
Origin	Age	(N)	%	Reservoir Reared	River Yearling	(N)	%	Reservoir Reared	River Yearling	Total (N)	Total %
Hatchery	2/2	0				0				0	
	3/1	1				0				1	
	3/2	2				0				2	
	4/1	1				1				2	
	4/2	8				9				17	
	5/2	0				3				3	
	6/2	0				1				1	
		12	6%			14	7%			26	13%
Wild	2/1	2				0				2	
	3/1	11				0				11	
	3/2	1		*1*		0				1	
	4/1	32				32				64	
	4/2	9		*9*		14		*14*		23	
	5/1	15				37				52	
	5/2	3		*3*		16		*16*		19	
	6/2	0				1		*1*		1	
		73	37%			100	50%			173	87%
Total		85				114				199	

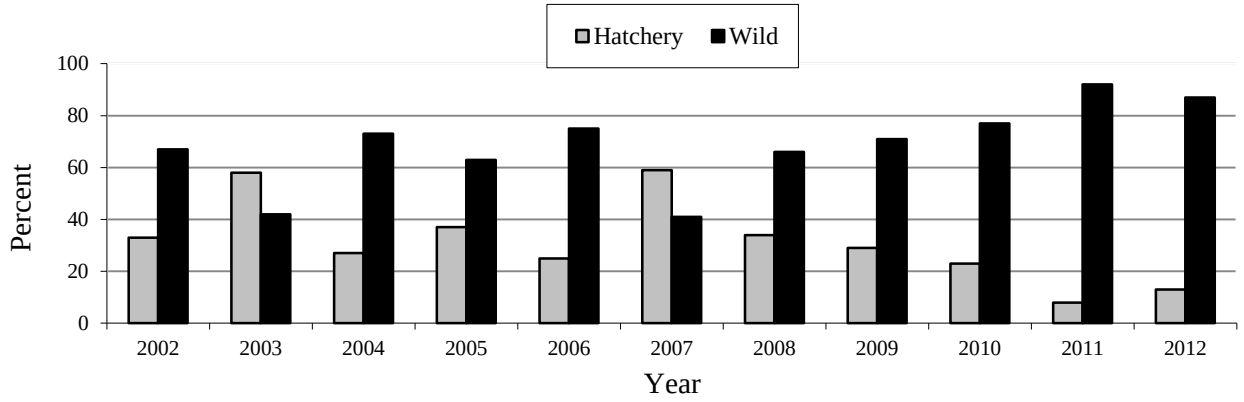

Figure 5. Estimated percent composition of hatchery and wild summer Chinook salmon escapement into the Entiat River, 2002-2012.

Passive Integrated Transponder Tag Recoveries from Summer Salmon Carcasses
Of the 207 recovered carcasses from the Entiat River, 201 were scanned with a portable transceiver for PIT tags. Three were identified as containing a PIT tag (Appendix 4).

Sockeye and Coho Salmon Redd, Live and Carcass Counts
Surveyors counted 52 sockeye salmon redds, 97 live adults and recovered 25 carcasses. No coho redds were identified and only 1 coho carcass was recovered.

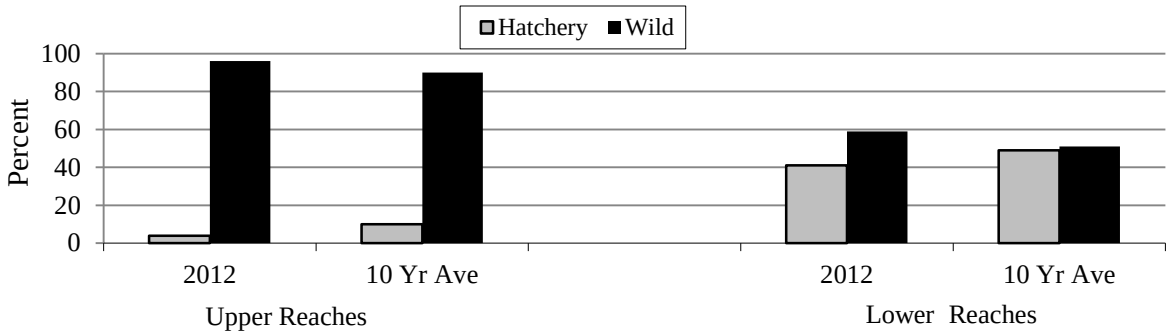

Figure 6. Estimated percent composition of hatchery and wild summer Chinook salmon spawning in the upper reaches (above rm 16.2) compared to the lower reaches (mainly below hatchery) in 2012 and the ten year average.

Table 6. Juvenile life history types and percentages for summer Chinook salmon sampled from the Entiat River in years 2006-2012.

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
2012	129	74.6	44	25.4	0	0.0
Ave.	67	75.3	21	23.1	1	1.4

Table 7. Coded-wire tag recoveries collected from summer Chinook salmon carcasses on the Entiat River in 2012.

Tag Code	Brood Year	Release Agency	Hatchery	Rcvrd	Sample Rate %	% CWT'd at release	Expanded Recoveries	Est. % of Hatchery Escapement
635373	09	WDFW	Chelan N.P.	1	22.4	99	5	5
632869	07	WDFW	Dryden Pond	1	22.4	99	5	
635097	08	WDFW	Dryden Pond	5	22.4	94	24	51
635098	08	WDFW	Dryden Pond	4	22.4	99	18	
635578	09	WDFW	Dryden Pond	1	22.4	98	5	
634184	06	WDFW	East Bank	1	22.4	98	5	5
634694	07	WDFW	Turtle Rock	1	22.4	97	5	
634778	08	WDFW	Turtle Rock	3	22.4	97	14	
634791	08	WDFW	Turtle Rock	1	22.4	99	5	39
635087	09	WDFW	Turtle Rock	1	22.4	97	5	
635164	08	WDFW	Turtle Rock	1	22.4	99	5	
635179	08	WDFW	Turtle Rock	1	22.4	99	5	
Total				21			101	100

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. Twenty-five sockeye carcasses were recovered of which eight contained a coded-wire tag. One coho carcass was recovered which contained a coded-wire tag (Table 8).

Passive Integrated Transponder Tag Recoveries from Sockeye Salmon Carcasses
All recovered carcasses from the Entiat River were scanned with a portable transceiver for PIT tags; one sockeye was identified as containing a PIT tag (Appendix 5).

Table 8. Coded-wire tag recoveries from sockeye and coho salmon carcasses on the Entiat River in 2012.

Species	Tag Code	Brood Year	Release Agency	Hatchery	Recovered
Sockeye	634389	08	WDFW	LK Wenatchee	8
Coho	190255	09	YAKAMA	Winthrop NFH	1
Total					9

SUMMARY

The total number of spring Chinook redds counted during the 2012 spawning ground surveys was 236 (Figure 7), which included 172 redds in the old index area and 64 redds found in the expanded section. Using the 2.4 fish per redd ratio and the total redd count of 236, an estimated 566 spring Chinook salmon returned to spawn in the Entiat River. One hundred twenty-five carcasses were recovered, gender was successfully determined for 124; females comprised 58% and males 42%. All 72 female carcasses were examined for spawning success; 79% (57) were fully voided, 3% (2) were incomplete, 3% (2) were partial voided and 15% (11) could not be determined because of carcass decomposition. Hatchery origin fish comprised 34% of the population compared to 66% wild origin. A total of 30 CWT's were recovered from carcasses, hatchery and release location from recovered CWT's are as follow; Kooskia NFH/ Clear Creek (1), Chiwawa Rearing Ponds/ Chiwawa River (28) and Clearwater Hatchery/ Powell Rearing Ponds (1). By expansion, this represents 16%, 81%, and 3% respectively of the known hatchery spawners. A total of 123 DNA samples were collected and sent to Abernathy Fish Technology Center for archival and future analyses.

The total number of summer Chinook redds counted during the 2012 spawning ground surveys was 374 (Figure 7), which included 315 redds in Reaches 1-5 and 59 located below river mile 16.2. Using the 2.4 fish per redd ratio and the total redd count of 374, an estimated 898 summer Chinook salmon returned to spawn in the Entiat River. Two hundred seven carcasses were recovered, gender was successfully determined for all 207; females comprised 58% and males 42%. All 120 female carcasses were examined for spawning success; 81% (97) were fully voided, 8% (10) were incomplete, 1% (1) was partial voided and 10% (12) could not be determined because of carcass decomposition. Hatchery origin fish comprised 13% of the population compared to 87% wild origin. Scale analysis revealed wild summer Chinook had two distinctive freshwater life histories; 75% were ocean-type juvenile migrants and 25% were

reservoir-type juvenile migrants. A total of 21 CWT's were recovered from carcasses, hatchery and release location from recovered CWT's are as follows; Dryden Acclamation Pond/ Wenatchee River (11), Turtle Rock Hatchery/ Columbia River (8), East Bank Hatchery/ Wenatchee River (1) and Chelan N.P./ Chelan River (1). A total of 199 DNA samples were collected and sent to Abernathy Fish Technology Center for archival and future analyses.

During the spring and summer Chinook spawning ground surveys, surveyors counted 52 sockeye salmon redds, 97 live adults and recovered 25 carcasses. No coho redds and only 1 carcass was recovered.

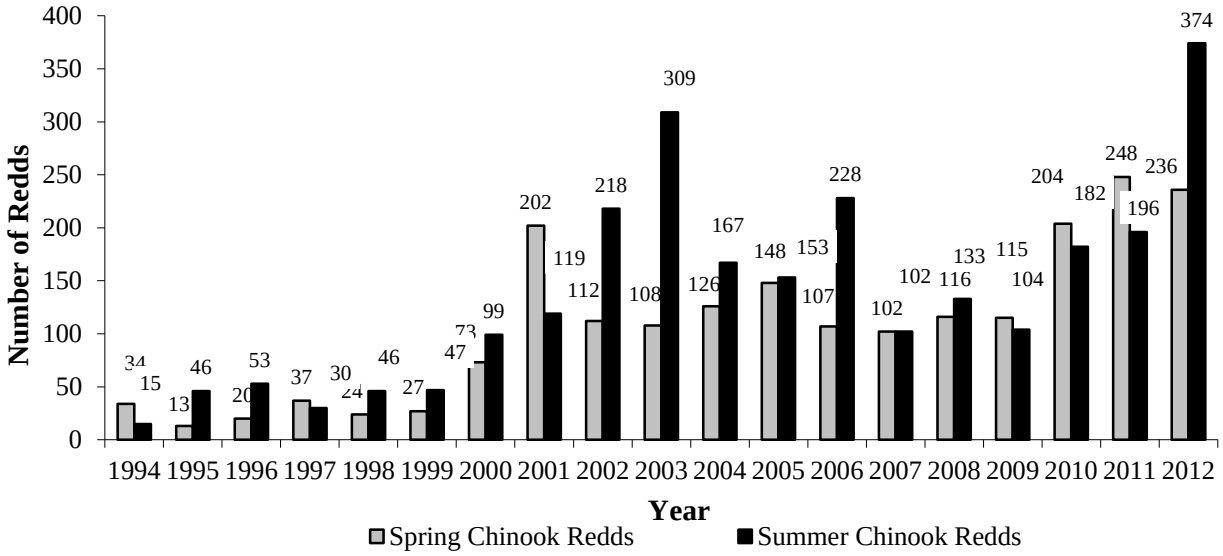

Figure 7. Spring and summer Chinook salmon redd counts for the Entiat River, 1994-2012.

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N/A= not available

APPENDIX 1

River Mile	Description
0.0	Mouth of Entiat River 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 (start of Reach 3)
23.9	Brennegan Creek
25.0	McCrea Creek
25.4	Burns Creek
28.2	Fox Creek
28.3	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 1994-2012 (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	2012	172
1974	88	1987	64	2000	28		

APPENDIX 3

Passive Integrated Transponder Tag interrogations from spring Chinook salmon carcasses on the Entiat River in 2012.

PIT Tag Code	Sex	Release Site	Release Date	Last Detection Site	Last Detection Date
3D9.1C2CCD39AC	M	Entiat River	10/27/08	Entiat R. ENF	07/08/12
3D9.1C2CDC1090	M	Entiat River	05/17/09	Entiat R. ENA	06/24/12
3D9.1C2CDD7A89	M	Entiat River	10/16/09	Entiat R. ENF	07/27/12
3D9.1BF1CF7C06	M	Entiat River	11/08/09	Entiat R. ENF	07/07/12
3D9.1C2CF6006A	F	Wells Dam	06/20/12	Entiat R. ENF	08/27/12
3D9.1C2DD7A061	F	Wells Dam	05/30/12	Entiat R. ENF	07/31/12

APPENDIX 4

Passive Intergrated Transponder Tag interrogations from summer Chinook salmon carcasses on the Entiat River in 2012.

PIT Tag Code	Sex	Release Site	Release Date	Last Detection Site	Last Detection Date
3D9.1C2D702C21	F	Wells Dam	07/10/12	Entiat R. ENL	07/25/12
3D9.1C2D6F2460	F	Wells Dam	07/18/12	Entiat R. ENL	08/03/12
3D9.1C2D703E06	M	Wells Dam	07/31/12	Entiat R. ENL	08/17/12

APPENDIX 5

Passive Intergrated Transponder Tag interrogations from a sockeye salmon carcass on the Entiat River in 2012.

PIT Tag Code	Sex	Release Site	Release Date	Last Detection Site	Last Detection Date
3D9.1C2D2DA384	M	Lk. Wenatchee	10/28/09	Entiat R. ENF	07/29/12

U. S. Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
7501 Icicle Road
Leavenworth, WA

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