

U.S. Fish & Wildlife Service
**SPRING AND SUMMER CHINOOK
SALMON SPAWNING GROUND
SURVEYS ON THE ENTIAT RIVER, 2005**



U. S. Fish and Wildlife Service
Mid-Columbia River Fishery Resource Office
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SPRING AND SUMMER CHINOOK SALMON SPAWNING
GROUND SURVEYS ON THE ENTIAT RIVER, 2005.

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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 28.9 to 21.3). From 1957 to 1991, Chelan County Public Utility District monitored summer Chinook salmon spawning in the lower ten miles (river mile 0 to 10.4) 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 2005 mark the twelfth year that MCRFRO has conducted the expanded spawning surveys.

The objectives of the spawning surveys are to:

1. 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.
2. Evaluate possible straying of hatchery spring and summer Chinook salmon.
3. Search for and note presence and/or redds of other salmonid species, which may include sockeye salmon, *O. nerka*, coho salmon, *O. kisutch*, Pacific lamprey, *Entosphenus tridentatus* and bull trout, *Salvelinus confluentus* 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 heads in a glaciated basin near the crest of the Cascade Mountains and flows southeasterly. Base flow is 385 cubic feet per second (Mullan et al. 1992) and major tributaries are the North Fork (river mile 34) and Mad River (river mile 10.5). The upstream limit of anadromy is Entiat Falls (river mile 33.8).

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 mainstem hydroelectric dams above the Pacific Ocean.

Spring Chinook salmon spawning ground surveys were conducted between Fox Creek Campground (C.G.) and McKenzie Diversion Dam (river mile 28.1 to 16.2), and Mad River (river mile 3.5 to 1.5) (Figure 1). Summer Chinook salmon surveys focused on Reaches 2 through 5 (river mile 28.1 to 16.2) and between Dinkleman Canyon Road to the Columbia River influence (river mile 4.1 to 0.3) (Figure 1).

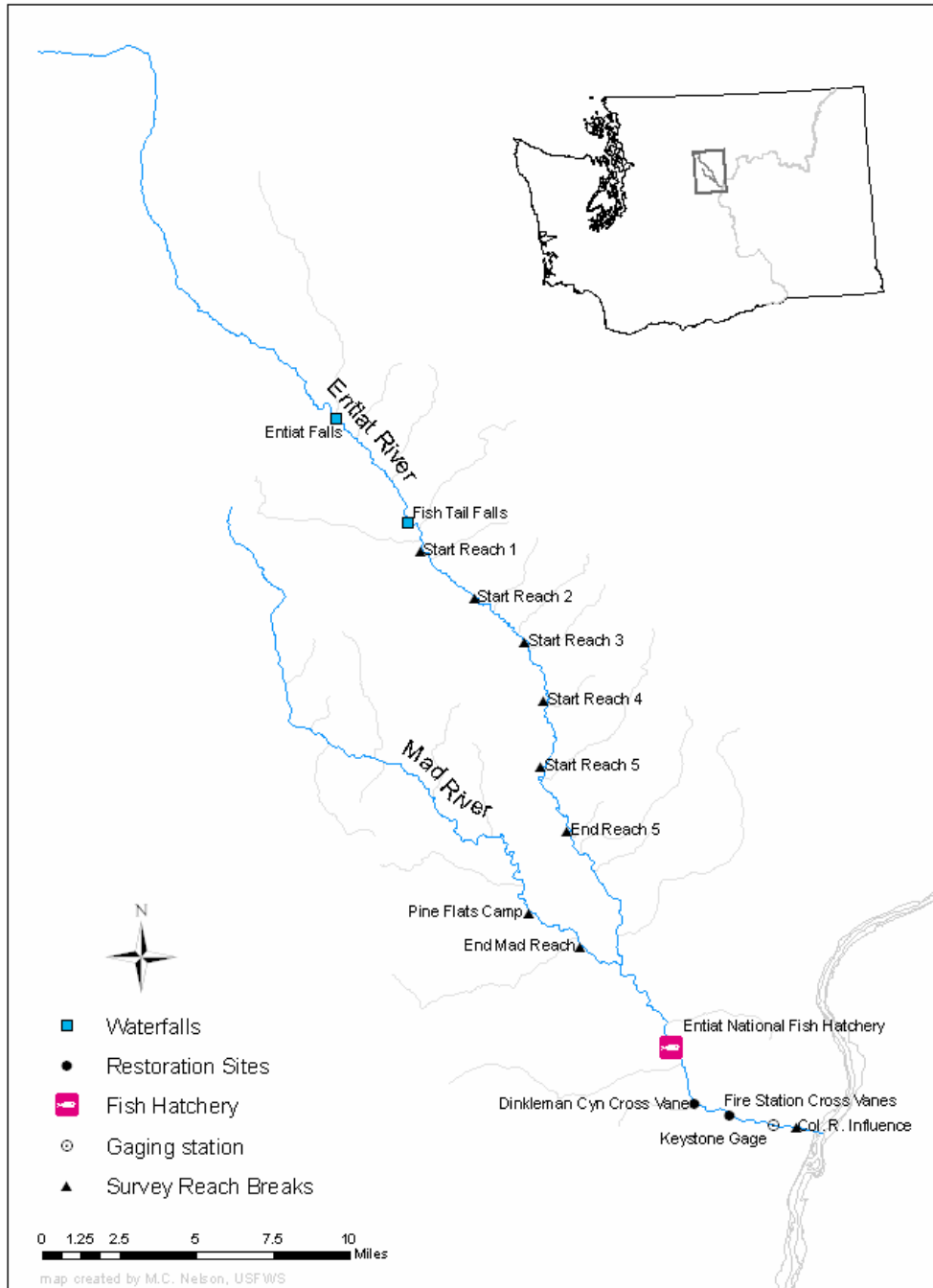


Figure 1. Overview of the Entiat River spawning ground survey areas.

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-yearling 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 has been counted in an *index* area between river mile 28 and 21 where an established spring Chinook salmon run has been documented. 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 2005.

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 in 1976 (Mullan 1987). Egg sources included the 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). 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 underestimate 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.

Bull Trout, Sockeye Salmon and Coho Salmon

Bull trout presence/absence surveys were conducted in 1984 and 1987, with limited data obtained (WDFW 1997). In 1989, Okanogan-Wenatchee National Forest contracted with

WDFW to determine bull trout distribution and abundance within the Wenatchee National Forest, including the Entiat River mainstem and Mad River (Brown 1993). In 2005, United States Forest Service (USFS) personnel counted 37 bull trout redds in the Mad River index reach, Young Creek to Jimmy Creek (Archibald, 2006). Incidental sightings of bull trout (1993 to 2004) have also been recorded by USFS personnel from Entiat Falls to the gauging station pool (river mile 33.8 to 33.5). In 2005, 16 bull trout redds were counted in this section. Since 1994, MCRFRO has searched for bull trout and/or redds during the spring and summer Chinook salmon spawning ground surveys. In 2005, only one bull trout was observed, no redds were identified. Beginning in 2004, MCRFRO initiated bull trout redd surveys from the gauging station pool to Fox Creek Camp Ground (river mile 33.5 to 28.0). In 2005, 34 redds were counted in this section (Nelson, 2006).

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). During the 2005 spawning ground surveys, 42 sockeye salmon redds, 144 live adults and 11 carcasses were identified, counted and recovered.

In an effort to re-introduce coho salmon to upper Columbia tributaries, the Yakama Nation has initiated a juvenile release program in the Wenatchee and Methow River basins. During the 2005 spawning ground surveys, two coho redds, one live adult and four carcasses were identified, counted and recovered.

METHODS

Spring and Summer Chinook Salmon Redd Surveys

Methods for surveying spring Chinook salmon redds consisted of dividing the survey area into several reaches. Each reach was surveyed walking downstream, enumerating and marking only well established redds, recording numbers of live fish and bio-sampling recovered carcasses. Each recovered carcass was examined for the presence of an adipose fin and scanned with a portable handheld wand detector, measured fork length and post orbital-to-hypural plate (POH), scale and DNA samples collected, gender identified and tails were removed to prevent recounting. Female carcasses were dissected to visually determine spawning success. All redd locations were marked using Global Positioning System (GPS) and with colored survey flagging on nearby vegetation to distinguish them from summer Chinook redds in subsequent surveys. Scales were pressed into acetate plastic and viewed using a microfiche reader to determine age and origin (wild or hatchery) and snouts were removed from carcasses with detected CWT's for later retrieval and de-coding of coded-wire tags.

Bull Trout, Sockeye and Coho Salmon

During the spring and summer Chinook salmon spawning ground surveys, bull trout, sockeye and coho salmon /or redds were searched for, recorded and marked when identified.

Estimating River Escapement by Fish/Redd Ratio

Estimating river 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 prespawning mortality.

To estimate return escapement for summer Chinook, the expansion value of 2.4 fish/redd is applied.

Age Designation

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

Using the estimated number of returning spring Chinook salmon (355), divided by the number of examined recovered carcasses (53) gives an expansion number of 6.7. To expand the number of coded-wire tags for each tag code recovered, multiply the expansion number (6.7) to the number of coded-wire tags recovered in each (100% marked) coded-wire tag group.

The estimated number of returning summer Chinook salmon (367), divided by the number of recovered carcasses (202) gives an expansion number of 1.8. To expand the number of coded-wire tags for each tag code recovered, multiply the expansion number (1.8) to the number of coded-wire tags recovered in each (100% marked) coded-wire tag group.

RESULTS

Spring Chinook Salmon Redd Counts

A total of **148** redds were identified during the 2005 spawning ground surveys (Table 1). Eighty-one (55%) of the spring Chinook salmon redds were counted in the old *index* area, an additional 67 (45%) redds were found in the expanded survey area including three redds in the Mad River. Annual redd counts from the old *index* area are found in Appendix 1. The peak spawning occurred around the first week in September.

Spring Chinook Salmon Escapement

Assuming the total spring Chinook salmon redd count is 148, and using the 2.4 fish per redd ratio, an estimate of **355** spring Chinook salmon returned to spawn in the Entiat River.

Spring Chinook Salmon Sex Ratio and Spawning Success

Fifty-three spring Chinook salmon carcasses were recovered and examined in 2005. Of these, 30 (58%) were females and 22 (42%) were males, with one unknown. All female carcasses were examined for spawning success, where 27 (100%) were completely spent and three could not be determined because of carcass decomposition. Thirty-three DNA samples were also collected from the 53 recovered carcasses.

Spring Chinook Salmon Age Composition and Origin

Of the 53 spring Chinook salmon carcasses recovered, age and origin were successfully determined for 43. Age composition was (11%) age-3, (80%) age-4 and (9%) age-5 (Table 2). Hatchery origin comprised 51% compared to wild origin of 49% (Table 2).

Table 1. Spring Chinook salmon spawning ground surveys on the Entiat and Mad Rivers in 2005.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	09/06/05	4	5	1
Old <i>Index</i> Area		09/20/05	<u>0</u>	<u>2</u>	<u>1</u>
Cumulative Total Count			4	7	2
Reach 2	25.8-23.4	08/19/05	0	1	0
Old <i>Index</i> Area		09/06/05	31	20	3
		09/20/05	14	0	<u>2</u>
		¹ 10/26/05	<u>2</u>	<u>NA</u>	<u>NA</u>
Cumulative Total Count			47	21	12
Reach 3	23.4-21.3	08/19/05	1	1	0
Old <i>Index</i> Area		09/08/05	16	7	2
		09/20/05	13	6	4
		² 10/11/05	<u>NA</u>	<u>NA</u>	<u>1</u>
Cumulative Total Count			30	14	7
Index Total			81	42	21
Reach 4	21.3-18.7	08/18/05	0	6	0
<i>Expanded</i> Area		09/08/05	20	24	1
		09/21/05	5	2	5
		³ 10/12/05	<u>NA</u>	<u>NA</u>	<u>2</u>
Cumulative Total Count			25	32	8
Reach 5	18.7—16.2	08/18/05	0	3	0
<i>Expanded</i> Area		09/09/05	24	29	5
		09/22/05	7	2	16
		⁴ 10/12/05	<u>NA</u>	<u>NA</u>	<u>1</u>
Cumulative Total Count			31	34	22
Entiat Falls G.S.-Box Cyn.	33.5-29.2	⁵ 09/12/05	3	1	0
<i>Expanded</i> Area		⁶ 09/19/05	0	0	1
		⁷ 09/29/05	3	0	0
		⁸ 10/05/05	2	0	0
Cumulative Total Count			<u>8</u>	<u>1</u>	<u>1</u>
Mad River	3.5-1.5	09/09/05	3	3	0
<i>Expanded</i> Area		09/22/05	<u>0</u>	<u>0</u>	<u>0</u>
Cumulative Total Count			3	3	0
DCRB-FS	4.1-3.1	⁹ 09/09/05	0	0	1
Expanded Total			67	70	32
Total			148	112	53

¹ Two spring Chinook test redds, observed during 09/20 survey, were counted as completed redds during the 10/26 summer Chinook survey. ² One spring Chinook carcass recovered during the 10/11 summer Chinook spawning ground survey. ³ Two spring Chinook carcass recovered during the 10/12 summer Chinook spawning ground survey. ⁴ One spring Chinook carcass recovered during 10/12 summer Chinook spawning ground survey. ⁵ Three spring Chinook redds and one live adult were observed during the 09/12 bull trout spawning ground survey. ⁶ One spring Chinook carcass recovered. ⁷ Three spring Chinook redds were observed during the 09/29 bull trout spawning ground survey. ⁸ Two spring Chinook redds were observed during the 10/05 bull trout spawning ground survey. ⁹ One spring Chinook carcass recovered during 11/07 summer Chinook spawning ground survey.

Table 2. Age composition for spring Chinook carcasses recovered from the Entiat River in 2005.

Origin	Age	Male		Female		Total (N)	Total %
		(N)	%	(N)	%		
Hatchery	3/2	4	9	0	0	4	9
	4/2	6	14	11	26	16	40
	5/2	<u>1</u>	<u>2</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>2</u>
		11	24	11	26	22	51
Wild	3/2	1	2	0	0	1	2
	4/2	4	9	13	31	17	40
	5/2	<u>1</u>	<u>2</u>	<u>2</u>	<u>5</u>	<u>3</u>	<u>7</u>
		6	14	15	36	21	49
Total		17		26			100

Coded-Wire Tag Recoveries from Spring Chinook Salmon Carcasses

All 53 recovered carcasses from the Entiat River were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Twenty-one (42%) were identified as having a missing adipose fin, of which six had a coded-wire tag, 29 (58%) had an adipose fin present, of which three had CWT's and three could not be determined due to carcass decomposition (Table 3).

Table 3. Coded-wire tag recoveries from spring Chinook carcasses for the Entiat River in 2005.

Tag Code	Brood Year	Release Agency	Hatchery	Recovered	Sample Rate %	CWT %	Ad Clip %	Expanded Recoveries
050490	01	USFWS	Entiat NFH	1	14.9	49.2	100	14
050792	01	USFWS	Leav. NFH	1	14.9	53.8	100	12
051197	02	USFWS	Entiat NFH	1	14.9	43.5	100	15
054938	01	USFWS	Entiat NFH	3	14.9	54.1	100	37
631389	02	WDFW	Chiwawa RP	2	14.9	96.9	36	14
631448	01	WDFW	Chiwawa RP	1	14.9	98.6	0	7
Total				9				99

Summer Chinook Salmon Redd Counts

A total of **153** redds were counted in reaches 2 to 5, Jon Small site, Stanton-Love site, Dinkleman Canyon Road Bridge to Columbia River influence, and lower half mile of Mad River in 2005 (Table 4).

Summer Chinook Salmon Escapement

Assuming the total summer Chinook salmon redd count is 153, and using the 2.4 fish per redd ratio, an estimate of **367** summer Chinook salmon returned to spawn in the Entiat River. This estimated number should be considered a minimum since not all portions of the Mad and lower Entiat River were surveyed.

Summer Chinook Salmon Sex Ratio and Spawning Success

Two hundred-two summer Chinook salmon carcasses were recovered in 2005, of which 115 (57%) were females and 87 (43%) males. All 115 female carcasses were examined for spawning success. Of the 115 females, 73 (66%) successfully spawned, 37 (34%) were pre-spawn mortalities and five were not sampled due to carcass decomposition. There was a notable difference in spawning success between hatchery and wild females. Only 38% of the hatchery females spawned successfully compared to 89% of the wild females.

Table 4. Summer Chinook spawning ground surveys on the Entiat and Mad Rivers in 2005.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 2	25.8-23.4	10/11/05	1	0	0
		10/26/05	<u>0</u>	<u>0</u>	<u>2</u>
Cumulative Total Count			1	0	2
Reach 3	23.4-21.3	10/11/05	12	14	0
		10/26/05	<u>3</u>	<u>1</u>	<u>4</u>
Cumulative Total Count			15	15	4
Reach 4	21.3-18.7	10/12/05	1	10	1
		¹ 10/14/05	0	0	1
		10/24/05	<u>1</u>	<u>0</u>	<u>0</u>
Cumulative Total Count			2	10	2
Reach 5	18.7—16.2	10/12/05	73	104	7
		10/24/05	<u>6</u>	<u>5</u>	<u>40</u>
Cumulative Total Count			79	109	47
Mad River	0.2-0.0	10/14/05	1	2	0
Jon Small Site	5.5	² 10/17/05	7	0	0
Stanton-Love Site	5.2	³ 10/17/05	6	0	0
Dinkleman Cyn. Rd. Br. to Fire Station	4.1-3.1	10/13/05	8	36	1
		10/27/05	11	36	28
		11/07/05	<u>2</u>	<u>3</u>	<u>39</u>
Cumulative Total Count			21	75	68
Fire Station to Keystone USGS Station	3.1-1.5	10/13/05	0	50	0
		10/27/05	1	0	5
		11/07/05	<u>1</u>	<u>0</u>	<u>4</u>
Cumulative Total Count			2	50	9
Keystone USGS Station to Columbia R. Influence	1.5-0.3	10/13/05	7	16	0
		10/27/05	12	16	42
		11/07/05	<u>0</u>	<u>0</u>	<u>28</u>
Cumulative Total Count			19	32	70
Total			153	293	202

¹ Recovered one summer Chinook carcass while obtaining GPS points for spring Chinook redds. ² MCRFRO observed seven summer Chinook redds while conducting snorkel survey on 10/17. ³ MCRFRO observed six summer Chinook redds while conducting snorkel survey on 10/19.

Summer Chinook Salmon Age Composition and Origin

Of the 202 summer Chinook salmon carcasses recovered, age and origin were determined for 186. Age of the 186 fish was (5%) age-3, (45%) age-4, (42%) age-5, (7%) age-6 and (1%) age-7 (Table 5). Hatchery origin comprised 37% compared to wild origin of 63% (Table 5).

Coded-Wire Tag Recoveries from Summer Chinook Salmon Carcasses

All 202 recovered carcasses from the Entiat River were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Seventy (35%) were identified as having a missing adipose fin with 66 containing a coded-wire tag (Table 6).

Table 5. Age composition for summer Chinook carcasses recovered from Entiat River in 2005.

Origin	Age	Male			Female			Total (N)	Total %
		(N)	%	Reservoir Reared	(N)	%	Reservoir Reared		
Hatchery	3/2	2	1		0	0		2	1
	4/2	8	4		12	6		20	10
	5/2	7	4		31	17		38	21
	6/2	2	1		6	3		8	4
	7/2	<u>1</u>	<u>1</u>		<u>0</u>	<u>0</u>		<u>1</u>	<u>1</u>
		20	11		49	26		69	37
Wild	3/1	5	3		0	0		5	3
	3/2	1	1	1	0	0		1	1
	4/1	30	16		22	12		52	28
	4/2	10	5	9	4	2	4	14	7
	5/1	2	1		5	3		7	4
	5/2	13	7	12	19	10	17	32	17
	6/1	0	0		0	0		0	0
6/2	<u>2</u>	<u>1</u>	2	<u>4</u>	<u>2</u>	4	<u>6</u>	<u>3</u>	
		63	34		54	28		117	63
Total		83			103			186	100

Table 6. Coded-wire tag recoveries from summer Chinook carcasses from the Entiat River in 2005.

Tag Code	Brood Year	Release Agency	Hatchery	Recovered	Sample Rate %	CWT %	Ad Clip %	Expanded Recoveries
630274	00	WDFW	Turtle Rock SFH	2	55	99	100	4
630470	99	WDFW	Turtle Rock SFH	5	55	98	98	9
630475	99	WDFW	Dryden Pond	2	55	98	96	4
630781	00	WDFW	Turtle Rock SFH	8	55	99	100	15
630889	01	WDFW	Turtle Rock SFH	4	55	99	88	7
630891	01	WDFW	Turtle Rock SFH	10	55	98	88	18
630893	01	WDFW	Turtle Rock SFH	1	55	99	98	2
630995	00	WDFW	Wells SFH	6	55	98	98	11
630996	00	WDFW	Similkameen SFH	4	55	99	99	7
631151	98	WDFW	Dryden Pond	1	55	99	98	2
631271	00	WDFW	Dryden Pond	6	55	99	98	11
631272	00	WDFW	Dryden Pond	10	55	95	99	18
631587	01	WDFW	Dryden Pond	5	55	99	99	9
631980	01	WDFW	Dryden Pond	2	55	96	99	4
No Tags				4				
Total				70				121

Bull Trout, Sockeye and Coho Salmon

Surveyors identified, counted and recovered two live bull trout; 42 sockeye salmon redds, 144 live and 11 carcasses; 2 coho salmon redds, 1 live and 4 carcasses.

Coded-Wire Tag Recoveries from Sockeye and Coho Salmon Carcasses

All sockeye and coho salmon carcasses were checked for missing adipose fins and scanned with a portable handheld wand detector for coded-wire tags. Of the 11 recovered sockeye carcasses, one was adipose clipped and coded-wire tagged (Table 7). All four coho carcasses were adipose present and coded-wire tagged (Table 7).

Table 7. Coded-wire tag recoveries from sockeye and coho carcasses from the Entiat River in 2005.

Species	Tag code	Brood Yr.	Release Agency	Hatchery	Recovered
Sockeye	631866	02	WDFW	Lk. Wenatchee Net Pens	1
Coho	050269	02	USFWS	Winthrop NFH	1
Coho	051180	02	USFWS	Winthrop NFH	1
Coho	051481	02	USFWS	Winthrop NFH	2

SUMMARY

The total number of redds counted during the spring Chinook spawning ground surveys was 148, which included 81 redds in the old index area and 61 redds found in the expanded section. The index count of 81 redds is the second largest since 1994, with a high of 144 redds in 2001 and a low of one in 1995. The total redd count of 148 is the second highest since 1994, with a high of 202 redds in 2001 and a low of 13 in 1995 (Figure 2). Using the 2.4 fish per redd ratio and the total redd count of 148, an estimate of 355 spring Chinook salmon returned to spawn in the Entiat River. The 53 recovered carcasses had a sex ratio of 58% female and 42% male and female spawning success was 100%. Age composition was (11%) age-3, (80%) age-4 and (9%) age-5. Hatchery origin comprised 51%, compared to wild origin of 49%. Nine of the 53 carcasses had CWT's; five were from Entiat NFH, one from Leavenworth NFH, and three from Chiwawa Rearing Ponds.

The number of redds counted during the summer Chinook spawning ground surveys was 153. The total redd count of 153 is the fourth highest since 1994, with a high of 309 redds in 2003 and a low of 15 in 1994 (Figure 2). Summer Chinook surveys have expanded over the years which could account for more redds being counted since 1994. Assuming the total summer Chinook salmon redd count is 153, and using the 2.4 fish per redd ratio, an estimated 367 summer Chinook salmon returned to spawn in the Entiat River. The 202 recovered carcasses had a sex ratio of 57% females and 43% males. All 115 of the female carcasses recovered were examined for spawning success; 73 (66%) successfully spawned, 37 (34%) were pre-spawn mortalities and five were not sampled due to carcass decomposition. There was a notable difference in spawning success between hatchery and wild females. Only 38% of the hatchery females spawned successfully compared to 89% of the wild females. Age composition was (5%) age-3, (45%) age-4, (42%) age-5, (7%) age-6 and (1%) age-7. Hatchery origin comprised 37% compared to wild origin of 63%. Scale analysis revealed summer Chinook had three distinctive freshwater life histories; 3% were resident yearling migrants, 42% were reservoir reared yearling migrants and 55% were sub-yearlings migrants. Sixty-six coded-wire tags were recovered; 30 were from Turtle Rock SFH, 26 from Dryden Pond, six from Wells SFH, and four from Similkameen SFH.

During the spring and summer Chinook spawning ground surveys, one live bull trout; 42 sockeye salmon redds, 144 live and 11 carcasses; two coho salmon redds, one live and four carcasses were identified, counted and recovered. Of the 11 recovered sockeye carcasses, one was coded-wire tagged which was released from the Lake Wenatchee net pens. All four of the coho carcasses were adipose present and coded-wire tagged, which were released from Winthrop NFH.

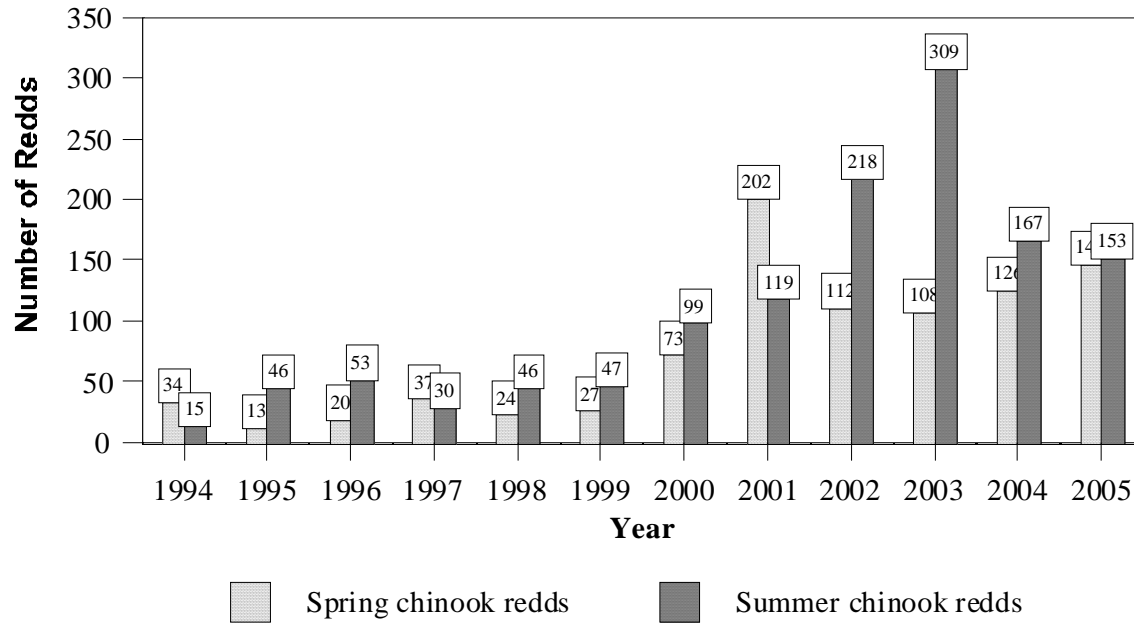


Figure 2. Spring and summer Chinook salmon redd counts for the Entiat River, 1994 to 2005.

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APPENDIX 1

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 1994-2005 (USFWS).

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

N/A= not available

APPENDIX 2

River mile index of the Entiat River from the mouth to Entiat Falls.

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
28.0	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

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