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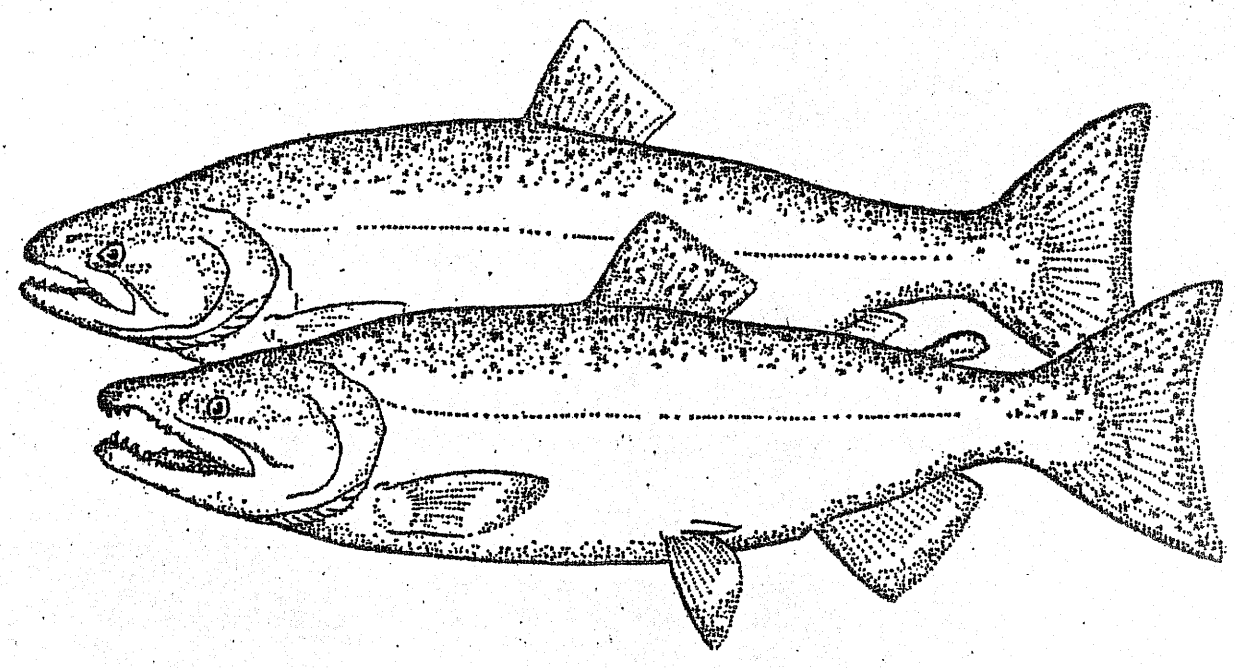
SPRING AND SUMMER CHINOOK SALMON SPAWNING GROUND SURVEYS ON THE ENTIAT RIVER, 2001



Fish and Wildlife Service
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Spring and Summer Chinook Salmon Spawning Ground Surveys on the Entiat River, 2001

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INTRODUCTION

From 1962 to 1994, spring chinook salmon (SCS), *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, the Chelan County Public Utility District (PUD) monitored summer chinook salmon (SUS) spawning in the lower ten miles (RM 0 to 10.4) of the Entiat River. While informative, these monitoring efforts were later believed to be either deficient in scope (area surveyed) and/or methodology. In 1994, in recognition of the need to improve the spawning survey efforts, the U.S. Fish and Wildlife Service's (USFWS) Mid-Columbia River Fishery Resource Office (MCRFRO) began a program of monitoring SCS and SUS spawning more intensely on the Entiat River. Efforts in 2001 mark the eighth year that MCRFRO has conducted the expanded SCS and SUS spawning surveys.

The objectives of the MCRFRO spawning surveys are to: (1) Continue to assess the distribution of SCS and SUS spawning throughout the index and expanded area of the Entiat & Mad Rivers and provide accurate estimates of the respective spawning populations, (2) Analyze population trend data for SCS and SUS in the Entiat River, (3) Evaluate possible straying of hatchery SCS and SUS, and (4) Search for and note presence and/or redds of other salmonid species, which may include sockeye salmon (SOS) *O. nerka*, coho salmon (COS) *O. kisutch*, 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/second (Mullan et al. 1992) and major tributaries are the North Fork (RM 34) and Mad River (RM 10.5). The upstream limit of anadromy is Entiat Falls (RM 33.8) (Figure 1).

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 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 approximately 484 RM's and eight mainstem hydroelectric dams above the Pacific Ocean.

Spring chinook salmon spawning ground surveys were conducted between Lake Creek Campground (C.G.) and McKenzie Diversion Dam (RM 28.9 to 16.2), and Mad River (RM 5.2 to 1.5) (Figure 1). SUS surveys focused on Reaches 2 through 5 (RM 25.8 to 16.2), between Dinkleman Canyon Road restoration site and Fire Station restoration site (RM 4.3 to 3.0) and Keystone Bridge to Columbia River influence (RM 1.5 to 0.3) (Figure 1).

SALMON AND BULL TROUT POPULATIONS

The Entiat River has historically supported excellent salmon runs consisting of chinook (probably SCS) and COS (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 SUS and fall chinook salmon (FCS), 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 SCS 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 SCS that were offspring of the upriver stocks collected at Rock Island Dam (Mullan 1987). No SCS were released from Entiat NFH from 1945 to 1975. As early as 1956 and 1957, a wild SCS run was observed spawning in the area above Stormy Creek (RM 18.4) (French and Wahle 1960). Since 1962, SCS redds have been counted in an *index* area between RM 28 and 21 where an established SCS run has been documented. Entiat NFH resumed SCS 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 broodstock in 1980 and from 1983 to 2001.

Summer Chinook Salmon

Although SUS are not believed to be endemic to the Entiat River (Craig and Suomela 1941), several efforts were made to establish SUS in the Entiat River following completion of Grand Coulee Dam. In 1939 and 1940, a total of 3,015 adult SUS, 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 SUS 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 RM's 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 just under five per year.

Bull Trout, Sockeye Salmon and Coho Salmon

Bull trout presence/absence data is limited to surveys conducted in 1984 and 1987 (WDFW 1997). Since 1994 the Mid-Columbia River FRO searched for bull trout and/or redds, during the SCS snd SUS spawning ground surveys. Between 1994 and 2000, nine redds and two adult bull

trout have been identified. Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941) and have only been stocked on two occasions, in 1943 and 1944, from Lake Quinault and Lake Whatcom stocks (Mullan 1986). A small run of SOS became established in the Entiat River and the Entiat NFH collected SOS from 1944 to 1963 for planting elsewhere (Mullan 1986). Spawning groung surveys conducted annually on the Entiat River observed SOS from 1945 to1955, with incidental counts of 75-150 between 1969 and 1981 (Mullan 1986), twelve SOS were counted during SCS and SUS surveys between 1994 to 2000 (USFWS 1997, 1998, 2000). In an effort to re-introduce COS to upper Columbia tributaries, the Yakama Nation has initiated a juvenile release program in the Wenatchee and Methow River basins. Although no coho releases have occurred in the Entiat basin, substantial "straying" of returning adults was documented here and elsewhere in the Upper Columbia region in 2001. While COS are not the focus of the survey, incidental sightings were recorded.

METHODS

Spring Chinook Salmon

Methods for surveying SCS consisted of dividing the survey area into several reaches. Single surveys of each reach were conducted twice, one in early September and again the third week of September. Each reach was surveyed walking downstream, enumerating and marking only well established redds, recording numbers of live fish and sampling any recovered carcasses. Carcasses were measured to the nearest centimeter (fork length), tails were removed to prevent recounting, gender was identified, females were dissected to visually determine spawning success, and scale samples were taken when possible. Scales were viewed using a microfiche reader and age and origin (wild or hatchery) determined. Snouts were removed from marked hatchery fish for later retrieval and de-coding of coded-wire tags (CWT). All redd locations were marked with colored survey flagging on nearby vegetation to distinguish them from summer chinook redds in subsequent surveys and GPS points were recorded. Landowners were contacted by mail to notify them of the spring and summer chinook salmon spawning surveys and to seek permission to access their property as surveyors walked downstream.

Spring chinook salmon spawning ground surveys were conducted from Lake Creek C.G. to McKenzie Diversion Dam (RM 28.9 to 16.2) from September 4 - 10, 2001 and from Fox Creek C.G. to McKenzie Diversion Dam (RM 28.1 to 16.2) September 13 - 24, 2001. Mad River was surveyed on September 4, from Pine Flats C.G. to just below Mad River road bridge (RM 3.5 to 1.5) and September 19, from just above Hornet Creek to just below Mad River road bridge (RM 5.2 to 1.5).

The number of SCS spawning in the Entiat River was estimated by expanding redd counts using the estimator of 2.4 chinook salmon adults per redd. This estimator is widely used and generally accepted in the mid-Columbia basin and under the assumption that all redds were counted.

Summer Chinook Salmon

Methods were the same as for SCS surveys with a few differences in area surveyed, and timing. Surveys were conducted from Reach 2 through Reach 5 (RM 25.8 to 16.2) from October 10 - 12, October 22 - 26, and November 6, 2001. Lower river surveys were conducted at Dinkleman

Canyon Road restoration site (RM 4.3 - 4.1), Fire Station restoration site (3.2 to 3.0), between restoration sites (RM 4.1 - 3.2) and Keystone Bridge to the Columbia River influence (RM 1.5 to 0.3) October 26 and 29 and a second time November 7 - 13, 2001. No surveys were conducted in the Mad River. The number of SUS that spawned was estimated by expanding redd counts using the estimator of 2.4 chinook salmon per redd.

Bull Trout, Sockeye Salmon and Coho Salmon

Bull trout and/or redds were searched for during SCS and SUS surveys. Bull trout redds are generally smaller in size and utilize smaller substrate than SCS and SUS redds. Sockeye and coho salmon redds were identified during the SCS and SUS surveys through observation of fish on occupied redds.

RESULTS

Spring Chinook Salmon

One hundred forty-four spring chinook salmon redds were counted in the *index* area (RM 28.1 to 21.3). An additional 58 redds were found in the expanded survey area (RM 28.9 to 28.1 and 21.3 to16.2), including one redd found in the Mad River. The complete survey identified a total of 202 redds (Table 1). Annual redd counts from *index* area surveys are found in Table 2.

The total redd count of 202 included all or most of the SCS spawning in the Entiat River since SCS are not known to spawn in the lower river. However, some spawning gravel exists in those areas not surveyed (RM 16.2 to 0.3), and it is possible that some spawning occurred in the lower river. Assuming all redds were counted, the total redd count of 202 multiplied by 2.4 fish per redd gives an estimate of **485** adults escaping to spawn in the Entiat River. The peak spawning appears to have occurred around the first week in September.

Spring Chinook Redd Counts

Reach 1 RM 28.1 - 25.8 (*Index* Area)

Twenty-six redds were counted in Reach 1. Surveys were conducted on September 10 and 24, 2001 (Table 1). Reach 1 accounted for 18.1 % of the *index* area count and 12.9 % of the total redds found in the Entiat River.

Reach 2 RM 25.8 - 23.4 (*Index* Area)

Seventy-eight redds were counted in Reach 2. Surveys were conducted on September 7 and 13, 2001 (Table 1). Reach 2 accounted for 54.2 % of the *index* area count and 38.6 % of the total redds found in the Entiat River.

Reach 3 RM 23.4 - 21.3 (*Index* Area)

Forty redds were counted in Reach 3. Surveys were conducted on September 6 and 14, 2001 (Table 1). Reach 3 accounted for 27.8 % of the *index* area count and 19.8 % of the total redds found in the Entiat River

Above Reach 1 RM 28.9 - 28.1 (*Expanded* Area)
One redd was counted in the section above Reach 1. This survey was conducted on September 10, 2001 (Table 1) . This area accounted for 0.5 % of the total redds found in the Entiat River.

Table 1. Spring chinook spawning ground surveys on the Entiat and Mad rivers, 2001.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.0- 25.8	09/10/01	23	3	18
Index Area		09/24/01	3	0	2
	Cumulative Total Count		26	3	20
Reach 2	25.8 - 23.4	09/07/01	73	67	47
Index Area		09/13/01	5	12	16
	Cumulative Total Count		78	79	63
Reach 3	23.4 - 21.3	09/06/01	36	33	16
Index Area		09/14/01	4	4	16
	Cumulative Total Count		40	37	32
	Index Total		**144**	**119**	**115**
Lake Creek C.G.	28.9 - 28.0	09/10/01	1	0	0
Expanded Area	Cumulative Total Count		1	0	0
Reach 4	21.3 - 18.7	09/04/01	19	16	6
Expanded Area		09/17/01	9	6	7
		10/11/01	1	0	0
	Cumulative Total Count		29	22	13
Reach 5	18.7 - 16.2	09/04/01	13	20	6
Expanded Area		09/17/01	14	10	9
	Cumulative Total Count		27	30	15
Mad River	3.5 - 1.5	09/04/01	0	0	1
	5.2 - 1.5	09/19/01	1	0	1
	Cumulative Total Count		1	0	2
	Expanded & Mad River Total		**58**	**52**	**30**
		TOTAL	**202**	**171**	**145**

Table 2. Entiat River spring chinook salmon redd counts from annual surveys in the *index* area, Fox Creek Campground to Dill Creek (RM 28 to 21), 1962-1994 (WDFW) and 1995-2001 (USFWS).

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

N/A= not available

Reach 4 RM 21.3 - 18.7 (*Expanded* Area)
Twenty-nine redds were counted in Reach 4. Surveys were conducted on September 4 and 17, 2001 (Table 1). Reach 4 accounted for 14.4 % of the total redds found in the Entiat River.

Reach 5 RM 18.7 - 16.2 (*Expanded* Area)
Twenty-seven redds were counted in Reach 5. Surveys were conducted on September 4 and 17, 2001 (Table 1). Reach 5 accounted for 13.4 % of the total redds found in the Entiat River.

Mad River RM 5.2 - 1.5
One redd was counted in Mad River surveys conducted on September 4 and 19, 2001 (Table 1). The September 4 survey didn't include area RM 5.2 - 3.5. Mad River accounted for 0.5 % of the total redds counted in the Entiat River.

Spring Chinook Carcass and Age Composition
One hundred forty-five spring chinook salmon carcasses were recovered from the Entiat River, of which 128 were bio-sampled. Of the 128 sampled carcasses, 73 (57 %) were females and 55 (43 %) were males. Through scale analysis and coded wire tags (CWT), it was determined that 74 (58 %) were wild, 32 (25 %) hatchery and 22 (17 %) were not identifiable (Table 3). All seventy-three female carcasses were examined for spawning success. Sixty-three (86 %) were

Table 3. Spring chinook age composition from Entiat River carcass recoveries, 2001.

Origin	Age	Male	Female	Total
Hatchery	3/2	0	0	0
	4/2	10	21	31
	5/2	1	0	1
		11	21	32
Wild	3/2	0	0	0
	4/2	24	35	59
	5/2	5	10	15
		29	45	74
Unknown		15	7	22
Total		55	73	128

completely spent, 2 (3 %) did not spawn and success could not be determined with 8 (11%) due to decomposition. One hundred DNA samples were also collected from the 128 bio-sampled carcasses.

From the 128 bio-sampled SCS carcasses in 2001, there were no age 3/2 wild or hatchery, 59 age 4/2 wild, 31 age 4/2 hatchery, 15 age 5/2 wild, 1 age 5/2 hatchery and 22 not identifiable (Table 3).

Spring Chinook Coded-Wire Tag Recoveries

Fifteen (8 males and 7 females) of the 145 carcasses recovered from the Entiat River had missing adipose fins. Their origins were as follow: Entiat NFH 6 (40 %), Winthrop NFH 5 (33 %), Methow SFH 1 (7 %), Chiwawa Rearing Ponds 1 (7 %) and 2 (13 %) had no tags (Table 4).

Table 4. Entiat River coded-wire tag recoveries from spring chinook carcasses, 2001.

Tag Code	Recovered #	Hatchery
050531	4	Entiat NFH
053913	2	Entiat NFH
054526	3	Winthrop NFH
054907	1	WinthropNFH
054948	1	Winthrop NFH
630613	1	Methow SFH
630740	1	Chiwawa R.P.
No Tag	2	
TOTAL	15	

Summer Chinook Salmon

A total of 119 redds were identified in 2001 (Table 5). The first SUS redd was discovered October 11, 2001, with peak spawning occurring the third week of October. Multiplying the 119 redds by 2.4 fish per redd yields an estimate of **286** SUS adults escaping to spawn in Entiat River. This estimate should be considered a minimum since not all portions of the lower river were surveyed.

Summer Chinook Redd Counts

Reach 2 RM 25.8 - 23.4

No redds were identified in 2001. Surveys were conducted on October 10 and 22, 2001 (Table 5).

Reach 3 RM 23.4 - 21.3

No redds were identified in 2001. Surveys were conducted on October 10 and 22, 2001 (Table 5).

Reach 4 RM 21.3 - 18.7

Three redds were counted in Reach 4. Surveys were conducted on October 11 and 24, 2001 (Table 5). Reach 4 accounted for 2.5 % of the total redds found in the Entiat River.

Reach 5 RM 18.7 - 16.2

Twenty-three redds were counted in Reach 5. Surveys were conducted on October 12, 26 and November 6, 2001 (Table 5). Reach 5 accounted for 19.3 % of the total redds found in the Entiat River.

Dinkleman Canyon Road Restoration Site RM 4.3 - 4.1

Seventeen redds were counted at Dinkleman Canyon Road restoration site. Surveys were conducted on October 29 and November 8, 2001 (Table 5). This site accounted for 14.3 % of the total redds found in the Entiat River.

Fire Station Restoration Site RM 3.2 - 3.0

Thirty-one redds were counted at Fire Station restoration site. Surveys were conducted on October 29 and November 8, 2001 (Table 5). This site accounted for 26.1 % of the total redds found in the Entiat River.

Dinkleman Canyon Road to Fire Station RM 4.1 - 3.2

Seven redds were counted from Dinkleman Canyon Road restoration site to Fire Station restoration site in a survey conducted on November 13, 2001 (Table 5). . This section accounted for 5.9 % of the total redds found in the Entiat River.

Keystone Bridge to Columbia River influence RM 1.5 - 0.3

Thirty-eight redds were counted from Keystone Bridge to the Columbia River influence during surveys conducted on October 26 and November 7 and 8, 2001 (Table 5). This section accounted for 32.0 % of the total redds counted in the Entiat River.

Table 5. Summer chinook spawning ground surveys on the Entiat River, 2001.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 2	25.8 - 23.4	10/10/01	0	0	0
		10/22/01	0	0	0
		Cumulative Total Count	0	0	0
Reach 3	23.4 - 21.3	10/11/01	0	0	0
		10/24/01	0	0	0
		Cumulative Total Count	0	0	0
Reach 4	21.3 - 18.7	10/11/01	3	3	0
		10/24/01	0	1	0
		Cumulative Total Count	3	4	0
Reach 5	18.7 - 16.2	10/12/01	15	26	3
		10/26/01	8	21	6
		11/06/01	0	1	10
		Cumulative Total Count	23	48	19
Dinkleman Cyn Rd	4.3 - 4.1	10/29/01	13	61	0
Restoration Site		11/08/01	4	13	7
		Cumulative Total Count	17	74	7
Fire Station	3.2 - 3.0	10/29/01	27	52	10
Restoration Site		11/08/01	4	10	19
		Cumulative Total Count	31	62	29
Dinkleman Cyn Rd	4.1 - 3.2	11/13/01	7	3	75
to Fire Station		Cumulative Total Count	7	3	75
Keystone Bridge to	1.5 - 0.3	09/19/01	0	0	0
Columbia R. influence		10/26/01	28	104	13
		11/07/01	10	30	20
		1/08/01	0	0	24
		Cumulative Total Count	38	134	57
		TOTAL	**119**	**325**	**187**

Summer Chinook Carcass and Age Composition

One hundred eighty-seven summer chinook carcasses were recovered from the Entiat River, of which 182 were bio-sampled. Of the 182 sampled carcasses, 102 (56 %) were females and 80 (44 %) males. Through scale analysis and CWTs, it was determined that 51 (28 %) were wild, 107 (58.8 %) were hatchery and 24 (13.2 %) were not identifiable (Table 6). All 102 female carcasses were examined for spawning success. Thirty-five (34.3 %) were completely spent, 35 (34.3 %) did not spawn, 29 (28.4 %) had varying degrees of success and 3 (2.9 %) were not sampled due to carcass decomposition.

From the 102 summer chinook carcasses bio-sampled in 2001, there were 3 age 3/2 wild, 3 age 3/2 hatchery, 26 age 4/2 wild, 69 age 4/2 hatchery, 22 age 5/2 wild, 31 age 5/2 hatchery, 4 age 6/2 hatchery and 24 not identifiable (Table 6).

Summer Chinook Coded-Wire Tag Recoveries

One hundred eleven (39 males and 72 females) of the 187 carcasses recovered from the Entiat River had missing adipose fins. Their origins were as follow: Turtle Rock SFH 59 (53.2 %), East Bank SFH 25 (22.5 %), Wells SFH 17 (15.3 %), ODFW 1 (0.9 %), no tags 7 (6.3 %) and 2 (1.8 %) were lost before decoding (Table 7).

Table 6. Summer chinook age composition from Entiat River carcass recoveries, 2001.

Origin	Age	Male	Female	Total
Hatchery	3/2	3	0	3
	4/2	29	40	69
	5/2	6	25	31
	6/2	1	3	4
		39	68	107
Wild	3/2	3	0	3
	4/2	18	8	26
	5/2	8	14	22
		29	22	51
Unknown		12	12	24
Total		80	102	182

Table 7. Entiat River coded-wire tag recoveries from summer chinook carcasses, 2001.

Tag Code	# Recovered	Hatchery
630124	24	Turtle Rock SFH
631032	2	Turtle Rock SFH
630139	3	East Bank SFH
634607	2	Turtle Rock SFH
630145	1	East Bank SFH
636049	2	East Bank SFH
630602	4	Wells SFH
636324	1	Turtle Rock SFH
630606	30	Turtle Rock SFH
092455	1	CEDC/ ODFW
630611	13	Wells SFH
630612	19	East Bank SFH
No Tag	7	
Lost Tag	2	
TOTAL	111	

Bull Trout, Sockeye Salmon and Coho Salmon

Surveys in 2001 identified one bull trout redd, (three adults and one carcass) and ten SOS redds, (twenty-one adults). Also, 12 COS redds, (three adults and three carcasses) were observed between Dinkleman Canyon and Fire Station restoration sites during the October 11, 2001 SUS spawning ground survey. Previous surveys had not discovered any COS in the Entiat River drainage.

DISCUSSION

In 2001, 144 SCS redds were counted in the *index* area, the highest number since 1978 and 24 % well above the 1962 - 2000 average of 110 (Table 2). Since 1987, *index* area redd counts have been depressed, averaging 38 redds for years 1987 - 2000, and 17 redds per year since 1994 (Figure 2). Spring chinook salmon counts at Rocky Reach and Wells dams increased in 2001 (Table 8). Counts at Rocky Reach Dam were the highest since 1962 and approximately 5 times greater than the previous 17 years (1984 - 2000) average of 3,099. Counts at Wells Dam were approximately 6 times greater than the same year average of 1,772. Potential adult SCS escapement (after deducting hatchery returns) between the two dams is estimated at 1,751 (Table 9), compared to the number generated by redd expansions of 485. Both methods of estimating the wild salmon spawning population have inherent assumptions that influence their results. Dam counts suffer from possible multiple counts due to fall back and failure to account for pre-spawning mortality. The date for separating the chinook run into spring and summer components is founded on historical dam counts. It does not allow for overlap of run timing between stocks nor annual variability in run timing for each stock. On the other hand, the accuracy of redd counts can be influenced by salmon spawning outside of the survey area, observer error, and/or the use of an incorrect expansion factor to estimate the number of spawners from redd counts. Given the inherent problems with each estimation method, we believe that the expanded redd counts provide a better monitoring tool, compared to dam counts, for determining trends in the Entiat River. We do not believe that the actual number of spring chinook spawning in the Entiat River differs significantly from our estimate of 485 fish.

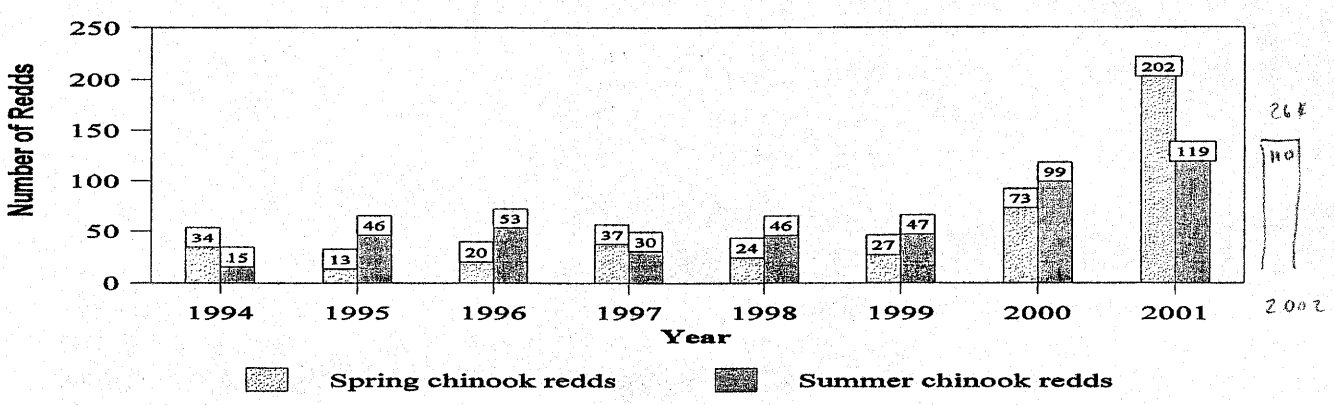

Figure 2. Total spring chinook and summer chinook salmon redds - Entiat River, 1994 to 2001.

In 2001, 119 SUS redds were counted in the Entiat River (Figure 2). The counts at Rocky Reach Dam of 47,699 SUS greatly exceeded the 17 year average (1984 - 2000) of 6,705 (Table 8). The difference in counts (after subtracting hatchery brood takes, spawners, and sport catch) between Rocky Reach and Wells dams was 6,724 fish (Table 9). The estimate from the Entiat River redd expansion of 2.4 fish per redd equals 286 summer chinook. Some additional redds may have been located between (RM 4.3 and 16.2), an area not surveyed, although suitable spawning gravel is lacking in these areas. Problems with accurate redd counts in the mainstem Columbia

River below Wells Dam, over-lapping of run timing between stocks, possible multiple counts due to fall back at dams and failure to account for pre-spawning mortality cause us to prefer using redd counts to better quantify the number of SUS actually spawning in the Entiat River.

Table 8. Historical fish counts of spring and summer chinook and sockeye salmon at Rocky Reach Dam, 1962-2001, and Wells Dam, 1967-2001.

	Spring Chinook		Summer Chinook		Sockeye Salmon	
Year	Rocky Reach	Wells	Rocky Reach	Wells	Rocky Reach	Wells
1962	3,697		9,295		9,870	
1963	4,644		5,776		37,046	
1964	6,536		10,752		32,159	
1965	2,755		15,975		31,735	
1966	6,962		19,445		129,557	
1967	5,560	1,157	15,558	12,504	109,434	113,232
1968	6,422	4,931	14,721	8,922	91,376	81,530
1969	4,400	3,599	12,996	6,846	20,374	17,352
1970	4,375	2,670	11,822	8,003	57,251	50,677
1971	4,132	3,168	10,031	5,988	49,838	48,172
1972	3,894	3,616	5,577	4,141	26,978	33,398
1973	4,344	2,937	9,683	5,052	48,856	37,178
1974	4,263	3,420	8,274	4,567	20,976	16,716
1975	3,353	2,225	15,367	8,522	26,925	22,286
1976	1,892	2,759	7,771	7,901	27,205	27,619
1977	5,948	4,211	10,593	7,527	25,648	21,973
1978	7,396	3,625	8,095	6,419	8,157	7,458
1979	2,203	1,103	8,577	10,080	28,747	22,655
1980	1,866	1,182	5,367	4,892	29,906	26,573
1981	3,529	1,935	4,668	4,276	30,649	28,234
1982	2,815	2,401	2,705	3,349	17,379	19,005
1983	3,406	2,869	2,777	2,821	26,069	27,925
1984	4,171	3,280	5,875	5,941	73,290	81,054
1985	8,910	5,257	5,937	4,456	54,077	53,170
1986	4,300	3,150	5,554	4,178	32,912	34,876
1987	3,586	2,344	4,078	3,142	41,115	39,948
1988	4,959	3,036	3,683	2,775	34,090	33,980
1989	3,316	1,740	5,654	3,333	16,176	15,895
1990	1,951	981	4,297	3,354	9,296	7,597
1991	1,401	779	3,158	2,028	27,439	27,492
1992	2,774	1,623	2,257	1,967	41,804	41,844
1993	4,256	2,444	4,980	3,603	28,318	23,038
1994	388	257	7,293	4,891	1,680	1,662
1995	290	103	5,638	5,043	4,985	4,892
1996	628	387	5,737	4,479	21,741	17,701
1997	2,014	971	6,750	3,902	30,485	25,304
1998	867	531	8,524	4,108	5,653	4,669
1999	1,688	649	14,752	9,033	14,118	12,388
2000	7,177	2,600	19,825	10,156	57,428	59,944
2001	15,574	11,157	47,699	38,126	66,222	74,490

Table 9. Estimated escapement in 2001 of wild spring and summer chinook between Rocky Reach and Wells dams using the difference between historical dam counts reduced by the number of salmon taken at state and federal fish hatcheries (includes jacks).

Count	Spring chinook	Summer chinook
Rocky Reach Dam	15,574❶	47,699❶
Wells Dam	11,157❷	38,126❷
Difference	4,417	9,573
Entiat NFH-# Fish Taken	2,666	0
Methow SFH # Fish Transferred	0	0
Wells SFH-# Fish Taken	0	1,338❸
Removed from Wells Dam fish ladder	0	556❸
Chelan River Spawners Estimate	0	576❸
Columbia River Spawners Estimate	0	206❹
Columbia River Sport Harvest Estimate	0	173❸❺
Potential Entiat R. natural spawners	1,751	6,724

❶ Mosey and Murphy, 2002
❷ Rick Klinge, pers comm. 2002.
❸Charlie Snow, pers comm. 2002
❹Andrew Murdoch, pers comm. 2002 (two hundred and forty redds observed multiplied by 2.4 fish/redd = 576 estimated Chelan River spawners) and (eighty-six redds multiplied by 2.4 fish/redd = 206 estimated Columbia River spawners below Wells Dam). This estimate is believed to be a several times lower than actual numbers.
❺Heather Bartlett, pers comm. 2002 (estimated 84 fish caught through creel surveys)
❸Charlie Snow, pers comm. 2002 (89 volunteer snouts at Wells Dam launching ramp = 173)

Summer chinook salmon surveys conducted in 2001 revealed a dramatic change in redd location with 78 % of spawning occurring below river mile 16.2. Surveys conducted between 1994 and 2000 observed that over 80 % of the redds were counted above river mile 16.2 (Figure 3). This change in spawning location could have been the result of: 1) Returning SUS encountered difficulty ascending above the lower river section due to extremely low stream flows; 2) Three recently installed vortex rock weirs at river miles 4.1 and 3.1 provided new holding opportunities and spawning areas for fish and; 3) Through analysis of scales and CWT's, 68% of the recovered SUS carcasses were believed to be out of basin hatchery strays, not destined for up-river spawning.

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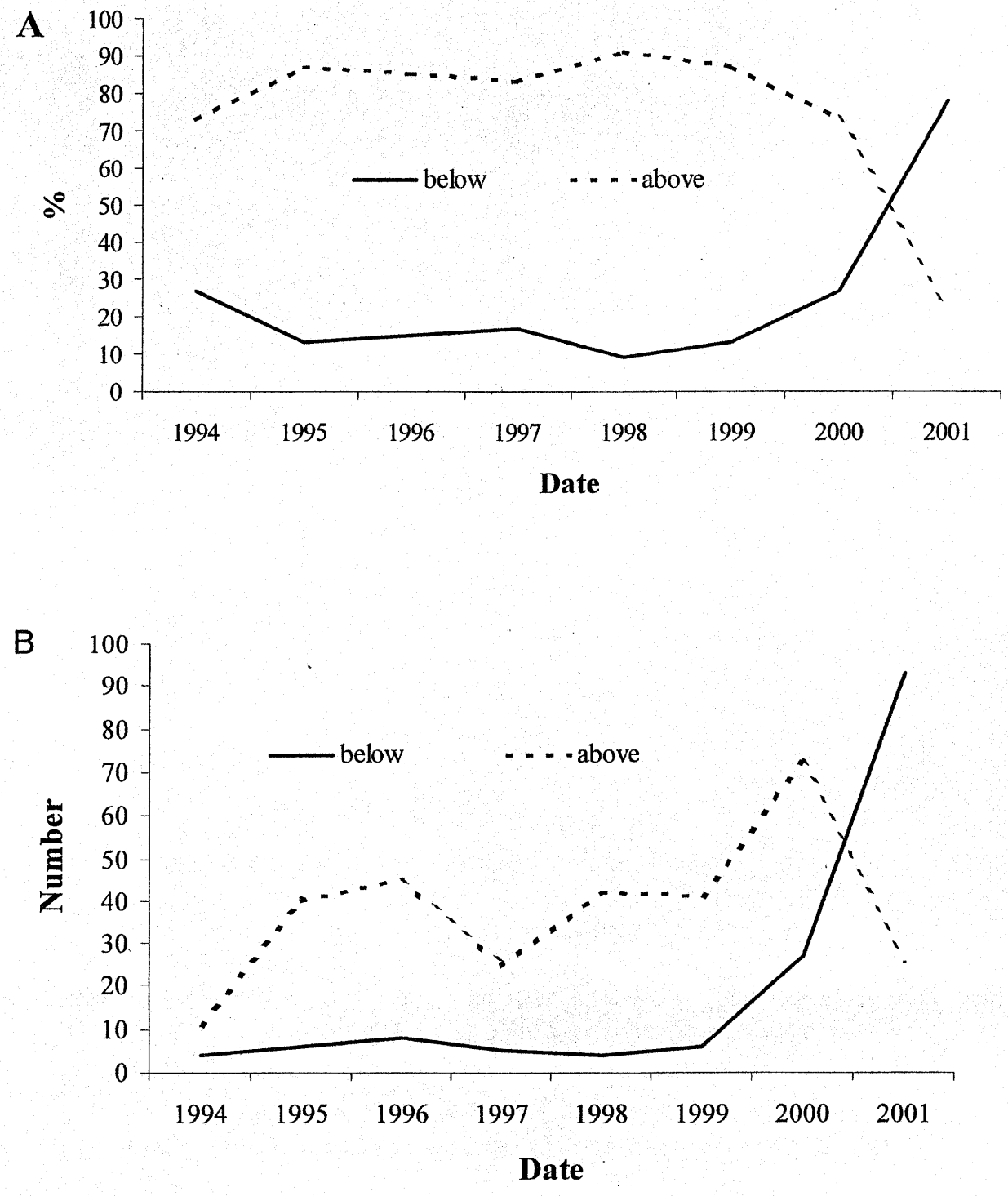

Figure 3. Percent(A) and number(B) of summer chinook redds above and below river mile 16.2 between 1994 and 2001.

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APPENDIX

Appendix A

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

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
10.5	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