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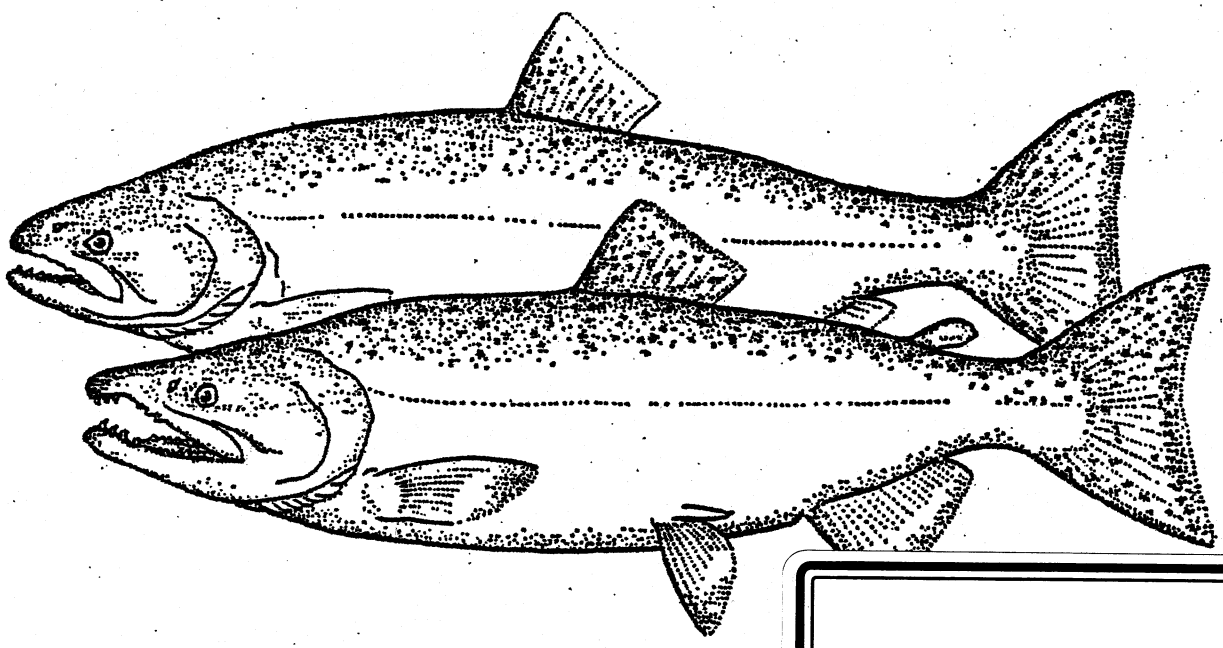
SPRING AND SUMMER CHINOOK SALMON SPAWNING GROUND SURVEYS ON THE ENTIAT RIVER, 2002



Fish and Wildlife Service
U.S. Department of the Interior

Spring and Summer Chinook Salmon Spawning Ground Surveys on the Entiat River, 2002

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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 2002 mark the ninth 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 per 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).

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 Fox Creek Campground (C.G.) and McKenzie Diversion Dam (RM 28.1 to 16.2), and Mad River (RM 5.2 to 1.5) (Figure 1). Summer chinook salmon surveys focused on Reaches 1 through 5 (RM 28.1 to 16.2), between Dinkleman Canyon Road and Fire Station (RM 4.1 to 3.1), Fire Station to Keystone Bridge (3.1 to 1.5) and Keystone Bridge to Columbia River influence (RM 1.5 to 0.3) (Figure 1).

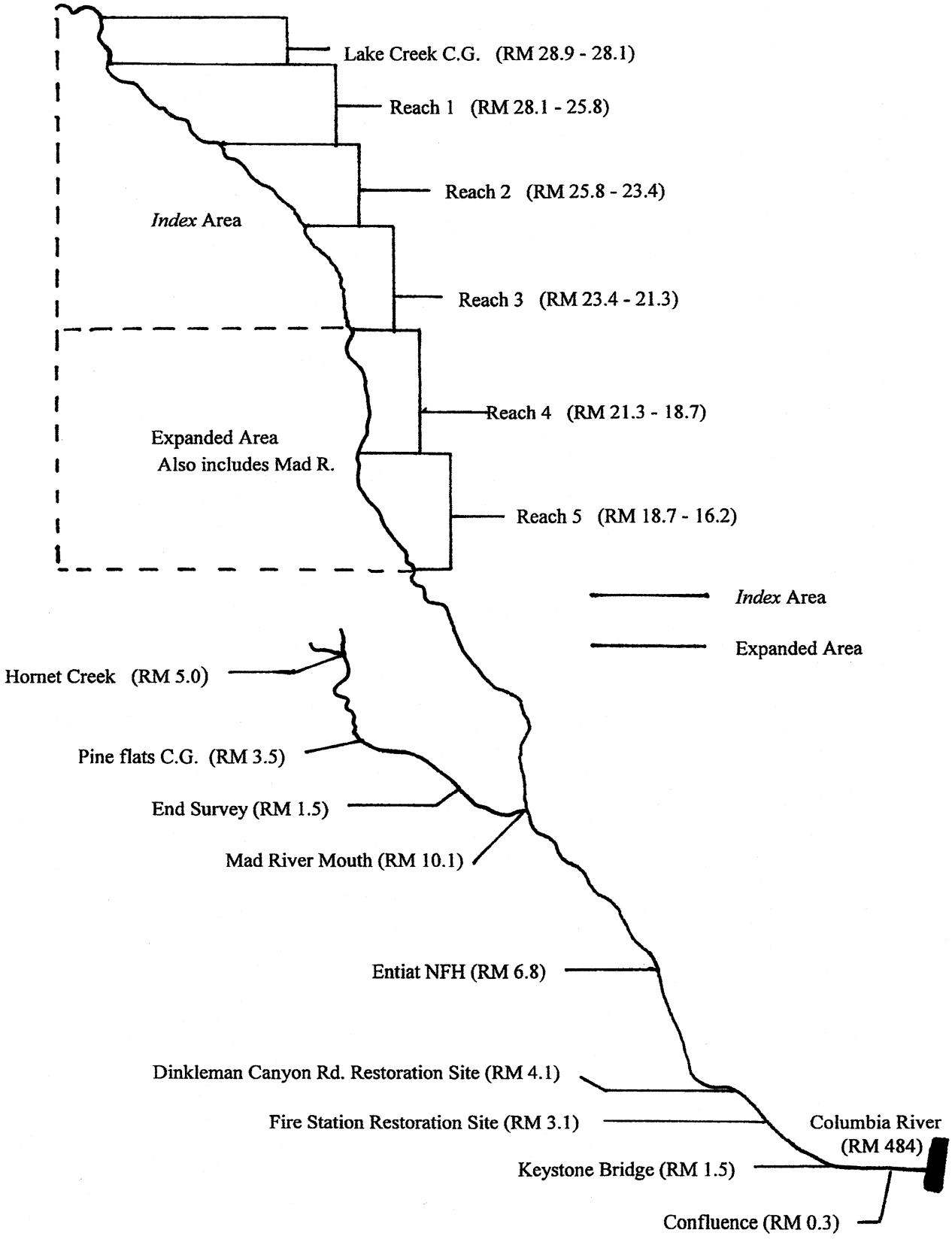


Figure 1. Overview of the Entiat River spawning ground survey areas.

SALMON AND BULL TROUT POPULATIONS

The Entiat River has historically supported excellent salmon runs consisting of chinook (probably 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 2002.

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 2002, nine redds and three 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 ground 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, an incidental sighting was recorded in 2002.

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 carcasses with missing adipose fins 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 Fox Creek C.G. to McKenzie Diversion Dam (RM 28.1 to 16.2) from September 5-9, and September 16-17, 2002. Mad River was surveyed on September 9, from just above Hornet Creek to just below Mad River road bridge (RM 5.2 to 1.5) and September 18, from Pine Flats C.G. to just below Mad River road bridge (RM 3.5 to 1.5). On August 26, 2002, a carcass recovery survey was conducted from Fox Creek C.G. to Brief Bridge (RM 28.1 to 23.4)

The number of SCS spawning in the Entiat River was estimated by expanding redd counts using the estimator of 3.3 chinook salmon adults per redd. In the1994-2001spawning ground reports we used an estimator of 2.4 fish per redd. Explanation for this change can be found in the Discussion.

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 1 through Reach 5 (RM 28.1 to 16.2) from October 8-10 and 24-30, 2002. Lower river surveys were conducted between Dinkleman Canyon Road and Fire Station (RM 4.1 to 3.1), Fire Station to Keystone Bridge (RM 3.1 to 1.5) and Keystone Bridge to the Columbia River influence (RM 1.5 to 0.3) on October 24 and a second time November 5-6, 2002. No surveys were conducted in the Mad River. The number of SUS that spawned was estimated by expanding redd counts using the estimator of 4.0 chinook salmon per redd (see Discussion).

Bull Trout and Sockeye 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. Sockeye salmon redds were identified during the SCS and SUS surveys through observation of fish on occupied redds.

Age Designation

Age designation in this report follows the Gilbert-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.

RESULTS

Spring Chinook Salmon

Seventy-two SCS redds were counted in the old *index* area (RM 28.1 to 21.3). An additional 40 redds were found in the expanded survey area (RM 21.3 to 16.2), including two redds found in the Mad River. The complete survey identified a total of **112** redds (Table 1). Annual redd counts from the old *index* area surveys are found in Table 2.

The total redd count of 112 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 112 multiplied by 3.3 fish per redd gives an estimate of **370** 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 to 25.8 (Old *Index* Area)

Twenty-six redds were counted in Reach 1. Surveys were conducted on September 5 and 16, 2002 (Table 1). Reach 1 accounted for 36.1% of the *index* area count and 23.2% of the total redds found in the Entiat River.

Reach 2 RM 25.8 to 23.4 (Old *Index* Area)

Twenty-nine redds were counted in Reach 2. Surveys were conducted on September 5 and 16, 2002 (Table 1). Reach 2 accounted for 40.3% of the *index* area count and 25.9% of the total redds found in the Entiat River.

Reach 3 RM 23.4 to 21.3 (Old *Index* Area)
Seventeen redds were counted in Reach 3. Surveys were conducted on September 6 and 16, 2002 (Table 1). Reach 3 accounted for 23.6% of the *index* area count and 15.2% of the total redds found in the Entiat River

Reach 4 RM 21.3 to 18.7 (*Expanded* Area)
Fourteen redds were counted in Reach 4. Surveys were conducted on September 6 and 17, 2002. Two of the14 redds were identified during the October 8, SUC survey (Table 1). Reach 4 accounted for 12.5% of the total redds found in the Entiat River.

Table 1. Spring chinook spawning ground surveys on the Entiat and Mad rivers, 2002.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	08/26/02	N/A	0	1
Old *Index* Area		09/05/02	25	2	9
		09/16/02	1	0	5
	Cumulative Total Count		26	2	15
Reach 2	25.8-23.4	08/26/02	N/A	4	4
Old *Index* Area		09/05/02	23	7	8
		09/16/02	6	2	8
		❶10/09/02	N/A	N/A	1
	Cumulative Total Count		29	13	21
Reach 3	23.4-21.3	09/06/02	15	2	2
Old *Index* Area		09/16/02	2	1	14
		❶10/09/02	N/A	N/A	3
	Cumulative Total Count		17	3	19
	Index Total		**72**	**18**	**55**
Reach 4	21.3-18.7	09/06/02	12	4	3
Expanded Area		09/17/02	0	0	2
		❷10/08/02	2	0	0
	Cumulative Total Count		14	4	5
Reach 5	18.7-16.2	09/06/02	17	5	4
Expanded Area		09/17/02	7	5	8
	Cumulative Total Count		24	10	12
Mad River	5.2-1.5	09/09/02	1	0	0
	3.5-1.5	09/18/02	1	0	0
	Cumulative Total Count		2	0	0
	Expanded & Mad River Total		**40**	**14**	**17**
		TOTAL	**112**	**32**	**72**

❶ Surveyor's recovered four additional SCS carcasses in Reach 2 & 3 during the 10/09/02 SUS spawning ground survey.
❷ Surveyor's identified two additional SCS redds in Reach 4 during the 10/08/02 SUS spawning ground survey.

Reach 5 RM 18.7-16.2 (*Expanded* Area)
Twenty-four redds were counted in Reach 5. Surveys were conducted on September 6 and 17, 2002 (Table 1). Reach 5 accounted for 21.4% of the total redds found in the Entiat River.

Mad River RM 5.2-1.5
Two redds were counted in Mad River surveys conducted on September 9 and 18, 2002 (Table 1). Mad River accounted for 1.8% of the total redds counted in the Entiat River.

Table 2. Entiat River spring chinook salmon redd counts from annual surveys in old *index* area, Fox Creek Campground to Dill Creek (RM 28 to 21), 1962-1994 (WDFW) and 1995-2002 (USFWS).

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

N/A= not available

Spring Chinook Carcass Recoveries
A total of 72 SCS carcasses were recovered in 2002, 68 were useable and sampled. Of the 68 sampled carcasses, 41 (60%) were females and 27 (40%) were males. All female carcasses were examined for spawning success. Thirty-five (85%) were completely spent, two (5%) were partial, one (2%) did not spawn, and success could not be determined with three (8%) due to decomposition. Of the 38 useable samples, no difference in spawning success between hatchery and wild females was detected. Fifteen (94%) of the hatchery females and twenty (91%) of the wild females were completely spawned. Sixty-two DNA samples were also collected from the 68 sampled carcasses.

Spring Chinook Age Composition
Through scale analysis and coded-wire tags (CWT's), it was determined that 41 (60%) of the 68 sampled carcasses were wild, 21 (31%) were of hatchery origin and 6 (9%) were unidentifiable (Table 3). From the 68 sampled carcasses, there were 2 age 3/2 hatchery, 18 age 4/2 wild, 18 age 4/2 hatchery, 23 age 5/2 wild, 1 age 5/2 hatchery and 6 unidentifiable (Table 3).

Spring Chinook Coded-Wire Tag Recoveries
Of the 68 sampled carcasses, a total of 13 (5 males and 8 females) had missing adipose fins (Table 4).

Table 3. Spring chinook age composition from Entiat River carcass recoveries, 2002.

Origin	Age	Male	Female	Total
Hatchery	3/2	2	0	2
	4/2	4	14	18
	5/2	0	1	1
		6	15	21
Wild	3/2	0	0	0
	4/2	5	13	18
	5/2	13	10	23
		18	23	41
Unknown		4	2	6
Total		28	40	68

Table 4. Coded-wire tag recoveries from summer chinook carcasses, recovered in the Entiat River, 2002.

Tag Code	Recovered #	Hatchery
053926	1	Entiat NFH
053927	1	Entiat NFH
054950	2	Entiat NFH
630740	1	Chiwawa R.P.
631024	1	Methow SFH
631102	5	Chiwawa R.P.
Ad missing/ no head	1	
No Tag	1	
	TOTAL 13	

Summer Chinook Salmon

A total of **218** redds were identified in 2002 (Table 5). The first SUS redd was discovered October 8, 2002, with peak spawning occurring the second week of October. Multiplying the 218 redds by 4.0 fish per redd yields an estimate of **872** 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 and this number doesn't account for any pre-spawn mortality.

Summer Chinook Redd Counts

Reach 1 RM 28.1 to 25.8

Two redds were counted in Reach 1. Survey was conducted on October 10, 2002 (Table 5). Reach 1 accounted for 0.9% of the total redds found in the Entiat River.

Reach 2 RM 25.8 to 23.4

Nine redds were identified in 2002. Surveys were conducted on October 9 and 29, 2002 (Table 5). Reach 2 accounted for 4.1% of the total redds found in the Entiat River.

Reach 3 RM 23.4 to 21.3

Five redds were identified in 2002. Surveys were conducted on October 9 and 29, 2002 (Table 5). Reach 3 accounted for 2.3% of the total redds found in the Entiat River.

Reach 4 RM 21.3 to 18.7

Nineteen redds were counted in Reach 4. Surveys were conducted on October 8 and 24, 2002 (Table 5). Reach 4 accounted for 8.7% of the total redds found in the Entiat River.

Reach 5 RM 18.7 to 16.2

One hundred thirty-six redds were counted in Reach 5. Surveys were conducted on October 8, 24 and 30, 2002 (Table 5). Reach 5 accounted for 62.4% of the total redds found in the Entiat River.

Road Mile Marker 13

One redd was identified in 2002. Survey was conducted on October 24, 2002 (Table 5). This area accounted for 0.5% of the total redds found in the Entiat River.

Table 5. Summer chinook spawning ground surveys on the Entiat River, 2002.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	10/10/02	2	7	0
Reach 2	25.8-23.4	10/09/02	8	10	4
		10/29/02	1	1	2
		Cumulative Total Count	9	11	6
Reach 3	23.4-21.3	10/09/02	3	4	4
		10/29/02	2	0	2
		Cumulative Total Count	5	4	6
Reach 4	21.3-18.7	10/08/02	13	31	3
		10/24/02	6	3	7
		Cumulative Total Count	19	34	10
Reach 5	18.7-16.2	10/08/02	76	190	11
		10/24/02	48	16	16
		10/30/02	12	5	60
		Cumulative Total Count	136	211	87
Road Mile Marker 13		10/24/02	1	2	0
		Cumulative Total Count	1	2	0
Dinkleman Cyn Rd	4.1-3.1	10/24/02	5	23	3
to Fire Station		11/05/02	1	4	13
		Cumulative Total Count	6	27	16
Fire Station to	3.1-1.5	10/24/02	1	4	0
Keystone Bridge		11/05/02	1	2	15
		Cumulative Total Count	2	6	15
Keystone Bridge to	1.5-0.3	10/24/02	25	50	15
Columbia R. confluence		11/06/02	13	13	33
		Cumulative Total Count	38	63	48
		TOTAL	**218**	**365**	**188**

Dinkleman Canyon Road to Fire Station RM 4.1 to 3.1
Six redds were counted from Dinkleman Canyon Road to Fire Station. Surveys were conducted on October 24 and November 5, 2002 (Table 5). This section accounted for 2.8% of the total redds found in the Entiat River.

Fire Station to Keystone Bridge RM 3.1 to 1.5
Two redds were counted from Fire Station to Keystone Bridge. Surveys were conducted on October 24 and November 5, 2002 (Table 5). This site accounted for 0.9% of the total redds found in the Entiat River.

Keystone Bridge to Columbia River confluence RM 1.5 to 0.3
Thirty-eight redds were counted from Keystone Bridge to the Columbia River influence. Surveys were conducted on October 24 and November 6, 2002 (Table 5). This section accounted for 17.4 % of the total redds counted in the Entiat River.

Summer Chinook Carcass Recoveries
One hundred eighty-eight SUS carcasses were recovered from the Entiat River, 187 were useable and sampled. Of the 187 sampled carcasses, 103 (55%) were females and 84 (45%) males. Through scale analysis and CWTs, it was determined that 115 (61%) were wild, 56 (30%) were hatchery and 16 (9%) were not identifiable (Table 6). One hundred and three female carcasses were examined for spawning success. Sixty (58%) were completely spent, 24 (23%) did not spawn, 15 (15%) had partially spawned and 4 (4%) were not sampled due to carcass decomposition. Of the 99 useable samples, a notable difference in spawning success between hatchery and wild females was found. Only nine (21%) of the hatchery females spawned successfully, compared to fourty-eight (90%) of the wild females.

Summer Chinook Age Composition
The 2002 scale samples were sent to John Sneva, WDFW fisheries biologist, for aging. From the 187 summer chinook carcasses, there were 2 age 3/1 wild, 59 age 4/1 wild, 28 age 4/2 wild, 14 age 4/2 hatchery, 17 age 5/1 wild, 8 age 5/2 wild, 40 age 5/2 hatchery, 1 age 6/2 hatchery and 18 not identifiable (Sneva, WDFW, pers comm.) (Table 6).

Summer Chinook Coded-Wire Tag Recoveries
Sixty-three (17 males and 46 females) of the 187 carcasses recovered from the Entiat River had missing adipose fins. Their origins are as follow: Turtle Rock SFH 21 (33.3%), Similkameen SFH 1 (1.6%), Wells SFH 9 (14.3%), Dryden Pond 16 (25.4%), Chelan PUD 8 (12.7%), and 8 no tags (12.7%) (Table 7). Note: Three CWT'ed SCS carcasses were recovered during the SUS spawning ground surveys.

Bull Trout, Sockeye and Coho Salmon, Pacific Lamprey
In 2002, surveyor's identified one adult bull trout in Reach 3, 139 SOS redds, 165 live SOS adults, and twelve SOS carcasses in Reaches 2-5. Also, one adult COS carcass was recovered between Keystone Bridge and Columbia River influence, and one adult Pacific lamprey carcass was recovered in Reach 1.

Table 6. Summer chinook age composition from Entiat River carcass recoveries, 2002.

Origin	Age	Male	Female	Total
Hatchery	4/2	7	7	14
	5/2	6	34	40
	6/2	0	1	1
		13	42	55
Wild	3/1	1	1	2
	4/1	34	25	59
	4/2	21	7	28
	5/1	3	14	17
	5/2	0	8	8
		59	55	114
Unknown		12	6	18
Grand Total		**84**	**103**	**187**

Table 7.Coded-wire tag recoveries from summer chinook carcasses, Entiat River, 2002.

Tag Code	# Recovered	Hatchery
630124	1	Turtle Rock SFH
630606	20	Turtle Rock SFH
630610	1	Similkameen SFH
630611	8	Wells SFH
630612	11	Dryden Pond
631032	8	Chelan PUD
631061	1	Wells SFH
631151	5	Dryden Pond
No Tag	8	
TOTAL	**63**	

DISCUSSION

Adult Escapement

Since 1994, Mid-Columbia River FRO has estimated the number of spring and summer chinook adults escaping to spawn in the Entiat River by a multiple of 2.4 fish per redd (Kohn 1987, 1988) by the total redd count. Spawning ground survey results from Wenatchee River tributary streams suggest that using 2.4 fish per redd as an estimator may be underestimating adult returns. Using 2002 SCS redd survey counts from Peshastin Creek (348 adults/ 107 redds) and Icicle Creek (828 adults/ 245 redds) point out a ratio of 3.25 and 3.38 fish per redd, respectively (Grassell, CCPUD, personal communication). Combining the two survey counts together (1176 adults and 352 redds), we calculated a fish per redd ratio of 3.3. Multiplying 3.3 fish per redd by total redd count (112) we estimated adult spawning escapement to be **370**.

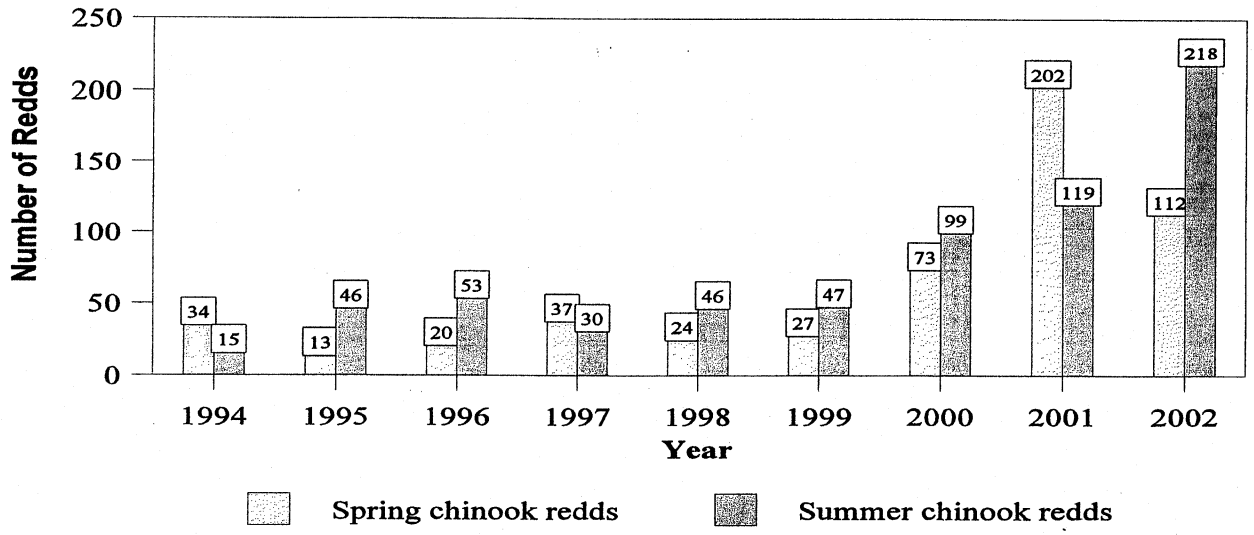


Figure 2. Total spring chinook and summer chinook salmon redds - Entiat River, 1994 to 2002.

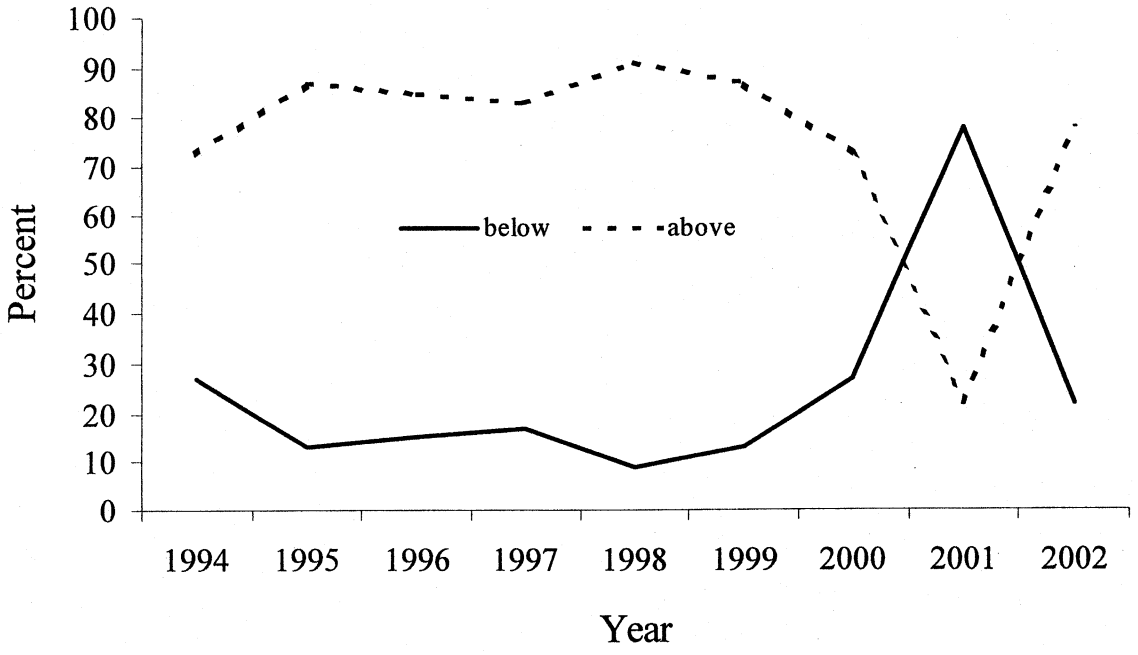
MCRFRO has also used the multiplier of 2.4 fish per redd in estimating the number of SUS adults escaping to spawn in the Entiat River. Utilizing historic SUS redd counts from the Wenatchee River, 1992-2001 (Mosey, T.R., and L.J. Murphy, 2002), we calculated a fish per redd ratio of 4.0. Multiplying 4.0 fish per redd by total redd count (218) we estimated adult spawning escapement to be **872.**

Summer Chinook Redd Location

Between 1994 and 2000, 80% of the summer chinook redds counted in the Entiat River were above river mile 16.2 (Figure 3). Surveyor's counts of summer chinook redds in 2001, revealed only 22% of the redds were counted above river mile 16.2 (Figure 3). This sudden decrease in redds above river mile 16.2 could have been contributed to: 1) Returning adults encountered difficultly ascending lower river section due to extremely low stream flows (Table 8); 2) Three recently installed vortex rock weirs at river mile 4.1 and 3.1 provide new holding opportunities and spawning areas for summer chinook and; 3) Through analysis of scales and CWT's, 68% of summer chinook carcasses recovered in the lower river were of hatchery origin. In 2002, summer chinook spawning exhibited similar results (78% of redds were located above river mile 16.2) as those from 1994 through 2000 season (Figure 3). Although data supporting any of the three assumptions is limited, we found plausible results leaning toward assumption one. There was a notable increase in mean flows from July-September in 2002 compared to 2001 (Table 8). Assumption two results showed a decrease in adults utilizing vortex rock weirs in 2002, (7 redds and 27 live) compared to 2001 of (55 redds and 139 live). Assumption three exhibited similar results between 2001 (68%) and 2002 (73%) hatchery strays.

Table 8. Monthly mean discharge in cubic feet per second (CFS), in Water Years 2001, 2002 and average % monthly mean data for Water Years 1996-2002.

Year(s)	July	August	September
2001	218	122	88
2002	779	233	123
1996-2002	892	310	164



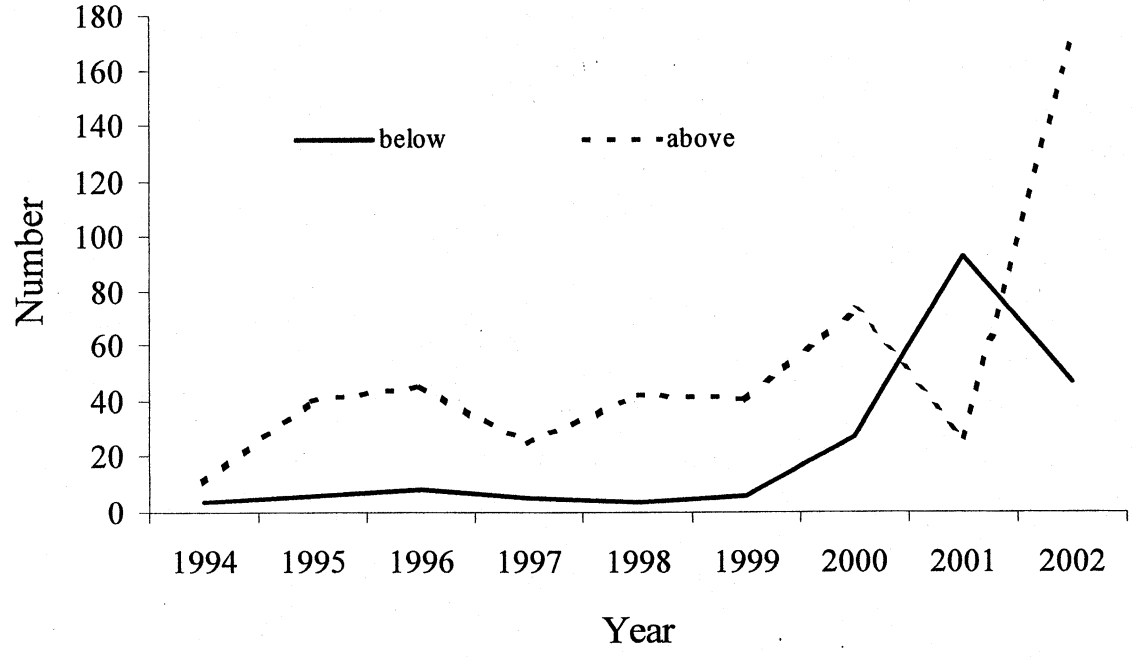


Figure 3. Percent (A) and number (B) of summer chinook redds above and below river mile 16.2 between 1994 and 2002.

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PERSONAL COMMUNICATIONS

J. Sneva, 2003. Washington Department of Fish & Wildlife.

A. Grassell, 2003. Chelan County Public Utilities District.

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
10.1	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