Work Completed for Compliance With the Biological Opinion for Hatchery Programs in the Willamette Basin, USACE funding: 2002

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TABLE OF CONTENTS

Tables and Figures

Introduction

The National Marine Fisheries Service (NMFS) has listed Spring Chinook salmon (*Oncorhynchus tshawytscha*) and Winter Steelhead (*O. mykiss*) in the Upper Willamette River Evolutionarily Significant Unit (ESU) as threatened under the Endangered Species Act (ESA; 64 FRN 14308; 64 FRN 14517). Concomitant with this listing, any actions taken or funded by a federal agency must be evaluated to assess whether these actions are likely to jeopardize the continued existence of threatened and endangered species, or result in the destruction or impairment of critical habitat. Several fish hatcheries operate within the ESU and may impact wild populations of listed species. Although all of the artificial propagation programs that potentially affect listed salmonids in the Upper Willamette River ESUs are operated by the Oregon Department of Fish and Wildlife (ODFW), 90% of the funding for these operations comes from the U.S. Army Corps of Engineers (COE).

Possible risks of artificial propagation programs have been well documented. Hazards include disease transfer, competition for food and spawning sites, increased predation, increased incidental mortality from harvest, loss of genetic variability, genetic drift, and domestication (Steward and Bjornn 1990; Hard *et al*. 1992; Cuenco *et al*. 1993; Busack and Currens 1995; NRC 1996; and Waples 1999). Hatcheries can also play a positive role for wild salmonids by bolstering populations, especially those on the verge of extirpation, providing a genetic reserve in the case of extirpation, and providing opportunities for nutrient enrichment of streams (Steward and Bjornn 1990; Cuenco *et al*. 1993). The objective of this project is to evaluate the potential effects hatchery programs on naturally spawning populations of Spring Chinook and winter Steelhead within the Upper Willamette River ESU. The project employs four types of activities to achieve this goal: sampling of returns to hatcheries, creels to assess fisheries, monitoring of adult and juvenile migration through the use of traps and video observations, and monitoring natural production through spawning ground surveys.

Approach

Hatchery Broodstock

Hatcheries conventionally include some naturally produced Spring Chinook in their broodstock, however, naturally produced fish in the broodstock should constitute no more than 10% of wild fish that spawn naturally. All Spring Chinook used for broodstock in the Upper Willamette in 2002 were examined for fin marks and coded-wire tags to determine their origin. In addition, otoliths were taken from all unmarked, untagged fish to detect fish that were reared in a hatchery, but overlooked during marking. Reference otolith samples were also taken from 30-50 fin-marked salmon at each hatchery to provide a standard for evaluating hatchery strays found on the spawning grounds. Sex and fork length were recorded for every fish that was spawned.

Creels
In 2002, statistical creels were conducted on the South Santiam River, the McKenzie River, and Foster Reservoir. Expanded catch statistics from the river creels were used to estimate the number of naturally produced adult Chinook and Steelhead in the bycatch, and to estimate the number of marked fish that were removed from the run. The Foster creel was designed to evaluate the number of Winter Steelhead and Spring Chinook that were caught in the trout fishery. In 2003 we will also conduct a creel on the North Santiam and on the Middle Fork Willamette. We will use the creel on the McKenzie River to collect stomach samples from hatchery-reared trout that are released in the vicinity. The stomach samples will be analyzed to determine if the consumption of wild juvenile Chinook by artificially produced trout is a common occurrence.

Adult and Juvenile Migration
Viewing stations are available at the Willamette Falls fish ladder and the Leaburg Dam fish ladder on the McKenzie River. Video cameras are in place at both locations, and the species and mark status of all fish that passed the ladders was recorded. Adult traps are available at the Leaburg Dam fish ladder, and at the ladders over Upper and Lower Bennett Dams on the North Santiam River. The capacity of the Leaburg trap is limited, and the trap cannot be operated during the peak of Chinook and Steelhead migration. The COE has plans to improve trapping at Leaburg Dam to allow trapping during the entire run. In 2002, this trap was operated from July 9th to December 31st. All marked Spring Chinook were removed and transported to McKenzie hatchery to be included in their broodstock. All other fish were passed upstream until October 1st, after which all Steelhead were recycled downstream (Steelhead are not native to the McKenzie River). The traps on the North Santiam River cannot be operated during high flows. In 2002, these traps were operated from March 4th to November 8th. This period encompassed the Spring Chinook and Summer Steelhead runs, and the peak of the Winter Steelhead run. All fish captured were examined for fin marks and passed above the trap. Scales were collected from all unmarked fish to verify that they were naturally produced.

Spawning Ground Surveys
In 2002, foot and boat surveys were conducted to make visual counts of Spring Chinook redds and spawners. Survey sites were visited regularly during the peak of the spawning season (August 1 to October 15). Carcasses were examined for fin marks, and otoliths and scales were collected for confirmation of origin and age. Spawning surveys are currently underway for non-native Summer Steelhead. The results of these surveys will be reported in the 2003 annual report.

Results and Discussion

<u>Task 1.1</u> Remove hatchery-reared Spring Chinook at Leaburg Dam [RPA 1, c, iii], thus reducing the number of hatchery Spring Chinook spawning above Leaburg Dam on the McKenzie River.

Chinook began appearing at Leaburg Dam in May of 2002, with peak passage occurring in late May and early June (Figure 1). The majority of these fish (62%) were unmarked. Run-timing was similar to the 20-year average (Figure 2), and showed two secondary peaks in July and September. The run in 2002 was one of the largest in the past 20 years, surpassed only by the runs in 1990 and 1988 (Figure 3).

The capacity of the Leaburg trap is limited, and the trap cannot be operated during the peak of Chinook and Steelhead migration. The COE has plans to improve trapping at Leaburg Dam to allow trapping during the entire run. Video recordings of passage are used to monitor the run when the trap cannot be used, and to monitor when the run has fallen off enough to allow trapping. In 2002, the trap was operated from July 9th to December 31st (Figure 4). Six hundred eighty-seven marked Spring Chinook were captured during this period and were removed and transported to McKenzie hatchery (Table 1). Five hundred eighty-four unmarked Spring Chinook were passed above the trap. According to video counts, a total of 1,864 marked Spring Chinook passed the dam in 2002. Thus, approximately 26% of the marked Spring Chinook that arrived at Leaburg dam were captured and transported to McKenzie hatchery and 28% of the run over Leaburg Dam were marked hatchery fish.

Table 1: Spring Chinook at Leaburg Dam, 2002.
Chinook removed and passed are subsets of marked Chinook observed at the dam.
Fish removed from the trap were transported to McKenzie Hatchery.

Month	Removed	Passed	Marked	Unmarked	Adults	Jacks	Total
May	0	164	164	461	625	0	625
June	0	1,252	1,252	2,493	3,745	14	3,759
Jul	189	403	592	934	1,526	3	1,529
Aug	65	21	86	103	189	0	189
Sep	428	24	452	231	683	1	684
Oct	5	0	5	1	6	0	6
Total	**687**	**1,864**	**2,551**	**4,223**	**6,774**	**18**	**6,792**

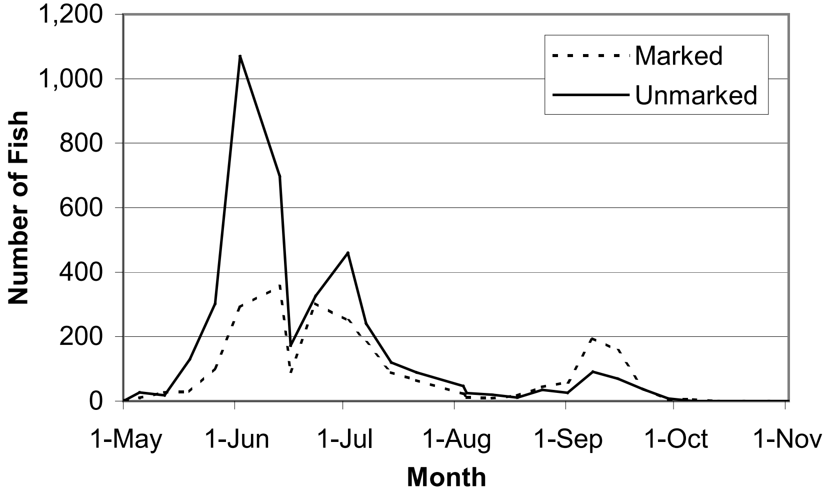

Figure 1. Chinook run-timing at Leaburg Dam: 2002.

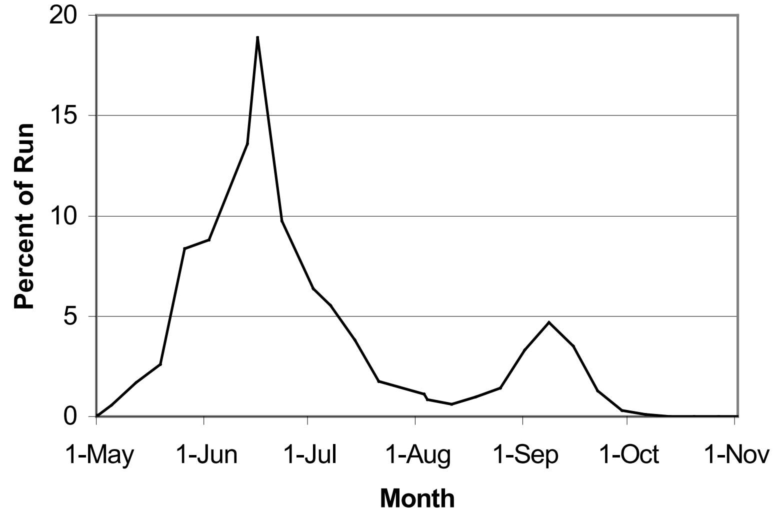

Figure 2. Chinook run-timing, Leaburg Dam: 1980-2001

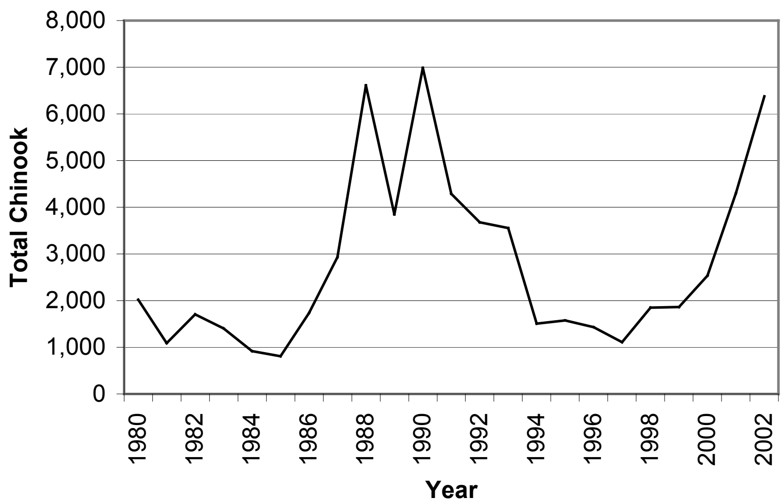

Figure 3. Chinook passage at Leaburg Dam: 1980-2002.

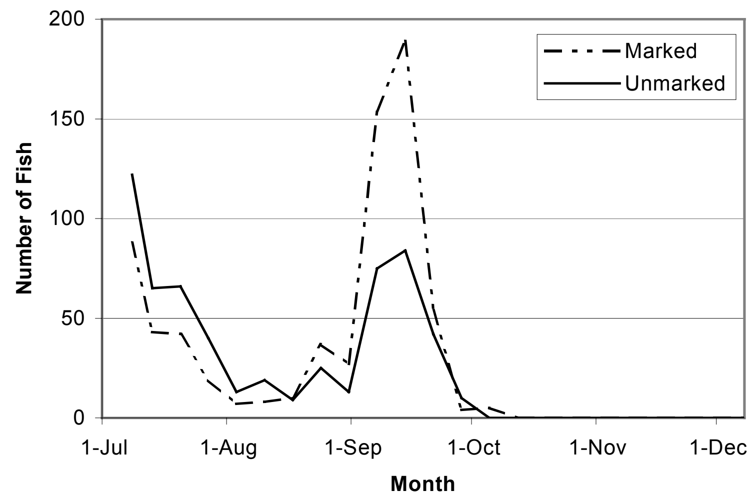

Figure 4. Chinook trapping at Leaburg Dam: 2002

<u>Task 1.2</u> Monitor straying of hatchery fish on natural spawning grounds: conduct annual spawning ground surveys. [RPM2,d]

We surveyed most of the major tributaries in the Willamette Basin above Willamette Falls in 2002 by boat and on foot to count Spring Chinook salmon carcasses and redds. We counted redds during peak times of spawning based on data from past surveys. Carcasses were examined for adipose fin marks to determine the proportion of hatchery fish on spawning grounds. Otoliths were also collected from unmarked carcasses to sort out unmarked hatchery fish from those produced naturally (*see* Otolith Sampling below).

Spawning Ground Surveys

The North Santiam River was regularly surveyed August 1–October 15 to recover carcasses and count redds. We observed some spawning activity by Chinook salmon in early August, similar to 2001. Peak spawning occurred in late September. The redd density in sections above Stayton was lower in 2002 than in 2001, with the exception of Mehama to Fishermen's Bend, which was higher in 2002 (Table 2). Although about 400 unclipped adult Chinook salmon from the Minto collection pond were tagged and transported to the Little North Fork Santiam River, the number of redds did not increase substantially over that seen in previous years (Table 2). We suspect most of these fish died shortly after transport because we recovered only 7 tagged fish; all were very decomposed and within a few miles of the release site. Of the carcasses we recovered in the North Santiam in 2002, 73% had fin clips (Table 3), compared to 86% in 2001.

Table 2. Summary of spawning surveys for Spring Chinook salmon in the North Santiam River, 2002, and comparison to redd densities in 1996–2001.

	Length	Number		Redds/mi						
Survey section	(mi)	Carcasses	Redds	2002	2001	2000	1999	1998	1997	1996
Minto–Fishermen's Bend	10.0	213	162	16.2	17.9	23.0[a]	15.6	11.8	8.5	7.8
Fishermen's Bend–Mehama	6.5	54	61	9.4	5.7	5.8	3.1	4.3	2.5	3.5
Mehama–Stayton Is.	7.0	35	43	6.1	10.0	b	--	0.6	0.9	1.0
Stayton Is.–Stayton	3.3	47	10	3.0	6.7	b	--	10.0	3.6	2.0
Stayton–Greens Bridge	13.7	25	6	0.4	0.1	--	0.0	0.4	1.1	0.1
Greens Br.–mouth	3.0	0	14	4.7	--	--	--	4.7	9.7	--
Little North Santiam [c]	17.0	16	30	1.8	1.1[a]	1.3[a]	1.0	2.3	0.5	0.0

[a] *Corrected number.*
[b] *Data was recorded for Mehama–Stayton; density for this section was 0.9 redds/mi.*
[c] *Four hundred surplus hatchery adult Spring Chinook were released into the Little North Fork Santiam on August 20 and 30, September 5 and 6, 2002.*

Table 3. Composition of naturally spawning Spring Chinook salmon based on carcasses recovered in the North Santiam River above Stayton Island, 2002.

Section	No fin clip[a]	Fin clipped
Minto–Fishermen's Bend	54	159
Fishermen's Bend–Mehama	9	45
Mehama–Stayton Island	10	25
Little North Fork Santiam	12[b]	4
Total	85	233

[a] *Otoliths have not yet been read to determine the proportion of wild and hatchery fish.*
[b] *Otoliths were not collected from 1 fish.*

Abundance and migration timing of adult Spring Chinook were also monitored at upper and lower Bennett dams in 2001 (Table 4 and Figure 5) with methods similar to previous years.

Table 4. Estimated number of Spring Chinook salmon passing upper and lower Bennett dams on the North Santiam River, May–October, 2002. Passage counts have been adjusted for a 2.6% fallback rate.

	May	June	July	August	September	October	Total
Unmarked:							
Adult	23	392	684	53	51	30	1233
Jack	0	0	11	4	0	9	24
Fin-clipped:							
Adult	86	2126	3744	223	225	3	6407
Jack	0	49	74	3	3	0	129
Total	109	2567	4513	283	279	42	7793

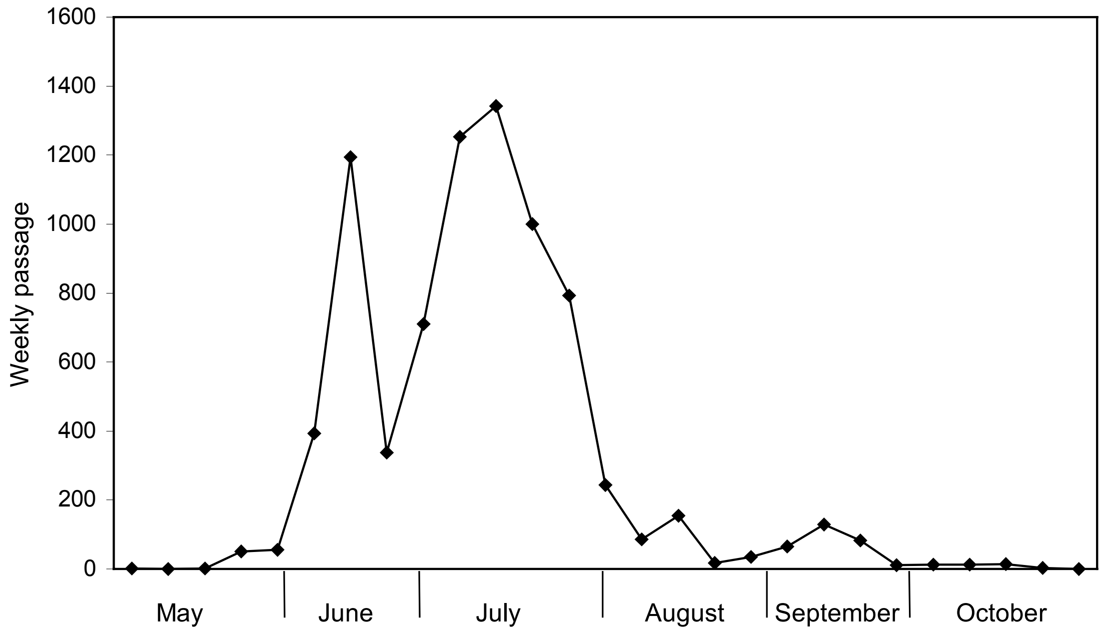

Figure 5. Weekly passage of Spring Chinook salmon at Upper and Lower Bennett dams on the North Santiam River, 2002.

We calculated approximate fish/redd ratios for Spring Chinook salmon in the North Santiam basin above Bennett dams. The fish/redd ratio was lower in 2002 (5.6) than in 2001 (8.6), and similar to that in 1999 (5.3). The percentage of females found on spawning grounds that died before spawning was lower in 2002 (52%) than in 2001 (75%). We estimated the number of potential spawners in the North Santiam from escapement estimates at Bennett dams minus the number of fish removed at the Minto collection pond (e.g., fish spawned and fish transported above Detroit Dam) and those caught in the sport fishery (assuming a 20% exploitation rate). All Spring Chinook salmon released above Minto Dam in 2002 (729) were marked with an anchor tag. About 4.5% of the fin-clipped fish released above the dam were captured again in the Minto trap and almost 2% were found in carcass surveys below the dam. About 3% of the unclipped fish were captured again in the Minto trap and none were found in carcass surveys. Because fish passed above Minto Dam were not tagged in earlier years, they could have been counted again at the Minto collection pond. The potential for error in fish/redd estimates is higher in 1998 and 1999 than in 2001 because more fish were passed above Minto Dam in these earlier years (Schroeder et al. 2001).

The McKenzie River was regularly surveyed August 15–October 10 to recover carcasses and count redds. Some redds were counted in August but active redd building occurred in early September, similar to 2001. Peak spawning occurred in late September to early October. Redd densities were generally higher in 2002 than in previous years (Table 5). The percentage of fin-clipped carcasses above Leaburg Dam was higher in 2002 (24%) than in 2001 (19%), but below Leaburg Dam the percentage of fin-clipped carcasses was lower in 2002 (67%) than in 2001 (72%) (Table 6).

Table 5. Summary of Chinook salmon spawning surveys in the McKenzie River above Leaburg Dam, 2002, and comparison to redd densities in 1996, 1997, 2000 and 2001.

Survey section	Length (mi)	Carcasses	Redds	Redds/mi 2002	2001	2000	1998	1997	1996
McKenzie River[a]:									
Ollalie–McKenzie Trail	10.3	71	168	16.3	17.7	5.6		11.4	7.0
McKenzie Trail–Hamlin	9.9	44	51	5.2	4.9	1.6			2.1
Hamlin–South Fork McKenzie	0.3	13	11	36.7					
South Fork–Forest Glen	2.4	40	40	16.7	0.8	2.1			0.8
Forest Glen–Rosboro Bridge	5.7	72	85	14.9	13.2	5.8			6.1
Rosboro Bridge–Ben and Kay	6.5	79	105	16.2	6.3	3.2			4.9
Ben and Kay–Leaburg Lake	5.9	3	17	2.9	3.2				
South Fork McKenzie:									
Cougar Dam–Road 19 bridge	2.3	142	84	36.5					
Road 19 bridge–mouth	2.1	35	24	11.4	8.1	7.6			2.9
Horse Creek:									
Separation Creek–mouth	10.7	112	129	12.1	7.4				
Lost Creek:									
Hwy 126–mouth	0.5	6	16	32.0					
McKenzie River:									
Leaburg Dam–Leaburg Landing	6.0	172	115	19.2	12.3		15.3	19.8	10.3

[a] *We counted 55 carcasses and 77 redds in the Carmen-Smith spawning channel (500 ft long)*

Table 6. Composition of naturally spawning Spring Chinook salmon based on carcasses recovered in the McKenzie River, 2002.

Section	No fin clip[a]	Fin clipped
McKenzie spawning channel	50	5
Spawning channel–Forest Glen	147[b]	21
Forest Glen–Leaburg Lake	98	56
S Fork McKenzie	108[c]	69
Horse Creek	101[c]	11
Lost Creek	5	1
Total above Leaburg	509	163
Below Leaburg	56[d]	116

[a] *Otoliths have not yet been read to determine the proportion of wild and hatchery fish.*
[b] *Otoliths were not collected from 2 fish.*
[c] *Otoliths were not collected from 3 fish.*
[d] *Otoliths were not collected from 1 fish.*

Other rivers that were regularly surveyed in 2002 were the South Santiam (August 6–October 9) and the Middle Fork Willamette (August 7–October 7). Active redd building began in early August in the South Santiam and in middle September in the Middle Fork Willamette. Peak spawning in both rivers was late September to early October. The percentage of fin-clipped carcasses was higher in the South Santiam (84%) than in the Middle Fork Willamette (77%) (Table 7), or than in the North Santiam (73%). In contrast, the percentage of fin-clipped carcasses was 39% in Fall Creek (Table 7). Most (93%) of the carcasses recovered in the Molalla River had fin clips.

Table 7. Summary of Chinook salmon spawning surveys in the Middle Fork Willamette, South Santiam, Santiam, Calapooia, and Molalla rivers including tributaries, 2002.

River	Section	Length (mi)	Redds	Carcasses: No fin clip[a]	Carcasses: Fin clipped
Middle Fork Willamette	Dexter–Jasper	9.0	64	58	197
	Jasper–Coast Fork	8.0	0	1	4
	Fall Creek (above reservoir)	13.3	171[b]	49[c]	31
South Santiam	Foster–Pleasant Valley	4.5	875	238	1256
	Pleasant Valley–Waterloo	10.5	19	29	126
	Lebanon–mouth	20.0	67	4	21
	Thomas Creek	7.6	18	2[d]	23[d]
	Crabtree Creek	5.2	2	0	0
	Wiley Creek	3.0	1	d	d
Santiam	Confluence–I-5 bridge	5.0	51	5	1
	I-5 bridge–mouth	6.0	46	2	0
Molalla	Trout Cr–Old Gawley Cr bridge	7.0	16	3	16
	Old Gawley bridge–Bull Cr	3.9	22	4	71
	Bull Cr–Copper Cr	4.0	11	0	8
	N Fork: Mile 2–old 151 bridge	1.4	3	0	0
Calapooia	Upstream of Brownsville	11.1	16	d	d

[a] *Otoliths have not yet been read to determine the proportion of wild and hatchery fish.*
[b] *Includes an estimated 50 redds in a 5.3 mi reach that was subsampled.*
[c] *Otoliths not collected from 1 fish.*
[d] *Carcasses too decomposed to determine presence or absence of fin clips were found in Calapooia River (181), Wiley Creek (30), and Thomas Creek (42), and were likely surplus hatchery fish outplanted from South Santiam Hatchery.*

Otolith Sampling

Restoration of Spring Chinook salmon under the Endangered Species Act and the implementation of ODFW's Wild Fish Management Policy require information on hatchery and wild fish in spawning populations. In response to this need and to implement a selective fishery, all hatchery Spring Chinook salmon released into the Willamette basin, beginning with the 1997 brood, are marked with adipose fin clips. Although the intention is to externally mark all juvenile hatchery fish, some are missed during marking. To help separate returning hatchery fish without fin clips from wild fish, otoliths have been thermally marked on all hatchery Spring Chinook released into the Willamette basin beginning with the 1997 brood. In 2002 all returning Spring Chinook salmon that originated from Willamette basin hatcheries should be otolith marked, except for a small percentage of fish that return at age 6.

Methods

Thermal marks were placed on otoliths of all 2001 brood, hatchery Spring Chinook salmon in the Willamette basin. Reference samples were collected at the hatcheries and were analyzed for mark quality at the otolith laboratory operated by Washington Department of Fish and Wildlife (WDFW) (Table 8).

Table 8. Data on thermal marking of Spring Chinook salmon in Willamette River hatcheries and collection of reference samples, 2001 brood.
Reference samples consisted of 40–50 fry (35–50 mm) from each egg take.

Stock	Egg takes analyzed	Treatment (hrs on/off)	Temperature differential (°F) [a]	Cycles[b]	Comments
McKenzie	6	Chilled (24/72)[c]	5.0–8.0	8[d]	--
N. Santiam	5	Heated (48/48)	5.0–9.0	8	--
Willamette	4	Heated (48/48)	9.5–13.5	8	--
S. Santiam	2	Heated (48/48)	8.0–13.5	8	Marked at Willamette H.

[a] *Difference between heated or chilled treatment and ambient incubation temperature.*
[b] *Number of treatment cycles for hatched fry, except where noted.*
[c] *Some pre-hatch cycles were 24 hrs on chilled water and 24 hrs off chilled water.*
[d] *Four cycles were administered to eggs and 4 cycles to hatched fry.*

We collected otoliths from adult fish on spawning grounds and at hatcheries in most of the major tributaries in the Willamette Basin in 2002 (Table 9). Carcass surveys were conducted throughout the spawning period to collect otoliths from Spring Chinook salmon without fin clips. Tissue samples were collected from fresh carcasses for future genetic analysis to separate Fall Chinook from Spring Chinook. Otoliths and tissues were removed from carcasses and placed into individually numbered vials. In addition, we collected otoliths from adult hatchery fish at Minto (North Santiam River), South Santiam, McKenzie, and Willamette hatcheries to serve as reference samples for blind tests of accuracy in identifying thermal marks (Table 9). We also collected otoliths from unclipped fish at the hatcheries. These samples will be sent to WDFW for analysis and will be reported in 2003.

Table 9. Otoliths collected from adult Spring Chinook salmon during spawning ground surveys and at hatcheries, 2002.

Basin and location	Group	Number
Middle Fork Willamette:		
Dexter–Jasper	Not clipped	58
Jasper–mouth	Not clipped	1
Fall Creek	Not clipped	48
Willamette Hatchery	AD clipped	30
Willamette Hatchery	Not clipped	58
McKenzie:		
Carmen–Smith spawning channel	Not clipped	50
Ollalie Boat Ramp–McKenzie Trail	Not clipped	66
McKenzie Trail–Forest Glen	Not clipped	79
Forest Glen–Ben and Kay Doris Park	Not clipped	97
Helfrich–Leaburg Lake	Not clipped	1
Horse Creek	Not clipped	98
South Fork McKenzie below Cougar Reservoir	Not clipped	105
Lost Creek	Not clipped	5
Below Leaburg Dam	Not clipped	55
McKenzie Hatchery	AD clipped	50
McKenzie Hatchery	Not clipped	116
South Santiam:		
Foster–Pleasant Valley	Not clipped	238
Pleasant Valley–Waterloo	Not clipped	29
Lebanon–mouth	Not clipped	4
Thomas Creek	Not clipped	2
South Santiam Hatchery	AD clipped	30
South Santiam Hatchery	Not clipped	45
North Santiam:		
Minto–Fishermen's Bend	Not clipped	54
Fishermen's Bend–Mehama	Not clipped	9
Mehama–Stayton Island	Not clipped	10
Stayton Island–Stayton	Not clipped	12
Stayton–Greens Bridge	Not clipped	7
Little North Santiam	Not clipped	11
Minto collection pond	AD clipped	50
Minto collection pond	Not clipped	11
Santiam:		
Confluence of North and South–mouth	Not clipped	7
Molalla:		
Trout Creek–Copper Creek	Not clipped	7

We estimated the proportion and number of naturally produced ("wild") fish on spawning grounds in the North Santiam and McKenzie rivers in 2001 based on otoliths collected in spawning surveys in 2001 (Table 10). The number of wild fish was estimated using the equation:

$$N_w = N_{nc} (1 - T_{nc})$$

where N_w is the number of wild fish, N_{nc} is the estimated number of fish without fin clips passing over Bennett Dam (North Santiam) or Leaburg Dam (McKenzie), and T_{nc} is the percentage of non-clipped carcasses on spawning grounds of the North Santiam or McKenzie rivers with thermal marks in their otoliths.

We tested the accuracy of identifying induced thermal marks by submitting otoliths from known hatchery adults as determined by adipose fin clips and coded wire tags. These samples were randomly mixed with samples collected from unclipped carcasses and were not identified as “hatchery” samples. We have also tested the laboratory with samples of known or suspected wild Spring Chinook collected as juveniles in the McKenzie River, and as adults in the John Day River and at Warm Springs National Fish Hatchery.

We used hand-held electronic tag detectors manufactured by Northwest Marine Technology, Inc. to determine if carcasses with adipose fin clips had a coded wire tag. We collected the snouts of fish with a tag, which were then put into plastic bags along with a unique identification number.

Table 10. Number of otoliths collected from adult Spring Chinook in the North Santiam and McKenzie basins that were analyzed for presence of thermal marks, 2001.

Group, location	Number
Adipose fin not clipped	
North Santiam River	62
McKenzie River	200
Adipose fin clipped	
Minto Hatchery	50
McKenzie Hatchery	85[a]

[a] *Included otoliths from 11 fish incubated at Willamette Hatchery.*

Results

High quality thermal marks were seen in all 2000 and 2001 brood juvenile reference samples sent from upper Willamette hatcheries. Although specimens from some of the egg takes had a fair amount of background “noise”, the temperature differentials and the number of cycles were high enough to produce strong thermal marks.

The WDFW otolith laboratory correctly identified 100% of adult hatchery Spring Chinook in the blind tests of the 1996 and 1997 brood years (Table 11). The laboratory also correctly identified 89–96% of wild fish as having no thermal marks (Table 11). The increased accuracy in identifying thermal marks in hatchery fish from the later brood years reflects the increased quality of thermal marks seen in the juvenile reference collections beginning with the 1996 brood. The accuracy of correctly classifying wild fish was lowest in a sample of unclipped adults collected at Warm Springs National Fish Hatchery (Table 11). We cannot discount the possibility that some of these otoliths were from unclipped hatchery fish that may show a mark “pattern” because of handling or treatment during incubation.

Table 11. Accuracy in blind tests of the WDFW otolith laboratory in identifying presence or absence of thermal marks in hatchery and wild Spring Chinook salmon.

Group, brood year	Number	Classified— Correctly	Classified— Incorrectly	Percent correct
McKenzie Hatchery				
1994	22	17	5	77
1995	45	29	16	64
1996	58	58	0	100
1997	13	13	0	100
Marion Forks Hatchery				
1995	23	22	1	96
1996	32	32	0	100
1997	18	18	0	100
Willamette Hatchery				
1997	10	10	0	100
Wild McKenzie River juveniles	30	28	2	93
Wild John Day River adults	48	46	2	96
Unclipped Warm Springs River adults[a]	36	32	4	89

[a] *Collected at Warm Springs National Fish Hatchery on the Warm Springs River.*

We estimated an escapement of 151 wild Spring Chinook salmon in the North Santiam River above Bennett Dam in 2001 compared to an escapement of 94 wild fish in 2000 (Table 12). However, the percentage of wild fish in the river was lower in 2001 than in 2000. We estimated an escapement of 2,901 wild Spring Chinook in the McKenzie River above Leaburg Dam in 2001, which represented 67% of the total escapement above the dam (Table 12).

Table 12. Estimated escapement of wild and hatchery adult Spring Chinook salmon in the North Santiam basin above Bennett Dam and in the McKenzie basin above Leaburg Dam. Estimated from counts at the dams and from presence of induced thermal marks in otoliths of unclipped carcasses recovered on spawning grounds.

Basin, run year	Count at dams: Not fin clipped	Count at dams: Fin clipped	No clip carcasses with thermal marks (%)	Estimated escapement: Wild	Estimated escapement: Hatchery	Estimated escapement: Percent wild
North Santiam						
2000[a]	1045	1241	91.0	94	2192	4
2001	388	6398	61.0	151	6635	2
McKenzie						
2001	3433	869	15.5	2901	1401	67

[a] *Escapement was likely underestimated* (see *Schroeder et al. 2001).*

Recoveries of coded wire tags from hatchery fish found on spawning grounds in 2001 suggest little straying into the McKenzie and North Santiam rivers (Table 13). The release of hatchery Spring Chinook from South Santiam Hatchery into the Molalla River accounted for most of the strays in the North Santiam basin. We collected almost 700 snouts from carcasses with adipose fin clips in 2002 (Table 14). Coded wire tags recovered from these fish will be read and reported in 2003.

Table 13. Origin of hatchery Spring Chinook salmon from recoveries of coded wire tags in spawning ground surveys, 2001.

River surveyed	n	Origin of coded wire tags recovered: Instream	Netpen[a]	Molalla[b]	Clackamas	North Santiam	South Santiam	Fall Creek (Willamette)
McKenzie	53	46	4	1	0	0	0	2
North Santiam	367	345	4	10	7		1	0
L North Santiam	4	--	0	2	1	1	0	0

[a] *McKenzie stock released in the lower Clackamas or Willamette rivers.*
[b] *South Santiam stock.*

Table 14. Number of snouts collected from carcasses of adult Spring Chinook salmon with adipose fin clips and a coded wire tag (determined with a hand-held detector), 2002.

River	Number of snouts
Middle Fork Willamette	95[a]
McKenzie	103[b]
South Santiam	320
North Santiam	131[c]
Molalla	34
Clackamas	16

[a] *Includes 31 collected in Fall Creek.*
[b] *Includes 48 collected below Leaburg Dam.*
[c] *Includes 2 collected in Little North Fork Santiam.*

<u>Task 2.1</u> Record the number of marked and unmarked fish that volitionally enter the hatcheries and broodstock collection facilities (McKenzie, Dexter, Minto and S. Santiam). [RPM 3,a]

A total of 32,303 Spring Chinook entered hatcheries and broodstock collection facilities in 2002 (Table 15). Of these, the vast majority were marked hatchery fish (91.8%). Males made up 56% of the collection and females 44%. Table 15 gives details of the status of Chinook that were captured at hatcheries and broodstock collection facilities. The released category includes both fish that were recycled, and fish that were released upstream of collection facilities. Most of the salmon collected were released alive (23,082, 71.4%). Table 16 shows details of the locations and magnitude of releases.

Table 15. Fate of Spring Chinook entering hatcheries and collection facilities.

Hatchery	Status	Male	Female	Jack	Total	% Mark	% UnMk
Marion Forks	Released	2,603	1,270	0	3,873	*84.9*	*15.1*
	Spawned	339	343	0	682	99.3	0.7
	Other dead				393	100.0	0.0
	Total	*2,942*	*1,613*	*0*	*4,948*	87.0	13.0
S. Santiam	Released	3,020	2,398	23	5,441	*87.0*	*13.0*
	Spawned	605	623	38	1,266	95.5	4.5
	Other dead	281	276	15	572	99.6	0.4
	Total	3,906	3,297	76	7,279	88.1	11.9
Dexter	Released	5,137	3,193	154	8,484	90.5	9.5
	To Willamette	902	1,022	7	1,931	97.2	35.7
	Dead	111	92	7	210	100.0	0.0
	Total	*6,150*	*4,307*	*168*	*10,625*	91.9	8.1
Willamette	Spawned	772	795	0	1,567	96.7	3.3
	Other dead	73	292	0	365	---	---
	Total	*845*	*1,087*	*0*	*1,932*	---	---
McKenzie	Released	2,644	1,916	51	4,611	*98.4*	*1.6*
	Spawned	500	500	0	1,000	90.3	9.7
	Other dead	624	584	13	1,221	98.5	1.5
	Total	*3,768*	*3,000*	*64*	*6,832*	97.2	2.8
Leaburg Trap	Released	325	341	7	673	100.0	0.0
	Dead	7	7	0	14	100.0	0.0
	Total	*332*	*348*	*7*	*687*	*100.0*	*0.0*
Grand Total		**17,943**	**13,652**	**315**	**32,303**	**91.8**	**8.2**

Table 16. Releases of Spring Chinook captured in hatcheries and collection facilities.

Hatchery	Release Location	Male	Female	Jack	Total	% Mark	% UnMk
Marion Forks	ABOVE DETROIT	1,806	871	0	2,677	100.0	0.0
	ABOVE MINTO	474	255	0	729	74.3	25.7
	LITTLE N. FORK	283	116	0	399	0.0	100.0
	RECYCLED DOWN	40	28	0	68	100.0	0.0
	TOTAL	*2,603*	*1,270*	*0*	*3,873*	*84.9*	*15.1*
S. Santiam	SANTIAM R, S FK (downstream)	1,569	1,370	20	2,959	99.6	0.4
	CALAPOOIA R	233	118	0	351	100.0	0.0
	SANTIAM R, S FK (above Foster)	437	325	3	765	8.9	91.1
	WILEY CR	303	243	0	546	100.0	0.0
	THOMAS CR	261	200	0	461	100.0	0.0
	CRABTREE CR	217	142	0	359	100.0	0.0
	TOTAL	*3,020*	*2,398*	*23*	*5,441*	*87.0*	*13.0*
Dexter	LOST CR	10	10	0	20	100.0	0.0
	WILLAMETTE R, MID FK	1,966	1,308	56	3,330	99.0	1.0
	SALT CR	865	488	14	1,367	83.7	16.3
	WILLAMETTE R, N FK MID FK	2,296	1,387	84	3,767	85.5	14.5
	TOTAL	*5,137*	*3,193*	*154*	*8,484*	*90.5*	*9.5*
McKenzie	MCKENZIE R	56	16	1	73	0.0	100.0
	MOHAWK R	65	131	1	197	100.0	0.0
	MCKENZIE R, S FK	2,467	1,726	49	4,242	100.0	0.0
	TRAIL BRIDGE RES	56	43	0	99	100.0	0.0
	TOTAL	*2,664*	*1,916*	*51*	*4,611*	*98.4*	*1.6*
Leaburg Trap	MOHAWK R	8	12	0	20	100.0	0.0
	MCKENZIE R, S FK	300	312	7	619	100.0	0.0
	TRAIL BRIDGE RES	17	17	0	34	100.0	0.0
	TOTAL	*325*	*341*	*7*	*673*	*100.0*	*0.0*
	Total Releases	**13,749**	**9,118**	**235**	**23,082**	**90.1**	**9.9**

In 2002, a total of 4,515 Spring Chinook were spawned at hatcheries in the Upper Willamette ESU. Of these, 95% were marked hatchery fish. Otoliths were collected from all unmarked fish in the broodstock to confirm their origin. The otoliths are currently being read. The data should be available by April of 2003. A breakdown of spawned fish by hatchery is presented in Table 17. The highest incidence of unmarked fish in the broodstock was at McKenzie Hatchery where 9.7% of the fish spawned were unmarked. The ‘Dead’ category includes mortalities, fish that were killed to retrieve coded wire tags, fish that were given to food banks, diseased fish that were culled, and excess fish. Spawned fish are not included in this category. Details can be found in Table 18. The only transfer recorded was a transfer of 1,931 fish from the Dexter collection facility to Willamette Hatchery.

Table 17. Spring Chinook spawned at hatcheries in the Upper Willamette ESU in 2002.

Hatchery	Male	Female	Jack	Total	Mark	Unmark	% Mark	% UnMk
Marion Forks	339	343	0	682	677	5	99.3	0.7
S. Santiam	605	623	38	1,266	1,189	77	95.5	4.5
McKenzie	500	500	0	1,000	903	97	90.3	9.7
Willamette	772	795	0	1,567	1,513	54	96.7	3.3
Grand Total	**2,216**	**2,261**	**38**	**4,515**	**4,282**	**233**	**94.8**	**5.2**

Table 18. Spring Chinook captured in hatcheries and broodstock collection facilities that died or were killed. (Fish spawned are not included in these totals).

Hatchery	TYPE	Male	Female	Jack	Total	% Mark	% UnMk
Marion Forks	*CWT REC*	149	79	0	228	100.0	0.0
	MORTS	48	81	0	129	100.0	0.0
	BKD CULL	---	---	---	36	---	---
	TOTAL	---	---	---	*393*	---	---
S. Santiam	BURY	11	13	1	25	95.8	4.2
	CWT REC	13	20	3	36	100.0	0.0
	GIVE AWAY	4	3	0	7	100.0	0.0
	MORTS	81	90	10	181	100.0	0.0
	OTHER	172	150	1	323	100.0	0.0
	TOTAL	*281*	*276*	*15*	*572*	*99.6*	*0.4*
Dexter	*CWT REC*	*111*	*92*	*7*	*210*	*100.0*	*0.0*
McKenzie	GIVE AWAY	535	502	1	1,038	100.0	0.0
	MORTS	75	52	9	136	85.8	14.2
	EXCESS	14	30	3	47	100.0	0.0
	TOTAL	*624*	*584*	*13*	*1,221*	*98.5*	*1.5*
Leaburg	MORTS	7	7	0	14	100.0	0.0
Willamette	EXCESS	29	115	0	144	100.0	0.0
	MORTS	44	177	0	221	---	---
	TOTAL	*73*	*292*	*0*	*365*	---	---
Grand Total		**1,293**	**1,411**	**35**	**2,775**	**---**	**---**

<u>Task 2.2</u> Determine number and percentage of the natural-origin (unmarked) Spring Chinook run that are taken annually for broodstock purposes. If natural component is >10%, then notify NMFS. [RPM 3,b]

The size of the natural-origin (unmarked) Spring Chinook run can be estimated using a combination of passage data from ladders at Stayton Island in the North Fork Santiam and at Leaburg Dam on the McKenzie River, data from Chinook spawning ground surveys, and hatchery collection data (Table 19). In these calculations, the total reported for hatchery collection excludes fish that were recycled downstream and thus could appear as carcasses in spawning surveys. This is likely an underestimate since not all fish released would appear in one of those two counts. The total reported for naturally spawned carcasses includes only carcasses from areas that are below the fish passage monitoring facility at Leaburg Dam. Generally, only a small proportion of naturally spawning fish are recovered as carcasses, so combining these two statistics gives a very conservative minimum estimate of the number of unmarked Spring Chinook run. In all cases, the number of unmarked Chinook spawned falls well within 10% of even this conservative minimum estimate.

Table 19. Estimates of the total natural-origin Spring Chinook run.

Basin	Passage at Dams	Naturally Spawned Carcasses	Hatchery Collections	Total	10% of total	Unmarked Chinook Spawned
North Fork Santiam	1,233			1,233	123	5
South Fork Santiam		271	694[a]	965	97	77
McKenzie River	4,223	56[b]	191	4,470	447	97
Middle Fork Willamette		59	928	987	99	54
Total	5,456	386	1,813	7,655	766	233

[a] – Excludes fish released downstream of Foster Dam
[b] – Excludes carcasses above trapping facilities.

<u>Task 4.1</u> Record the date, number, length, sex and origin (hatchery vs. wild) of Spring Chinook spawned (by hatchery: McKenzie, Dexter, Minto, and S. Santiam). [RPM 5, c]

The number of Spring Chinook spawned, the sex ratio, and the mark rate are shown in Table 15 under Task 2.1. Length statistics for Spring Chinook spawned in hatcheries in the Upper Willamette ESU can be found in Table 20. Length data were collected for 4,401 adult Spring Chinook in the hatchery broodstock. Jacks were defined as Spring Chinook with a fork length less than 600 mm. Jacks made up a very small proportion of the broodstock (37 of 4,438), and were excluded from this analysis. Lengths ranged between 600 and 1,150 mm, with an overall average length of 801.2 ± 2.1 mm. Mean lengths among hatcheries were compared using a Kruskal-Wallis One-Way ANOVA on ranks followed by Dunn's pairwise multiple comparison method. There were significant differences in fork length among hatcheries, except between Marion Forks and McKenzie ($p<0.05$ for all comparisons). Mean lengths of marked and unmarked Chinook were also significantly different (t-Test, $p<0.001$). Among hatcheries, mean fork length was greatest at Marion Forks hatchery (825.7 ± 6.9 mm) and least at Willamette Hatchery (781.1 ± 2.9 mm; Figure 6). Mean fork length was greater for unmarked fish (823.4 ± 10.5 mm) than for marked fish of hatchery origin (800.0 ± 2.2 mm; Figure 7).

Table 20. Fork Length statistics from Upper Willamette hatchery broodstock, 2002.

Hatchery	Mark	Count	Min. (mm)	Max. (mm)	Mean (mm)	95% C.I.
Marion Forks	Unmk	5	740	860	792.0	40.8
Marion Forks	Marked	462	620	1,050	826.1	7.0
S. Santiam	Unmk	45	690	1,100	845.0	27.2
S. Santiam	Marked	1,180	600	1,150	800.6	4.1
McKenzie	Unmk	115	600	1,010	816.3	14.2
McKenzie	Marked	933	610	1,020	821.5	4.8
Willamette	Unmk	58	650	990	823.4	19.1
Willamette	Marked	1,603	600	1,060	779.6	2.9
Marion Forks	All	467	620	1,050	825.7	6.9
S. Santiam	All	1,225	600	1,150	802.2	4.1
McKenzie	All	1,048	600	1,020	821.0	4.6
Willamette	All	1,661	600	1,060	781.1	2.9
All	Unmk	223	600	1,100	823.4	10.5
All	Marked	4,178	600	1,150	800.0	2.2

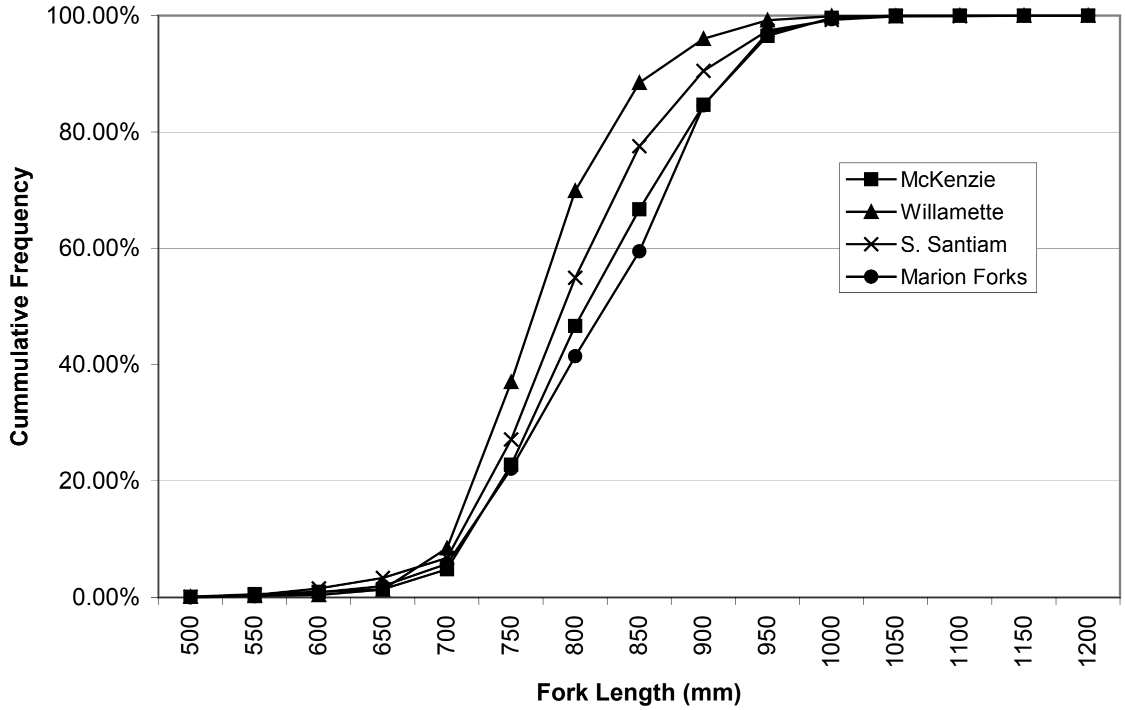

Figure 6. Cumulative frequency distributions of fork length for Spring Chinook hatchery broodstock: comparison among hatcheries.

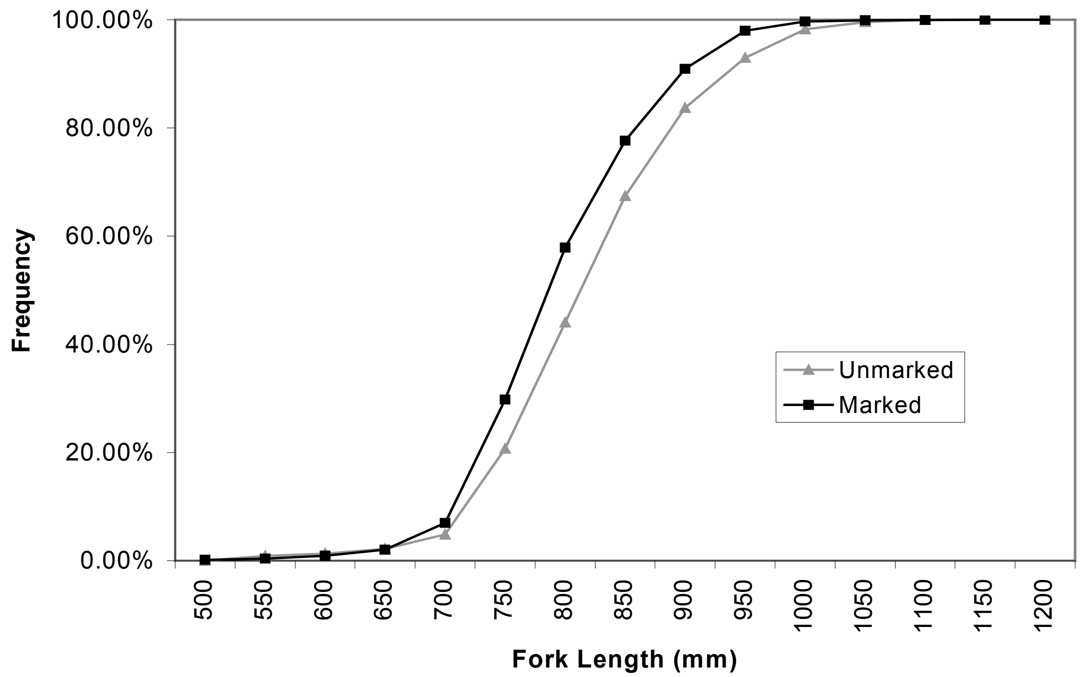

Figure 7. Cumulative frequency distributions of fork length for Spring Chinook hatchery broodstock: comparison between marked vs. unmarked fish.

<u>Task 3.1</u> Monitor the effects of hatchery rainbow stocking in the McKenzie Subbasin on listed Spring Chinook. Sample stomach contents of hatchery-produced Steelhead smolts and Rainbow Trout observed during creel surveys for adult Chinook and Steelhead.

This creel will be conducted in the spring of 2003.

<u>Task 3.2</u> Monitor the effects of the non-native Summer Steelhead program in the North and South Santiam and McKenzie rivers. Estimate the percentage of the Summer Steelhead run that is harvested and/or the number of Steelhead potentially spawning naturally in the streams. [RPM 4, e]

Steelhead passage can be monitored at Leaburg Dam on the McKenzie River and at the Upper and Lower Bennett Dams at Stayton Island on the North Santiam River. Summer Steelhead first began appearing at Stayton Island in late March of 2002, with peak migration occurring in June and July (Figure 8). Almost all of these fish were marked with a fin clip, although there was a small component of unclipped Steelhead that passed during this period. Unmarked Steelhead outnumbered marked Steelhead in late October and early November, but the fish passing during this time period made up a very small proportion of the total run. Scales were collected from all unmarked Steelhead to verify their origin.

At Leaburg Dam on the McKenzie River, Summer Steelhead began appearing in late April, with peak migration occurring in June and July (Figure 9). Marked fish outnumbered unmarked fish, but the proportion of unmarked fish in the McKenzie was greater than in the North Fork Santiam. However, since the total number of Summer Steelhead that passed Leaburg Dam was much lower than at Stayton Island (929 vs. 6,184; Table 21), the total number of unmarked Summer Steelhead passing Leaburg was less than at Stayton Island (199 vs. 371).

We are currently conducting spawning ground surveys to verify the number of Summer Steelhead that spawn naturally. We will also monitor Steelhead smolt emigration past Leaburg Dam in the spring of 2003.

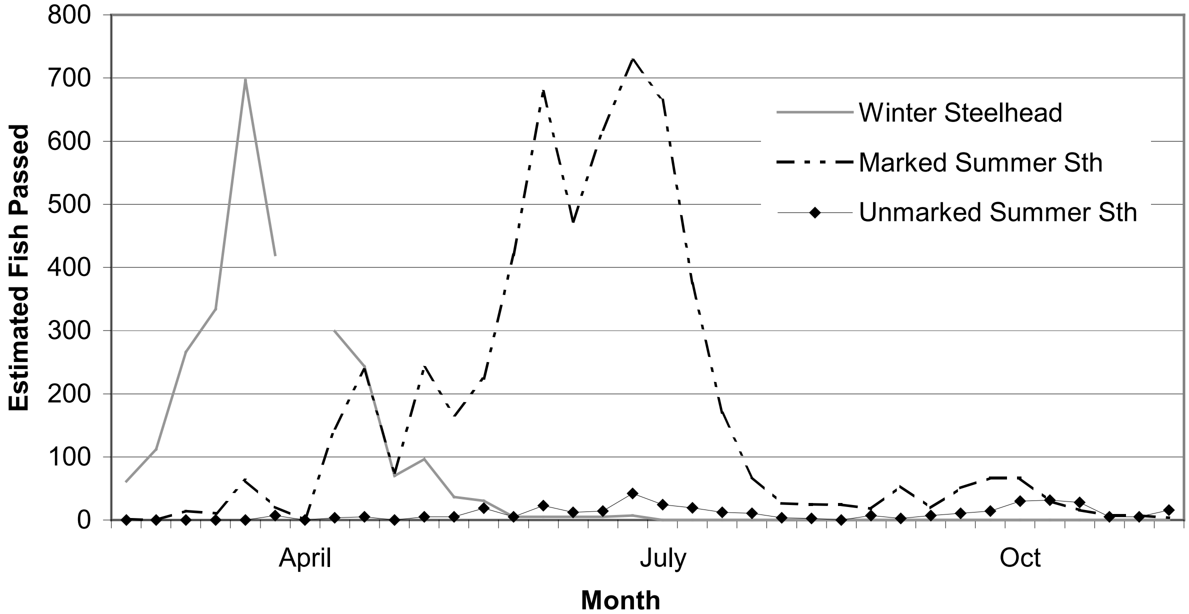

Figure 8. Steelhead run-timing at Stayton Island, N. Fk. Santiam River, 2002.

Table 21. Summer Steelhead passage at Stayton Island, North Santiam River, and Leaburg Dam, McKenzie River, 2002.

	North Santiam R.		McKenzie River	
Month	Marked	Unmarked	Marked	Unmarked
Mar	27	0	0	0
Apr	229	11	29	8
May	945	34	109	20
Jun	2,190	54	347	85
Jul	1,938	98	218	78
Aug	162	24	21	6
Sep	191	34	6	2
Oct	120	95	0	0
Nov	11	21	0	0
Total	**5,813**	**371**	**730**	**199**

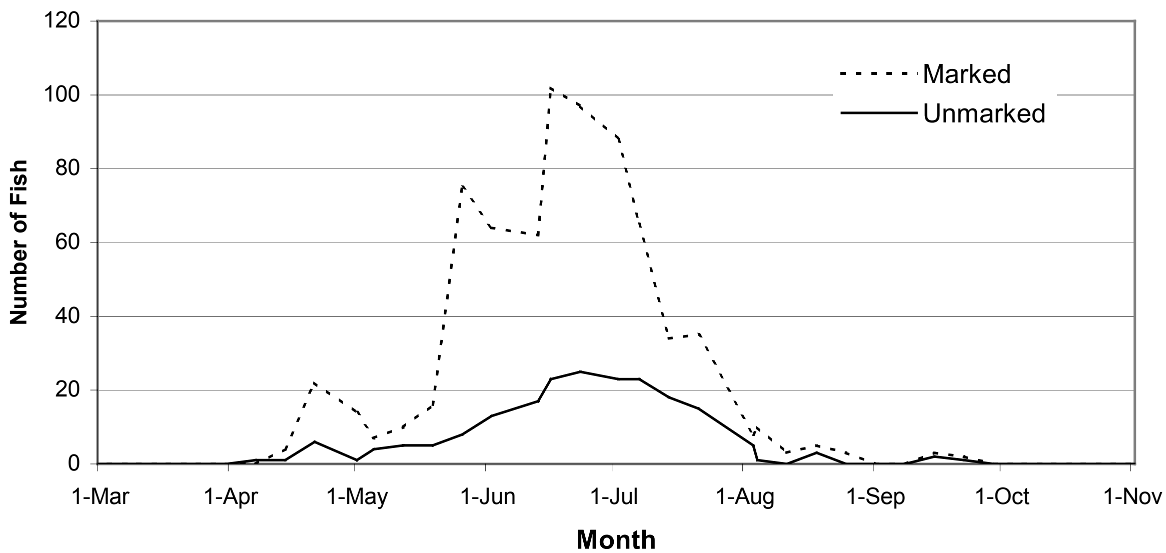

Figure 9. Steelhead run-timing at Leaburg Dam, McKenzie River, 2002.

Task 3.3 Conduct creels to determine the location and total catch of adipose fin-clipped and unmarked Spring Chinook in the North Santiam River, Middle Fork Willamette River, and McKenzie River.

Data are being analyzed. Results will be reported as soon as data are available.

Task 4.3 Assess impacts of the Foster Reservoir recreational trout fishery, created and sustained by the stocking of hatchery rainbow trout, on listed Steelhead and Spring Chinook. [Terms and Conditions s,e]

Data are being analyzed. Results will be reported as soon as data are available.

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