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INTRODUCTION

The Willamette and Sandy rivers support intense recreational fisheries for spring chinook salmon (*Oncorhynchus tshawytscha*). Fisheries in these basins rely primarily on annual hatchery releases of 5–8 million juveniles. Hatchery programs exist in the McKenzie, Middle Fork Willamette, North and South Santiam, Clackamas, and Sandy rivers mainly as mitigation for dams that blocked natural production areas. Some natural spawning occurs in most of the major basins and a few smaller tributaries upstream of Willamette Falls.

The Oregon Fish and Wildlife Commission adopted the Wild Fish Management Policy to reduce adverse impacts of hatchery programs on wild native stocks (ODFW 1992a). The main goal of the policy is to protect the genetic diversity of these stocks recognizing that genetic resources are a major component, not only in sustaining wild stocks, but also in perpetuating hatchery programs and the fisheries they support.

In the past, hatchery programs and fish passage issues were the focus of spring chinook salmon management in the Willamette and Sandy basins. Limited information was collected on the genetic structure among basin populations, on abundance and distribution of natural spawning, on rearing and migrating of juvenile salmon, or on strategies for reducing risks that large hatchery programs pose for wild salmon populations. This study is being implemented to gather this information. A schematic of the study plan is shown in **APPENDIX A**.

We conducted work in the main-stem Willamette River at Willamette Falls, and in the Middle Fork Willamette, McKenzie, North Santiam, South Santiam, Molalla, Clackamas, and Sandy rivers in 2002. Basin descriptions and background information on management and fish runs can be found in subbasin plans developed by the Oregon Department of Fish and Wildlife (ODFW 1988, ODFW 1992b, ODFW 1992c, and ODFW 1996). Task headings below cross reference the study plan outlined in **APPENDIX A.** This report covers tasks that were worked on in late 2001 through early fall 2002.

TASK 1.2–THE PROPORTION OF WILD FISH IN NATURAL SPAWNING POPULATIONS

Implementation of the Wild Fish Management Policy requires 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 in the Willamette basin, beginning with the 1997 brood, were marked with adipose fin clips. Although intentions were to mark all hatchery chinook, less than 100% of the returning adults will have an external mark for several reasons. First, a percentage of hatchery releases do not receive a clip because fin-clipping personnel do not clip the adipose fin or clip only a portion of the fin, which then regenerates. For example, about 3% of hatchery fish were released without a clip in a sample of 76 release groups from the 1996–1999 broods.

Second, fry and pre-smolts without fin clips have been released in the basin. Given the large numbers of hatchery fish released, even a small percentage of unmarked hatchery fish can bias estimates of wild spawners, especially because the number of wild fish in the basin is low. To help separate hatchery fish without fin clips from wild fish, otoliths were thermally marked on all hatchery spring chinook released into the McKenzie and North Santiam rivers in the 1995 and 1996 brood years, and on all Willamette basin releases beginning with the 1997 brood year. In 2002, all returning spring chinook salmon originating from Willamette basin hatcheries should be otolith marked, except for a small percentage of fish that return at age 6.

Methods

Juveniles

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 1).

Table 1. 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	--
Clackamas	1	Heated (48/48)	9.0–14.5	8	Marked at Willamette H.
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 had 24 hrs on chilled water and 24 hrs off chilled water.*
[d] *4 cycles were administered to eggs and 4 cycles to hatched fry.*

Adults

We collected otoliths from adult chinook salmon on spawning grounds and at hatcheries in most of the major tributaries in the Willamette and Sandy basins in 2002 (**APPENDIX B**). 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 in the Santiam basin for future genetic analysis to separate fall chinook from spring chinook (**APPENDIX B**). We also collected tissues from spring chinook salmon at hatcheries and in the upper McKenzie River for possible use as reference samples. Otoliths and tissues were removed from carcasses and placed into individually numbered vials. In addition, we collected otoliths from adult hatchery fish at Clackamas, Minto (North Santiam River), South Santiam, McKenzie, and Willamette hatcheries to serve as reference samples for blind tests of accuracy in identifying thermal marks (**APPENDIX B**). We also collected otoliths from unclipped fish at the hatcheries. Otolith samples will be sent to WDFW for analysis and will be reported in 2003.

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 2). 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 handheld 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 2. 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 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 cover the “noise” and 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 3). 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 laboratory also correctly identified 89–96% of wild fish as having no thermal marks (Table 3). The accuracy of correctly classifying wild fish was lowest in a sample of unclipped adults collected at Warm Springs National Fish Hatchery (Table 3). 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 3. 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 4). 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 4).

Table 4. 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.

	Count at dams		No clip carcasses	Estimated escapement		
Basin, run year	Not fin clipped	Fin clipped	with thermal marks (%)	Wild	Hatchery	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 at Bennett Dam was likely underestimated (*see *Schroeder et al. 2001).*

Recoveries of coded wire tags from carcasses found on spawning grounds in 2001 suggest little straying into the McKenzie and North Santiam rivers (Table 5). 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. In 2002, we collected almost 700 snouts from carcasses with adipose fin clips (Table 6). Coded wire tags recovered from these fish will be read and reported in 2003.

Table 5. Origin of hatchery spring chinook salmon from recoveries of coded wire tags in spawning ground surveys, 2001.

		Origin of coded wire tags recovered						
River surveyed	n	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 6. 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.*

TASK 1.3–DISTRIBUTION AND ABUNDANCE OF NATURAL SPAWNERS

We surveyed most of the major tributaries in the Willamette and Sandy basins 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. In areas where we regularly surveyed to collect otoliths from carcasses, we used the highest number of redds counted in any one survey as the total number of redds for an individual section.

The North Santiam River was regularly surveyed August 1–October 15 to recover carcasses and count redds. We observed some spawning activity 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 7). 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 7). 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 8), compared to 86% in 2001.

Abundance and migration timing of adult spring chinook were monitored at upper and lower Bennett dams in 2001 (Table 9 and Figure 1) with methods similar to previous years.

Table 7. Summary of spawning surveys for spring chinook salmon in the North Santiam River, 2002, and comparison to redd densities in 1996–2001.

Survey section	Length (mi)	Carcasses	Redds	Redds/mi 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 8. 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.*

Table 9. 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

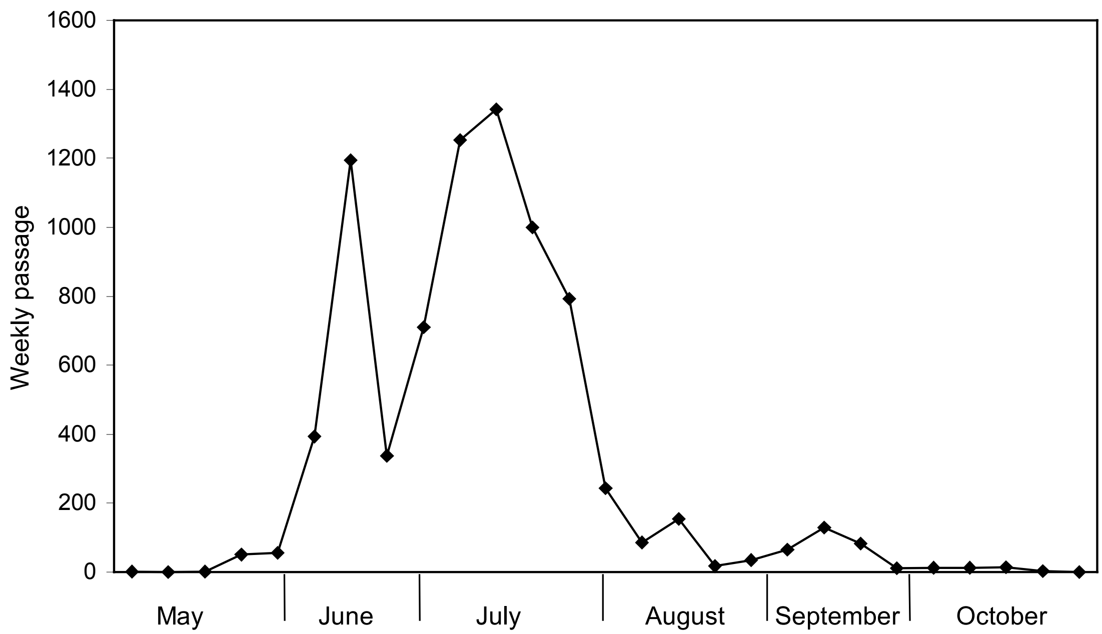

Figure 1. Weekly passage of spring chinook salmon at Upper and Lower Bennett dams on the North Santiam River, 2002.

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%). The percentage of females that died before spawning in other rivers was 26% in the South Santiam, 8% in the McKenzie, and 83% in the Middle Fork Willamette. 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 the carcass surveys below the dam. 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 began 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 10). 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 11).

Table 10. Summary of chinook salmon spawning surveys in the McKenzie River, 2002, and comparison to redd densities in 1996–1998 and 2000–2001.

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 11. 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.*

We regularly surveyed the Clackamas River basin above North Fork Dam September 17–October 16 to recover carcasses and count redds. Peak spawning generally occurred in late September, with the exception of the South Fork Clackamas River where peak spawning was in mid October. A higher percentage of redds was counted below Cripple Creek in 2002 (58%) than in 1996–1999 (34%), and redd densities were particularly high in the South Fork Clackamas River (Table 12). We accounted for a lower percentage of the spring chinook salmon run over North Fork Dam in 2002 (36%) than in 1996–1999 (53%) (Table 13). A higher percentage of the spring chinook run in the upper Clackamas River passed North Fork Dam in May–August in 2002 (68%) than in 1996–2001 (51%), which might increase the possibility of pre-spawning mortality in the earlier portion of the run. In addition, we may have underestimated redd numbers in some areas below Cripple Creek where surveyors frequently encountered multiple redds, which subsequently would result in an underestimate of the number of spawners. The Clackamas River below River Mill Dam was surveyed on September 11 and October 16. We counted more redds in the upper reach of this section than in previous years (Table 12). Scales collected from carcasses that could help separate spring chinook salmon from fall chinook salmon were not read at the time of this report, but in previous years the spring race composed 65 and 28% of the fish above and below Barton, respectively.

Table 12. Summary of spawning surveys for spring chinook salmon in the Clackamas River basin, 2002, and comparison to redd densities in 1996–1999.

Survey section	Length (mi)	Carcasses	Redds	Redds/mi 2002	1999	1998	1997	1996
Clackamas River:								
Sisi Creek–Forest Rd 4650	9.1	6	49	5.4	3.2	9.6	7.5	3.2
Forest Rd 4650–Collawash R.	8.0	2	38	4.8	4.1	7.0	5.9	4.1
Collawash R–Cripple Cr.	8.5	19	61	7.2	4.2	11.4	7.3	6.1
Cripple Cr.–South Fork	14.5	26	148	10.2	4.3	5.2	7.4	3.2
South Fork–Reservoir	1.0	0	15	15.0	1.0	7.0	17.0	
South Fork Clackamas:								
Falls–mouth	0.6	44	42	70.0	16.7	5.0	11.7	
Collawash River:								
Hot Springs Fork–mouth	6.5	4	7	1.1	0.8	5.7	6.4	1.6
Fish Creek:								
Forest Rd 5430–mouth	4.5	0	2	0.4		1.7	2.6	1.1
Roaring River:								
Falls–mouth	2.0	0	5	2.5		1.5	3.0	3.0
North Fork Clackamas:								
Mouth area	0.2	0	3	15.0		0.0	0.0	0.0
Below Faraday Dam:								
Free-flowing stretch	1.5	6	0	0.0				
Below River Mill Dam:								
McIver–Barton	9.5	62[a]	62[a]	6.5	3.9	3.4		
Barton–mouth	13.5	18[a]	4[a]	0.3	0.3	1.2		

[a] *Scales have not been read to separate spring chinook salmon from fall chinook salmon.*

Table 13. Counts of adult spring chinook salmon at North Fork Dam and the relationship to successful spawners in the Clackamas River basin above the dam, 1996–1999, 2002.

Year	Counts: North Fork Dam[a]	Total Redds	Spawners[b]	Fish/redd[c]
1996	824	182	364	4.53
1997	1261	376	752	3.35
1998	1382	380	760	3.64
1999	818	212[d]	424	3.86
2002	2154	370	740	5.82

[a] *Total from video counts (1996–1998) or fishway trap counts (1999, 2002) up to one week prior to last spawning survey.*
[b] *Estimated from redds using 1:1 sex ratio and two fish per redd.*
[c] *From dam count minus harvest divided by redds.*
[d] *Expanded by 5% to account for areas not surveyed. 95% of all redds in 1996–1998 were counted in the 1999 surveyed area. 22 redds were added to account for spawning of live fish that were counted on the last survey.*

We regularly surveyed the Sandy River basin above Marmot Dam September 11–October 18 to recover carcasses and count redds (Table 14). Peak spawning generally occurred in early to mid October. A lower percentage of redds in the basin was counted in the Salmon River in 2002 (69%) than in previous years (81%), and a higher percentage of redds was counted in Still Creek and the Zigzag River in 2002 (28%) than in previous years (16%). We accounted for a similar percentage of the spring chinook salmon run over Marmot Dam in 2002 (47%) as in 1996 and 1997 (45%) (Table 15).

Table 14. Summary of spawning surveys for spring chinook salmon in the Sandy River above Marmot Dam, 2002, and comparisons to redd densities in 1996–1999.

Section	Length (mi)	Carcasses	Redds	Redds/mi 2002	1999	1998	1997	1996
Salmon River:								
Final Falls–Forest Rd 2618	3.2	19	53	16.6	19.1	66.6	57.8	39.7
Forest Rd 2618–Bridge St.	3.6	12	33	9.2	9.4	15.3	12.2	19.7
Bridge St.–Highway 26	6.2	85	95	15.3	20.0	52.3	45.2	41.5
Highway 26–mouth	0.6	10	9	15.0		15.0		
Still Creek:								
Cool Creek– mouth	3.3	35	62	18.8	10.0	27.9	33.3	19.4
Zigzag River:								
Camp Creek– mouth	4.0	4	15	3.8		2.5	18.8	
Lost Creek:								
Riley Campground–mouth	2.0	7	6	3.0		6.5	4.0	6.0
Camp Creek:								
Campground–mouth	2.0	0	1	0.5		4.5	6.0	3.0
Clear Fork Creek:								
Barrier–mouth	0.6	1	0	0.0		28.3	5.0	15.0
Clear Creek:								
E. Barlow Rd–mouth	0.5	0	0	0.0		0.0	0.0	2.0

Table 15. Counts of adult spring chinook salmon at Marmot Dam and the relationship to successful spawners in the Sandy River basin above the dam, 1996–1999, 2002.

	Counts				
Year	Marmot Dam[a]	Harvest[b]	Total Redds	Spawners[c]	Fish:redd[d]
1996	2461	78	569	1138	4.19
1997	3277	233	731	1462	4.16
1998	2606	185	744	1488	3.25
1999	1828		310[e]	620	5.90
2002	1159		274	548	4.23

[a] *Total from video counts (1996–1998) or fishway trap counts (1999, 2002) up to one week prior to last spawning survey.*
[b] *Sandy River above dam from punchcard estimates. No fishery after 1998.*
[c] *Estimated from redds using 1:1 sex ratio and two fish per redd.*
[d] *From dam count minus harvest divided by redds.*
[e] *Expanded by 9% to account for areas not surveyed. 91% of all redds in 1996–1998 were counted in the 1999 surveyed area. 32 redds were added to account for spawning of live fish that were counted on the last survey.*

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 16), or than in the North Santiam (73%). In contrast, the percentage of fin-clipped carcasses was 39% in Fall Creek (Table 16). Most (93%) of the carcasses recovered in the Molalla River had fin clips.

TASK 2.1– MORTALITY IN A CATCH AND RELEASE FISHERY

We conducted a study of hooking mortality of spring chinook salmon in the lower Willamette River sport fishery in 1998–2000. A manuscript describing this study was submitted and accepted for publication (Lindsay et al. in press). The paper will be published in 2003.

Table 16. Summary of chinook salmon spawning surveys in the Middle Fork Willamette, South Santiam, Santiam, Calapooia, Molalla rivers and 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.*

TASK 3.1– EVALUATION OF NET PENS IN THE LOWER WILLAMETTE RIVER

In the 1970's, studies by Smith et al. (1985) found that trucking juvenile spring chinook salmon below Willamette Falls at Oregon City increased angler catch in the Clackamas and lower Willamette rivers by improving survival to adult. Straying also increased. However, Specker and Schreck (1980) found that trucking smolts caused severe stress that tended to reduce survival compared to fish not trucked. Johnson et al. (1990) and Seiler (1989) suggested that stress from trucking could be reduced and survival increased by acclimating juveniles at a site for several weeks before release. Acclimation at lower river sites may increase angler harvest by improving survival of juveniles and by delaying migration to upriver areas.

A study was begun in 1994 to determine if acclimation prior to release could be used to increase sport harvest of hatchery spring chinook salmon returning to the lower Willamette River. We used McKenzie River stock in the study because of concerns about straying of other stocks into the McKenzie, a stronghold for wild spring chinook salmon. The evaluation of straying was an important part of the study. Fish were acclimated in net pens and compared to fish trucked directly from the hatchery. Control groups were released into the McKenzie River from McKenzie Hatchery. The study was originally planned for 4 brood years. However, numerous problems led to modifications in study design beginning with the 1995 brood and an extension of the study for 4 additional years through 1999 brood releases. Releases from 1992–1999 broods are described in Lindsay et al. (1997), Lindsay et al. (1998, 2000), and Schroeder et al. (1999, 2001). The types of experimental groups released in all brood years are summarized in **APPENDIX D**.

Adult Recovery of 1992–1995 Brood Releases

Coded wire tags from experimental releases were primarily recovered in fisheries, in hatcheries, in traps at dams and on spawning grounds. Most of the sport fishery for spring chinook salmon in the Willamette River occurs below Willamette Falls. Although some catch of spring chinook salmon occurs above Willamette Falls, the fisheries generally are not surveyed. Based on salmon catch card records, the fishery above Willamette Falls accounted for about 30% of the total basin harvest annually in 1981–1995 (calculated from Foster 2001). Adult recoveries from 1992 through 1995 broods are reported in Tables 17–20. Data for 1992–1994 broods are largely complete; data for 1995 brood are incomplete.

Several tentative conclusions can be reach based on tag recoveries reported to date. First, smolt releases into the lower Willamette River did not increase sport catch. Sport catch below the falls of control fish released from McKenzie Hatchery was equal to or higher than catch of fish from groups acclimated or released directly into the lower main-stem Willamette. Second, fish released into the lower Willamette River tended to stray. The highest straying was between the Clackamas and McKenzie rivers, but some fish were found in most other tributaries as well. Third, based on hatchery recoveries, fish released into Clackamette Cove returned mainly to the Clackamas River. Finally, in general, groups released into the Cove strayed less than the same groups released into the Willamette or the Clackamas rivers.

Table 17. Recovery of 1992 brood spring chinook salmon from the net pen evaluation in the lower Willamette basin. Numbers were adjusted to a standard release of 100,000 smolts. Tag recoveries were obtained from databases of the Pacific States Marine Fisheries Commission, November 2002.

		Willamette River			
		Fall release		Spring release	
Recovery location	McKenzie control	Accli-mated	Direct	Accli-mated	Direct
Fisheries:					
Ocean	13	--	--	20	0
Columbia River	2	--	--	0	0
Willamette below the falls	25	--	--	3	0
(% in Clackamas River)	(8)	--	--	(0)	--
Hatcheries:					
McKenzie	185	--	--	10	5
Clackamas	1	--	--	12	0
Other	1	--	--	2	0
Spawning areas:					
McKenzie River	3	--	--	0	0
Clackamas River	0	--	--	0	0
Other	0	--	--	0	0
Leaburg Dam	7	--	--	0	0
Misc. Willamette[a]	2	--	--	0	0

[a] *Includes dead fish found immediately below Willamette Falls, fish sampled in Willamette Falls fishway, and fish caught in treaty test fishery.*

Table 18. Recovery of 1993 brood spring chinook salmon from the net pen evaluation in the lower Willamette basin. Numbers were adjusted to a standard release of 100,000 smolts. Tag recoveries were obtained from databases of the Pacific States Marine Fisheries Commission, November 2002.

		Willamette River			
		Fall release		Spring release	
Recovery location	McKenzie control	Accli-mated	Direct	Accli-mated	Direct
Fisheries:					
Ocean	16	41	3	5	1
Columbia River	1	1	2	3	0
Willamette below the falls	15	16	14	16	0
(% in Clackamas River)	(33)	(62)	(36)	(75)	--
Hatcheries:					
McKenzie	149	57	8	13	8
Clackamas	1	32	5	8	2
Other	0	5	1	2	1
Spawning areas:					
McKenzie River	4	2	1	0	0
Clackamas River	0	2	0	0	0
Other	0	0	0	0	0
Leaburg Dam	7	5	2	2	1

Table 19. Recovery of 1994 brood spring chinook salmon from the net pen evaluation in the lower Willamette basin. Clackamas stock was used for all groups except the control, which was McKenzie stock. Numbers were adjusted to a standard release of 100,000 smolts. Tag recoveries were obtained from databases of the Pacific States Marine Fisheries Commission, November 2002.

Recovery location	McKenzie control	Willamette River fall release: Accli-mated	Willamette River fall release: Direct	Clackamas River spring release: Cove acclimated	Clackamas River spring release: Cove direct
Fisheries:					
Ocean	0	47	0	0	5
Columbia River	0	5	0	1	0
Willamette below the falls	20	7	0	4	5
(% in Clackamas River)	(0)	(0)	--	(100)	(0)
Hatcheries:					
McKenzie	144	24	8	0	0
Clackamas	0	37	3	14	15
Other	0	10	2	0	1
Spawning areas:					
McKenzie River	4	3	2	0	1
Clackamas River	0	3	0	0	3
Other	0	2	0	0	0
Leaburg Dam	8	2	0	0	0
Misc. Willamette[a]	0	4	0	0	0

[a] *Includes dead fish found immediately below Willamette Falls and fish sampled in Willamette Falls fishway.*

Table 20. Recovery of 1995 brood spring chinook salmon from the net pen evaluation in the lower Willamette basin. Numbers were adjusted to a standard release of 100,000 smolts. Tag recoveries were obtained from databases of the Pacific States Marine Fisheries Commission, November 2002. Data are preliminary.

		Multnomah Channel		Clackamas River				
		Spring release		Fall release			Spring release	
Recovery location	McKenzie control	Accli-mated	Direct	Cove-acclimated	Cove-direct	River-direct	Cove-acclimated	Cove-direct
Fisheries:								
Ocean	20	--	7	10	10	15	4	0
Columbia River	1	--	0	3	2	0	0	0
Willamette below the falls	19	--	3	19	24	22	13	0
(% in Clackamas River)	(0)	--	(0)	(26)	(38)	(32)	(15)	--
Hatcheries:								
McKenzie	124	--	9	2	3	29	0	0
Clackamas	0	--	0	14	34	25	14	5
Other	0	--	0	0	10	5	0	0
Spawning areas:								
McKenzie	2	--	0	0	0	0	0	0
Clackamas	0	--	0	0	0	0	0	0
Other	0	--	0		0	0	0	0
Leaburg Dam	22	--	2	0	0	0	0	0

TASK 4.1– MIGRATION TIMING OF WILD JUVENILE SPRING CHINOOK SALMON

We started field work in 1999–2000 under Objective 4 of our project study plan (**APPENDIX A**). Information collected under Objective 4 will allow managers to better understand spatial and temporal use of habitat by juvenile wild spring chinook in the Willamette basin and to better protect existing natural production areas. Initial work was begun on wild chinook in the McKenzie River. Three life history types of wild chinook were defined at Leaburg Dam on the McKenzie: age 0 fry that migrate in late winter through early spring, age 0 fingerlings that migrate in fall, and yearling smolts that migrate in early spring. Initial work has concentrated on determining juvenile migration timing of these three life history stages below Leaburg Dam in the McKenzie and Willamette rivers.

Methods

We used PIT tags (Prentice et al. 1990a, 1990b) to monitor migration of juvenile spring chinook salmon in the McKenzie and Willamette rivers. We injected fish with 134.2 kHz tags, and used a tag detector (Destron-Fearing® FS2001F), a laptop computer, and a computer program developed by Pacific States Marine Fisheries Commission (PSMFC) to enter data. All tagging data were loaded into a PIT tag database (PTAGIS) maintained by PSMFC.

Age 0 juvenile chinook salmon migrating in fall 2001 were collected in a bypass trap at Leaburg Dam. Yearling smolts migrating in spring 2002 were collected with a rotary screw trap installed in the Leaburg Dam bypass flume. The bypass trap could not be used to collect yearlings because fry, which migrate past Leaburg Dam at the same time as yearlings, are impinged on diversion screens in Leaburg Canal when the bypass trap is operated. Age 0 chinook salmon representative of the fry migrants were seined and tagged in the lower McKenzie and upper Willamette rivers in June and July because fry are too small to tag when they migrate past Leaburg Dam in February–April. We confined our sampling to the lower McKenzie and upper Willamette rivers downstream of spawning reaches to insure the juvenile chinook salmon we tagged had migrated. We also tagged a sample of hatchery fish that were released in the fall and spring from McKenzie Hatchery. In addition, we seined in sections of the Willamette River from Harrisburg to Newburg and in the Santiam River below the I-5 bridge. Some of these chinook salmon were injected with PIT tags and some were collected for genetic identification to determine their race (spring or fall).

Migrating juvenile chinook salmon were scanned with a tag detector (Destron-Fearing® FS1001) at Willamette Falls in the bypass system of the Sullivan hydroelectric plant operated by Portland General Electric Company (PGE). Only a portion of the juvenile salmon migrating past Willamette Falls uses the bypass system (Royer et al. 2001). Additional tags were detected and reported by the National Marine Fisheries Service during their juvenile salmonid studies in the Columbia River estuary (Ledgerwood et al. 2000).

Because most of our tags were detected by passive interrogation, we did not measure growth between time of tagging and time of detection, with the exception of juvenile chinook salmon seined and recaptured within the lower McKenzie and upper Willamette rivers. We used fork lengths (FL) of individual fish at the time they were tagged to examine differences between the mean length of all tagged fish and the mean length of detected fish. We compared the difference in mean length by considering all tagged fish as a known population (N) and the detected fish as a sample (n) of N. We statistically analyzed differences in mean length by calculating a *t* value using the following equation:

$$\frac{(\overline{FL}_N - \overline{FL}_n)}{\sqrt{v_n(1-p)/n}}$$

where $\overline{FL}_N$ is the mean length of all juvenile fish given PIT tags, $\overline{FL}_n$ is the mean length at the time of tagging of fish that were later detected, v_n is the variance of the mean length of detected fish, and p is the detection rate of tagged fish (Willamette Falls and Columbia River). The square root of 1-p is the finite population correction (Snedecor and Cochran 1980).

Results

We tagged over 6,800 wild spring chinook salmon in the McKenzie and Willamette rivers and about 2,000 hatchery fish from McKenzie Hatchery in October 2001–March 2002 (Table 21). In addition, we tagged over 3,400 age 0 wild chinook salmon in the lower McKenzie and upper Willamette rivers in summer 2002 (Table 22). Most of the age 0 fish will be recaptured as migrants in the next report period (2002–2003), although we detected two fish at Willamette Falls in July, 14 days after they had been tagged and released. This was the first year we operated the Sullivan Plant interrogator through the summer.

We also tagged 487 age 0 wild chinook salmon in the lower Santiam River and 225 in the lower Willamette River in summer 2002 (Table 22). Tissue samples from some of these fish will be examined to determine if they are spring or fall chinook salmon. We detected 13 lower Santiam fish and 3 lower Willamette fish at Willamette Falls 4–13 days after they had been tagged and released.

Most of the fish that migrated during the report period were tagged in 2001 and spring 2002 and most were detected at Willamette Falls (Table 21). Detection rates at Willamette Falls generally decreased in 2001–2002 from 2000–2001 (Table 23). River flow affects the efficiency of the passive interrogator by affecting the proportion of juveniles that uses the bypass system at the Sullivan Plant and by affecting the amount of debris that moves through the bypass system. In high flows, fewer fish migrate through the bypass system and the interrogator is more difficult to operate because of debris, particularly during high flows in November–January (Table 24).

Table 21. Detection of juvenile wild and hatchery spring chinook salmon given PIT tags and released, 2001–2002. Tags were detected at the PGE Sullivan Plant at Willamette Falls unless noted.

	Leaburg Dam	Leaburg Dam	McKenzie River	Willamette River	McKenzie Hatchery	McKenzie Hatchery
	Oct 26 –Nov 23, 2001 (3017)	Feb 14 –Apr 3, 2002 (1007)	Jul 9–Aug 2, 2001 (1897)	Jul 2–31, 2001 (922)	Nov 7, 2001 (997)	Mar 6, 2002 (998)
Month tag detected						
September[a]	--	--	0	0	--	--
October	0	--	20	6	--	--
November	0	--	3	1	89	--
December	0	--	0	0	0	--
January	0	--	0	0	0	--
February	10	--	3	0	0	--
March	5	7	1	0	1	22
April	8	17	1	0	3	2
May	4[b]	62[c]	0	0	1	0
June	0	5	0	0	0	0
Detection rate at Willamette Falls (%)	0.9	8.5	1.5	0.8	9.4	2.4
95% CI	0.5–1.3	7.3–9.8	0.9–2.0	0.4–1.2	8.1–10.7	1.7–3.1
Median days to Willamette Falls	127	53	101	91	9	6
Mean length (mm) at time of tagging for—						
Fish released	96.8	94.9	94.8	94.4	159.8	156.2
Fish detected	93.7	93.9	101.4	102.1	171.4	150.2

[a] *Sullivan Plant tag detector started September 27, 2001 and operated through September 30, 2002 with occasional shutdowns.*
[b] *Includes five fish detected in Columbia River estuary (RM 47), does not include three fish detected in Columbia River estuary that were previously detected at Willamette Falls 4, 4, and 7 days earlier.*
[c] *Does not include one fish detected in Columbia River estuary that was previously detected at Willamette Falls 6 days earlier.*

Table 22. Number of wild spring chinook salmon (age 0) that were seined, PIT-tagged, and released in the McKenzie River below Hendricks Bridge (RM 21), in the Willamette River above and below the Santiam River, and in the lower Santiam River below the I-5 bridge (RM 6), July–September 2000, July–August 2001, and June–July 2002.

	Number tagged			Mean length (mm)		
River	2000[a]	2001	2002	2000	2001	2002
McKenzie	650	1897	1848	109.1	94.8	84.8
Upper Willamette	796	937[b]	1606	113.7	94.4	83.3
Lower Willamette			225			90.6
Santiam			487			90.3

[a] *An additional 67 and 136 hatchery fish were seined and tagged in the McKenzie and Upper Willamette rivers, respectively.*
[b] *Does not include four hatchery fish*

Table 23. Detection rate (%) at Willamette Falls of spring chinook salmon that were seined, PIT-tagged, and released in the McKenzie and Willamette rivers, October 1999–October 2002.

	Summer		Fall		Spring	
Years	McKenzie River	Willamette River	McKenzie wild	McKenzie hatchery	McKenzie wild	McKenzie hatchery
1999–2000			1.3	4.4		
2000–2001	3.7	0.8	6.9	11.7	14.1	
2001–2002	1.5	0.8	0.9	9.4	8.5	2.4

Table 24. Percentage of days in November–January the PIT tag interrogator at the PGE Sullivan Plant was operational and November–January monthly flow, 1999–2002. Dates of operation for 2001–2002 are listed in **APPENDIX D**.

Years	Percent operational	Flow (cfs)	Percent of average flow[a]
1999–2000	48	43,807	104
2000–2001	100	13,691	33
2001–2002	55	42,486	103

[a] *Post-1965 November, December, and January monthly flow.*

Almost all the wild spring chinook salmon tagged as age 0 fish in summer 2001 migrated in the fall, whereas all the wild chinook tagged in fall 2001 migrated the following spring (Figure 2). In contrast, fish tagged in the summer and fall 2000 both migrated primarily in the spring. The migration of hatchery fish peaked at Willamette Falls shortly after their release (Figure 2). The peak migration at Willamette Falls of chinook salmon smolts tagged in the spring was in May (Figure 2). Although the migration of wild smolts was relatively rapid, their median travel time was much longer than that of hatchery fish (Table 21). The median travel time of wild chinook salmon tagged in fall and spring 2001–2002 was about the same as the travel time in 2000–2001. In contrast, the travel time of wild chinook salmon tagged in summer and of hatchery fish released in fall was shorter in 2001–2002 than in 2000–2001.

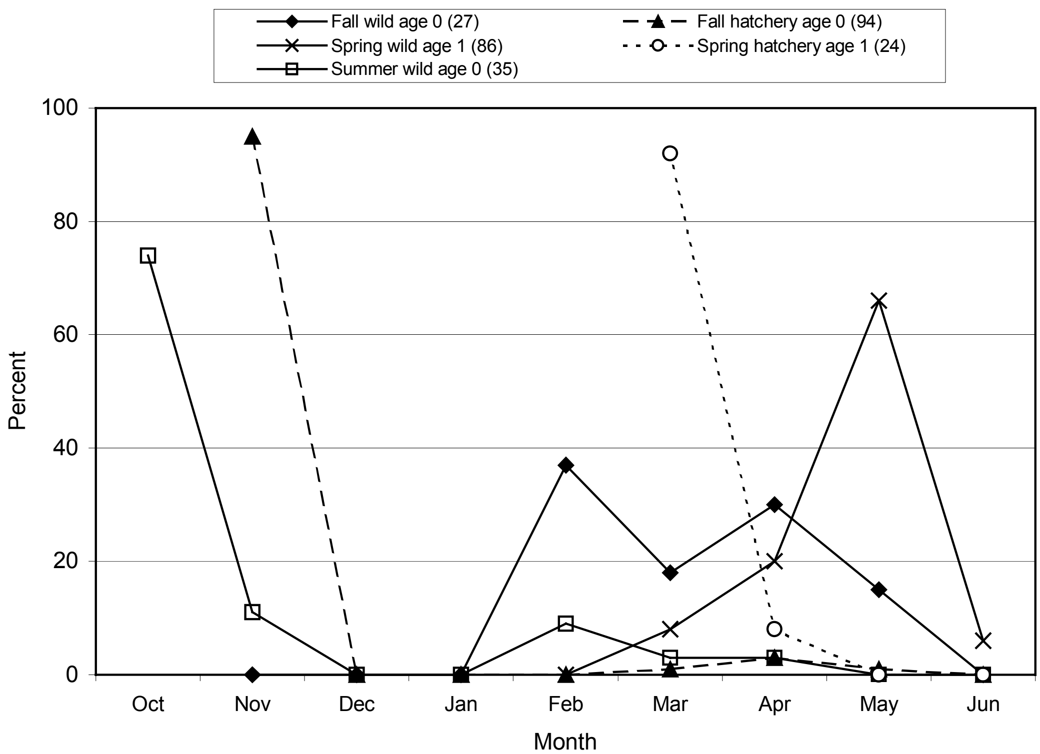

Figure 2. Migration timing of juvenile spring chinook salmon past Willamette Falls, 2001–2002. Based on detection of fish given PIT tags in the McKenzie and upper Willamette rivers. The number of detected tags is given in parentheses in the legend.

The mean fork length of tagged juvenile chinook salmon that were later detected was significantly larger (P <0.05) than the mean fork length of all fish tagged for wild fish released in summer and for hatchery fish released in fall (Table 21). We saw no significant differences between the mean length of detected fish and the mean length of all tagged fish for the other groups. However, within tag groups, larger fish generally migrated faster than smaller fish (Figure 3).

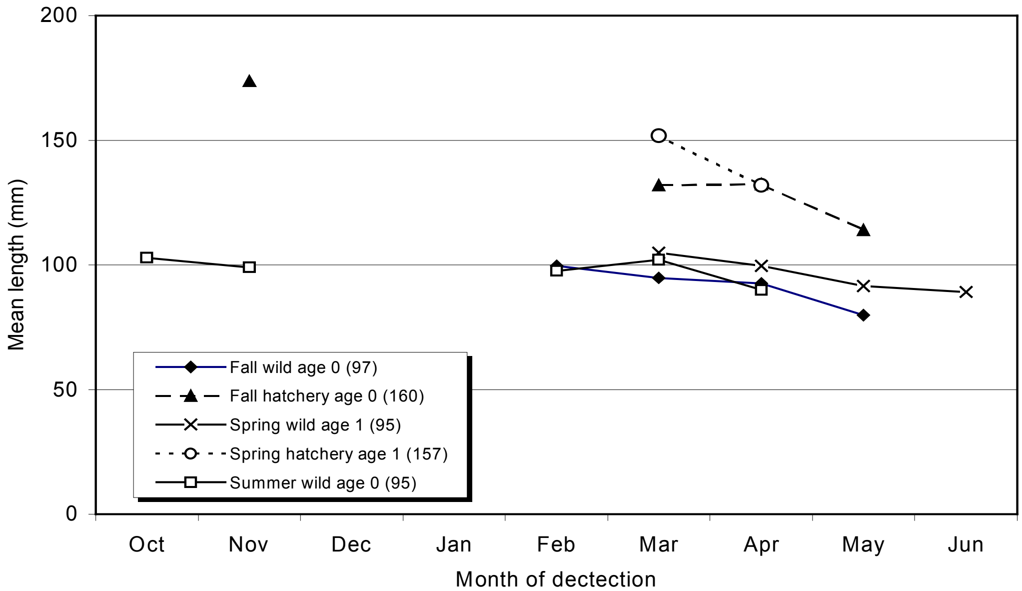

Figure 3. Mean lengths (measured at time of tagging) by month of PIT-tagged juvenile chinook salmon that were later detected at Willamette Falls, 2001–2002. The mean length of all fish tagged by group is shown in parentheses in the legend.

Age 0 chinook salmon were found throughout the lower McKenzie, upper and lower Willamette, and lower Santiam rivers. However, chinook salmon in the Willamette River downstream of the Santiam and in the Santiam River could be fall chinook salmon. Of the spring chinook salmon seined in the Willamette River upstream of the Santiam (1808), 85% were caught from Harrisburg to the McKenzie River where our effort was concentrated. The catch of juvenile chinook salmon has been highest in the McKenzie River and lowest in the Willamette River below Harrisburg (Table 25).

The mean length of spring chinook salmon seined in 2002 increased in the Willamette River from late June to late July (80.6 to 89.5 mm; $P<0.001$), but did not increase significantly in the McKenzie River (86.2 to 87.2 mm; $P = 0.98$). The mean length of all tagged fish in 2002 was similar in both rivers (83–85 mm). The mean length of spring chinook salmon captured in similar locations and on similar dates was smaller in 2002 than in 2001 (Table 26).

Table 25. Catch rate with a beach seine (fish/seine set) of juvenile chinook salmon in the Willamette, McKenzie, and Santiam rivers, 2000–2002.

	Willamette River				
Dates	Newburg–Santiam R.	Santiam R.–Harrisburg	Harrisburg–McKenzie R.	McKenzie River	Santiam River
Jun 19–Jul 31, 2002	3.4	11.0	16.6	22.0	10.2
Jul 2–Aug 9, 2001		1.4	6.1	10.9	
Jul 25–Sep 11, 2000		3.8	4.1	5.3	

Table 26. Comparison of mean fork lengths of wild spring chinook salmon seined in sections of the McKenzie and Willamette rivers on similar dates, 2001 and 2002.

River, area, date	N	Mean length (mm)	Standard deviation	*t*	*P*
McKenzie River:					
Mouth–Interstate 5 bridge					
July 9–11, 2001	703	95.4	11.42	12.42	<0.001
July 8–9, 2002	514	87.7	9.54		
Willamette River:					
Harrisburg–Marshall Island					
July 12, 2001	53	93.5	13.96	1.93	0.06
July 11, 2002	158	90.3	8.60		
Marshall Island–McKenzie River					
July 16, 2001	186	92.5	10.91	7.63	<0.001
July 18, 2002	244	85.7	7.61		
July 30, 2001	92	94.9	11.95	3.51	<0.001
July 25, 2002	96	89.5	9.18		

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APPENDIX A

Schematic of Willamette Spring Chinook Salmon Study Plan

MANAGEMENT GOAL: A management strategy for spring chinook salmon in the Willamette and Sandy basins that (1) protects the genetic integrity of natural populations, and (2) maintains sport and commercial fisheries and the programs that support them.

STUDY PLAN OVERVIEW
(see proposal for details)

To Achieve this Goal, R&D will Help Managers:

OBJ. 1

Determine the numerical status of existing natural populations and develop methods for monitoring that status. Determine if these populations belong to one or more gene conservation groups.

- **1.1.** Determine if Sandy and Clackamas ChS belong to the same gene conservation group as ChS above the falls
- **1.2.** Estimate the proportion of wild fish in spawning populations
- **1.3.** Develop annual indexes for monitoring natural spawner abundance of ChS
- **1.4.** Establish escapement goals for natural production in Willamette subbasins and in the Sandy

OBJ. 2

Decrease mortality of wild fish in fisheries by determining feasibility of catch and release sport fisheries and by exploring options for reducing mortality in commericial fisheries.

- **2.1.** Estimate sport angling mortality of caught and released fish
- **2.2.** Estimate mortality that would occur from finclipping hatchery fish so that anglers could tell hatchery from wild
- **2.3.** Evaluate other mass marking techniques so anglers can identify hatchery adults in sport fisheries
- **2.4.** Explore options with Salmon Program Mgr. and Columbia River Mgt for reducing mortality of wild fish in commericial fisheries

OBJ. 3

Reduce the risk that large hatchery programs pose for natural populations by developing ways of decreasing interactions between wild and hatchery in streams and by determining need for more wild fish in hatchery broodstocks

- **3.1.** Evaluate fishery contribution and straying from netpen releases below the falls
- **3.2.** Determine if hatchery fish released in the fall overwinter, potentially competing with wild ChS
- **3.3.** Explore options for trapping hatchery ChS above or near traditional fisheries but below wild spawning areas
- **3.4.** Determine need and look at ways of incorporating wild fish into hatchery broodstock
- **3.5.** Look at overlap of spawning between fall and ChS

OBJ. 4

Protect existing natural production areas by defining temporal and spatial use patterns by life stages of ChS and identify the habitat/environmental attributes conducive to that use.

- **4.1.** Document distribution of spawning and rearing, timing of emergence and migration in basins used by ChS
- **4.2.** Identify ChS habitat & environmental attributes
- **4.3.** Identify life histories and the habitat/environment critical to maintaining them

OBJ. 5

Increase natural production by improving habitat in existing production areas and by re-establishing populations where they were found historically.

- **5.1.** Identify opportunities to re-establish populations and to improve habitat
- **5.2.** Estimate the potential of Willamette/Sandy (post-dam) to produce wild ChS
- **5.3.** Evaluate current efforts to re-establish ChS (S. Santiam above dams, Thomas, Crabtree, and Calapooia)

APPENDIX B

Tissues and Otoliths Collected from Adult Spring Chinook Salmon, 2002

Appendix Table B-1. Tissue samples collected from adult spring chinook in the Willamette and Sandy basins, 2002.

Basin and location	Group	Number
Middle Fork Willamette:		
Dexter–Jasper	Not clipped	2
Willamette Hatchery	AD clipped	31
McKenzie:		
Carmen–Smith spawning channel	Not clipped	28
Ollalie Boat Ramp–McKenzie Trail	Not clipped	42
Horse Creek	Not clipped	1
Lost Creek	Not clipped	3
McKenzie Hatchery	AD clipped	50
South Santiam:		
Foster–Pleasant Valley	Not clipped	74
Pleasant Valley–Waterloo	Not clipped	23
Lebanon–mouth	Not clipped	4
South Santiam Hatchery	AD clipped	30
South Santiam Hatchery	Not clipped	15
North Santiam:		
Minto–Fishermen's Bend	Not clipped	28
Fishermen's Bend–Mehama	Not clipped	7
Mehama–Stayton Island	Not clipped	8
Stayton Island–Stayton	Not clipped	10
Stayton–Greens Bridge	Not clipped	1
Little North Santiam	Not clipped	2
Minto collection pond	AD clipped	50
Santiam:		
Confluence of North and South–mouth	Not clipped	5
Molalla:		
Trout Creek–Copper Creek	Not clipped	1
Clackamas:		
Above North Fork Dam	Not clipped	2
Below River Mill Dam	Not clipped	16
Clackamas Hatchery (Clackamas stock)	AD clipped	38
Sandy:		
Clackamas Hatchery (Sandy stock)	Not clipped	50

Appendix Table B-2. Otoliths collected from adult spring chinook salmon in the Willamette and Sandy basins, 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

Appendix Table B-2. Continued.

Basin and location	Group	Number
Clackamas:		
Sisi Creek–Collawash River	Not clipped	7
Collawash River–Cripple Creek	Not clipped	18
Cripple Creek–reservoir	Not clipped	25
South Fork Clackamas	Not clipped	43
Below Faraday Dam	Not clipped	3
McIver Park–Barton	Not clipped	26
Barton–mouth	Not clipped	6
Clackamas Hatchery (Clackamas stock)	AD clipped	38
Clackamas Hatchery	Not clipped	1
Sandy:		
Final Falls–Road 2618 bridge	Not clipped	15
Road 2618 bridge–Bridge St. bridge	Not clipped	12
Bridge St. bridge–Highway 26 bridge	Not clipped	77
Highway 26 bridge–mouth	Not clipped	10
Still Creek	Not clipped	25
Zigzag River	Not clipped	1
Lost Creek	Not clipped	7
Clackamas Hatchery (Sandy stock)	Not clipped	100

APPENDIX C

Experimental Groups of Hatchery Spring Chinook Released to Evaluate Acclimation in Net Pens, 1992–1999 Brood Years.

Release locations are described in Lindsay et al. (1997). McKenzie River stock was used except where noted.

	Willamette River				Clackamas River		
	Lone Star (RM 14),	Willamette Park (RM 15),	Multnomah Channel (RM 20.5)		Clackamette Cove (RM 0.5)		Clackamette Park (RM 0.1),
Time of release	Acclimate	Direct	Acclimate	Direct	Acclimate	Direct	Direct
				1992			
Fall							
Spring	**X**	**X**					
				1993			
Fall	**X**	**X**					
Spring	**X**[a]	**X**					
				1994[b]			
Fall	**X**	**X**					
Spring					**X**	**X**[c]	
				1995			
Fall					**X**	**X**	**X**
Spring				**X**	**X**	**X**	
				1996			
Fall			**X**	**X**			
Spring				**X**	**X**	**X**	**X**
				1997[d]			
Fall			**X**	**X**			
Spring				**X**[e]	**X**	**X**	**X**[e]
				1998			
Fall			**X**	**X**			
Spring				**X**	**X**	**X**	**X**
				1999			
Fall			**X**	**X**			
Spring				**X**	**X**	**X**	**X**

[a] *Two of three groups acclimated for just 7 days because of nitrogen supersaturation.*
[b] *Clackamas stock used because of insufficient brood stock at McKenzie Hatchery.*
[c] *Bacterial kidney disease infection in this group.*
[d] *No replicated tag groups this year.*
[e] *One truckload (22,278) accidentally released at Clackamette Park instead of Multnomah Channel.*

APPENDIX D

Migration and Rearing Data for McKenzie, Willamette, and Santiam Rivers, 2002

Appendix Table D-1. Fish species and numbers caught in seines in the McKenzie (RM 0–21), upper Willamette (RM 112–175), lower Willamette (RM 57–112), and Santiam (RM 0–4) rivers, June 15–July 31, 2002.

	Number caught by location and date (seine sets in parentheses)						
	McKenzie	upper Willamette		lower Willamette		Santiam	
Species	July 8-25 (88)	June 18-27 (18)	July 11-25 (65)	June 19-24 (29)	July 1-31 (78)	June 19-25 (15)	July 3-22 (49)
Chinook salmon (wild)	1937	1308	500	270	96	348	304
Rainbow trout	409	83	176	13	9	40	225
Cutthroat trout	259	368	318	8	2	22	23
Trout fry	1	0	34	0	0	1	5
Mountain whitefish	5	153	101	65	80	7	382
Chinook salmon (hatchery)	0	0	6	0	0	0	0
Summer steelhead (adult)	2	5	1	1	4	0	2
Chinook salmon (adult)	0	1	0	0	0	0	1
Redside shiner	219	1994	540	287	749	249	234
Northern pikeminnow	91	376	1024	279	270	105	453
Peamouth	0	19	43	96	446	2	7
Chiselmouth	0	6	1	20	177	0	2
Dace	0	171	18	59	36	13	25
Largescale sucker	9	269	47	143	152	80	140
Lamprey adult	1	1	0	0	0	0	0
Sculpin	20	10	7	12	25	6	10
Sand roller	0	5	0	0	0	0	2
Three-spine stickleback	0	3	0	0	0	0	1
Bluegill	0	1	1	0	0	0	0
Smallmouth bass	0	0	0	5	1	0	1
Largemouth bass	0	1	1	0	0	0	0
Yellow perch	0	0	0	1	0	0	0
Banded killifish	0	0	0	0	4	0	1

Appendix Table D-2. Dates the PIT tag interrogator in the PGE Sullivan Plant at Willamette Falls was operational September 2001–September 2002.

Month	Dates	Status	Comments
September	27–30	Operating	Put into operation
October	1–31	Operating	
November	1–23	Operating	
	24–28	Shut down	High flows and debris. Flows at Salem over 50,000 cfs
	29	Operating	
	30	Shut down	High flow and debris
December	1–5	Shut down	Flows at Salem over 80,000 cfs
	6–13	Operating	
	14–27	Shut down	Flows at Salem over 80,000 cfs
	27–31	Operating	
January	1–8	Operating	
	9–10	Shut down	High flow and debris
	11	Operating	
	12–14	Shut down	High flow and debris
	15–23	Operating	
	24–30	Shut down	Flows at Salem up to 87,000 cfs
	31	Operating	
February	1–4	Operating	
	5	Shut down	8 hours
	6–28	Operating	
March	1–12	Operating	
	13	Shut down	Plant maintenance
	14–31	Operating	
April	1–15	Operating	
	16–17	Operating	Screen partially opened
	18–30	Operating	
May	1–31	Operating	
June	1–30	Operating	
July	1–31	Operating	
August	1–25	Operating	
	26–31	Shut down	Plant maintenance
September	1–2	Shut down	Plant maintenance
	3–30	Operating	