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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 production of 5–8 million juveniles. Hatchery programs exist in the McKenzie, Middle Fork Willamette, North and South Santiams, 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, spring chinook salmon management in the Willamette and Sandy basins focused on hatchery and fish passage issues. Limited information was collected on the genetic structure among basin populations, abundance and distribution of natural spawning, 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**.

Work was conducted in the main-stem Willamette River at Willamette Falls, and in the McKenzie, and North Santiam rivers in 2000. 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 work completed in late 1999 through early fall 2000.

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. Partly in response to this need, all hatchery spring chinook salmon in the Willamette basin were marked with adipose fin clips beginning with the 1997 brood. 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 the adipose fin is missed by the clippers or clips are of poor quality. For example, 1% to over 10% of hatchery fish were released without a clip in a sample of 40 release groups from the 1996 brood. Second, unmarked fry and pre-smolts have been released in the basin. Given the large numbers of hatchery fish released in the basin, 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 externally unmarked hatchery fish from wild fish, otoliths were thermally marked on all hatchery spring chinook released into the Willamette basin beginning with the 1997 brood year.

Methods

Juveniles

Thermal marks were placed on otoliths of all 1999 brood, hatchery spring chinook salmon released into the Willamette basin. Quality of the marks was assessed in reference samples collected at the hatcheries and sent to Washington Department of Fish and Wildlife (WDFW) for analysis (Table 1).

Table 1. Data on thermal marking of spring chinook salmon in Willamette River hatcheries and collection of reference samples, 1999 brood. Reference samples were salmon fry (35–50 mm).

Stock	Sample Size	Egg takes sampled	Treatment (hrs on/off)	Temperature differential[a] (°F)	Cycles[b]	Comments
McKenzie	202	4	Chilled (24/96)	4.0–6.0	12[c]	Marked at McKenzie H.
McKenzie	50	1	Heated (48/48)	10.5–14.0	8	Marked at Willamette H.
N. Santiam	94	2	Heated (48/48)	5.0–10.0	6[d]	
Willamette	153	3	Heated (48/48)	6.0–14.0	8	
Clackamas	84	2	Heated (48/48)	10.5–13.5	7–8	Marked at Willamette H.
S. Santiam	141	2	Heated (48/48)	6.0–13.5	8	Marked at Willamette H.

[a] *Difference in temperature between heated or chilled treatment and ambient incubation temperature.*
[b] *Number of treatment cycles for hatched fry.*
[c] *Four cycles were administered to eggs and eight to fry.*
[d] *Nine day separation between the fourth and fifth cycle because of power outage.*

Adults

The usefulness of otoliths to identify hatchery fish depends on how accurately otolith marks can be detected on returning hatchery adults. In 1999 we collected otoliths from 74 spring chinook adults of known McKenzie and North Santiam hatchery origin (based on coded wire tags) and from 48 John Day River wild fish taken from carcasses during spawning surveys. Otoliths were removed from adult fish and placed in individual vials. The pool of samples was then randomly mixed and assigned sequential numbers, but samples were not identified as hatchery or wild fish. The WDFW otolith lab was then asked to identify these "blind" samples as being thermally marked (hatchery fish) or not thermally marked (wild fish).

Returns of spring chinook salmon in 2000 presented the first opportunity to determine the proportion of naturally produced ("wild") salmon on spawning grounds in the North Santiam and McKenzie rivers. Most, but not all, of the 1996 brood hatchery spring chinook were externally marked with adipose fin clips in these two rivers. However, all North Santiam and McKenzie hatchery fish from the 1996 brood received good otolith marks, with which we hoped to differentiate hatchery from wild fish in unmarked, age 4 fish that returned in 2000.

Carcass surveys were conducted weekly on spawning grounds in the North Santiam and McKenzie Rivers to collect otoliths from unmarked spring chinook (Table 2). Scales were collected to determine age. Fish heads were sectioned and otoliths removed. Otoliths from age 4 fish will be sent to WDFW in 2001 to differentiate wild from hatchery fish. We also collected otoliths from a sample of unmarked spring chinook at Minto Hatchery. In addition, we collected otoliths from fin-marked fish at Minto and McKenzie hatcheries that will serve as a reference sample.

Table 2. Collection of otoliths from unmarked adult spring chinook carcasses in the McKenzie, North Santiam, and Little North Santiam rivers, and from adult hatchery spring chinook, 2000.

River, section	Number of surveys	Otoliths collected
McKenzie:		
Ollalie Boat Ramp–McKenzie Bridge	3	34
McKenzie Bridge–Forest Glen	3	21
Forest Glen–Ben and Kay Doris Park	2	35
South Fork McKenzie below Cougar Reservoir	3	23
McKenzie Hatchery, marked adults	--	50
North Santiam:		
Minto–Fishermen's Bend	5	240
Fishermen's Bend–Mehama	4	30
Mehama–Stayton	2	9
Little North Santiam	1	4
Minto Hatchery, unmarked adults	--	58
Minto Hatchery, marked adults	--	54

Results

With the exception of chinook marked at Marion Forks Hatchery, high quality thermal marks were seen in all 1999 brood reference samples sent from upper Willamette basin hatcheries (Table 1). A power outage at Marion Forks Hatchery interrupted the marking cycle and only six marks were applied instead of eight. In addition, visual "noise" was present in the reference samples, which could reduce the accuracy of identifying thermal marks in returning adults.

The WDFW lab correctly classified from 63% to 96% of adult hatchery spring chinook and 96% of wild spring chinook (Table 3). From these results the number of wild fish would be overestimated based on otolith marks in a hypothetical sample of adults without fin clips or coded wire tags. The exceptionally poor classification rate of the 1995 brood from McKenzie Hatchery may have been because the juveniles received only four mark cycles at 5–6°F temperature differentials. The 1994 and 1996 brood years received 5 and 6 marks, respectively. The 1997 brood received only four marks, but temperature differentials were 5–8°F. The marking was changed to four pre-hatch and eight post-hatch marks at McKenzie Hatchery beginning with the 1998 brood, which should improve the accuracy of identifying thermal marks. Although the proportion of fish correctly classified varied among brood years, otoliths would still provide a means of identifying most hatchery adults that have no fin clips or coded wire tags.

Table 3. Accuracy in a blind test of the WDFW otolith lab in identifying hatchery adult spring chinook thermally marked as fry and wild spring chinook not marked, 2000.

Location, brood year	Number	Classified— Correctly	Wrongly
McKenzie Hatchery:			
1994	22	17	5
1995	43	27	16
1996	8	7	1
Marion Fork Hatchery :			
1995	23	22	1
John Day River (wild)	48	46	2

TASK 1.3–DISTRIBUTION AND ABUNDANCE OF NATURAL SPAWNERS

Redd counts by boat and on foot were conducted in the North Santiam River in 2000. An early October survey was selected for a complete redd census to document the magnitude of natural spawning based on peak spawn timing from previous years (Schroeder et al. 1999). No redd counts were made in the Clackamas or Sandy rivers in 2000 because of budget constraints. Redds were counted in the McKenzie River during surveys designed to collect carcasses for otoliths.

The main-stem North Santiam River was surveyed for redds on October 2 and October 5 and the Little North Santiam was surveyed on October 9 (Table 4). Sections of the McKenzie River were surveyed on September 28, October 3, and October 10 (Table 5). Abundance and migration timing of adult spring chinook were also monitored at upper and lower Bennett dams in 2000 (Table 6 and Figure 1) with methods similar to previous years. In 2000 an adult trap was added to the Stayton Power Canal ladder but few chinook were trapped.

Table 4. Summary of chinook salmon spawning surveys in the North Santiam River, 2000, and comparison to redd densities in 1996–99.

Race and survey section	Length (mi)	Number		Redds/mi				
		Carcasses	Redds	2000	1999	1998	1997	1996
Spring chinook:								
Minto – Fishermen's Bend	10.0	338	279	27.9	15.6	11.8	8.5	7.8
Fishermen's Bend – Mehama	6.5	46	38	5.8	3.1	4.3	2.5	3.5
Mehama – Stayton	10.3	21	6	0.6	--	3.6	1.7	2.0
Stayton – Greens Bridge	13.7	--	--	--	0.0[a]	0.4	1.1	0.1
Little North Santiam	10.7	18	22	2.1	1.0	2.3	0.5	0.0
Fall chinook:								
Stayton – Greens Bridge	13.7	--	--	--	0.1[a]	4.3	9.6	0.9
Greens Bridge – mouth	3.0	--	--	--	0.7[a]	4.7	--	--

[a] *Only one chinook carcass was recovered below Stayton so apportionment for spring or fall race based on analysis of scales from carcasses was not possible. All redds were assumed to be from fall chinook.*

Table 5. Summary of chinook salmon spawning surveys in the McKenzie River, 2000, and comparison to redd densities in 1996–97.

Section	Length (mi)	redds	Redds/mi		
			2000	1997	1996
Ollalie to McKenzie Trail	10.3	58	5.6	11.4	7.0
McKenzie Trail to Hamlin	9.9	16	1.6	--	2.1
South Fork McKenzie below bridge	2.1	16	7.6	--	2.9
South Fork McKenzie to Forest Glen	2.4	5	2.1	--	0.8
Forest Glen to Rosboro Bridge	5.7	33	5.8	--	6.1
Rosboro Bridge to Ben and Kay	6.5	21	3.2	--	4.9

Table 6. Estimated number of spring chinook salmon passing Upper Bennett Dam, Lower Bennett Dam, and the Stayton Power Canal Dam on the North Santiam River, May–September, 2000. Passage counts have been adjusted for a 4.8% fallback rate.

	May	June	July	August	September	Total
Unmarked:						
Adult	170	566	180	23	106	1045
Jack	0	5	0	0	3	8
Adipose clip:						
Adult	248	693	237	17	46	1241
Jack	2	45	28	7	11	93
Total	420	1309	445	47	166	2387

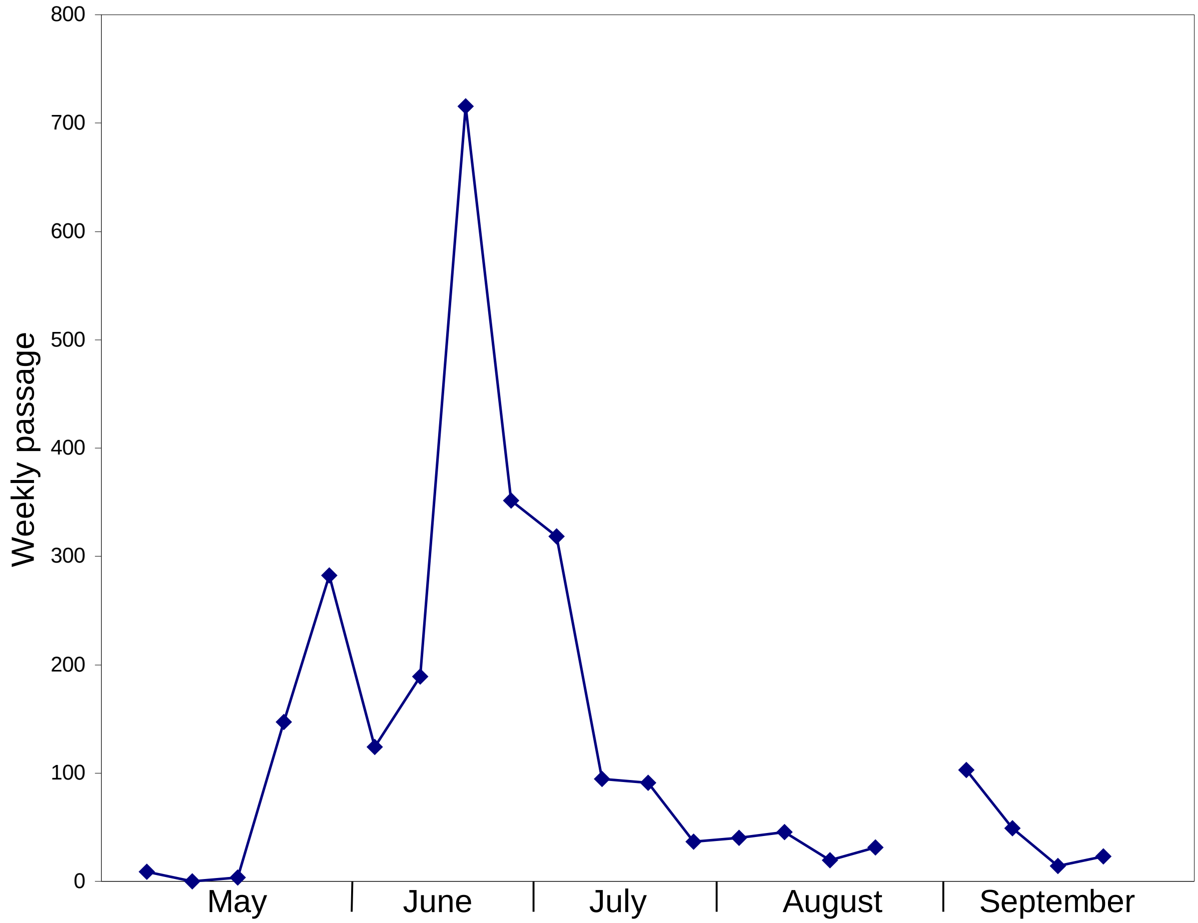

Figure 1. Weekly passage of spring chinook salmon at Upper and Lower Bennett dams on the North Santiam River, 2000. No sampling was conducted from August 26 to September 4.

TASK 2.1– MORTALITY IN A CATCH AND RELEASE FISHERY

Estimating Hooking Mortality

Methods

Study methods were similar to those used in 1998 and 1999 (Lindsay et al. 1998, Schroeder et al. 1999). Changes in sport gear in 2000 included the almost exclusive use of eggs when bait was used to better estimate mortality of fish hooked in gill arches and the stomach. For lures, a single hook group was added to compare mortality between lures with treble hooks and those with single hooks. As in 1999, chinook salmon in 2000 were tagged with a single tag because tag loss was low in 1998.

Hooking mortality was estimated by anatomical hook location from combined 1998–2000 data. We pooled the two control groups (fishway and river) and compared recoveries of these fish to those caught with sport fishing gear at Willamette Falls. A mortality rate was calculated for each of five anatomical hook locations for fish caught on sport fishing gear. The summaries presented in this report are preliminary (*see also* **APPENDIX B**). A thorough analysis of the data collected for the 3 years of study will be completed in 2001.

Results

Hooking mortality was lowest for fish hooked in the jaw and highest for those hooked in gill arches and the stomach (Table 7). In the lower Willamette River sport fishery, fish hooked in the jaw accounted for a mean of 81% of the total fish caught by anglers in 1998–2000 (Table 8). The distribution of anatomical hook locations in the general fishery was similar in each of the 3 years that surveys were conducted (Table 8). The estimated hooking mortality of fish caught and released in a sport fishery was 12.5% based on the estimated mortality for each anatomical hook location and the distribution of anatomical hook locations in the sport fishery in 1998–2000 (Table 9). This is higher than the 7.6% rate reported for chinook salmon fisheries in the Kenai River, Alaska (Bendock and Alexandersdottir 1993). Accounting for the exploitation rate on runs of spring chinook salmon in the lower Willamette fishery, mortality in a catch and release fishery on wild salmon in the Willamette River would be 3.5% of the run into the river (Table 9).

Table 7. Mortality by anatomical hook location of experimental spring chinook salmon that were caught on sport gear, tagged, and released at Willamette Falls, 1998–2000. Recovery of control groups, 1998–2000, is shown for reference.

Group	Number tagged	Number recovered	Percentage recovered	Mortality (%)
Sport gear:				
Jaw[a]	633	269	42.5	2.3
Tongue	39	14	35.9	17.5
Gill arches	112	9	8.0	81.5
Stomach[b]	70	10	14.3	67.1
Eye	15	7	46.7	0.0
Control	825	359	43.5	--

[a] *Includes fish hooked in the roof of the mouth.*
[b] *Includes fish hooked in the esophagus.*

Table 8. Anatomical hook locations (%) of fish caught by anglers in the lower Willamette River sport fishery, 1998–2000.

Year	Anatomical hook location (%)					Sample size
	Jaw	Tongue	Gill arches	Stomach	Eye	
1998	77.8	9.1	4.8	8.3	0.0	252
1999	84.3	2.9	4.9	7.9	0.0	611
2000	79.6	4.9	4.5	9.6	1.4	852

Table 9. Estimate of mortality in a catch and release fishery on a hypothetical wild run of 5,000 spring chinook salmon (in a 50,000 fish run) in the Willamette River, based on results of hooking mortality studies and gear surveys of sport fisheries in 1998–2000.

	Rate (%)	Estimated number
Catch of wild fish in sport fishery	28[a]	1400
Hooked in jaw[b]	80.6	1128
Hooked in tongue	5.6	79
Hooked in gill arches	4.7	66
Hooked in stomach[c]	8.6	120
Hooked in eye	0.5	7
Mortality in catch and release fishery		
Fish hooked in jaw[b]	2.3	26
Fish hooked in tongue	17.5	14
Fish hooked in gill arches	81.5	54
Fish hooked in stomach[c]	67.1	81
Fish hooked in eye	0.0	0
Mortality in wild run	3.5	175

[a] *Mean exploitation rate in normal fishing seasons, 1970–95 (Foster 1997).*
[b] *Includes fish hooked in roof of mouth.*
[c] *Includes fish hooked in esophagus.*

Chinook salmon caught on lures with treble hooks had a higher mortality than those caught on lures with single hooks (Table 10). A higher percentage of fish caught with treble hooks (17%) were hooked in the tongue and gill arches compared to fish caught on single hooks (6%). Both anatomical hook locations are associated with high mortality (Table 7). More importantly, the recovery rate of fish hooked in the jaw was lower for treble hooks (28%) than for single hooks (38%). The difference in recovery of jaw-hooked fish accounts for most of the difference in the overall recovery between treble and single hooks.

Fish caught with treble hooks may sustain greater injury than those caught on single hooks, which may reduce survival. In the process of netting fish, lures with treble hooks more often tangled in the net and were ripped out as the fish dropped to the bottom of the net. Significantly more (P = 0.05) lures with treble hooks (31%) were ripped out in the net than were lures with single hooks (19%). However, relative bleeding of jaw-hooked fish was similar for the two hook types (Table 11). The elapsed time of hook removal from fish that remained hooked during netting was also higher for treble-hooked fish (50 sec) than for single-hooked fish (42 sec), but the difference was not significant (P = 0.11).

Table 10. Recovery of chinook salmon caught on lures with treble or single hooks at Willamette Falls, 2000.

Hook type	Number tagged	Number recovered	Percentage recovered	Percent mortality
Lures:				
Treble	121	34	28.1	29.2
Single	84	30	35.7	10.1
Control	350	139	39.7	--

Anatomical Hook Location of Fish Caught in the Lower River Fishery

In addition to estimating hooking mortality by hook location at Willamette Falls, a survey of spring chinook salmon anglers was conducted in the Willamette River in 2000. One of the purposes of the survey was to identify the types of terminal gear used and the anatomical hook location of fish caught in the general sport fishery. These data along with the hooking mortality data at Willamette Falls were used to estimate a mortality rate for wild fish in a hypothetical selective fishery on hatchery fish in the lower Willamette River (Table 9). Survey methods in 2000 were similar to those used in 1998 (Lindsay et al. 1998).

Table 11. Relative severity of bleeding from hook wounds in five anatomical locations at the time adult spring chinook salmon were caught and tagged, 1998–2000.

Hook location, gear	Relative bleeding from hook wound (%) None/slight	Moderate	Severe	Sample size
Jaw:				
Lure, treble hook	97.2	2.8	0.0	322
Lure, single hook	94.6	5.4	0.0	74
Bait, single hook	95.7	3.9	0.4	234
Tongue:				
Lure, treble hook	80.0	8.0	12.0	25
Lure, single hook	66.7	33.3	0.0	3
Bait, single hook	81.8	18.2	0.0	11
Gill arches:				
Lure, treble hook	5.6	13.9	80.6	36
Lure, single hook	0.0	0.0	100.0	2
Bait ,single hook[a]	16.4	14.9	68.7	67
Stomach:				
Lure, treble hook	0.0	0.0	0.0	0
Lure, single hook	0.0	0.0	0.0	0
Bait, single hook[a]	75.7	14.3	10.0	70
Eye:				
Lure, treble hook	50.0	50.0	0.0	4
Lure, single hook	80.0	20.2	0.0	5
Bait, single hook	66.7	33.3	0.0	6

[a] *Hooks were generally cut off and left in place rather than being removed.*

Anglers in the fishery below Willamette Falls primarily used bait to fish for spring chinook salmon, although the type of bait varied depending on the section of river (Table 12). In 2000, bait accounted for 85% of the fish caught by anglers and lures accounted for 15% (Table 13). Most of the fish caught on bait and lures were hooked in the jaw, although more lure-caught fish where hooked in the jaw (89%) than bait-caught fish (78%)(Table 13). The percentage of fish hooked in the jaw on bait also varied considerably depending on the type of bait. For example, 85% of the fish caught on herring were hooked in the jaw compared to 72% of those caught on prawns (Table 13).

Table 12. The percentage of time spring chinook anglers used different gear types in each of three sections of the lower Willamette River, March 11–June 12, 2000. Baits used with a lure attractor are included under the bait category. Percentages may not add to 100% due to rounding.

Gear types	Mouth to St. John's Bridge[a]	St. John's Bridge to Lake Oswego	Lake Oswego to Willamette Falls
Bait:			
Fish	69	39	7
Eggs	<1	<1	3
Prawns	6	50	55
Unspecified bait	0	0	<1
Lure:			
Plugs[b]	13	3	7
Spinners	10	7	12
Wobblers, spoons	<1	<1	6
Spinglo	<1	<1	8
Other lures[c]	<1	<1	<1

[a] *Includes Multnomah Channel.*
[b] *Flatfish, Wiggle Warts, etc.*
[c] *Includes corkys, plastic prawn and unspecified lures.*

The harvest of spring chinook salmon in the fishery below Willamette Falls in 2000 was greatest in the upper section from Lake Oswego to Willamette Falls, consistent with the previous 2 years (Figure 3). The 1998–2000 fishing seasons were under various restrictive regulations because of low runs, which apparently shifted harvest from the lowermost to the uppermost section of the river compared to historical catch distributions (Figure 3). Assuming the historical catch distribution is more representative of catch distribution during typical fishing seasons, the distribution of anatomical hook locations based on 1998–2000 fisheries is weighted for the uppermost sections where prawns are used more often for bait. Consequently, our estimates of hooking mortality in this report may be somewhat higher than those that would occur during typical fishing seasons when a higher percentage of the catch would take place in the lowermost section on herring. We will address this problem in more detailed analyses of data in 2001.

Table 13. Anatomical hook locations by gear type for spring chinook salmon caught by anglers in the Willamette River below Willamette Falls, March 11–June 12, 2000. Only hook locations verified by ODFW creel clerks are included.

Gear	Jaw	Tongue	Gill arches	Eye	Stomach	Total
Bait:						
Bait (unspecified)	0	1	0	0	0	1
Eggs	5	0	2	0	1	8
Eggs/shrimp	0	0	0	0	1	1
Herring	288	11	10	2	25	336
Herring/flasher	1	0	0	0	0	1
Herring/hoochie	1	0	0	0	0	1
Herring/spinner	8	0	0	0	3	11
Prawn	205	17	20	4	39	285
Prawn/eggs	1	0	0	0	0	1
Prawn/SpinGlo	6	2	0	0	1	9
Prawn/spinner	16	1	1	0	1	19
Shrimp	31	4	3	1	10	49
Shrimp/SpinGlo	2	0	0	0	0	2
Bait total	564	36	36	7	81	724
Lure:						
Lure (unspecified)	3	0	0	0	0	3
Spinner	43	4	2	2	1	52
Plug	10	0	0	0	0	10
Flatfish/Kwikfish	34	2	0	0	0	36
Wiggle Wart	3	0	0	0	0	3
Wobbler	8	0	0	0	0	8
Alvin	4	0	0	3	0	7
FST	1	0	0	0	0	1
SpinGlo	8	0	0	0	0	8
Lure total	114	6	2	5	1	128

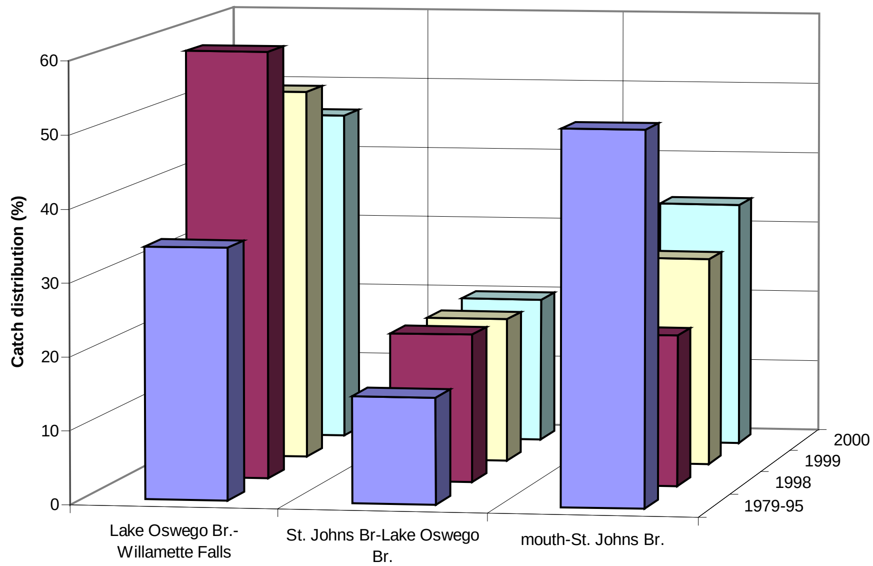

Figure 3. Distribution of the catch of adult spring chinook salmon in three sections of the Willamette River below Willamette Falls, 1979–95 (Foster 1997) and 1998–2000 (Craig Foster, ODFW, unpublished data).

A non-statistical creel survey was also conducted in the Willamette River above Willamette Falls in 2000. About 6,400 hours of angling effort and a catch of 48 spring chinook were tallied from Willamette Falls (RM 26) to Buena Vista (RM 106). Anglers in this area tended to use primarily lures (**APPENDIX B**), compared to the lower river fishery where anglers used primarily bait (Table 14). Consequently, a higher percentage of fish were hooked in the jaw in the fishery above Willamette Falls (87.5%) than below the falls (80.6%).

Table 14. Anatomical hook locations for spring chinook salmon caught by anglers in the Willamette River from Willamette Falls to Buena Vista, 2000.

Hook location	Number	Percentage
Jaw	42	87.5
Tongue	3	6.3
Gill arches	1	2.1
Stomach	2	4.2

TASK 2.2– MORTALITY FROM CLIPPING HATCHERY FISH

Mortality from clipping ventral fins or maxillary bones of hatchery spring chinook salmon was originally identified as an important factor in evaluating the feasibility of a selective fishery in the lower Willamette River. Hatchery fish needed to be externally marked for anglers to distinguish them from unmarked wild fish. At the time our study was designed, the adipose fin clip (Ad) was sequestered for use only with coded wire tags (CWT). Because coded wire tags are expensive, the adipose clip was not a long-term option for identifying hatchery chinook in the Willamette basin. Beginning with the 1998 brood, however, most of the Willamette spring chinook hatchery production has been marked with adipose clips, but not coded wire tags, something not foreseen when the study was initiated in 1996. The need for evaluating mortality from other clips for Willamette River spring chinook is currently unnecessary because it is generally accepted that clipping the adipose fin results in lower mortality than any other clip. However, in 1998 we thought results might still be useful to other managers within and outside of ODFW. Consequently, we monitored the first adult returns to hatcheries from experimental groups in 1999 (Schroeder et al. 1999).

The unexpected adoption of fishing regulations that targeted adipose clipped chinook in parts of the Willamette basin in 2000 rather than in 2002 as we had anticipated compromised our experimental design because of differential affects on control groups. We used specific Ad+CWT release groups as controls for evaluating mortality from ventral and maxillary experimental groups. We anticipate additional selective fisheries on adipose-clipped fish will be adopted in other locations in 2001. Although relatively minor, an unknown number of fish with ventral or maxillary clips will also be caught, released, and die in selective fisheries. Further, surplus adult spring chinook with adipose fin clips and unknown coded wire tag codes were transported to areas above reservoirs in the North Santiam River beginning in 2000. We would have to rely on various expansions of coded wire tags collected in creel surveys or in the hatchery brood stock to estimate the return of control groups. We have little confidence in the accuracy of these expansions for estimating returns of relatively small release groups. As a consequence of these complications and with the consensus of ODFW staff, we terminated this experiment in 2000.

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 prior to release. Acclimation at lower river release sites may increase angler harvest by improving survival of juveniles and by delaying migration to upriver areas.

1998 Brood Releases

A study was begun in 1992 to determine if acclimation prior to release could be used to increase harvest of hatchery spring chinook salmon in the lower Willamette River. McKenzie River stock was used 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 four additional years through 1999 brood releases. Releases from 1992–1997 broods are described in Lindsay et al. (1997), Lindsay et al. (1998), and Schroeder et al. (1999). Table 15 shows releases of 1998 brood spring chinook.

Table 15. Releases of spring chinook salmon into the lower Clackamas and Willamette rivers to evaluate acclimation in net pens, 1998 brood.

Stock	Tag code	Treatment	Location of release	Number AD+CWT	Fish/lb	Length (mm)	Days Accli-mated	Release date
McKenzie	092906	Acclimate	Mult. Channel	27,646	8.3	162.9	20	11/4/99
McKenzie	092905	Acclimate	Mult. Channel	28,661	8.1	162.9	20	11/4/99
McKenzie	092903	Direct	Mult. Channel	27,871	8.3	161.3	--	11/4/99
McKenzie	092904	Direct	Mult. Channel	29,063	8.1	162.3	--	11/4/99
McKenzie	092862	Acclimate	Clack. Cove	37,434	7.0	165.0	22	3/07/00
McKenzie	092863	Acclimate	Clack. Cove	37,376	8.1	164.8	22	3/07/00
McKenzie	092860	Direct	Clack. Cove	37,217	8.9	157.6	--	3/07/00
McKenzie	092961	Direct	Clack. Cove	36,907	8.9	156.4	--	3/07/00
McKenzie	092901	Direct	Clack. River	38,447	9.1	161.3	--	3/08/00
McKenzie	092902	Direct	Clack. River	38,948	9.0	161.8	--	3/08/00
McKenzie	092858	Direct	Mult. Channel	36,698	9.3	157.5	--	3/06/00
McKenzie	092859	Direct	Mult. Channel	37,118	9.5	164.5	--	3/06/00
McKenzie	092653	Control	McK. Hatch.	29,032	9.0	158.3	--	3/08/00
McKenzie	092654	Control	McK. Hatch.	29,244	9.0	158.3	--	3/08/00

Adult Recovery of 1992–1995 Brood Releases

The main objective of acclimating juveniles in net pens in the lower Willamette River was to increase the sport harvest of these fish below Willamette Falls when they returned. Adult recoveries from 1992 through 1995 broods are reported in Tables 16–19. Data for 1992 and 1993 broods are largely complete; data for 1994 and 1995 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 controls released from McKenzie Hatchery was equal to or higher than catch of fish from acclimated or direct groups released into the lower main-stem Willamette. Secondly, 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 the main-stem Willamette, acclimated groups survived better than direct groups. There were no clear differences in survival between acclimated and direct groups released into Clackamette Cove, although data to date are limited.

TASK 4.1– MIGRATION TIMING OF WILD JUVENILE SPRING CHINOOK SALMON

Field work was started 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, fingerlings that migrate in fall, and yearling smolts that migrate in early spring. Work the first year 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. Juvenile chinook migrating in fall of 1999 were collected in a bypass trap at Leaburg Dam. We also tagged a sample of hatchery chinook that were released in the fall from McKenzie Hatchery. Age 0 fry that migrate past Leaburg Dam in late winter and early spring are too small to tag at the time they migrate. We used beach seines to catch these fish from late July into September in the lower McKenzie and upper Willamette rivers. We used screw traps at the mouth of the McKenzie River (RM 175) and below Harrisburg (RM 156) to capture juvenile chinook and scan them for PIT tags. Fish were also scanned with a tag interrogator at Portland General Electric Company's (PGE) Sullivan Plant at Willamette Falls (RM 26). Additional tags were recovered in the Columbia River estuary by the National Marine Fisheries Service. We planned on tagging yearling smolts at Leaburg Dam in spring 2000, but had to postpone that sampling until collection methods could be developed that would minimize fry mortality.

Table 16. 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, August 2000.

		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 River	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.[a]	2	--	--	0	0

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

Table 17. 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, August 2000.

		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 River	15	16	14	16	0
(% in Clackamas River)	(33)	(62)	(36)	(75)	--
Hatcheries:					
McKenzie	148	55	8	13	8
Clackamas	1	31	5	8	2
Other	0	5	0	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
Misc.[a]	0	0	0	0	0

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

Table 18. 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. Numbers were adjusted to a standard release of 100,000 smolts. Tag recoveries were obtained from databases of the Pacific States Marine Fisheries Commission and ODFW, August 2000. Data are preliminary.

		Willamette River fall release		Clackamas River spring release	
Recovery location	McKenzie control	Accli-mated	Direct	Cove acclimated	Cove direct
Fisheries:					
Ocean	0	41	0	0	5
Columbia River	0	3	0	1	0
Willamette River	20	3	0	4	3
(% 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	0	0	1
Clackamas River	0	2	0	0	5
Other	0	2	0	0	0
Leaburg Dam	8	2	0	0	0
Misc.[a]	0	0	0	0	0

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

Table 19. 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 the ODFW database in August 2000 and are incomplete.

		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	0	--	0	0	0	0	0	0
Columbia River	7	--	0	3	2	0	0	0
Willamette River	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
Misc.[a]	0	--	0	0	0	0	0	0

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

Results

In 1999 we tagged 3,002 wild fall migrants at Leaburg Dam, and 427 hatchery spring chinook that were released in fall from McKenzie Hatchery (Table 20). In addition, we tagged 1,649 juvenile wild and hatchery spring chinook by seining in the lower McKenzie and upper Willamette rivers, July 25–September 11, 2000 (Table 21).

Only fish that were PIT tagged in fall 1999 were recaptured in the report period. Most of the recaptures came from the Sullivan Plant fish evaluator at Willamette Falls (Table 20). In general, it appeared that wild fish tagged in fall did not migrate past Willamette Falls until the following spring, but operational problems with the Sullivan Plant evaluator limited sampling in winter and late spring, 1999–2000 (Table 22). In contrast, hatchery fish released in fall appeared to migrate rapidly out of the upper reaches and past Willamette Falls (Table 20). Few tagged fish were recaptured in screw traps in the McKenzie or Willamette rivers even though these traps sampled a higher number of days than did the Sullivan Plant evaluator (Tables 23 and 24).

Juveniles that were PIT tagged in summer in the lower McKenzie and Willamette rivers will not be recaptured until the next report period (2000–2001). We found wild juvenile chinook distributed throughout the lower McKenzie and upper Willamette rivers below the confluence of the McKenzie River. However, the number we were able to capture with seines was relatively small. Hatchery fish identified by adipose fin clips were captured in the Willamette River from July through September (Table 21). We recovered one coded wire tag that indicated these fish were from the 1999 brood being reared at Dexter Pond on the Middle Fork Willamette. Since this brood had not yet been released, these fish apparently escaped from Dexter Ponds. Hatchery fish in the McKenzie River were found only in late September just before sampling ended (Table 21) and were likely fish that moved downstream from a September release into the upper Mohawk River, a tributary that enters the McKenzie at RM 11. The mean length of wild juvenile chinook increased throughout the sampling period (Figure 4), and suggested that growth of wild fish was higher in the Willamette than in the McKenzie. However, larger fish in the McKenzie River could have migrated downstream into the Willamette River during our sampling period (Figure 4).

Table 20. Release and recapture data for juvenile wild and hatchery fish inserted with PIT tags and released at Leaburg Dam (wild) or McKenzie Hatchery, 1999–2000. Recaptures were at the Sullivan Plant unless noted. Capture data for other species is listed in **APPENDIX C**.

	Release dates (number tagged)		
	Wild		Hatchery
Recapture dates	November 1–15 (880)	November 16–December 1 (2122)	November 10 (427)
Nov 1–15	4	--	21[c]
Nov 16–30[a]	1[b]	0	1
Dec 1–15[a]	0	1[b]	0
Dec 16–31[a]	0	0	0
Jan 1–15[a]	0	0	0
Jan 16–31[a]	0	0	0
Feb 1–15	0	0	0
Feb 16–28	0	2	0
Mar 1–15	3	4	0
Mar 16–31	2	8	0
Apr 1–15	3	13	0
Apr 16–30	0	1[d]	0
May 1–15	0	2[e]	0
Mean length			
Release	113.7	106.9	167.3
Recaptures[f]	118.5	107.7	168.9

[a] *Sullivan Plant inoperable November 18, 26–30, December 1–21, 24–29, 31, January 1–3, 11–20.*
[b] *Cartney Park screw trap (RM 156).*
[c] *Includes 2 in McKenzie screw trap (RM 175) and 1 in Cartney trap.*
[d] *Truax Pond (RM 127).*
[e] *Columbia River (RM 47).*
[f] *Length of the recaptured fish at time of tagging.*

Table 21. Number of PIT tags inserted into juvenile wild and hatchery spring chinook salmon that were seined in the McKenzie River below Hendricks Bridge (RM 21) and in the Willamette River, July–September, 2000.

	Number tagged		Mean length (mm)	
River	Wild	Hatchery	Wild	Hatchery
McKenzie	650	67	109.1	127.2
Willamette	796[a]	136	112.5	113.7

[a] *Two fish were not measured.*

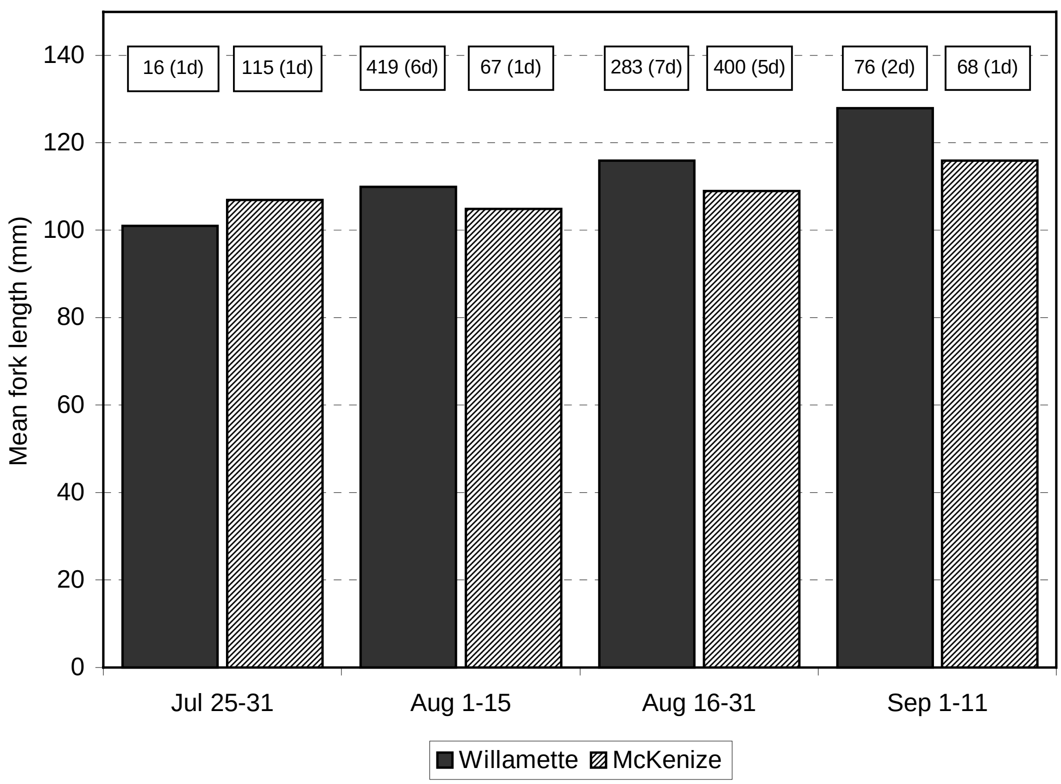

Figure 4. Mean fork length of juvenile spring chinook salmon that were seined in the Willamette and McKenzie rivers in four sampling periods. Data are for wild fish only (no adipose clips). Numbers in boxes denote sample size and number of tagging days within each period.

Table 22. Percentage of days the fish evaluator at the Sullivan Plant was operational November 1999 through March 2000. Dates of operation are listed in **APPENDIX C.**

Month	Days operational	Percentage of days operational
November	17	57
December	4	13
January	18	58
February	29	100
March	31	100
April 1–10[a]	10	100
Total	109	67

[a] *No tag data sent from reader to computer after April 10 due to a mechanical problem.*

Table 23. Percentage of days the screw trap at the mouth of the McKenzie River was operational October 1999 through September 2000. The trap was installed October 11 and was not fished May 31–July 31. Dates of operation are listed in **APPENDIX C.**

Month	Days operational	Percentage of days operational
October	21	68
November	25	83
December	31	100
January	19	61
February	29	100
March	31	100
April	30	100
May	29	94
June	0	0
July	0	0
August	29	94
September	30	100
Total	274	75

Table 24. Percentage of days the screw trap in the main-stem Willamette River near Harrisburg was operational October 1999 through September 2000. The trap was installed October 25 and was not fished May 11–August 30. Dates of operation are listed in **APPENDIX C.**

Month	Days operational	Percentage of days operational
October	7	23
November	19	63
December	31	100
January	15	48
February	29	100
March	31	100
April	27	90
May	4	13
June	0	0
July	0	0
August	1	3
September	30	100
Total	194	53

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APPENDIX A

Schematic of Willamette Spring Chinook Salmon Study Plan

STUDY PLAN OVERVIEW
(see proposal for details)

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.

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

Hooking Mortality Data Collected in the Willamette River, 1998–2000.

Appendix Table B-1. Streamflow, temperature, and number of spring chinook salmon tagged on each sample day at Willamette Falls, 2000.

	Streamflow (cfs)[a]	Temperature (°F)[b]	River releases			Fishway
			Lures	Bait	Control	Control
Apr 28	19,700	53	22			3
29	20,000	--	25		4	7
30	20,100	--	16		3	6
May 1	19,000	53	26	11		22
2	18,000	54	15	11	31	29
3	17,100	55	13	4	33	
4	16,500	55	1	38		11
5	16,100	55	16	26		21
6	15,400	--	12	23	4	
7	16,300	--	4	12	8	
8	16,000	56	9	18	7	1
9	16,000	56	9		18	
10	20,300	55	5	13	5	5
16	25,800	54	2	14	33	6
19	25,100	56	10			1
21	22,000	--	11			18
23	20,100	61	9		28	56
Total			205	156	174	176

[a] *Measured at the Salem gauge.*
[b] *Water temperature measured in the forebay.*

Appendix Table B-2. Number of spring chinook salmon tagged at Willamette Falls to evaluate hooking mortality, April–May 1998–2000. Fish were sampled with sport fishing gear (and grouped by anatomical hook location) or with a trap in the Willamette Falls fishway (controls).

Group	1998	1999	2000
Sport gear:			
Jaw[a]	240	167	226
Tongue	14	6	19
Gill arches	24	35	53
Stomach[b]	5	12	53
Eye	4	1	10
Control	226	249	350

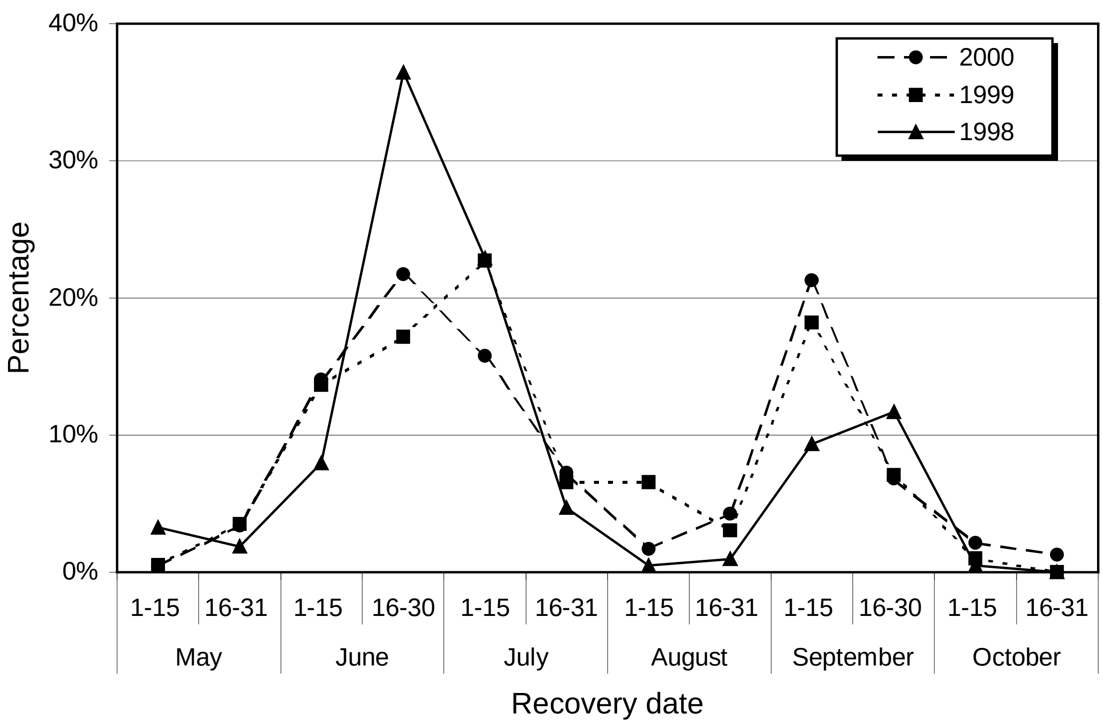
[a] *Includes fish hooked in the roof of the mouth.*
[b] *Includes fish hooked in the esophagus.*

Appendix Table B-3. Summary of recoveries of adult spring chinook salmon tagged and released at Willamette Falls, 1998–2000.

Recoveries	1998	1999	2000
Above falls	96%	96%	97%
Hatcheries	76%	73%	83%
Traps	10%	7%	10%
Spawning survey	2%	1%	3%
Below falls	4%	4%	3%
Clackamas River	60%	75%	67%
Angler returns	14%	20%	5%
Days to recovery			
Average	69	70	77
Range	6–158	4–152	1–168

Appendix Table B-4. Number of anglers interviewed, hours they fished, and the percentage of time different types of gear was used at locations upriver of Willamette Falls, April 24-June 12, 2000. Locations: 6 = Rodgers Landing, 7 = San Salvador, 9 = Wheatland Ferry, 10 = Mennonite Hole, 11 = Wallace, 12 = Emil Mark Hole/ Lloyd Strange Hole, 13 = Independence Ramp, 14 = Buena Vista.

	Location							
	6	7	9	10	11	12	13	14
Eggs	0.2	<1.0	0.3	0.0	0.3	0.0	0.0	7.3
Fish	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plug	3.4	7.5	5.0	8.3	6.6	1.0	0.0	25.2
Prawn	5.5	8.4	9.9	46.8	0.3	56.9	15.3	7.1
Spinglo	0.5	1.8	2.7	21.9	4.8	40.0	74.6	0.9
Spinner	88.2	81.6	82.1	22.9	88.0	1.4	10.1	57.6
Wobbler	1.4	0.7	0.0	0.0	0.0	0.6	0.0	1.8
Anglers	253	125	161	47	140	233	13	57
Hours	1856	566	1148	216	967	1131	105	391
Catch	26	6	9	0	3	1	2	1



Appendix Figure B-1. Temporal distribution of recoveries for adult spring chinook salmon tagged and released at Willamette Falls, 1998–2000.

APPENDIX C

Migration and Rearing Data for McKenzie and Willamette Rivers, 2000

Appendix Table C-1. Catch of various fish species by month in the screw trap at the mouth of the McKenzie River, 1999–2000. Trap was installed October 11 and was not operated May 31 through July 31, 2000. Catch was not expanded for unsampled days or for capture efficiency.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Aug	Sep
Chinook (unmarked)	8	42	16	5	9	11	2	0	1	0
Chinook (adipose)	11	615	1	0	211	112	0	0	0	0
Chinook (fry)	0	0	0	54	256	50	16	42	0	0
Cutthroat trout	1	14	1	0	16	63	40	17	1	4
Rainbow trout	0	2	0	0	0	7	6	5	1	2
Summer steelhead (hatchery)	0	0	0	0	0	0	32	22	0	0
Trout (fry)	0	12	52	31	50	97	78	45	1	5
Lamprey (adult)	0	0	0	0	0	0	0	2	0	0
Lamprey (ammocete)	1	13	191	146	85	57	20	142	0	0
Coarse scale sucker	2	2	29	29	37	22	20	16	7	17
Longnose dace	3	0	7	22	63	41	92	91	40	101
Redside shiner	13	20	101	107	94	45	101	79	108	77
Northern Pikeminnow	1	9	31	12	21	15	76	26	25	38
Sculpin	0	3	8	20	29	4	15	11	2	4
Mountain Whitefish	0	1	0	0	0	0	0	0	4	0
Sand roller	4	0	1	0	4	2	0	2	4	2
Stickleback	0	0	0	2	0	2	3	4	0	0
Peamouth	0	0	0	0	0	0	0	0	1	0
Chiselmouth	0	0	0	0	0	0	15	128	0	0
Bluegill	0	4	15	4	0	2	0	22	0	0

Appendix Table C-2. Catch of various fish species by month in the screw trap in the main-stem Willamette River near Harrisburg, 1999–2000. Trap was installed October 25 and was not operated May 5 through August 30, 2000. Catch was not expanded for unsampled days or for capture efficiency.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Aug	Sep
Chinook (unmarked)	2	8	54	14	8	9	4	0	1	4
Chinook (adipose)	2	156	4	15	98	163	0	0	0	2
Chinook (fry)	0	0	7	92	446	46	11	2	0	0
Cutthroat trout	0	2	21	5	1	8	1	12	0	0
Rainbow trout	0	0	0	1	0	0	3	0	0	0
Trout (fry)	0	1	21	6	1	8	4	0	0	16
Lamprey (ammocete)	55	82	352	499	236	113	24	7	0	33
Coarse scale sucker	5	40	73	38	84	28	11	0	0	54
Longnose dace	19	25	2	41	84	28	5	0	1	151
Redside shiner	112	175	143	148	167	36	43	3	100	498
Northern Pikeminnow	19	49	52	20	18	28	8	0	0	26
Sculpin	0	12	4	6	17	6	20	0	0	5
Mountain Whitefish	0	0	0	0	1	0	0	0	0	0
Sand roller	0	1	1	1	6	1	0	0	0	0
Sturgeon	0	0	1	0	0	0	0	0	0	0
Chiselmouth	0	1	0	0	0	0	1	0	0	0
Stickleback	0	0	1	0	0	1	0	0	0	0
Peamouth	0	6	0	0	0	0	0	0	0	0
Bluegill	1	5	15	8	2	0	0	0	0	0

Appendix Table C-3. Dates that the screw trap at the mouth of the McKenzie River was operational, October 1999 to September 2000.

Month	Date(s)	Comments
October	11–31	Trap installed Oct 11
November	1–24,30	Out of service Nov 25–29
December	1–31	
January	1–11, 24–31	Out of service Jan 12–23
February	1–29	
March	1–31	Debris stopped trap Mar 20
April	1–31	
May	1–30	Log stopped trap May 10 Trap pulled May 31
August	1–4, 7–31	Trap installed Jul 31
September	1–30	

Appendix Table C-4. Dates that the screw trap in the main-stem Willamette River near Harrisburg was operational, October 1999 to September 2000.

Month	Date(s)	Comments
October	25–31	Trap installed Oct 25
November	1–18, 30	High debris Nov 20–29
December	1–31	
January	1–11, 28–31	High debris Jan 12–27
February	1–29	
March	1–31	Trap vandalized Mar 4
April	1–14, 18–30	High debris Apr 15–17
May	1–10	High debris, trap pulled May 10
August	31	Trap installed Aug 30
September	1–30	

Appendix Table C-5. Dates the fish evaluator at the Sullivan Plant at Willamette Falls was operational, November 1999 to June 2000.

Month	Date(s)	Status	Comments
November	1–7	Shut down	
	8–17	Operating	
	18	Shut down	
	19–25	Operating	
	26–30	Shut down	High flow and debris. Flows at Salem jumped from 20,100 to 101,000 cfs on November 26.
December	1–21	Shut down	High flow and debris
	22–23	Operating	
	24–29	Shut down	Plant maintenance, rack cleaning
	29–30	Operating	
	31	Shut down	Holiday
January	1–3	Shut down	Holiday
	4–10	Operating	Flow and debris decrease.
	11–20	Shut down	Plant maintenance
	21–31	Operating	
February	1–29	Operating	
March	1–31	Operating	
April	1–30	Operating	No tag data sent from reader to computer after April 10 due to mechanical problem.
May	1–31	Operating	
June	1–16	Operating	Evaluator shut down due to shad migration.