Compliance with the Biological Opinion for Hatchery Programs in the Willamette Basin

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Final Report

Task Order: NWP-OP-FH-02-01

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

Page

LIST OF TABLES

LIST OF TABLES (continued)

CONCLUSIONS

Task 1.1. Remove hatchery reared Chinook at Leaburg Dam to reduce the number of hatchery fish spawning upstream of Leaburg Dam.

About 25% of the fin-clipped Chinook were removed in 2002 and 2003. The large number of fish returning to the McKenzie River precluded operating the left bank ladder during the peak of migration. The right bank ladder that became operational in 2004 does not have trapping capabilities. Less than 10% of the fin-clipped Chinook were removed in 2004 and 2005.

Task 1.2. Monitor straying of hatchery fish on natural spawning grounds.

Activity 1.2.1. Monitor the distribution and abundance of natural spawning Chinook salmon by counting redds.

The McKenzie River accounted for almost half of the Chinook redds in 2002–2005. The South Santiam River accounted for 26%, followed by the North Santiam and the Middle Fork Willamette, with Fall Creek accounting for most of the redds in the Middle Fork Willamette Basin. The McKenzie River (and tributaries) upstream of Forest Glen accounted for an average of 60% of all redds in 2002–2005. The highest density of redds in the North Santiam Basin occurred from Fishermen's Bend to Minto, accounting for at least 50% of all redds. A large number of redds were counted in the South Santiam from Foster Dam to Pleasant Valley, accounting for the second highest number of redds counted in basins upstream of Willamette Falls. Estimated pre-spawning mortality was high (>50%) in the Middle Fork Willamette and North Santiam basins and was about 30% in South Santiam, with the exception of 2004 (72%), and generally < 20% in the McKenzie Basin.

Activity 1.2.2. Estimate the number of marked and unmarked Chinook salmon passing Bennett Dam on the North Santiam River.

An average of 396 naturally produced and 9,801 hatchery Chinook passed Bennett dams in 2001–2004.

Activity 1.2.3. Determine the proportion of hatchery fish in natural spawning populations of Chinook from fin clips and otolith analysis.

The percentage of naturally produced Chinook carcasses recovered on spawning grounds in 2001–2004 was highest in the McKenzie Basin (68%). Relatively low proportions of naturally produced fish were found elsewhere (South Santiam 11%, North Santiam 11%, Middle Fork Willamette 7% and Molalla 3%).

Task 1.3. Conduct annual spawning ground surveys to determine the percentage and origin of hatchery strays from coded wire tags.

Most hatchery fish spawning naturally were released as smolts in that same stream. McKenzie stock released in the Lower Willamette and Clackamas comprised the majority of the adults in the McKenzie, North Santiam, and South Santiam rivers that were released as smolts elsewhere. Hatchery fish released in the North Santiam River did not stray to the South Santiam, but hatchery fish released in the South Santiam returned to the North Santiam.

Task 2.1 Determine the number and percentage of Chinook captured at the hatcheries and broodstock collection facilities that are unmarked, naturally produced fish.

An average of 4% of the Chinook captured at Minto were naturally produced, 7% at Foster Dam, 0.6% at McKenzie Hatchery, and 0.4% at Dexter in 2002–2004.

Task 2.2. Determine the number and percentage of naturally produced Chinook that are taken annually for broodstock.

Naturally produced Chinook spawned at McKenzie Hatchery were 0.4% of the number of non-fin-clipped fish counted at Leaburg Dam in 2002–2004. Naturally produced Chinook spawned at Marion Forks Hatchery were 1.3% of the naturally produced fish estimated at Bennett dams.

Task 3.1. Monitor the effects of hatchery rainbow stocking in the McKenzie Subbasin on listed Chinook.

Activity 3.1.2. Sample the stomach contents of hatchery steelhead smolts and rainbow trout.

Salmonids were found in few rainbow trout stomachs (26 juvenile salmonids in 3,905 stomachs from hatchery rainbow). The number of salmonids found in stomachs was higher in trout sampled in the lower river and in the Leaburg Power Canal, than in Leaburg Reservoir or the upper river. However, we did not expand the stomach contents data to estimate the number of Chinook fry consumed by hatchery steelhead smolts and rainbow trout because of the uncertainties about digestion rate, consumption rates of Chinook fry by hatchery steelhead and rainbow due to sampling almost exclusively during daylight hours, species composition of fish in stomach samples, and abundance of hatchery rainbow trout and steelhead in the river over time. Therefore, we could not determine the extent of predation on Chinook fry by hatchery steelhead smolts and rainbow trout.

Task 3.2. Monitor the effects of non-native summer steelhead in the North Santiam, South Santiam, and the McKenzie rivers for at least two years.

Activity 3.2.1. Determine harvest of summer steelhead.

In 2003, 1,758 summer steelhead were harvested in the North Santiam, 5,474 in the South Santiam, 1,171 in the McKenzie, and 2,591 in the Middle Fork Willamette, for a total of 10,994. In 2004, 3,684 summer steelhead were harvested in the North Santiam, 4,645 in the South Santiam, 4,864 in the McKenzie, and 1,286 in the Middle Fork Willamette, for a total of 14,479.

Activity 3.2.2. Monitor passage of adipose fin-clipped and unmarked adult summer steelhead passing fishways at Stayton Island (North Santiam) and Leaburg Dam.

The estimated number of summer steelhead passing Bennett dams on the North Santiam ranged from 3,579 to 8,584 fish in 2001 through 2005. Counts of summer steelhead at Leaburg Dam ranged from 900 to 2,685 fish annually from 2003 to 2005 with 2.9% to 14.2% of those fish being non fin-clipped.

Activity 3.2.3. Determine the number of summer steelhead spawning naturally.

We expanded the number of redds counted on random surveys and estimated 3,528 ± 1,686 summer steelhead redds in the Willamette Basin upstream of Willamette Falls in 2003, 1,562 ± 736 in 2004, and 3,817 ±1,050 in 2005. If each redd represents two fish, then 10% to 30% of the summer steelhead counted at Willamette Falls spawned. Roughly twice as many winter steelhead passed Willamette Falls during this period. Summer steelhead redds were widely distributed throughout the ESU.

Activity 3.2.4. Estimate the number of naturally produced steelhead smolts migrating past Leaburg Dam.

We estimate that 5,735 ± 2,575 and 1,390 ± 566 naturally produced summer steelhead smolts migrated past Leaburg Dam in 2003 and 2005 respectively.

Task 3.3. Determine the location and total catch of adipose fin-clipped and unmarked Chinook.

In 2003 4,972 marked Chinook were caught in the North Santiam (4,893 kept), 4,081 were caught in the South Santiam (3,297 kept), 1,571 were caught in the McKenzie (1,475 kept), and 1,949 were caught in the Middle Fork Willamette (1,583 kept). A total of 846 unmarked Chinook were caught in the North Santiam (all were released), 650 were caught in the South Santiam (10 kept), 416 were caught in the McKenzie (42 kept), and 833 were caught in the Middle Fork Willamette (all were released).

In 2004 3,201 marked Chinook were caught in the North Santiam (2,941 kept), 6,103 were caught in the South Santiam (4,986 kept), 3,437 were caught in the McKenzie (3,032 kept), and 6,140 were caught in the Middle Fork Willamette (5,451 kept). A total of 392 unmarked Chinook were caught in the North Santiam (all were released), 467 were caught in the South Santiam (25 kept), 1,807 were caught in the McKenzie (19 kept), and 1,150 were caught in the Middle Fork Willamette (all were released).

Task 4.1. Record date, number, length, sex, and origin (hatchery or wild) of Chinook spawned.

Data on individual fish spawned are available and have been sent to NMFS. The percentage of naturally produced Chinook used for broodstock was higher in 2004 than in previous years, and was highest at South Santiam Hatchery (average 4%) than at McKenzie (2%), Marion Forks (1%), or Willamette (0.5%) hatcheries.

Task 4.3. Monitor and evaluate the bycatch of listed steelhead and Chinook in the Foster Reservoir trout fishery.

Anglers retained an estimated 612 naturally produced steelhead smolts and released 109 in the Foster Reservoir fishery annually determined by creel surveys conducted from February 2002 through October 2004. No juvenile Chinook were reported by anglers or observed by creel surveyors. Angling regulations have changed and now allow only fin-clipped trout to be harvested.

RECOMMENDATIONS

1. The number of hatchery Chinook spawning with wild fish upstream of Leaburg Dam should be reduced. The percentage of carcasses from hatchery fish in spawning areas upstream of the dam averaged over 30% in 2001–2004, with percentages exceeding 60% in the South Fork McKenzie River and areas downstream. The number of hatchery adults could be reduced by reducing the number of hatchery smolts released in the McKenzie River, by excluding hatchery adults from passing Leaburg Dam, by increasing the percentage of returning hatchery fish that home to the hatchery, or by a combination of these actions.

2. The number of hatchery and naturally produced Chinook spawning naturally, the number and distribution of redds and age at return of naturally produced Chinook should be determined annually for each of the Chinook populations in the Upper Willamette ESU.

3. Video recording systems should be installed at Bennett dams on the North Santiam and at Lebanon Dam on the South Santiam to count adipose clipped and non fin-clipped Chinook, and winter steelhead.

4. The extent and causes of pre-spawning mortality of Chinook in the North Santiam, South Santiam and Middle Fork Willamette rivers should be determined. High pre-spawning mortality in these rivers could limit natural production.

5. Rearing and release methods for hatchery spring Chinook smolts should be evaluated and modified to reduce straying by returning adults to streams other than where they were released. Rearing and release strategies for hatchery Chinook should be evaluated (e.g., outmigration and use of rearing habitat) for potential effects on wild juvenile chinook.

6. The number of naturally produced Chinook incorporated into hatchery broodstocks should be monitored by collecting and analyzing otoliths of non fin-clipped fish.

7. The number of Chinook fry consumed by hatchery rainbow trout in the McKenzie River could be substantial and needs to be determined.

8. Restricting the trout season in Foster Reservoir to late April or late May through October and delaying releases of hatchery trout would better protect wild steelhead smolts, and would be consistent with regulations for North Fork Reservoir (Clackamas River) where there is a fishery for stocked trout and naturally produced steelhead smolts are also present.

9. Samples should be collected from wild steelhead smolts in the North Santiam and South Santiam to determine the extent of natural reproduction by summer steelhead and genetic introgression with native winter steelhead.

IMPLEMENTATION OF ACTIONS FOR COMPLIANCE WITH THE REASONABLE AND PRUDENT ALTERNATIVES AND MEASURES IDENTIFIED IN THE NATIONAL MARINE FISHERIES SERVICE'S BIOLOGICAL OPINION FOR HATCHERY PROGRAMS IN THE WILLAMETTE BASIN

INTRODUCTION

The National Marine Fisheries Service listed Upper Willamette River Chinook (*Oncorhynchus tshawytscha*) and Upper Willamette River steelhead (*O. mykiss*) as threatened under the Endangered Species Act (ESA; 64 FRN 14308; 64 FRN 14517). The Oregon Department of Fish and Wildlife operates fish hatcheries in the Willamette Basin with the funding, in large part, from the U.S. Army Corps of Engineers. Concomitant with ESA listing, any actions taken or funded by a federal agency must be evaluated to assess whether they are likely to jeopardize the continued existence of threatened and endangered species, or result in the destruction or impairment of critical habitat. The National Marine Fisheries Service issued the ***Biological Opinion on the Impacts From the Collection, Rearing, and Release of Salmonids Associated with Artificial Propagation Programs in the Upper Willamette Spring Chinook and Winter Steelhead Evolutionarily Significant Units*** on July 14, 2000. The Biological Opinion concluded that "the proposed artificial propagation programs are likely to jeopardize the continued existence of listed Upper Willamette River Chinook." The Oregon Department of Fish and Wildlife implemented actions on behalf of the United States Army Corps of Engineers to assist with meeting the requirements of the reasonable and prudent alternative and measures prescribed in the Biological Opinion. The Oregon Department of Fish and Wildlife submits this report in fulfillment of Task Order: NWP-OP-FH-02-01

OBJECTIVES

Objective 1 ***Manage programs to minimize potential interbreeding of hatchery reared fish and listed salmon and steelhead in the Columbia River Basin [RPM 2]. The result would be to reduce natural spawning of hatchery-origin Chinook with existing Chinook salmon populations [RPA 1].***

> ***Task 1.1*** ***Beginning in 2001, the USACE and ODFW shall remove hatchery reared Chinook at Leaburg Dam [RPA 1, c, iii], thus reducing the number of hatchery Chinook spawning upstream of Leaburg Dam on the McKenzie River [RPM 2a].***

We used a temporary trap in the left bank ladder at Leaburg Dam to remove about 25% of the fin-clipped Chinook at Leaburg Dam in 2002 and 2003 (Table 1). Large runs of salmon in those years precluded operating the trap during the peak of the migration. We could not operate the left bank trap and remove fish in 2004 because this ladder was closed for modifications. The new right bank ladder was placed in operation in 2004, but this ladder was built without a trap and access for removing fish is limited. Therefore, less than 10% of the fin-clipped Chinook were removed in 2004 and 2005.

Table 1. Fin-clipped Chinook removed at Leaburg Dam.

Year	Passed over Leaburg Dam: Not fin-clipped	Fin-clipped	Jacks	Total	Fin-clipped removed	Percent removed—of fin-clipped	of run
2001	3,433	869	a	4,302	126	12.7	2.8
2002	4,223	1,864	18[a]	6,105	687	26.9	10.1
2003	5,784	3,543	115[a]	9,442	1,197	25.3	11.3
2004	4,788	4,246	18[b]	9,052	9	0.2	0.1
2005	2,579	515	14[c]	3,108	40	7.1	1.3

[a] Jacks were counted, or not classified by fin clip.

[b] 11 not fin-clipped and 7 fin-clipped.

[c] 7 not fin-clipped and 7 fin-clipped.

***Task 1.2** Monitor straying of hatchery fish on natural spawning grounds: conduct annual spawning ground surveys. [RPM 2, d]*

***Activity 1.2.1** Monitor the distribution and abundance of natural spawning Chinook salmon in the Willamette Basin by counting redds. Basins surveyed will be the North Santiam, McKenzie, Molalla, South Santiam, and Calapooia, rivers (also possibly the MF Willamette R. and tributaries).*

The McKenzie Basin accounted for 48% of the Chinook redds in the areas we surveyed in 2002–2005 (Figure 1). The South Santiam Basin accounted for 26% of the redds, followed by the North Santiam and Middle Fork Willamette basins, with Fall Creek accounting for most of the redds in the Middle Fork Willamette Basin. Details of these surveys can be found in Schroeder et al. 2002, Schroeder et al. 2003, Schroeder and Kenaston 2004 and Schroeder et al. 2005.

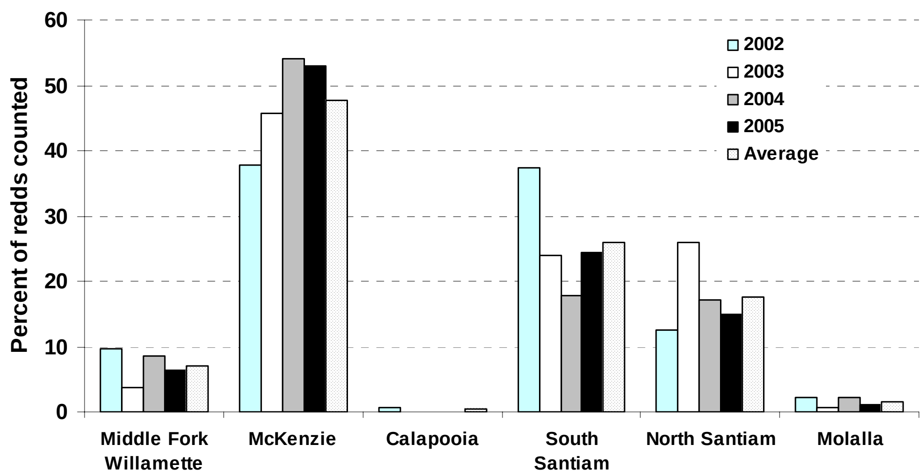

Figure 1. Chinook redds counted in the Willamette River basin, 2002–2005. The Middle Fork Willamette includes Fall Creek and the South Santiam includes Thomas Creek (Appendix A Table 1).

McKenzie Basin

Chinook redds were widely distributed in the McKenzie Basin with the majority upstream of Leaburg Dam (Figures 2 and 3, Table 2). The distribution redds varied between years. The McKenzie River (and tributaries) upstream of Forest Glen accounted for about 55% of all redds in 2002–2004, and increased to over 75% in 2005 because of the large number of redds counted in Horse and Lost creeks (Figures 2 and 3).

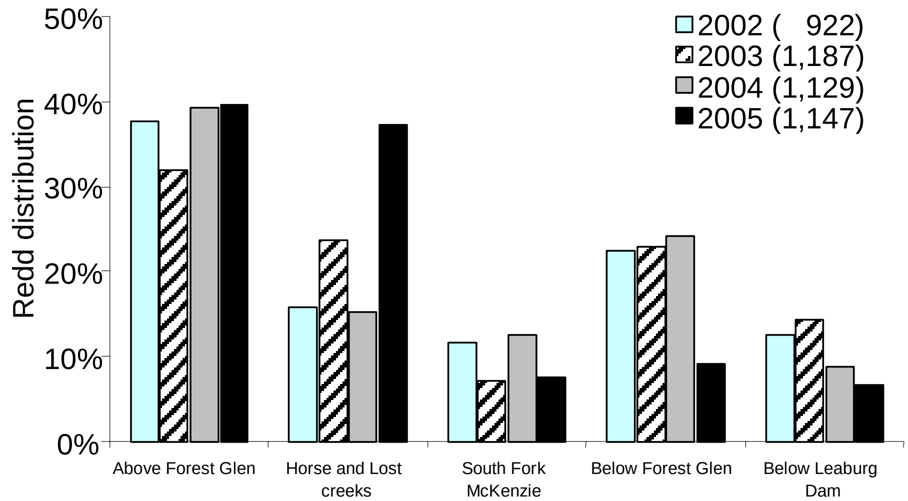

Figure 2. Distribution of Chinook redds among five areas of the McKenzie River basin, 2002–2005. Total redds counted annually in the McKenzie Basin are shown in parentheses in the legend (Appendix A Table 2).

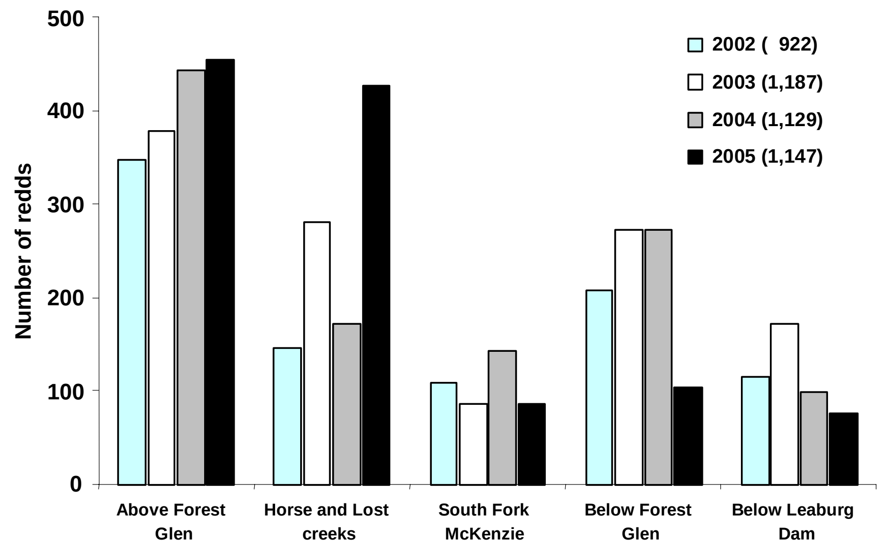

Figure 3. Number of Chinook redds counted in five areas of the McKenzie River basin, 2002–2005. Total redds counted annually in the McKenzie Basin are shown in parentheses in the legend (Appendix A Table 3).

Table 2. Counts of Chinook carcasses and redds in the McKenzie River, 2005, and comparison to redd densities in 1996–1998 and 2000–2004.

Stream: Reach	Length (mi)	2005		Redds/mi								
		Carcasses	Redds	2005	2004	2003	2002	2001	2000	1998	1997	1996
McKenzie River:												
Spawning channel	0.1	7	64	12.8[a]	18.6[a]	7.2[a]	15.4[a]	--	--	--	1.0[a]	2.6[a]
Olallie–McKenzie Trail	10.3	64	320	31.1	22.1	24.7	16.3	17.7	5.6	--	11.4	7.0
McKenzie Trail–Hamlin	9.9	40	42	4.2	9.4	4.0	5.2	4.9	1.6	--	--	2.1
Hamlin–S. Fork McKenzie	0.3	--	--	--	--	10.0	36.7	--	--	--	--	--
South Fork–Forest Glen	2.4	7	29	12.1	12.1	19.2	16.7	0.8	2.1	--	--	0.8
Forest Glen–Rosboro Br.	5.7	12	21	3.7	36.1	26.8	14.9	13.2	5.8	--	--	6.1
Rosboro Br.–Ben and Kay	6.5	34	81	12.5	10.3	7.4	16.2	6.3	3.2	--	--	4.9
Ben and Kay–Leaburg Lake	5.9	1	2	0.3	--	12.0	2.9	3.2	--	--	--	1.8
South Fork McKenzie:												
Cougar Dam–Road 19 Br.	2.3	21	51	22.2	49.1	31.7	36.5	--	--	--	--	--
Road 19 bridge–mouth	2.1	12	35	16.7	13.8	5.7	11.4	8.1	7.6	--	--	2.9
Horse Creek:												
Pothole Cr.–Separation Cr.	2.8	0	15	5.4	5.4	18.6	--	--	--	--	--	--
Separation Cr.–mouth	10.7	60	205	19.2	10.3	13.6	12.1	7.4	--	--	--	5.3
Lost Creek:												
Spring–Limberlost	2.8	7	43	15.4	6.4	9.3	--	--	--	--	--	--
Limberlost–Hwy 126	2.0	33	157	78.5	13.5	21.0	--	--	--	--	--	--
Hwy 126–mouth	0.5	0	7	14.0	4.0	30.0	32.0	--	--	--	--	--
McKenzie River:												
Leaburg Dam–Leaburg town	6.0	28	75	12.5	16.5	28.5	19.2	12.3	--	15.3	19.8	10.3

[a] Redds/100 ft.

North Santiam Basin

The highest density of Chinook redds in the North Santiam Basin occurred in the reach from Fisherman's Bend to Minto (Table 3). This reach consistently accounted for at least 50% of the redds in the North Santiam Basin, whereas other areas rarely accounted for more than 25% (Figure 4). The reach from Fisherman's Bend to Minto probably accounts for such a large proportion of the redds because Minto is the hatchery smolt release site and hatchery Chinook comprise a high percentage of the run (*see* **Task 1.3**).

The number of redds counted in the North Santiam upstream of Bennett Dam (Stayton Island) was 2–5 times higher in 2001–2005 than in 1996–1998, while the number of Chinook counted at Bennett Dam was 2–13 times higher. Generally, the number of redds counted in each area of the North Santiam Basin increased in 2001–2005 from the 1996–1998 average (Figure 5). We estimated that pre-spawning mortality reduced the number of naturally spawning Chinook in the North Santiam Basin 50% to 80% (*see* **Pre-spawning mortality**).

Several hundred non fin-clipped Chinook were collected at Minto and released into the Little North Santiam each year from 2002 to 2005 (Table 3). This resulted in a relatively small increase in the number of redds in the Little North Santiam.

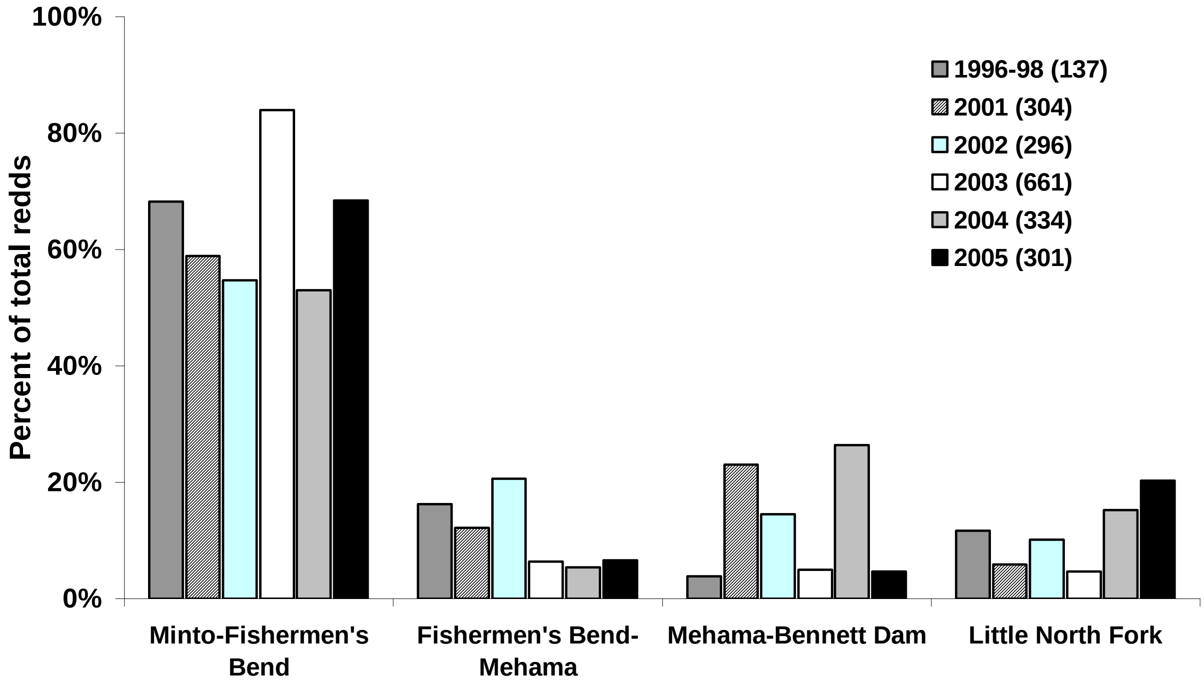

Figure 4. Distribution of Chinook redds among four areas of the North Santiam Basin upstream of Bennett dams, 1996–1998 and 2001–2005. Total redds counted annually in the basin are shown in parentheses in the legend (Appendix A Table 4).

Table 3. Counts of Chinook carcasses and redds in the North Santiam River, 2005, and comparison to redd densities in 1996–2004. Counts of carcasses and redds in areas below Stayton may include some fall Chinook.

Survey section	Length (mi)	2005		Redds/mi									
		Carcasses	Redds	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
Minto–Fishermen's Bend	10.0	140	206	20.6	17.7	55.5	16.2	17.9	23.0[a]	15.6	11.8	8.5	7.8
Fishermen's Bend–Mehama	6.5	31	20	3.1	2.8	6.5	9.4	5.7	5.8	3.1	4.3	2.5	3.5
Mehama–Stayton Is.	7.0	23	14	2.0	12.6	4.7	6.1	10.0	0.9[a]	--	0.6	0.9	1.0
Stayton Is.–Stayton	3.3	33	24	7.3	7.9	3.6	3.0	6.7		--	10.0	3.6	2.0
Stayton–Greens Bridge	13.7	7	4	0.3	0.2	0.1	0.4	0.1	--	0.0	0.4	1.1	0.1
Greens Br.–mouth	3.0	3	0	0.0	0.0	1.7	4.7	--	--	--	4.7	9.7	--
Little North Santiam	17.0	73	61	3.6[b]	3.0[c]	1.8[d]	1.8[e]	1.1[f]	1.3	1.0	2.2	0.6	0.0

[a] Data was recorded for Mehama–Stayton and density was 0.9 redds/mi.

[b] A total of 329 non fin-clipped adult Chinook were released on July 27, August 30, and September 2, 6, 9, 12, 2005.

[c] A total of 377 non fin-clipped adult Chinook were released on July 9, August 19, 27, and September 9, 2004.

[d] A total of 268 non fin-clipped adult Chinook were released on June 25, July 9, 15, 22, August 25, and September 2, 4, 2003.

[e] A total of 400 non fin-clipped adult Chinook were released on August 20, 30, September 5, 6, 2002.

[f] Corrected number.

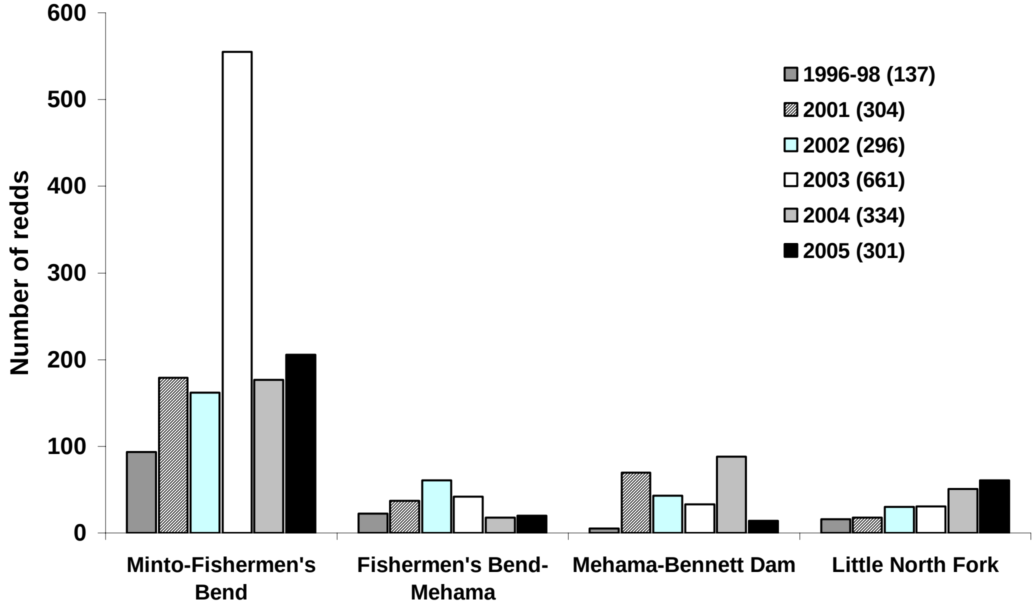

Figure 5. Number of Chinook redds counted in four areas of the North Santiam Basin upstream of Bennett dams, 1996–1998 and 2001–2005. Total redds counted annually in the basin are shown in parentheses in the legend (Appendix A Table 5).

Other Basins

We consistently counted a large number of redds in the 4.5 miles of South Fork Santiam between Foster Dam and Pleasant Valley, but few redds in the Calapooia, Molalla and Middle Fork Willamette below Dexter Dam (Table 4 and Figure 6).

Table 4. Counts of Chinook carcasses and redds in the Middle Fork Willamette, South Santiam and Molalla rivers, 2005, and comparison to redd densities in previous years.

River Section	Length (mi)	2005 Carcasses	2005 Redds	Redds/mi 2005	Redds/mi 2004	Redds/mi 2003	Redds/mi 2002	Redds/mi 1998
Mid. Fk. Willamette								
Dexter–Jasper	9.0	45	9	1.0	1.0	1.6	7.1	1.1
Fall Creek (above res.)	16.0	12	130	8.1	12.9	6.2	12.9	--
South Santiam								
Foster–Pleasant Valley	4.5	525	507	112.7	75.1	132.0	194.4	36.0
Pleasant Val.–Waterloo	10.5	82	23	2.2	3.3	1.5	1.8	1.8
Lebanon–mouth	20.0	7	--	--	0.2	1.0	3.4	2.9
Molalla								
Horse Cr–Pine Cr [a]	6.2	23	25	4.0	2.7	1.3	3.2	--

[a] The number of redds counted in the Molalla River was relatively low in 2005, but the redd density was slightly higher because we surveyed a 6.2 mile sub-section of the Haybarn Cr–Trout Cr reach of which we surveyed 16.1, 11.5, and 16.3 miles in 2004, 2003, and 2002, respectively.

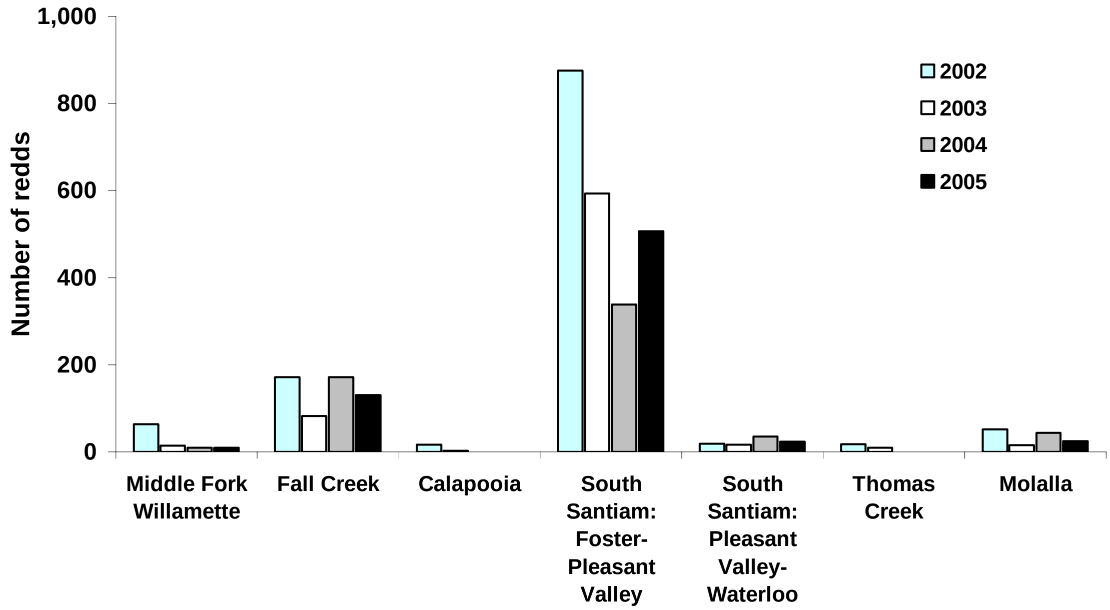

Figure 6. Number of Chinook redds counted in seven areas of the Willamette River basin, 2002–2005. A shorter section of the Molalla River was surveyed in 2005 (Appendix A Table 6).

Pre-spawning Mortality

We estimated pre-spawning mortality of female Chinook from the ratio of spawned to unspawned carcasses. We determined if a female had spawned by the presence of eggs. We did not use males to determine pre-spawning mortality because we could not reliably determine if they had spawned before dying. Most surveys were not conducted explicitly to estimate pre-spawning mortality, and beginning dates varied between years and among rivers. Surveys began in some years in early to mid summer and continued through the end of the spawning season in October, and in other years did not begin until late summer. In addition, recovering carcasses can be difficult when flows increase during the spawning season, either from late summer rain or from increased discharge from reservoirs. Therefore, caution should be used in comparing estimates of pre-spawning mortality between years within basins or among basins.

We calculated the ratio of the estimated number of successful spawners (from redd counts) to the estimated number of potential spawners as a second measure of pre-spawning mortality in the North Santiam and McKenzie rivers. We assumed a sex ratio of 1.2 males:1 female and a ratio of one female per redd to estimate the number of successful spawners per redd. We used the number of Chinook passed at Leaburg Dam for potential spawners in the McKenzie River. We subtracted the estimated number of Chinook harvested and the number collected at Minto Pond from the number counted at Bennett dams to calculate the number of potential spawners in the North Santiam. Caution should be used with these numbers because of the assumptions we made in deriving estimates.

Pre-spawning mortality can significantly reduce the number of naturally spawning Chinook. The Middle Fork Willamette River below Dexter Dam had the highest pre-spawning mortality for

Chinook (consistently above 80%) among the basins we surveyed (Table 5). Although we estimated 100% pre-spawning mortality in the Middle Fork Willamette River in 2003, we counted 14 redds indicating some survival of adult fish to spawning. Mortality in the South Santiam River appeared to be much lower than that in the North Santiam River, with the exception of 2004. Non fin-clipped Chinook (300–400) were transported from Minto Pond and released in the Little North Santiam River. Stress from handling and transportation likely increased pre-spawning mortality of these fish.

Table 5. Estimates of pre-spawning mortality of Chinook in the upper Willamette River basin based on recovery of female carcasses, 2001–2005. Starting dates of carcass surveys for each year are in parentheses.

Year	Middle Fork Willamette	Fall Creek	McKenzie	So. Santiam	No. Santiam	Little North Santiam
2001			7 (Aug 21)		75 (Aug 14)	
2002	83 (Aug 7)	58 (Aug 27)	8 (Aug 15)	26 (Aug 15)	52 (Aug 1)	
2003	100 (Jul 15)	44 (Aug 27)	21 (Aug 7)	28 (Jul 14)	72 (Jun 27)	81 (Jul 10)
2004		57 (Aug 10)	17 (Aug 18)	72 (Jul 20)	77 (Jun 17)	50 (Jul 14)
2005	94 (Jul 29)		18 (Aug 10)	32 (Jul 14)	51 (Jul 12)	41 (Aug 31)

An analysis of potential effects of environmental factors such as water flow and temperature on pre-spawning mortality was not possible because of the confounding effect of different starting dates for the surveys, and other uncertainties about the estimates. In the North and South Santiam rivers, water flow and temperature during the summer are likely to affect pre-spawning mortality because of stress and associated effects on resistance to disease of fish holding in the river or negotiating dams and shallow riffles. Passage at Upper Bennett Dam is more difficult during low flow, which results in fish holding downstream for longer periods of time. In years with large numbers of returning adults, effect of flow and temperature may have an increased effect if suitable holding habitat is limited because more fish would be holding in marginal habitat.

Estimates of pre-spawning mortality in the North Santiam from female carcasses were generally lower than estimates from successful and potential spawners, but the trend was similar for both estimates (Figure 7). Both estimates indicate that the number of naturally spawning Chinook is reduced by 50% to 80% in the North Santiam Basin by pre-spawning mortality. Because surveys began on different dates each year, the estimates among methods and years are not wholly comparable. For example, we surveyed the North Santiam Basin from mid June through October in 2003 and 2004, and found that pre-spawning mortality calculated from female carcasses would have been underestimated if only data from late August through October had been collected (Figure 8). The difference between the estimates was greater in 2003 than in 2004 because a larger proportion of the total mortality occurred in early summer. These data indicate that, at least in some years, carcass surveys beginning in late summer can greatly underestimate pre-spawning mortality, the degree of which will depend on the timing of mortality.

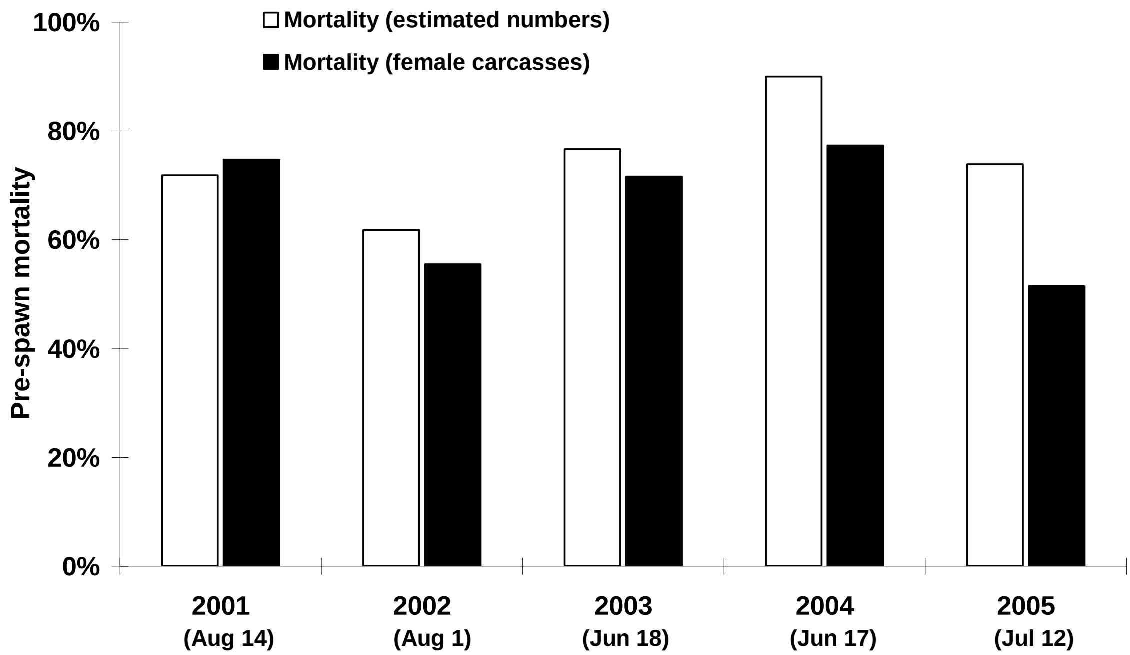

Figure 7. Percent pre-spawning mortality for adult Chinook in the North Santiam River estimated from recovery of female carcasses, and estimated from the ratio of the number of successful spawners (from redd counts) to the number of potential spawners (counts of adult fish at Bennett dams minus fish removed at Minto Pond and estimated harvest), 2001–2005. Starting dates of carcass surveys for each year are in parentheses (Appendix A Table 7).

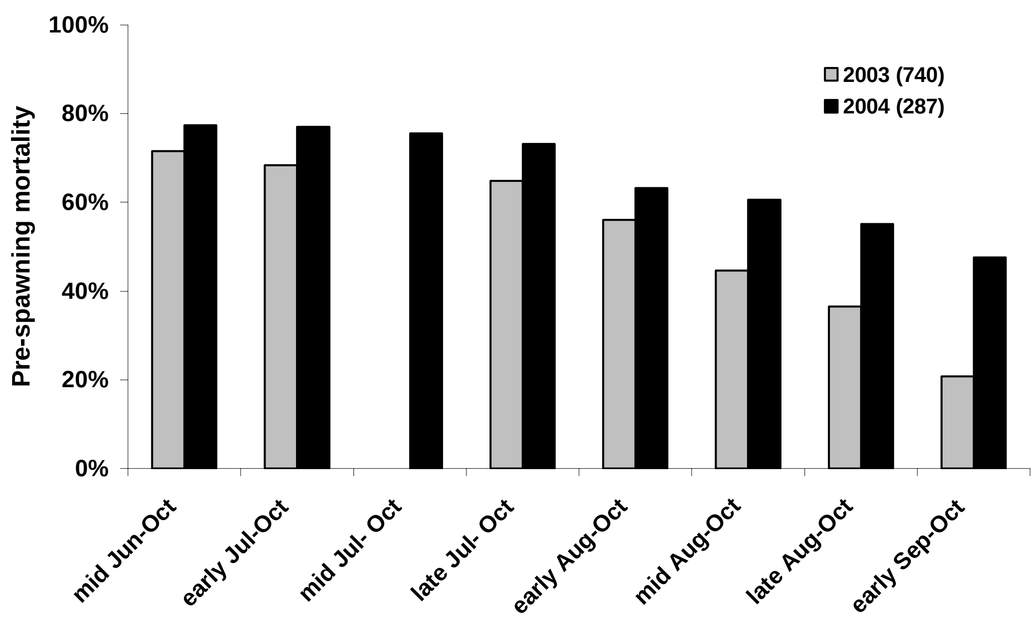

Figure 8. Percentage of female Chinook that died before spawning in the North Santiam River, estimated using progressively later starting dates, 2003–2004. Total number of female carcasses recovered is shown in parentheses in the legend (Appendix A Table 8).

Based on recovery of carcasses, pre-spawning mortality in the McKenzie River was much lower than the North Santiam, and suggested number of natural spawners might be reduced by about 6–16%. With the exception of 2005, pre-spawning mortality in the McKenzie River basin estimated from female carcasses was much lower than estimates from potential and successful spawners (Figure 9). This is in contrast to results in the North Santiam Basin where the two estimates were relatively similar. Carcass surveys began in mid to late August. Although mortality may be higher than that estimated from carcasses, it is unlikely that mortality rates exceeding 60%, as estimated from potential spawners and number of redds, would go unnoticed. We believe estimates from carcasses provide a better gauge of pre-spawning mortality than estimates from potential spawners and redds in the McKenzie Basin because:

1. Counts of Chinook at Leaburg may overestimate the number of Chinook spawning upstream of Leaburg Dam, especially for hatchery fish (Schroeder et al. 2005),
2. Counts of redds could be underestimated because of factors such as variability in redd counts by different survey crews (Schroeder et al. 2005), changes in late season conditions that may make redds difficult to see, and wide distribution of Chinook spawning in the basin.

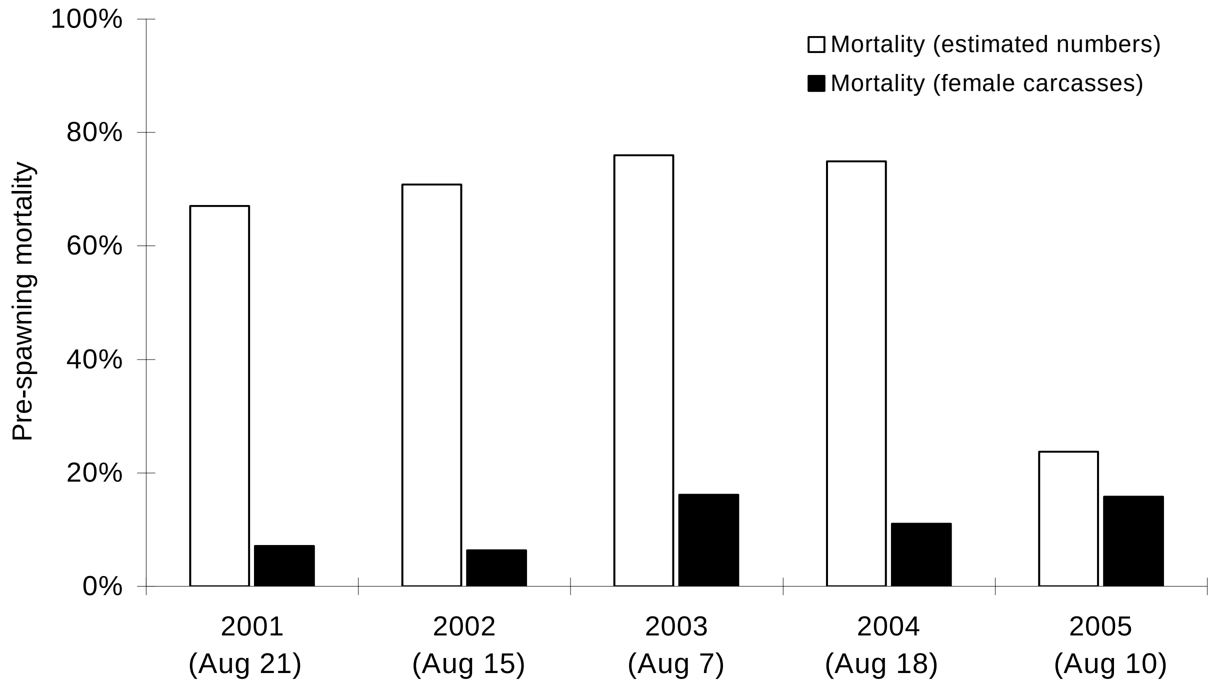

Figure 9. Percent pre-spawning mortality for Chinook in the McKenzie Basin upstream of Leaburg Dam estimated from recovery of female carcasses, and estimated from the ratio of the number of successful spawners (from redd counts upstream of Leaburg Dam) to the number of potential spawners (counts of fish passing Leaburg Dam), 2001–2005. Starting dates of carcass surveys for each year are in parentheses (Appendix A Table 9).

<u>Activity 1.2.2</u> Estimate the number of marked and unmarked Chinook salmon passing Bennett Dam near Stayton on the N. Santiam River.

The total number of adult Chinook counted at Bennett dams ranged from 6,786 to 13,531 in 2001–2005. A low percentage of these were naturally produced fish (Table 6).

Table 6. Number of wild and hatchery Chinook passing Bennett dams expanded for non-sampling days and for fall-back, and estimated number of adult Chinook adjusted by the percentage of non fin-clipped carcasses with induced thermal marks recovered upstream of the dams.

	Dam counts							
	Adults				Percent non fin-	Estimated adults		
Year	Non fin-clipped	Fin-clipped	Total	Jacks	clipped carcasses with thermal marks	Wild	Hatchery	Percent wild
2001	388	6,398	6,786	217[a]	43.4	220	6,566	3
2002	1,233	6,407	7,640	153[a]	51.0	604	7,036	8
2003	1,262	11,570	12,832	b	78.5	271	12,561	2
2004	1,510	12,021	13,531	423[c]	67.6	489	13,042	4
2005	924	3,959	4,883	b	d	--	--	--

[a] Non fin-clipped jacks numbered 22 in 2001 and 24 in 2002.

[b] Jacks were not differentiated.

[c] No differentiation by fin clip.

[d] Otoliths have not been analyzed.

Table 7. Number of spring Chinook passing Bennett dams in 2005.

	Number of adult Chinook		
Location:	Non fin-clipped	Fin-clipped	Total
Upper Bennett Dam			
Estimated passage through July 4	563	2,625	3,188
Estimated passage after July 5[a]	212	989	1,203
Lower Bennett (LB) passage	177	463	640
Total at Upper and Lower Bennett	952	4077	5,029
Fallback correction[b]	(-28)	(-118)	(-146)
Corrected total passage at Upper and Lower Bennett	924	3,959	4,883

[a] The fishway at Upper Bennett was closed to construct a new fishway. Estimate is based on average run timing from 2000-2003 (72.6%).

[b] 2.9% fallback rate

***Activity 1.2.3** Determine the proportion of hatchery fish in natural spawning populations of Chinook by enumerating fish with and without fin clips, and by otolith analysis. [RPM 10.3.2b and 10.3.3b]*

All hatchery Chinook smolts released in the Willamette Basin (except double-index groups) were marked with an adipose fin-clip, beginning with the 1997 brood. Although the intention is to adipose fin-clip all hatchery smolts, some are missed during marking. Otoliths have been thermally marked on all hatchery Chinook beginning with the 1997 brood year to distinguish adult hatchery fish without an adipose fin-clip from wild fish.

We collected otoliths from non fin-clipped adult Chinook on spawning grounds in most of the major tributaries in the Willamette Basin and at Minto (North Santiam River), South Santiam, McKenzie, and Willamette hatcheries. We classified a fish as wild if it did not have an adipose fin-clip and an induced thermal mark in the otoliths. We tested the accuracy of the WDFW lab in identifying induced thermal marks by submitting blind samples of otoliths from coded wire tagged hatchery adults collected at the hatcheries (Schroeder et al. 2005).

We previously documented a significant difference between the distribution of redds and the distribution of carcasses recovered among survey areas within some watersheds (Schroeder et al. 2003). Therefore, we used the distribution of redds among survey areas to weight the number of non fin-clipped carcasses in each area with the results of otolith analysis to estimate the number of wild fish that spawned within a survey area.

Wild fish comprised a high percentage of carcasses recovered from naturally spawning Chinook in the McKenzie Basin and a much lower percentage in other basins (Table 8).

Table 8. Origin of naturally-spawning adult Chinook in the Willamette River basin based on carcasses weighted for distribution of redds among survey areas within a watershed (except Middle Fork Willamette, and 2005 data).

		Non fin-clipped [a]		
River (section) Year	Fin-clipped	Hatchery	Wild	Percent wild [b]
McKenzie (upstream of Leaburg Dam)				
2001	62	51	265	70 (69)
2002	140	78	454	68 (62)
2003	131	60	333	64 (62)
2004	137	26	313	66 (60)
2005	38	260 [c]		
North Santiam (Minto–Bennett Dam) [d]				
2001	385	43	56	12 (6)
2002	230	44	45	14 (13)
2003	855	89	27	3 (4)
2004	321	21	56	14 (15)
2005	164	103 [c]		
South Santiam (Foster–Waterloo)				
2002	1,604	37	224	12 (12)
2003	970	31	151	13 (13)
2004	838	30	85	9 (9)
2005	469	138 [c]		
Middle Fk Willamette (Dexter–Jasper) [e]				
2002	167	151	15	(5)
2003	62	48	4	(4)
2004	120	32	22	(13)
2005	37	20 [c]		
Molalla (Copper Creek–Trout Creek)				
2002	94	5	3	3 (2)
2003	17	6	1	4 (4)
2004				
2005	19	4 [c]		

[a] The proportion of hatchery and wild fish were determined by thermal marks in otoliths.
[b] Percentage in parentheses is not weighted for redd distribution.
[c] Otoliths collected in 2005 have not been analyzed.
[d] Includes Little North Fork Santiam.
[e] Includes Fall Creek, no clipped fish were processed in Fall Creek in 2005.

The highest proportions of wild spawners in the McKenzie River basin were in the mainstem upstream of Forest Glen, and in Horse and Lost creeks (Figure 10). The percentages of wild fish were lower in the areas downstream near Leaburg Dam, areas closer to McKenzie Hatchery. Similar results were observed in the Clackamas River basin upstream of North Fork Dam where the proportion of wild origin fish spawning was lowest in the areas nearest the dam and Clackamas Hatchery (Schroeder et al. 2005).

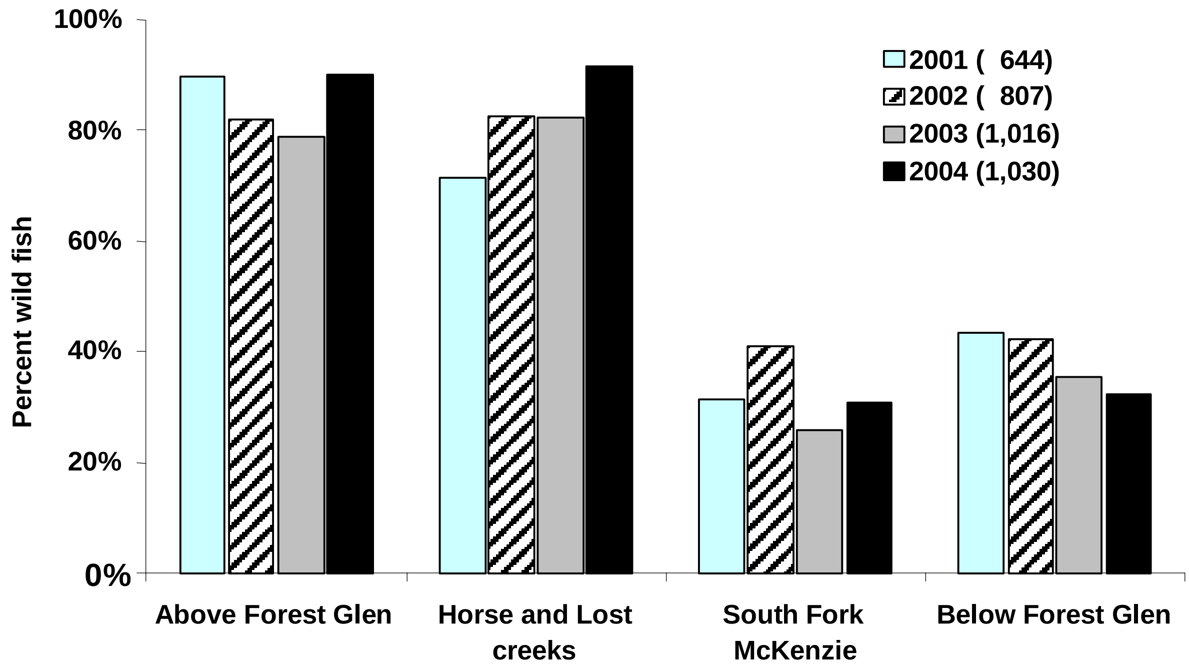

Figure 10. Percentage of adult Chinook carcasses in four areas of the McKenzie River basin upstream of Leaburg Dam that were wild based on absence of fin clips and thermal marks in otoliths, 2001–2004. Total redds counted annually in the McKenzie Basin upstream of Leaburg Dam are shown in parentheses in the legend.

The percentage of adult hatchery Chinook without a fin clip generally decreased from 2002 to 2004 (Figure 11). Adult Chinook in the Willamette Basin are comprised primarily of age 4 and age 5 fish, therefore these results likely reflect an increase in quality of fin clipping from the 1997–1998 brood years (2002 return) to the 1999–2000 brood years (2004 return). With the exception of returns to the South Santiam, the percentage of the 2002 hatchery return without a fin clip was greater than the estimated percentage of hatchery fish released without a fin clip (Figure 12). By the 2004 return year, the hatchery return to the North Santiam was the only one in which the percentage of non fin-clipped adults exceeded that of the non fin-clipped juveniles at release. The estimated effects of differential harvest of clipped fish (26% of run, Foster and Boatner 2002) compared to catch and release mortality of non fin-clipped fish (3.2% of run, Lindsay et al. 2004) reduces the percentage of non fin-clipped hatchery returns by about 23%, but the trend in decreasing percentage of hatchery fish without fish clips remains the same.

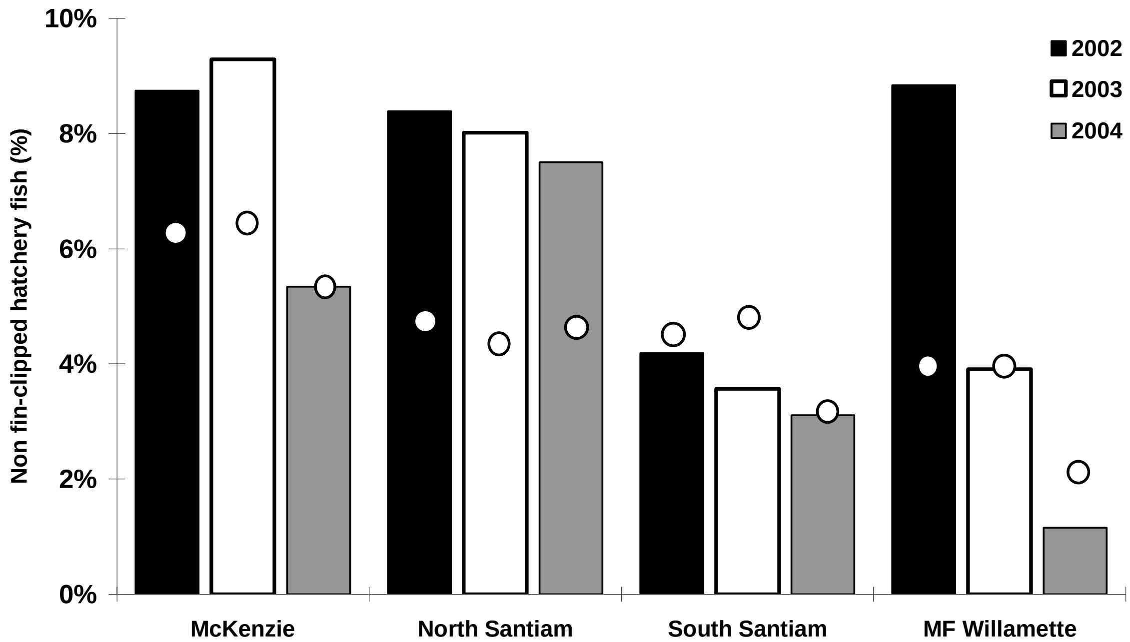

Figure 11. Percentage of adult hatchery Chinook without a fin clip returning to four Willamette Basin watersheds, 2002–2004. Non-fin-clipped adults were identified as hatchery fish by analysis of otoliths. The percentages of adults without a fin-clip were not adjusted to account for differential harvest of fin-clipped and non fin-clipped fish. The circles are the average percentage of hatchery smolts released without a fin clip for the brood years corresponding to age 4 and age 5 returns.

<u>Task 1.3</u> Conduct annual spawning ground surveys to determine the percentage and origin of hatchery strays by sampling carcasses for coded wire tags. [RPM 10.3.2b and 10.3.2d]

We surveyed most of the major tributaries in the Willamette Basin upstream of Willamette Falls in 2001–2005 by boat and on foot to collect snouts from Chinook with coded wire tags (CWT). The ODFW Fish ID Lab in Clackamas removed the tags from the snouts and decoded the tags to determine the origin of release for each fish. Adult hatchery fish were defined as “local” if they were released as juveniles within the basin or “stray” if they were released as juveniles in other locations. The percentage of hatchery Chinook released with adipose fin clips and CWTs varied between years. All hatchery fish from the 1997 brood year release were clipped and tagged, whereas the percentage of tagged fish from other brood years varied among release groups and basins. For example, all hatchery fish used in an experimental evaluation of acclimation were clipped and tagged compared to other releases in which 5–20% were clipped and tagged. Therefore, the numbers of tagged fish recovered in spawning surveys were expanded by the percentage of tagged fish in each of the release groups before we estimated the extent and origin of straying.

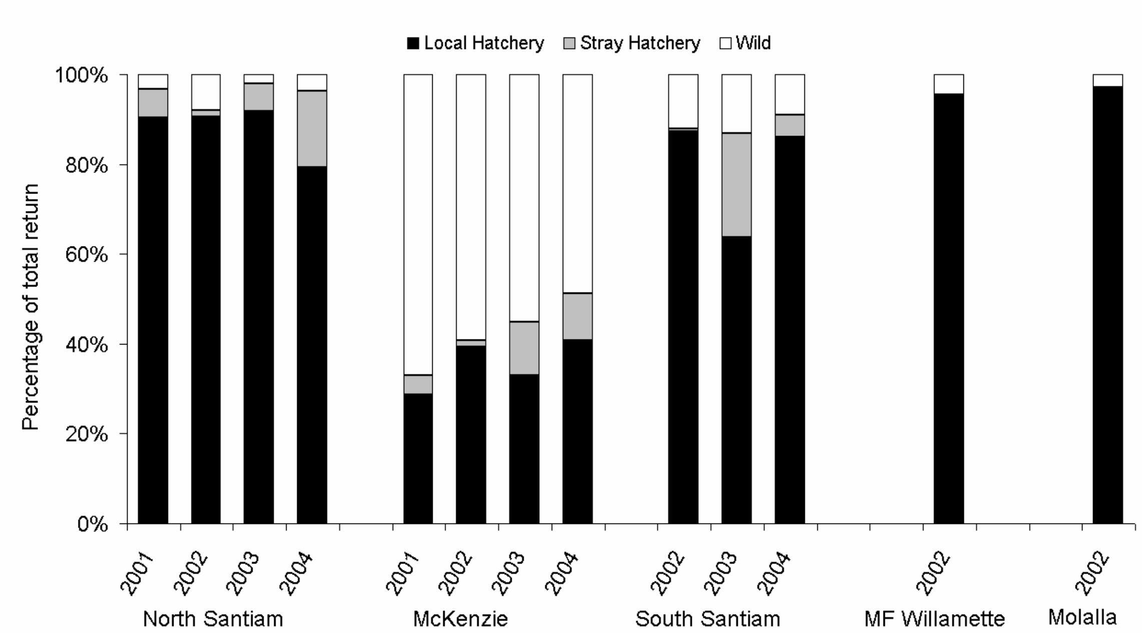

Figure 12. Origin of naturally spawning Chinook in five Willamette Basin rivers determined by recoveries of coded wire tags (CWT) from spawned and unspawned carcasses and expanded for percentage of the hatchery release that was tagged. Adult hatchery fish were defined as "local" if they were released as juveniles within the basin or "stray if they were released as juveniles in other locations (Appendix A Table 10).

The origin of stray hatchery fish varied within each basin and between years (Table 9). McKenzie stock that were released in the Lower Columbia, Willamette, and Clackamas basins as part of a netpen and direct release evaluation (Schroeder and Kenaston 2004) comprised much of the strays. These experimental releases composed 54% of the strays to the McKenzie Basin, 24% of the stray returns to the North Santiam, and 78% of the strays to the South Santiam. Hatchery fish released in the North Santiam River did not stray to the South Santiam, but hatchery fish released in the South Santiam comprised 29% of the strays in the North Santiam.

Table 9. Origin of naturally spawning, hatchery Chinook based on recoveries of coded wire tagged carcasses from spawning grounds, 2001–2005. Includes only rivers and years when more than 10 tags were recovered (Appendix A Table 11).

River Year	Number of tags recovered		Origin of hatchery fish									
	Not expanded	Expanded [a]	Local	Lower Clackamas [b]	Lower Willamette [c]	Molalla [d]	North Santiam	South Santiam	McKenzie	Clackamas	Mid. Fk. Willamette	Youngs Bay [e]
McKenzie												
2001	53	55	87.2	7.3	0.0	1.9	0.0	0.0	--	0.0	3.6	0.0
2002	95	263	96.4	3.2	0.4	0.0	0.0	0.0	--	0.0	0.0	0.0
2003	16	81	73.7	0.9	6.5	0.0	18.9	0.0	--	0.0	0.0	0.0
2004	19	79	80.0	2.5	8.9	0.0	0.0	8.5	--	0.0	0.0	0.0
North Santiam												
2001	369	374	93.4	1.3	0.0	3.3	--	0.5	0.0	1.4	0.0	0.0
2002	80	217	98.1	0.5	0.0	1.4	--	0.0	0.0	0.0	0.0	0.0
2003	46	634	93.8	0.3	1.3	1.7	--	1.7	1.1	0.0	0.0	0.2
2004	28	228	82.3	0.4	3.9	5.4	--	7.9	0.0	0.0	0.0	0.0
South Santiam												
2001	310	1,111	99.3	0.0	0.7	0.0	0.0	--	0.0	0.0	0.0	0.0
2002	97	640	73.2	20.7	4.2	1.7	0.0	--	0.0	0.0	0.0	0.2
2003	121	605	94.5	0.8	3.8	0.9	0.0	--	0.0	0.0	0.0	0.0
2004	50	299	94.1	0.0	0.3	1.5	0.0	--	3.8	0.0	0.0	0.3
Mid. Fk. Willamette												
2002	356	1,736	99.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	--	0.0
Molalla												
2002	22	57	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[a] Expanded for percentage of a release that was coded wire tagged.
[b] McKenzie stock acclimated or directly released in the lower Clackamas River.
[c] McKenzie stock acclimated or directly released in the lower Willamette River.
[d] South Santiam and McKenzie stocks.
[e] Middle Fork Willamette stock released into netpens near mouth of Columbia River.

***Objective 2** Quantify the effects of hatchery broodstock collection on listed Chinook and winter steelhead in the UWR ESUs [RPM 3]*

> ***Task 2.1** Beginning in 2002, determine the number and percentage of Chinook captured at the hatcheries and broodstock collection facilities (Minto, S. Santiam McKenzie, Dexter) that are unmarked, naturally produced fish. If the percentage is greater than 10% of the total fish captured over the trapping season, the action agencies must notify NMFS. [RPM 3a]*

The percentage of Chinook captured at the hatcheries that were naturally produced exceeded 10% at South Santiam Hatchery in 2004 (Table 10). The percentage of naturally produced fish at Marion Forks Hatchery was $\leq$ 10% and was < 1% at McKenzie and Willamette hatcheries.

Table 10. Percentage of naturally produced fish captured at Marion Forks, South Santiam, McKenzie and Willamette hatcheries, 2002–2005.

	Hatchery			
Hatchery, year	Fin-clipped	Non fin-clipped[a]	Naturally produced	Percent naturally produced
Marion Forks				
2002	4,305	643	263	5.1
2003	4,032	409	88	1.9
2004	3,554	498	183	4.3
2005	1,441	385 [b]		
South Santiam				
2002	6,413	866	501	6.4
2003	5,937	449	234	3.5
2004	9,846	1,755	1,457	11.2
2005	3,197	900 [b]		
McKenzie				
2002	6,641	191	22	0.3
2003	6,088	172	43	0.7
2004	4,752	226	42	0.8
2005	3,199	57 [b]		
Willamette				
2002	9,764	861	74	0.7
2003	6,457	113	9	0.1
2004	11,237	138	50	0.4
2005	6,344	48 [b]		

[a] The proportion of hatchery and wild fish were determined by presence or absence of thermal marks in otoliths.

[b] Otoliths collected in 2005 have not been analyzed.

Task 2.2 ***Beginning in 2002, determine the number and percentage of natural-origin (unmarked) Chinook run that are taken annually for broodstock. If natural component is > 10%, then notify NMFS. [RPM 3b]***

Less than 10 percent of the natural-origin Chinook run was used for hatchery broodstock in the North Santiam and McKenzie rivers (Table 11). We could not estimate the run size of Chinook in the South Santiam or Middle Fork Willamette rivers.

Table 11. Number and percentage of unmarked (wild) Chinook retained for broodstock in the North Santiam and McKenzie rivers, 2002–2004.

Population Year	Number retained for broodstock [a]	Estimated wild run [b]	Percent wild run taken
North Santiam			
2002	4	604	0.7%
2003	2	271	0.7%
2004	12	489	2.5%
McKenzie			
2002	13	3,602	0.4%
2003	14	4,899	0.3%
2004	24	4,419	0.5%

[a] Number of naturally produced fish spawned.

[b] Estimated number of wild Chinook at Bennett (North Santiam) and Leaburg (McKenzie) dams.

Objective 3 ***Minimize potential negative impacts to listed salmon and steelhead in the Upper Willamette Basin from operation of the hatcheries. [RPM 4]***

Task 3.1 ***The USACE shall monitor the effects of hatchery rainbow stocking in the McKenzie Subbasin on listed Chinook. Creel surveys shall be conducted to determine the bycatch of listed juvenile and adult Chinook in recreational fisheries targeting trout. [RPM 4d]***

Activity 3.1.1 ***Sample the stomach contents of hatchery steelhead smolts and rainbow trout observed during creel surveys for adult Chinook and steelhead (late April through June) (See Activity 3.2.1 and Task 3.3).***

Activity 3.1.2 ***Sample the stomach contents of hatchery steelhead smolts and rainbow trout collected by angling or seining in the McKenzie River (early April through early June).***

ODFW releases more than 250,000 summer steelhead smolts and rainbow trout into the McKenzie River each year (Table 12). All of the steelhead smolts are released from Leaburg Hatchery or trucked to locations below Leaburg Dam. The rainbow trout are released into three reaches: 1) the lower river—17 miles from the Bellinger Boat landing upstream to Greenwood Boat Landing, 2) Leaburg Reservoir—1.5 miles from Leaburg Dam to the head of the reservoir, and 3) the upper river Upper River—27 miles from Leaburg Reservoir to the Forest Glen boat ramp (Figure 13).

Table 12. The number of steelhead smolts and rainbow trout stocked in the McKenzie River, 2001–2005.

		Rainbow trout		
Year	Steelhead smolts	Below Leaburg Dam	Leaburg Reservoir	Above Leaburg Reservoir
2001	116,611	40,659	28,785	90,238
2002	113,230	43,621	30,844	78,559
2003	121,303	22,341[a]	14,217[a]	50,621[a]
2004	113,305	40,241	26,047	78,535
2005	108,512	35,449	30,128	79,996

[a] The number of hatchery trout stocked was reduced by an outbreak of IHN at Leaburg Hatchery.

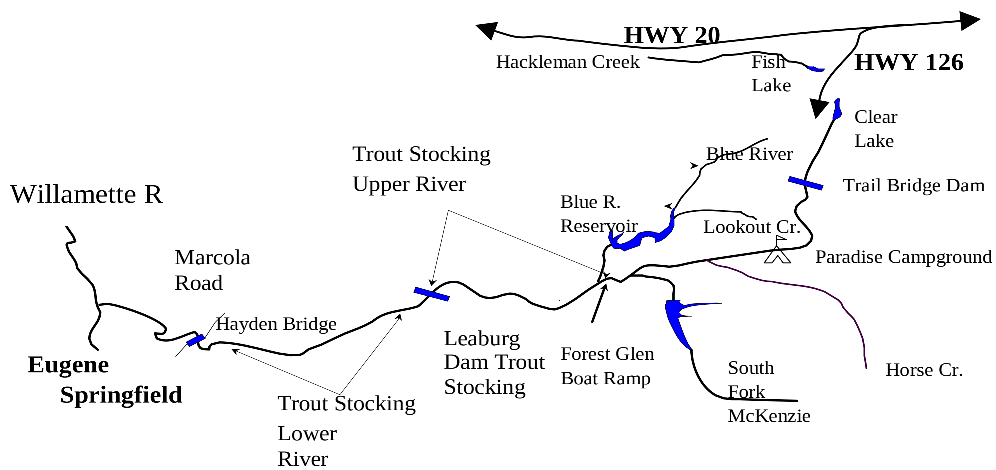

Figure 13. Areas of the McKenzie River where rainbow trout are stocked.

We determined the average time Chinook fry could be identified in the stomach of hatchery rainbow trout and summer steelhead smolts. We placed 40 Cape Cod rainbow trout and 40 Skamania summer steelhead in separate 500 gallon Canadian troughs supplied with water from the McKenzie River at Leaburg Hatchery. Both groups were starved for three days before 100–300 Chinook fry, similar in size to wild fry, were introduced into each trough. After one to two hours, we removed the remaining fry and flushed the stomachs of a sample of the steelhead and rainbow. We sampled additional steelhead and rainbow each hour until we could not find fish parts in the stomachs. Steelhead smolts digested Chinook fry in 3–7 hours at 7.2 degrees Celsius. Rainbow trout digested Chinook fry in 2–6 hours at 7.2 degrees Celsius, 3–8 hours at 8.8 degrees Celsius and 1–7 hours at 10.0 degrees Celsius.

We sampled stomach contents of hatchery rainbow trout and steelhead retained in the fishery, caught by seining and caught by angling, to assess predation on ESA listed Chinook fry. In general, salmonids were found in few rainbow trout stomachs and occurred at a higher rate in trout from the lower river and Leaburg Canal intake than in the reservoir or upper river (Table 13), with the highest percentage of salmonids coming from the trout sampled in the Leaburg Canal intake. No attempt was made to randomly sample the hatchery fish temporally or in proportion to their distribution. Most of the hatchery rainbow trout we sampled (39%) were from just upstream of the fish screens in the Leaburg canal, a 2,300 cfs diversion used for power production (Table 13). We sampled the stomach contents of 44 hatchery rainbow trout caught in the Leaburg power canal inlet on one night, August 4, 2005, between 12:00 am and 8:00 am, and found three fish, two Chinook and one unidentified salmonid. We sampled the remainder of the hatchery rainbow trout between 8:00 am and 4:30 pm. Since the time we could identify fish in the stomach contents was between 2 and 8 hours after ingestion, our sampling could have greatly underestimated the rate at which rainbow trout consume Chinook fry.

Table 13. Number of hatchery rainbow trout sampled and number of stomach content samples that contained salmonids.

	Lower River		Leaburg Canal intake		Leaburg Reservoir		Upper River	
Year	Rainbow sampled	Salmonids found	Rainbow sampled	Salmonids found	Rainbow sampled	Salmonids found	Rainbow sampled	Salmonids found
2003	324	1	16	0	41	0	0	0
2004	358	6	557	8	433	1	55	0
2005	0	0	945	8	0	0	1,176	2
Total	682	7	1,518	16	474	1	1,231	2
Percent	17%	27%	39%	62%	12%	4%	32%	7%

We applied freeze brands to 10% of the hatchery rainbow trout stocked in Leaburg Reservoir and the upper McKenzie River from April 20, 2005 to June 23, 2005 to determine a mortality rate. Although we were unable to recapture enough fish to estimate the rate of mortality, we found some fish survived up to 18 weeks. Hutchinson and Hooton (1990) also found that hatchery rainbow released in the McKenzie River survived up to 18 weeks.

We did not expand the stomach contents data to estimate the number of Chinook fry consumed by hatchery steelhead smolts and rainbow trout because of the uncertainties about digestion rate, consumption rates of Chinook fry by hatchery steelhead and rainbow due to sampling almost exclusively during daylight hours, species composition of fish in some stomach samples, and abundance of hatchery rainbow trout and steelhead in the river over time. Therefore, we could not determine the extent of predation on Chinook fry by hatchery steelhead or rainbow trout.

Task 3.2 ***Monitor the effects of non-native summer steelhead in the North and South Santiam, and the McKenzie rivers for at least two years to determine: 1) percentage of the summer steelhead run that is harvested in the fishery, and 2) number of summer steelhead spawning naturally. [RPM 4, e]***

Activity 3.2.1 ***Conduct creel surveys in the subject streams to determine harvest of summer steelhead (April through November).***

We conducted creel surveys to estimate catch of steelhead in the North Santiam, South Santiam, McKenzie and Middle Fork Willamette rivers in 2003 and 2004 (Tables 14–17). Effort reported includes number of hours spent angling for all species, not just steelhead. We also conducted creels surveys on the South Santiam River and McKenzie River in 2002, however these surveys covered only a portion of the season (Firman and Buckman 2003).

Table 14. Estimated angling effort and catch of steelhead in the North Santiam River, 2003–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	27,338	525	445	40	0	40
May	62,569	1085	929	88	0	68
June	37,784	336	263	38	0	35
July	14,698	100	72	14	0	14
Aug	3,734	45	45	0	0	0
Sept	1,863	35	4	16	0	15
Oct	433	2	0	2	0	0
Total	148,419	2,128	1,758	198	0	172
2004						
April	14,627	352	312	16	0	24
May	27,666	693	610	57	0	26
June	40,249	1880	1,784	72	0	24
July	19,430	616	571	38	0	7
Aug	6,513	314	293	21	0	0
Sept	1,778	97	45	34	0	18
Oct	1,655	69	69	0	0	0
Total	111,918	4,021	3,684	238	0	99

Table 15. Estimated angling effort and catch of steelhead in the South Santiam River, 2003–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	12,418	726	601	0	0	125
May	53,278	1402	1,329	51	0	22
June	46,283	2045	1,860	171	0	14
July	22,254	1259	1,131	128	0	0
Aug	7,285	303	254	49	0	0
Sept	3,366	251	216	31	0	4
Oct	1,361	98	83	12	0	3
Total	146,245	6,084	5,474	442	0	168
2004						
April	19,141	466	435	31	0	0
May	61,647	811	723	88	0	0
June	41,221	2038	1,861	177	0	0
July	20,606	1502	1,223	262	0	17
Aug	7,406	282	252	30	0	0
Sept	909	123	111	12	0	0
Oct	877	66	40	23	0	3
Total	151,807	5,288	4,645	623	0	20

Table 16. Estimated angling effort and catch of steelhead in the McKenzie River, 2003 – 2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	3,509	39	37	2	0	0
May	22,019	335	331	0	0	4
June	27,634	420	357	55	0	8
July	11,223	129	111	9	0	9
Aug	6,904	31	25	0	0	6
Sept	3,529	99	82	17	0	0
Oct	2,921	253	171	81	0	1
Nov	421	61	57	4	0	0
Total	78,160	1,367	1,171	168	0	28
2004						
April	9,389	385	353	24	0	8
May	31,824	1047	856	152	6	33
June	37,478	2194	2029	108	0	57
July	21,045	605	578	10	0	17
Aug	10,808	304	232	72	0	0
Sept	7,651	1171	646	520	0	5
Oct	2,107	333	170	145	0	18
Total	120,302	6,039	4,864	1,007	6	138

Table 17. Estimated angling effort and catch of steelhead in the Middle Fork Willamette River, 2003 – 2004.

			Fin-clipped		Non fin-clipped	
Year, month	Effort (hrs)	Catch	Kept	Released	Kept	Released
2003						
April	13,194	438	270	0	11	157
May	39,620	911	621	113	0	177
June	33,323	1281	1,138	78	6	59
July	14,448	621	562	49	0	10
Aug	--	--	--	--	--	--
Sept	--	--	--	--	--	--
Oct	--	--	--	--	--	--
Total	100,585	3,251	2,591	240	17	403
2004						
April	16,203	519	450	39	0	30
May	41,925	1533	1309	185	0	39
June	41,677	3741	2837	726	0	178
July	22,595	2306	1955	336	0	15
Aug	--	--	--	--	--	--
Sept	--	--	--	--	--	--
Oct	--	--	--	--	--	--
Total	122,400	8,099	6,551	1,286	0	262

<u>Activity 3.2.2</u> Monitor passage of adipose fin-clipped and unmarked adult summer steelhead passing fishways at Stayton Island (North Santiam) and Leaburg. Investigate the feasibility of monitoring steelhead passage at Lebanon Dam on the South Santiam.

The number of summer steelhead in the McKenzie River ranged from about 900–2,700 fish, of which about 3–14% were not fin-clipped (Table 18). Summer steelhead in the North Santiam ranged from about 3,600–8,600 (Table 19).

Table 18. Number of summer steelhead counted at Leaburg Dam on the McKenzie River, 2003–2005.

Run year	Adipose fin-clipped	Non fin-clipped	Total	% non fin-clipped
2003	772	128	900	14.2%
2004	2,607	78	2,685	2.9%
2005	1,519	62	1,581	3.9%

Table 19. Number of summer steelhead counted at Bennett dams on the North Santiam River, 2001–2005.

Run year	Number of summer steelhead
2001	5,460
2002	6,211
2003	4,073
2004	8,584
2005	3,576

Activity 3.2.3 ***Survey spawning areas to determine the number of summer steelhead spawning naturally (mid-December through mid-March).***

We counted adult steelhead and new redds bi-weekly in randomly selected sample areas distributed throughout the presumed spawning distribution of summer steelhead and used these data to estimate the number of summer steelhead redds in the Middle Willamette (Molalla, North Santiam, South Santiam and Calapooia rivers) and the Upper Willamette (McKenzie, Middle Fork Willamette and Coast Fork Willamette rivers) in 2003–2005. Redds found after March 15 were classified as winter steelhead. Surveys were conducted on foot and by boat. We attempted to determine if the adult steelhead we observed were adipose fin-clipped. Additional details of survey methods can be found in Susac and Jacobs (1998). Peak spawning occurred later in the mid-Willamette (Feb–Mar) than in the upper Willamette (Jan–Feb) (Figure 14). The estimated number of redds ranged from about 1,600–3,800 and was related to the size of the steelhead run over Willamette Falls (Table 20).

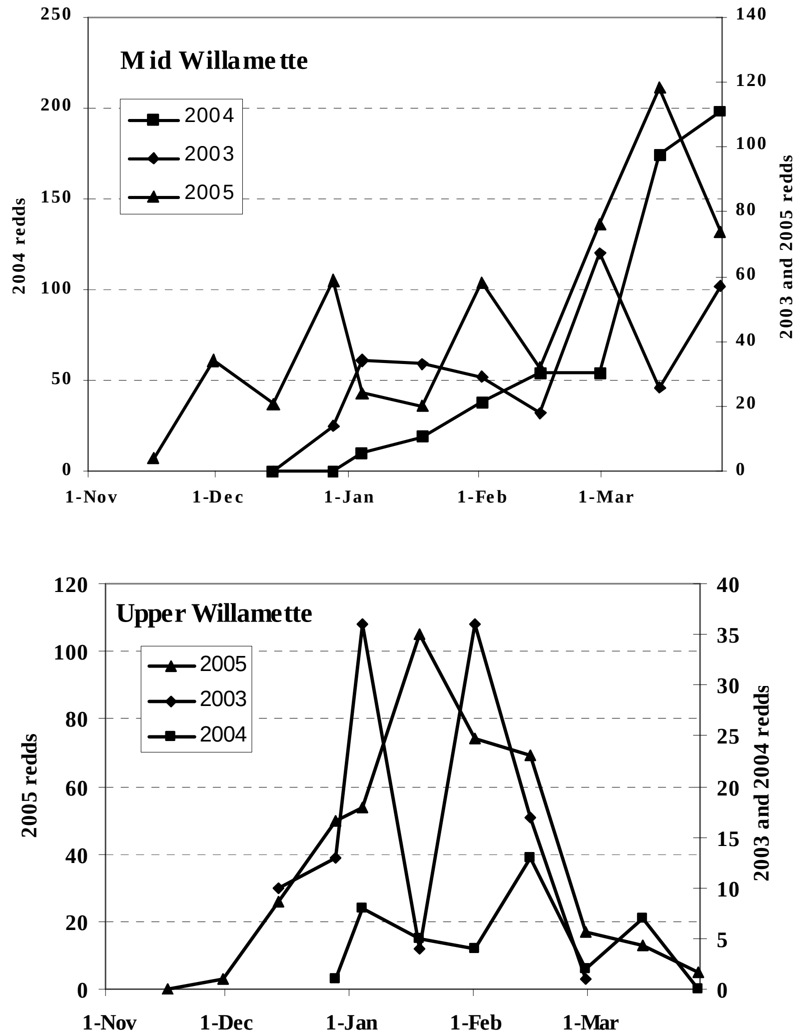

Figure 14. Timing of spawning by summer steelhead in the Willamette Basin upstream of Willamette Falls, 2003–2005. The Middle Willamette includes the Molalla, North Santiam, South Santiam and Calapooia rivers. The Upper Willamette includes the McKenzie, Middle Fork Willamette and Coast Fork Willamette rivers.

Table 20. Estimated number of summer steelhead redds in the Middle Willamette (Molalla, North Santiam, South Santiam and Calapooia rivers) and the Upper Willamette (McKenzie, Middle Fork Willamette and Coast Fork Willamette rivers), 2003–2005.

Year	Monitoring area			Summer steelhead counted at Willamette Falls
	Mid Willamette	Upper Willamette	Total (C.I.)	
2003	1,480	2,048	3,528 (± 1,686)	34,291
2004	1,298	264	1,562 (± 736)	15,170
2005	1,752	2,064	3,817 (± 1,050)	33,440

Summer steelhead redds were widely distributed in the areas surveyed in 2005 (Figure 15, Table 21). Comparable information on distribution of redds in 2003 and 2004 can be found in Firman et al. (2003, 2004). Average density was 1.8 redds per mile in 2003, 0.3 redds per mile in 2004 and 3.7 redds per mile in 2005. A dry winter in 2005 made redds easier to observe and probably increased the length of time they were visible.

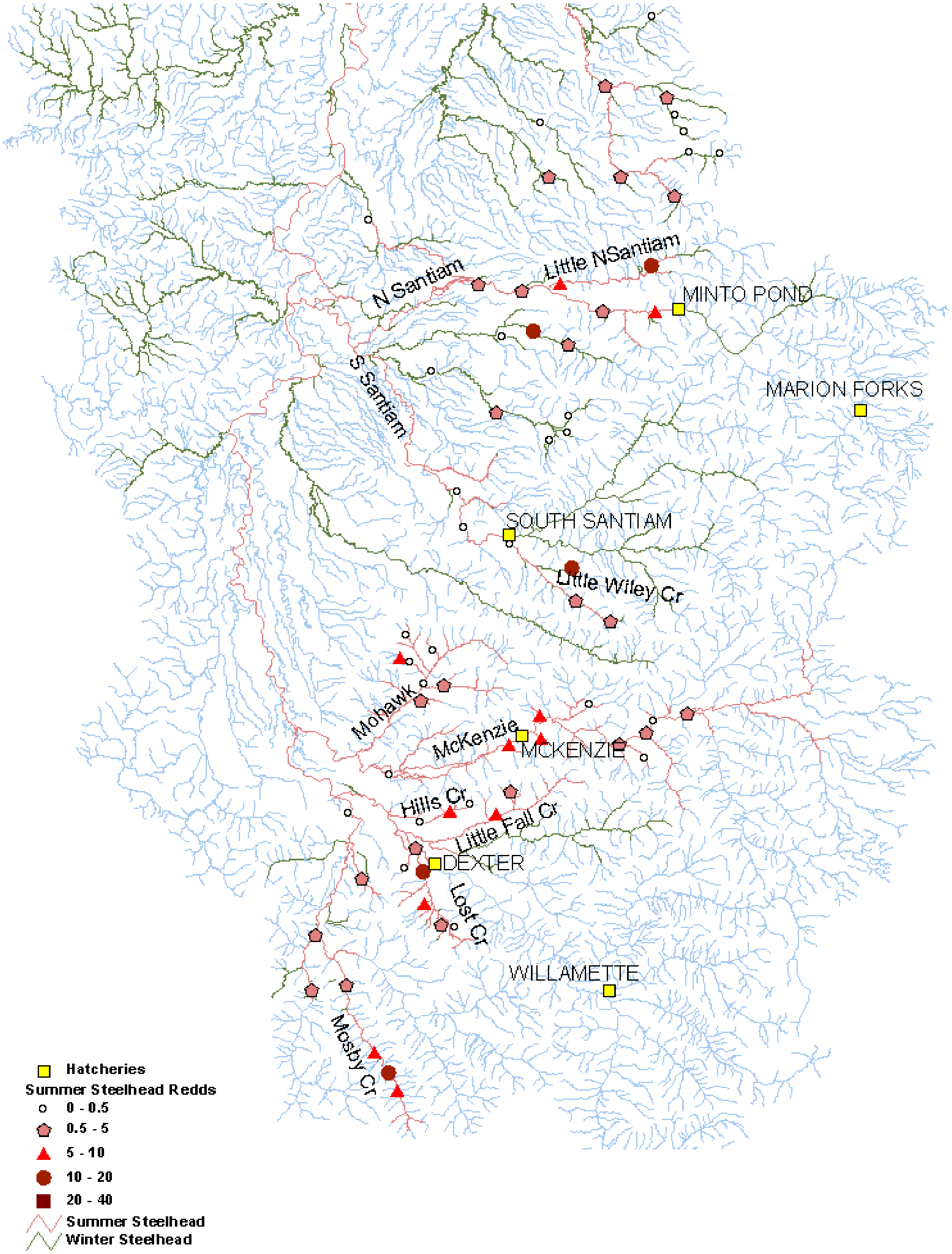

Figure 15. Density of summer steelhead redds in randomly selected stream segments, 2005.

Table 21. Proportions of fin-clipped and non fin-clipped summer steelhead by area, 2003–2005.

Area	Fin-clipped	Non fin-clipped	Percent fin-clipped	Unknown	Percent known
Mid Willamette					
Molalla	0	52	0	44	54
N. Santiam	19	117	14	196	41
S. Santiam	2	113	2	59	66
Total	21	282	7	299	50
Upper Willamette					
Coast Fork. Willamette	5	2	71	23	23
Middle Fork Willamette	3	2	60	28	15
McKenzie	11	15	42	39	40
Mohawk River	0	1	0	8	11
Total	19	20	49	98	28
Total	40	302	12	397	46

There was a higher proportion of steelhead without adipose fin clips in the Mid Willamette due to the higher abundance of winter steelhead. Table 22 shows the percentage of the adult steelhead that we could classify as fin-clipped or non fin-clipped and the percentage of the known fish that were adipose fin-clipped.

Table 22. Proportions of fin-clipped and non fin-clipped summer steelhead by year, 2003–2005.

Year	Fin-clipped	Non fin-clipped	Percent fin-clipped	Unknown	Percent known
2003	4	95	4	55	64
2004	4	139	3	133	52
2005	32	68	32	209	32
Total	40	302	12	397	46

Activity 3.2.4 ***Estimate the number of natural-origin steelhead smolts migrating past Leaburg Dam (mid-March through May).***

The estimated number of steelhead smolts passing Leaburg Dam was about 5,700 in 2003 and 1,400 in 2005 (Table 23). The power canal was closed in 2004 to modify the fish screen. Leaburg Dam diverts approximately 2,300 cfs of water into the power canal. Screens in the power canal divert migrating fish into a 60 cfs bypass channel and a rotary screw trap captures a portion of the fish. Pumps in the bypass are turned on around June 1 when downstream movement of Chinook fry is essentially done and the number of adult Chinook below the dam increases. The pumps reduce flow in the bypass channel to 15 cfs and allow us to catch virtually all fish using the bypass.

We marked all steelhead smolts with nontoxic paint using insulin needles and released them two miles upstream to estimate trap efficiencies. The number of smolts migrating past Leaburg Dam was calculated using the equation:

$$N=n_i\ (m_i / r_i)$$

Where: N = estimated smolts
n_i = number of smolts captured
m_i = number of marked smolts released
r_i = number of recaptured marked smolts

We determined 95% confidence intervals, variances and estimates of the population bias with bootstrap methods using 1,000 iterations (Efron and Tibshiani, 1986). We estimated steelhead smolt numbers separately for time periods when pumps were operated and when they were not operated because of effects on trap efficiencies.

Table 23. Estimated number of wild steelhead smolts passing Leaburg Dam.

Year, time period	Marked	Recaptured	Percent recaptured	Number of smolts
2003				
April 3 - May 31	302	20	6.6%	5,447 ± 2,574
June 1 - June 28	91	45	49.4%	298 ± 77
Total				5,735 ± 2,575
2005				
March 3 – June 2	155	21	13.5%	1,199 ± 559
June 3 – August 18	56	17	30.4%	191 ± 91
Total				1,390 ± 566

In 2005 steelhead smolts first appeared in the trap on March 18, with peak passage occurring from mid April to mid May (Figure 16). Downstream movement in 2005 started on March 18, two weeks earlier than 2003, and downstream movement ended in late June in both years. Steelhead smolts captured at Leaburg Dam in 2005 ranged from 100–240 mm fork length, with a mean of 181 mm (Figure 17), similar to that in 2003 when mean length was 180 mm.

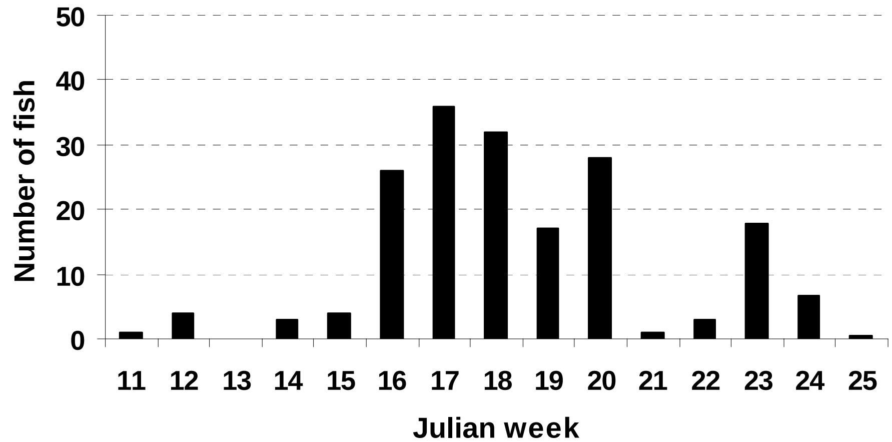

Figure 16. Timing of steelhead smolts at the Leaburg Dam bypass trap, 2005.

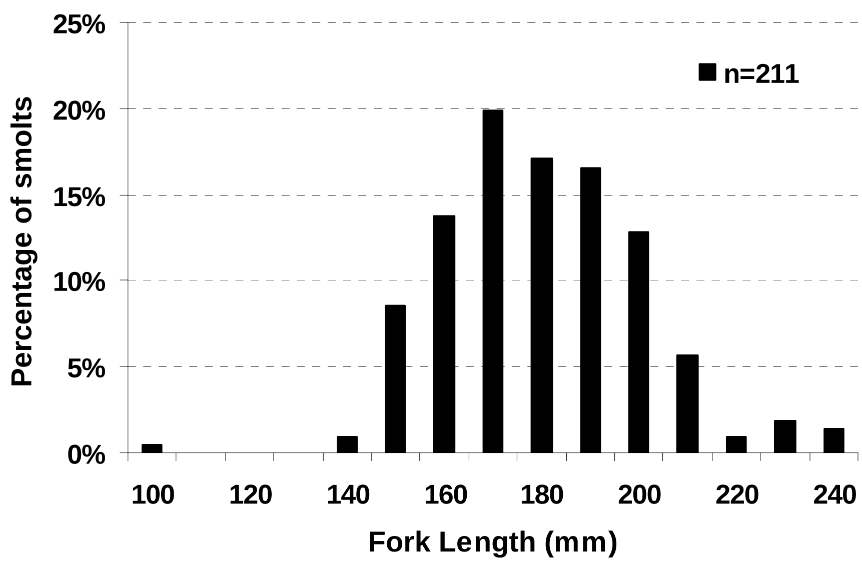

Figure 17. Fork lengths of steelhead smolts captured at Leaburg Dam, 2005.

<u>Task 3.3</u> Conduct a creel survey to determine the location and total catch of adipose fin-clipped and unmarked Chinook in the North Santiam River, South Santiam River, Middle Fork Willamette River, and McKenzie River (conducted simultaneous with summer steelhead creel survey; see Activity 3.2.1).

We conducted creel surveys to estimate catch of Chinook in the North Santiam, South Santiam, McKenzie and Middle Fork Willamette rivers in 2003 and 2004 (Tables 24–27). Effort reported includes number of hours spent angling for all species, not just Chinook. We also conducted creels surveys on the South Santiam River and McKenzie River in 2002, however these surveys covered only a portion of the season (Firman and Buckman 2003).

Table 24. Estimated angling effort and catch of Chinook in the North Santiam River, 2002–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped Kept	Fin-clipped Released	Non fin-clipped Kept	Non fin-clipped Released
2003						
April	27,338	0	0	0	0	0
May	62,569	1915	1,507	20	0	388
June	37,784	2907	2,531	10	0	366
July	14,698	821	755	29	0	37
Aug	3,734	170	99	16	0	55
Sept	1,863	5	1	4	0	0
Oct	433	0	0	0	0	0
Total	148,419	5,818	4,893	79	0	846
2004						
April	14,627	8	0	0	0	8
May	27,666	1092	919	58	0	115
June	40,249	1386	1,206	29	0	151
July	19,430	920	713	101	0	106
Aug	6,513	151	103	36	0	12
Sept	1,778	36	0	36	0	0
Oct	1,655	0	0	0	0	0
Total	111,918	3,593	2,941	260	0	392

Table 25. Estimated angling effort and catch of Chinook in the South Santiam River, 2002–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	12,418	44	44	0	0	0
May	53,278	1,610	1,371	35	0	204
June	46,283	1,822	1,443	148	0	231
July	22,254	610	359	197	10	44
Aug	7,285	251	80	129	0	42
Sept	3,366	391	0	275	0	116
Oct	1,361	3	0	0	0	3
Total	146,245	4,731	3,297	784	10	640
2004						
April	19,141	177	171	6	0	0
May	61,647	4,041	3,526	414	21	80
June	41,221	1,150	928	102	0	120
July	20,606	695	309	259	4	123
Aug	7,406	323	50	178	0	95
Sept	909	169	2	148	0	19
Oct	877	15	0	10	0	5
Total	151,807	6,570	4,986	1,117	25	442

Table 26. Estimated angling effort and catch of Chinook in the McKenzie River, 2002–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	3,509	0	0	0	0	0
May	22,019	516	417	4	0	95
June	27,634	1,047	775	54	42	176
July	11,223	321	230	15	0	76
Aug	6,904	81	53	6	0	22
Sept	3,529	20	0	17	0	3
Oct	2,921	2	0	0	0	2
Total	77,739	1,987	1,475	96	42	374
2004						
April	9,389	9	9	0	0	0
May	31,824	1,749	1,032	41	0	676
June	37,478	2,466	1,570	93	0	803
July	21,045	633	376	30	19	208
Aug	10,808	215	38	136	0	41
Sept	7,651	172	7	105	0	60
Oct	2,107	0	0	0	0	0
Total	120,302	5,244	3,032	405	19	1,788

Table 27. Estimated angling effort and catch of Chinook in the Middle Fork Willamette River, 2002–2004.

Year, month	Effort (hrs)	Catch	Fin-clipped		Non fin-clipped	
			Kept	Released	Kept	Released
2003						
April	13,194	29	3	0	0	26
May	39,620	726	429	71	0	226
June	33,323	1,287	780	164	0	343
July	14,448	740	371	131	0	238
Aug	--	--	--	--	--	--
Sept	--	--	--	--	--	--
Oct	--	--	--	--	--	--
Total	100,585	2,782	1,583	366	0	833
2004						
April	16,203	78	66	7	0	5
May	41,925	3,323	2,529	92	0	702
June	41,677	3,006	2,356	307	0	343
July	22,595	883	500	284	0	99
Aug	--	--	--	--	--	--
Sept	--	--	--	--	--	--
Oct	--	--	--	--	--	--
Total	122,400	7,290	5,451	689	0	1,150

Objective 4 ***Monitor and evaluate each respective hatchery program in the UWR ESU [RPM 5]***

Task 4.1 ***Record date, number, length, sex, and origin (hatchery vs. wild) of Chinook spawned (by hatchery: McKenzie, Dexter, Minto, and S. Santiam). [RPM 5c] (No additional cost, it is included in Task 2.1)***

We recorded the date, length, sex, and origin (hatchery or wild) of Chinook spawned by McKenzie, Willamette, Marion Forks, and S. Santiam hatcheries and sent the information to NMFS (*See annual reports* Firman et al. 2002, 2003, 2004). The percentage of wild fish was higher in 2004 than in previous years, and was highest at South Santiam (Table 28).

Table 28. Origin (hatchery or wild) of Chinook spawned at Marion Forks, South Santiam, McKenzie and Willamette hatcheries.

	Non Fin-clipped			
Hatchery, year	Wild	Hatchery	Fin-clipped	Percent wild in broodstock
McKenzie				
2002	13	101	933	1.2
2003	14	42	953	1.4
2004	24	105	880	2.4
2005	60[a]		1,022	a
Marion Forks				
2002	4	7	671	0.6
2003	2	17	599	0.3
2004	12	13	541	2.1
2005	34[a]		470	a
South Santiam				
2002	26	19	1,174	2.1
2003	25	23	1,048	2.3
2004	78	16	905	7.8
2005	90[a]		999	a
Willamette				
2002	5	53	1,602	0.3
2003	5	59	1,465	0.3
2004	16	28	1,807	0.9
2005	43[a]		1,497	a

[a] Otoliths collected in 2005 have not been analyzed.

***<u>Task 4.2</u>* Conduct a smolt emigration study to evaluate hatchery Chinook emigration performance (RPM 4b).**

No work was accomplished on this task.

***<u>Task 4.3</u>* Conduct creel surveys to monitor and evaluate the bycatch of listed steelhead and Chinook in the Foster Reservoir trout fishery for at least two seasons. [Terms and Conditions 5e]**

Anglers retained an estimated 612 naturally produced steelhead smolts and released 109 in the Foster Reservoir fishery annually based on creel surveys conducted from February 2002 through October 2004 (Table 29). Angling regulations have changed and now allow only fin-clipped trout to be harvested. If we assume 20% mortality for released fish, then the estimated mortality would be 144 wild steelhead smolts under current regulations. It is not known if juvenile Chinook were not caught or if they were just not reported.

Table 29. Monthly average estimated hours of angler effort, and catch of naturally produced steelhead smolts and hatchery rainbow trout in Foster Reservoir in creel surveys conducted February 2002– October 2004.

Month	Angler effort (hrs)	Wild smolts		Hatchery rainbow	
		Kept	Released	Kept	Released
January	1,305	50	2	272	4
February	1,226	83	11	286	23
March	3,666	139	19	509	94
April	3,809	153	36	2,241	519
May	7,287	20	4	7,895	1,834
June	13,541	35	11	6,430	904
July	7,217	7	0	2,816	448
August	3,590	7	0	1,220	174
September	4,590	21	3	2,537	241
October	4,085	36	6	2,328	643
November	2,218	35	12	762	165
December	1,444	26	7	931	52
Total	53,977	612	109	28,227	5,101

Table 30 shows the potential impact of a take of 144 wild steelhead smolts annually on the number of adult steelhead returning to Foster Dam. Most wild steelhead smolts were caught in January through April while most hatchery trout were caught in April through October (Table 30). Restricting the trout season to late April or late May through October and delaying releases of hatchery trout would better protect wild steelhead smolts, and would be consistent with regulations for North Fork Reservoir (Clackamas River) where there is a fishery for stocked trout and naturally produced steelhead smolts are also present.

Table 30. Number of adult steelhead foregone at assumed levels of smolt survival and resulting percent reduction of the adult winter steelhead run at Foster dam at various adult run sizes with 144 smolts killed annually in the Foster Reservoir trout fishery.

% smolt survival	Number of adults foregone	Adult run size			
		200	300	500	800
0.5	1	0.4	0.2	0.1	0.1
1.0	1	0.7	0.5	0.3	0.2
2.5	4	1.8	1.2	0.7	0.5
5.0	7	3.6	2.4	1.4	0.9

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APPENDIX A

Appendix A Table 1. Number of spring Chinook redds counted in six watersheds of the Willamette River basin, 2002–2005 (Figure 1).

Watershed	2002	2003	2004	2005
Middle Fork Willamette[a]	235	96	181	139
McKenzie	922	1,187	1,129	1,147
Calapooia	16	2		
South Santiam[b]	914	619	373	530
North Santiam	306	673	360	325
Molalla	52	15	44	25

[a] *Includes Fall Creek.*

[b] *Includes Thomas and Crabtree creeks.*

Appendix A Table 2. Distribution (%) of spring Chinook redds in the McKenzie River basin, 2002–2005 (Figure 2).

Section	2002	2003	2004	2005
Upstream of Forest Glen	37.6	31.9	39.2	39.7
Horse and Lost creeks	15.7	23.6	15.2	37.2
South Fork McKenzie	11.7	7.2	12.6	7.5
Below Forest Glen	22.5	22.9	24.2	9.1
Below Leaburg Dam	12.5	14.4	8.8	6.5

Appendix A Table 3. Number of spring Chinook redds counted in five areas of the McKenzie River basin, 2002–2005 (Figure 3).

Section	2002	2003	2004	2005
Upstream of Forest Glen	347	379	443	455
Horse and Lost creeks	145	280	172	427
South Fork McKenzie	108	85	142	86
Below Forest Glen	207	272	273	104
Below Leaburg Dam	115	171	99	75

Appendix A Table 4. Distribution (%) of spring Chinook redds in the North Santiam River basin, 1996–2005 (Figure 4).

Section	1996	1997	1998	2001	2002	2003	2004	2005
Minto–Fishermen's Bend	72.2	73.3	62.8	58.9	54.7	84.0	53.0	68.4
Fishermen's Bend–Mehama	21.3	13.8	14.9	12.2	20.6	6.4	5.4	6.6
Mehama–Bennett Dam	6.5	4.3	2.1	23.0	14.5	5.0	26.3	4.7
Little North Fork	0.0	8.6	20.2	5.9	10.1	4.7	15.3	20.3

Appendix A Table 5. Number of spring Chinook redds counted in four areas of the North Santiam River basin, 1996–2005 (Figure 5).

Section	1996	1997	1998	2001	2002	2003	2004	2005
Minto–Fishermen's Bend	78	85	118	179	162	555	177	206
Fishermen's Bend–Mehama	23	16	28	37	61	42	18	20
Mehama–Bennett Dam	7	5	4	70	43	33	88	14
Little North Fork	0	10	38	18	30	31	51	61

Appendix A Table 6. Number of spring Chinook salmon redds counted in seven areas of the Willamette River basin, 2002–2005 (Figure 6).

Area (section)	2002	2003	2004	2005
Middle Fork Willamette (Dexter–Jasper)	64	14	9	9
Fall Creek	171	82	172	130
Calapooia	16	2		
South Santiam (Foster–Pleasant Valley)	875	594	338	507
South Santiam (Pleasant Valley–Waterloo)	19	16	35	23
Thomas Creek	18	9		
Molalla	52	15	44	25

Appendix A Table 7. Number of adult spring Chinook salmon that successfully spawned in the North Santiam River from estimates of potential and successful spawners and from recovery of female carcasses, 2001–2005 (Figure 7).

		Spawners			Female carcasses	
Year	Bennett count	potential[a]	successful[b]	Redds	spawned	not spawned
2001	6,786	2,377	669	304	80	237
2002	7,640	1,704	651	296	102	127
2003	12,832	6,227	1,454	661	210	530
2004	13,531	7,380	735	334	65	222
2005	4,883	2,534	662	301	84	89

[a] *Bennett count minus estimated harvest and removed at Minto collection pond (spawned, died, or outplanted).*

[b] *From redd counts, assuming 1 female and 1.2 males per redd, based on sex ratio at Minto pond.*

Appendix A Table 8. Number of female spring Chinook that spawned and that died before spawning through October for eight survey season lengths using progressively later starting periods (from mid June to early September), 2003 and 2004 (Figure 8).

	2003		2004	
Starting period	spawned	not spawned	spawned	not spawned
mid Jun	210	530	65	222
early Jul	210	454	65	218
mid Jul	--	--	65	201
late Jul	210	387	65	177
early Aug	210	268	65	112
mid Aug	210	169	65	100
late Aug	210	121	65	80
early Sep	209	55	65	59

Appendix A Table 9. Number of adult spring Chinook that successfully spawned in the McKenzie River basin from estimates of potential and successful spawners and from recovery of female carcasses, 2001–2005 (Figure 9).

Year	Spawners		Redds	Female carcasses	
	Potential[a]	Successful[b]		Spawned	Not spawned
2001	4,302	1,417	644[d]	184	14
2002	6,087	1,775	807	396	27
2003	9,327	2,235	1,016	265	51
2004	9,034	2,266	1,030	267	33
2005	3,094	2,358	1,072	160	30

[a] *From Leaburg Dam counts.*

[b] *From redd counts, assuming 1 female and 1.2 males per redd.*

[c] *Expanded from partial counts based on redd distribution in full surveys in 2002–2005.*

Appendix A Table 10. Estimated number of spring Chinook salmon in spawning areas that were of wild, local hatchery, and stray hatchery origin for five Willamette Basin rivers, 2001–2005, determined by analyses of otoliths in non fin-clipped fish and coded wire tags in fin-clipped fish (expanded for percentage of the hatchery release that was tagged) (Figure 12).

River Year	Wild	Hatchery	
		Local	Stray
North Santiam			
2001	220	6,134	432
2002	604	6,913	123
2003	271	11,783	788
2004	489	10,723	2,319
McKenzie			
2001	2,887	1,232	183
2002	3,602	2,396	89
2003	4,899	3,256	1,172
2004	4,419	3,683	932
South Santiam			
2002	224	1,629	12
2003	151	733	268
2004	85	821	47
Middle Fork Willamette			
2002	15	318	0
2003	4	110	0
2004	22	152	0
Molalla			
2002	3	99	0
2003	1	23	0

Appendix A Table 11. Numbers of naturally spawning hatchery spring chinook that were released as smolts within the basin (local) or released in other basins, 2001-2005, determined by recoveries of coded wire tags from carcasses on spawning grounds. Numbers in parenthesis are the expanded estimate after accounting for percentage of each smolt release group that was tagged (Table 9).

		Origin of release								
River Year	n	Local	Netpen[a]	Lower Willamette[b]	Molalla[c]	N. Santiam	S. Santiam	McKenzie	Youngs Bay[d]	Clackamas
McKenzie										
2001[e]	53 (55)	46 (48)	4 (4)	0	1 (1)	0	0		0	0
2002	95 (263)	93 (254)	1 (8)	1 (1)	0	0	0		0	0
2003	16 (81)	8 (53)	1 (1)	7 (7)	0	1 (20)	0		0	0
2004	19 (79)	9 (63)	2 (2)	7 (7)	0	0	1 (7)		0	0
2005	3 (29)	2 (22)	0	0	0	0	1 (7)		0	0
North Santiam										
2001	369 (374)	345 (349)	5 (5)	0	12 (12)		2 (2)	0	0	5 (5)
2002	80 (217)	76 (213)	0	1 (1)	3 (3)		0	0	0	0
2003	46 (634)	29 (594)	2 (2)	8 (8)	4 (11)		1 (11)	1 (7)	1 (1)	0
2004	28 (228)	10 (188)	1 (1)	9 (9)	5 (12)		3 (18)	0	0	0
2005	7 (114)	1 (10)	0	5 (98)	0		1 (6)	0	0	0
South Santiam										
2002	310 (1111)	302 (1103)	0	8 (8)	0	0		0	0	0
2003	97 (640)	53 (468)	12 (133)	27 (27)	4 (11)	0		0	1 (1)	0
2004	121 (605)	91 (572)	5 (5)	23 (23)	2 (5)	0		0	0	0
2005	50 (299)	45 (281)	0	1 (1)	2 (5)	0		1 (11)	1 (1)	0
Middle Fork Willamette										
2002	356 (1736)	355 (1735)	0	1 (1)	0	0	0	0	0	0
2003	1 (19)	1 (19)	0	0	0	0	0	0	0	0
2004	5 (38)	5 (38)	0	0	0	0	0	0	0	0
2005	3 (22)	3 (22)	0	0	0	0	0	0	0	0
Molalla										
2002	22 (57)	22 (57)	0	0		0	0	0	0	0
2003	5 (14)	5 (14)	0	0		0	0	0	0	0
2004	2 (3)	1 (2)	0	1 (1)		0	0	0	0	0
2005	4 (9)	4 (9)	0	0		0	0	0	0	0

[a] *McKenzie stock acclimated or directly released in the lower Clackamas River.*
[b] *McKenzie stock acclimated or directly released in the lower Willamette River.*
[c] *South Santiam and McKenzie stocks.*
[d] *Middle Fork Willamette stock released into netpens near mouth of Columbia River.*
[e] *Two (expanded = 2) additional carcasses were recovered in Fall Creek (Middle Fork Willamette)*

APPENDIX B

Appendix B Table 1. Density of summer steelhead redds in randomly selected stream segments, 2005.

Subbasin	Stream	Reach ID	Seg	Redds/mi
Molalla	Butte Cr.	31360	20	0
Molalla	Abiqua Cr.	31390	1	0
Molalla	Abiqua Cr.	31398	2	4.6
Molalla	Milk Cr.	31471	1	0
Molalla	Molalla R.	31480	1.1	0.67
Molalla	Lukens Cr.	31486	1	3.8
Molalla	Cougar Cr.	31488	1	0
Molalla	North Fork Molalla	31489	3	0
Molalla	Gawley Cr.	31501	1	1.4
Molalla	Table Rock Fork Molalla R.	31515	1	0
Molalla	Lost Cr.	31522	2	0
Molalla	Molalla R.	31536	1	3.7
Middle Willamette	Mill Cr.	31794	6	0
South Santiam	Neal Cr.	31959	1	0
South Santiam	Thomas Cr.	31964	4	20
South Santiam	Thomas Cr.	31966	2	6.2
South Santiam	Crabtree Cr.	31976	4	0
South Santiam	Bald Peter Cr.	31988	1	0
South Santiam	South Fork Crabtree Cr.	31991	3	0
South Santiam	Crabtree Cr.	31992	4	0
South Santiam	South Santiam R.	32009	1	0
South Santiam	McDowell Cr.	32010	1	0
South Santiam	South Santiam R.	32021	2	0.26
South Santiam	Wiley Cr.	32024	2	0
South Santiam	Little Wiley Cr.	32027	5	10.7
South Santiam	Wiley Cr.	32028	3	0.91
South Santiam	Wiley Cr.	32028	9	2.6
North Santiam	North Santiam R.	32165	1.2	6.2
North Santiam	Little North Santiam R.	32174	1	7.3
North Santiam	Little North Santiam R.	32212	1	17.5
North Santiam	North Santiam R.	32231	4	4.1
North Santiam	North Santiam R.	32235	2.1	5.2
Mohawk	Cartwright Cr.	32668	2	4.2

Appendix B Table 1 (continued)

Subbasin	Subbasin	Subbasin	Subbasin	Subbasin
Mohawk	Mill Cr.	32672	1	1
Mohawk	Mohawk R.	32681	1	0
Mohawk	Cash Cr.	32684	1	0
Mohawk	Cash Cr.	32684	2	5
Mohawk	Crooked Cr.	32688.3	2	0
Mohawk	Shotgun Cr.	32688.7	2	0
Mohawk	Drury Cr.	32690	2	0
McKenzie	Cedar Flat Cr.	32697	4	0
McKenzie	Richie Cr.	32717	1	9.1
McKenzie	Trout Cr.	32721	2	8.5
McKenzie	Finn Cr.	32725	1	6.15
McKenzie	Unnamed trib of Gate Cr.	32730.3		0
McKenzie	McKenzie R.	32748	2.1	1.9
McKenzie	Ennis Cr.	32749	3	0
McKenzie	Elk Cr.	32767	1	0
Coast Fork Willamette	Coast Fork Willamette R.	32927		0.52
Coast Fork Willamette	Bear Cr.	32932	4	0.91
Coast Fork Willamette	Mosby Cr.	32945	2	2.5
Coast Fork Willamette	Mosby Cr.	32953	1	6.25
Coast Fork Willamette	Mosby Cr.	32957	3	18.8
Coast Fork Willamette	Mosby Cr.	32961	1	3
Coast Fork Willamette	Coast Fork Willamette R.	33018	1.1	3.5
Middle Fork Willamette	Hills Cr.	33054	1	0
Middle Fork Willamette	Hills Cr.	33056	1	5.38
Middle Fork Willamette	Hills Cr.	33058	3	0
Middle Fork Willamette	Middle Fork Willamette R.	33059	1.1	2.6
Middle Fork Willamette	Rattle Snake Cr.	33060	7	0
Middle Fork Willamette	Little Fall Cr.	33065	1	6.25
Middle Fork Willamette	Sturdy Cr.	33068		3.6
Middle Fork Willamette	Little Fall Cr.	33069	5	11.4
Middle Fork Willamette	Little Fall Cr.	33069	7	6.7
Middle Fork Willamette	Lost Cr.	33159	5	12.9
Middle Fork Willamette	Lost Cr.	33163	1	30
Middle Fork Willamette	Middle Cr.	33164	2	5.7
Middle Fork Willamette	Lost Cr.	33167	1	22.5
Middle Fork Willamette	Guiley Cr.	33172	2	1.8
Middle Fork Willamette	Unnamed trib. of Lost Cr.	33173.3	1	0