ADDENDUM

Work Completed for Compliance With the Biological Opinion for Hatchery Programs in the Willamette Basin, USACE funding: 2002-03

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

October 2003

Introduction

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

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

This report is an addendum to the report on activities in 2002 that was generated in December of that year. This report also presents results of spawning surveys and stomach content analysis that were completed in 2003. A complete report for the 2003 survey season will be prepared after the seasons trapping and angler surveys have ended.

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

Hatchery releases of trout and steelhead can directly impact native populations of spring chinook by preying upon juvenile fish. To assess this impact, we sampled stomach contents of hatchery-produced rainbow trout and steelhead smolts released in the McKenzie River in 2003. Samples were obtained by examining fish retained in the fishery, sampling fish caught in the bypass trap at Leaburg Dam, seining, and angling. A total of 878 trout were sampled between April 26, 2003 and August 24, 2003. Most samples were collected using the bypass trap and the McKenzie angler survey (Figure 1). The most common prey items found in the gut samples were aquatic invertebrates (71%; Figure 2). No prey items were found in another 20% of fish sampled. Fish were found in the stomach contents of only 1.6% of the trout sampled. All of the identifiable salmonids found were juvenile chinook. Details of trout that had consumed fish are shown in Table 1. Chinook in stomach contents were found from late May until late June. Juvenile chinook may be large enough in the later part of the summer to avoid predation by hatchery-reared trout. This work is currently ongoing.

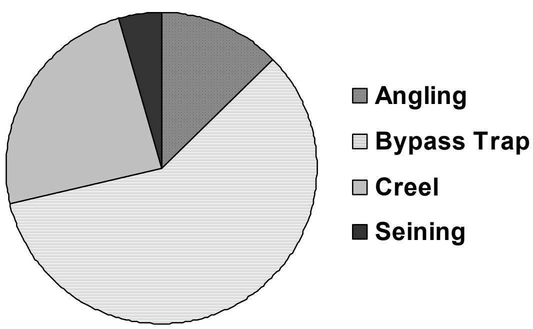

Figure 1. Hatchery trout collection methods

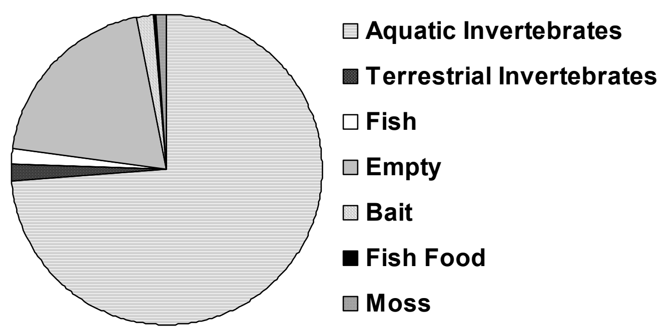

Figure 2. Stomach contents of hatchery trout.

Table 1. Fish found in stomach contents of hatchery-reared trout released in the McKenzie River.

Date	Location caught	Length (mm)	Number of fish	Unidentifiable fish	Unidentifiable salmonids	Chinook	Other
5/29/2003	Bypass	260	5			5	
5/29/2003	Bypass	220	1		1		
5/30/2003	Bypass	200	2			2	
5/31/2003	Bypass	230	1	1			
6/2/2003	Bypass	230	1			1	
6/5/2003	Bypass	230	2		2		
6/24/2003	Bypass	240	1			1	
6/24/2003	Bypass	240	1	1			
6/24/2003	Bypass	240	1	1			
6/24/2003	Bypass	250	1	1			
6/26/2003	Bypass	240	2		2		
7/1/2003	Hendricks to Bellinger	250	1	1			
7/23/2003	EWEB Channel	260	1				1 juvenile lamprey
7/23/2003	EWEB Channel	250	1				1 sculpin
Total			21	5	5	9	2

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

<u>Willamette Mainstem Passage</u>

In 2002, 34,291 summer steelhead and 16,658 winter steelhead passed Willamette Falls (Interjurisdictional Fisheries Management Program, 2003). Summer steelhead were observed from March through October, with peak passage in May and June (Table 2; Figure 3).

Table 2. Steelhead in the Upper Willamette

		Summer Steelhead	Marked kept	Marked released	Unmk released	Reference
Passage	Willamette Falls	34,291				I.J. website*
	North Santiam	6,184				Bennett count
	South Santiam	7,500				Bill Nyara‡
	McKenzie	929				Leaburg count
Harvest	South Santiam**		1,447	329	106	Angler survey
	McKenzie***		1,221	494	189	Angler survey
Broodstock	South Santiam	1,528				Bill Nyara‡
Redds	Mid-Willamette	1,480 ± 836				Spawn Surv.
	Upper Willamette	2,048 ± 1,464				Spawn Surv.
	Total	3,529 ± 1,686				Spawn Surv.

*Interjurisdictional Fisheries Management Program:
http://www.dfw.state.or.us/ODFWhtml/InfoCntrFish/Interfish/2002wfcounts.htm
**Partial angler survey – includes harvest from July through October.
***Partial angler survey – includes harvest from July through August.
‡South Santiam Hatchery Manager

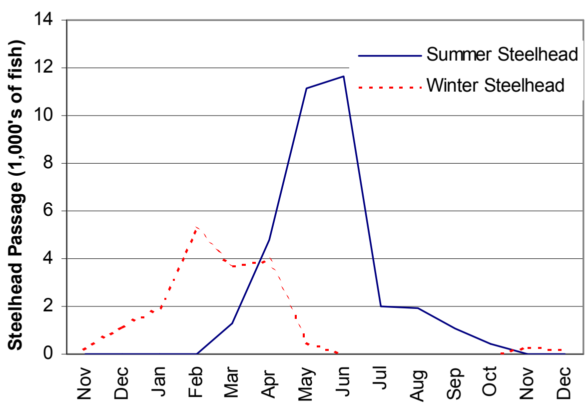

Figure 3. Steelhead passage at Willamette Falls.

North Santiam and McKenzie Passage

Steelhead passage can be monitored at Leaburg Dam on the McKenzie River and at the Upper and Lower Bennett Dams at Stayton Island on the North Santiam River. Summer steelhead first began appearing at Stayton Island in late March of 2002, with peak migration occurring in June and July (Figure 4). Almost all of these fish were marked with a fin clip, although there was a small component of unclipped steelhead that passed during this period.

At Leaburg Dam on the McKenzie River, summer steelhead began appearing in late April, with peak migration occurring in June and July (Figure 5). Marked fish outnumbered unmarked fish, but the proportion of unmarked fish in the McKenzie was greater than in the North Santiam. However, since the total number of summer steelhead that passed Leaburg Dam was much lower than at Stayton Island (929 vs. 6,184; Table 3), the total number of unmarked Summer Steelhead passing Leaburg was less than at Stayton Island (199 vs. 371).

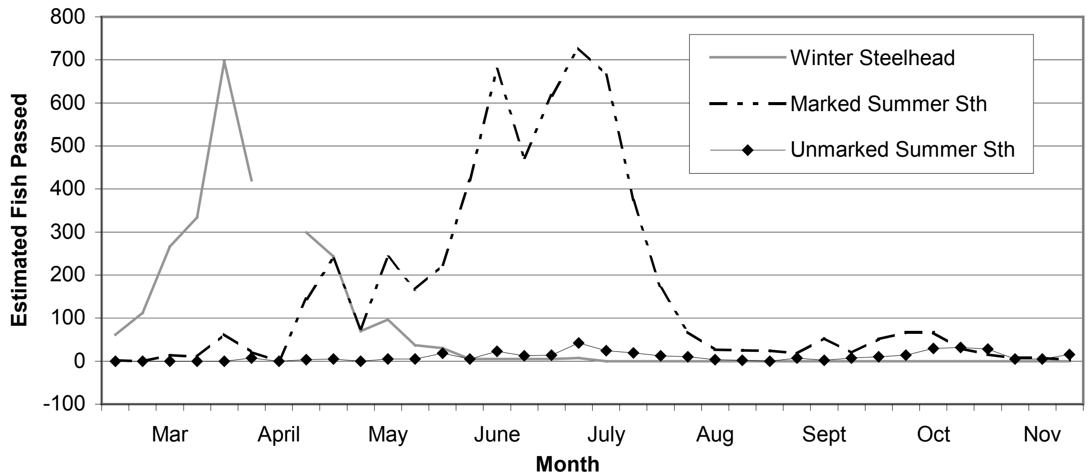

Figure 4. Steelhead run timing at Stayton Island, N. Fk. Santiam River, 2002.

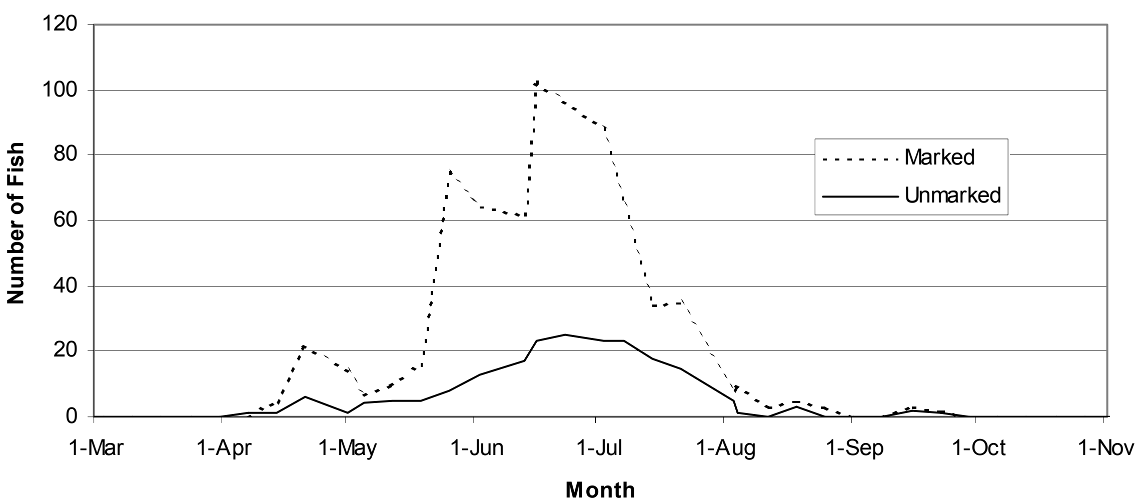

Figure 5. Steelhead run timing at Leaburg Dam, McKenzie River, 2002.

Table 3. Summer Steelhead passage at Stayton Island, North Santiam River, and Leaburg Dam, McKenzie River.

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

South Santiam and McKenzie Harvest

Partial angler surveys were conducted on the South Santiam River and the McKenzie River in 2002 (see Task 3.3 for details of angler survey methods). These angler surveys commenced in July, and thus do not include data from the fishery in April, May and June. In the South Santiam, 1,447 marked steelhead were harvested during the period of the angler survey, and another 1,221 were removed in the McKenzie. In 2003, angler surveys are being conducted from April through October in the North Santiam, South Santiam and McKenzie, and from April through July in the Middle Fork Willamette.

Spawning Surveys

A statistical survey to estimate spawning by Summer Steelhead strays in the Upper Willamette ESU was conducted for the first time in the winter and early spring of 2003. Surveys were conducted on foot and by boat throughout the supposed spawning distribution of summer steelhead. In addition, some surveys were conducted in areas of the winter steelhead spawning distribution that were believed to be outside of the regions where summer steelhead might spawn. Surveys were conducted at weekly to monthly intervals. The number of adult steelhead and new redds were recorded on each visit. When possible, the mark status of adult steelhead was also ascertained. Additional details of survey methods can be found in Susac and Jacobs, 1998.

Flow Conditions

Stream flow conditions influence the success of spawning surveys. Exceptionally low flows can prevent fish from accessing spawning areas, high flows can redistribute gravel making redds less obvious, and high turbid flows interfere with visual counts. Flows are generally high during the period when summer steelhead spawn (winter and early spring). Unsuitably high flows sustained by dam releases were a particular problem for the mainstem float surveys. Figure 6 illustrates the flow conditions for the 2003 spawning season along with the 95th and 5th percentile of mean daily flows. The flow regime in 2003 was typical. Four significant freshets occurred during the season. The first small freshet occurred during the first week of January. This freshet allowed access to some, but not all spawning areas. The second freshet in late January was much larger and provided access to all spawning grounds. The final two freshets came back to back and resulted in higher flows for the greater part of the month of March.

Spawn timing
Estimates of spawn timing were made based on the observation of fresh redds and spawning adults in survey areas. Figure 7 shows estimates of spawning timing for summer steelhead in the Middle Willamette Monitoring Area (Molalla, North Santiam, South Santiam, and Calapooia Rivers) and the Upper Willamette Monitoring Area (McKenzie, Middle Fork Willamette and Coast Fork Willamette Rivers). Small numbers of adult fish were observed throughout the season. We used these observations to confirm that we were identifying steelhead redds correctly. Steelhead spawners first appeared in the Middle Willamette in early January, just after the first small freshet of the season.

Spawning peaked in late January, and slowly declined until early March. A second, larger peak of steelhead spawners arrived in mid- to late March, but we believe that these steelhead were winter steelhead. Several hundred winter steelhead had passed Willamette Falls in early March, and this second peak coincides with the appearance of winter steelhead at our traps at Stayton Island in the North Santiam River (Figure 7). There is no native run of winter steelhead in McKenzie, Middle Fork Willamette or the Coast Fork Willamette, and the later peak was not observed in these areas. Consequently, we excluded all counts after March 10, 2002 when making estimates of spawning by summer steelhead.

Estimates of Abundance
Estimates of the abundance of summer steelhead redds and the associated 95% confidence intervals are provided in Table 4. The confidence interval comes to approximately 50% of the total estimate for the Mid Willamette Monitoring Area and the Upper Willamette ESU. It was over 70% of the estimate for the Upper Willamette Monitoring Area. There were a greater proportion of surveys with no steelhead redds in the Upper Willamette Monitoring Area. This increased the variance, and thus the confidence interval is wider for this segment of the population.

Table 4. Population estimates for summer steelhead redds in the Upper Willamette ESU.

Monitoring Area	Estimate	C.I.	C.I. %
Mid Willamette Monitoring Area	1,480	836	56.5
Upper Willamette Monitoring Area	2,048	1,464	71.5
Upper Willamette ESU	3,529	1,686	47.8

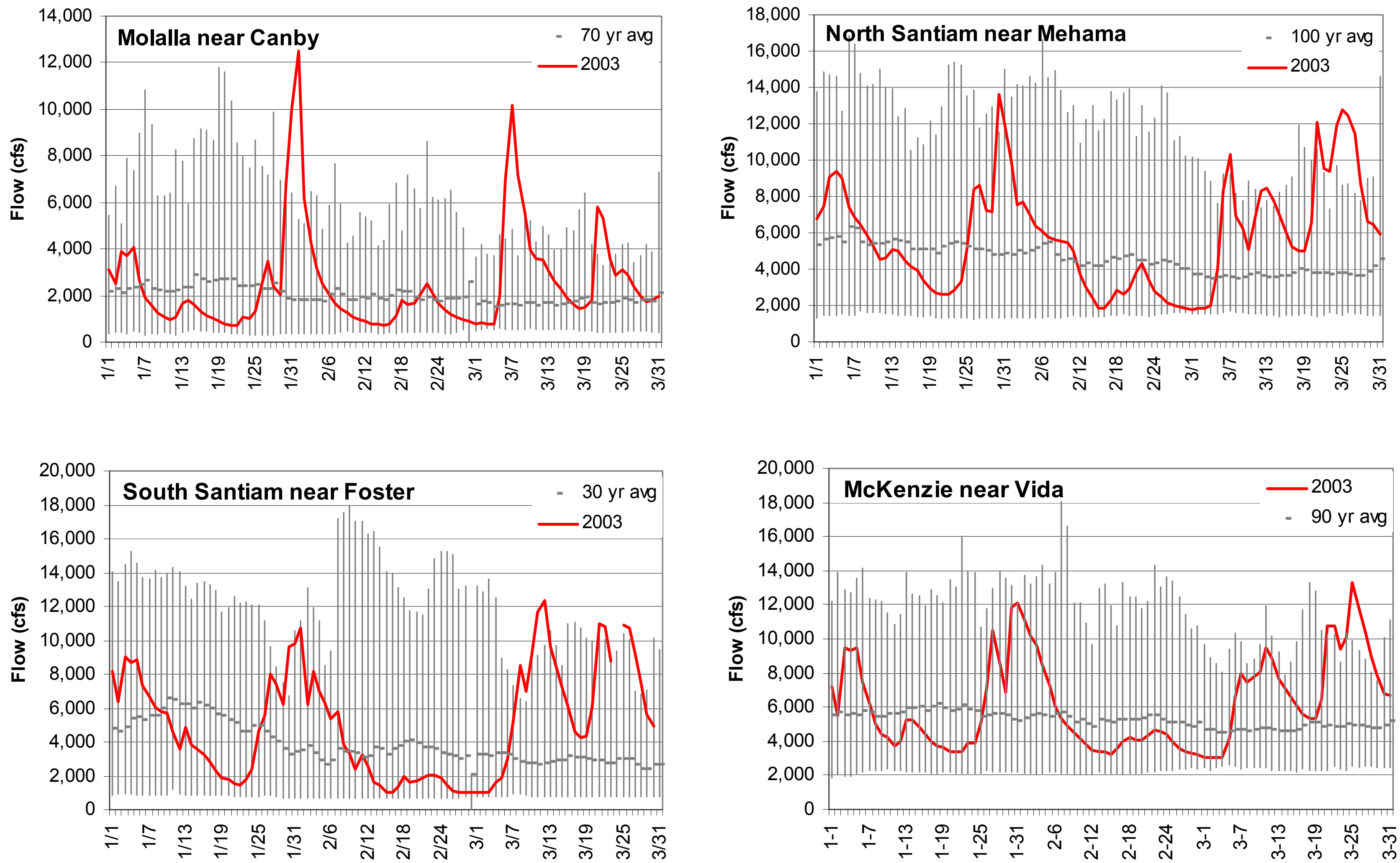

Figure 6. Daily mean river discharge in cubic feet per second for four surface water stations. Vertical bars represent the 95^{th} and 5^{th} percentiles of mean daily flows for the period of record. Data obtained at http://water.usgs.gov/.

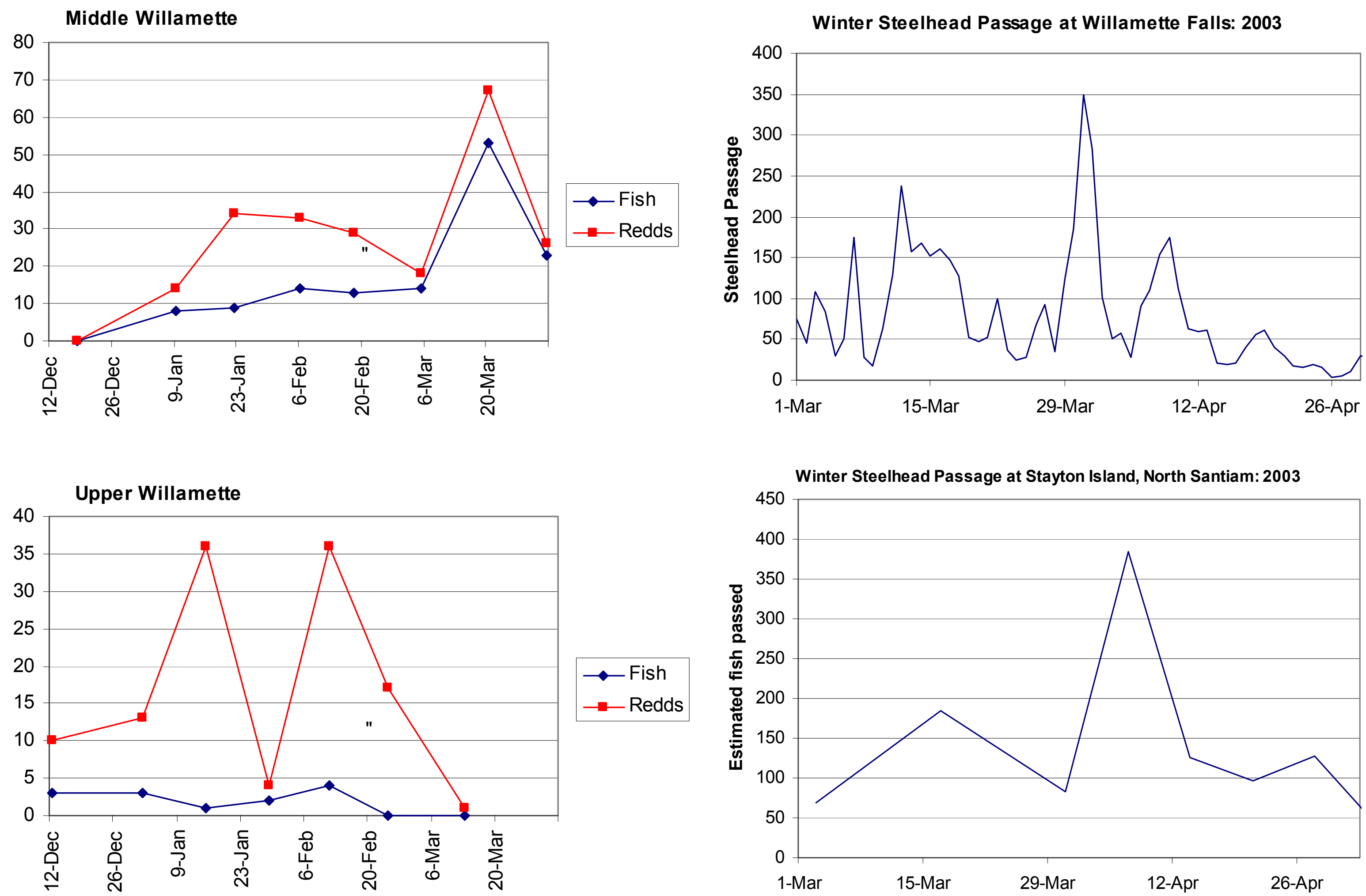

Figure 7. Summer steelhead spawn timing, and winter steelhead run timing in the Upper Willamette ESU. The Middle Willamette Monitoring Area includes the Molalla, North Santiam, South Santiam and Calapooia. The Upper Willamette Monitoring Area includes the McKenzie, Middle Fork Willamette and Coast Fork Willamette. Low counts in the Upper Willamette during the last week of January are the result of poor surveys conditions due to high water.

Comparison to traditional surveys
Surveys for summer steelhead redds were conducted at 10 sites in the Calapooia, North and South Santiam Rivers that are traditionally surveyed to count winter steelhead redds. Summer steelhead spawning was observed in all but three of these surveys (Table 5). The density of summer steelhead redds was generally lower than that of winter steelhead redds, but the number of summer steelhead redds exceeded the number of winter steelhead redds observed in Sinker Creek.

Table 5. Comparison of summer steelhead (StS) and winter steelhead (StW) redd counts in 2003 on traditional surveys. Average and maximum values for winter steelhead are based on 17 to 30 years of data.

Subbasin	Stream	StS Redds	StW Redds	Avg StW Redds	Max StW Redds	n
N Santiam River	Rock Cr.	19	49	6	16	26
N Santiam River	Mad Cr.	26	27	40	77	18
N Santiam River	Elkhorn Cr.	6	18	9	31	16
N Santiam River	Sinker Cr.	14	13	24	63	30
S Santiam River	Wiley Cr, upper	2	19	4	11	24
S Santiam River	Wiley Cr, lower	1	16	10	26	24
S Santiam River	Crabtree Cr.	0	6	27	93	17
S Santiam River	Thomas Cr.	2	13	17	35	18
Calapooia River	N Fk Calapooia	0	11	15	76	20
Calapooia River	Potts Cr	0	2	8	15	21

Spawner Distribution
Spawning summer steelhead were widely distributed in the areas surveyed. Densities ranged from 0 to close to 40 redds per mile, with an average density of 1.8 redds per mile (Table 6). Randomly selected surveys are designed to provide a representative sample of the occurrence of spawners in a variety of habitats. Consequently, they provide us with a means to monitor the status and trends of spawner populations and distribution. Redd densities in surveys that are traditionally surveyed for winter steelhead tended to be higher (4.8 redds/mi) than the average seen in random surveys. The map in Figure 8 shows the number of redds/mile in both randomly selected and traditional surveys.

Table 6. Redd densities on randomly selected summer steelhead spawning surveys, 2003.

Subbasin	Reach ID	Seg	Survey	Redds/mi
Molalla River	31398.00	2	Abiqua Creek	0.77
Molalla River	31474.00	1.1	Molalla River	0.00
Molalla River	31488.00	2	Cougar Creek	1.22
Molalla River	31489.00	3	North Fork Molalla River	2.00
Molalla River	31522.00	1	Lost Creek	0.00
Molalla River	31542.00	1	Molalla River	6.50
S Santiam River	31966.00	2	Thomas Creek	0.00
S Santiam River	31991.00	3	South Fork Crabtree Creek	0.00
S Santiam River	32024.00	2	Wiley Creek	1.79
S Santiam River	32028.00	5	Wiley Creek	1.82
N Santiam River	32163.00	1.1	Mehama to Stayton float	0.00
N Santiam River	32212.00	1	Little North Santiam River	5.00
Calapooia River	32414.00	2	Calapooia River	0.00
Mohawk River	32652.00	1	McGowan Creek	1.72

Table 6. (cont.)

Subbasin	Reach ID	Seg	Survey	Redds/mi
Mohawk River	32654.00	1	McGowan Creek	1.79
Mohawk River	32658.00	1	Parsons Creek	1.87
Mohawk River	32673.00	2	Wolf Creek	0.00
Mohawk River	32674.00	3	Mill Creek	0.00
Mohawk River	32680.00	2	Mill Creek	0.00
Mohawk River	32688.30	2	Crooked Creek	0.00
Mohawk River	32690.00	1	Drury Creek	0.00
Mohawk River	32695.00	6	Mohawk River	6.39
McKenzie River	32699.00	2	Camp Creek	0.00
McKenzie River	32703.00	2	Camp Creek	0.00
McKenzie River	32710.00	1.1	McKenzie River	0.39
McKenzie River	32726.00	1.1	McKenzie River	0.57
McKenzie River	32733.00	1	North Fork Gate Creek	6.56
McKenzie River	32740.00	1	Gale Creek	0.00
McKenzie River	32742.00	1.1	McKenzie River	0.00
McKenzie River	32744.00	1.1	McKenzie River	0.33
McKenzie River	32745.00	2	Deer Cr.	1.94
McKenzie River	32751.00	3	Quartz Creek	1.21
McKenzie River	32761.00	2	Quartz Creek	0.00
McKenzie River	32771.00	1	Blue River	2.32
S Fk McKenzie	32801.00	1	South Fork Mckenzie	0.00
McKenzie River	32889.00	1.1	Mckenzie River	0.00
Mosby Creek	32942.00	1	Row River	0.00
Mosby Creek	32947.00	1.1	Mosby Cr.	0.00
Mosby Creek	32970.00	1	West Fork Mosby Cr.	7.35
Mosby Creek	32976.00	1	Row R: Dorena to Mosby	0.00
Mosby Creek	33024.00	1.1	Coast Fork Willamette River	0.27
M Fk Willamette	33049.00	1.1	Middle Fork Willamette River	0.00
M Fk Willamette	33059.00	1.1	Middle Fork Willamette River	0.00
M Fk Willamette	33062.00	1.1	Fall Creek	0.91
M Fk Willamette	33064.00	2	Norton Creek	38.30
M Fk Willamette	33068.00	1	Sturdy Creek	1.32
M Fk Willamette	33069.00	1	Little Fall Creek	3.38
M Fk Willamette	33070.00	1.1	Fall Creek	3.86
M Fk Willamette	33172.00	2	Guiley Creek	0.00
M Fk Willamette	33173.00	6	Lost Creek	0.00
M Fk Willamette	33174.00	1.1	Middle Fork Willamette River	0.63

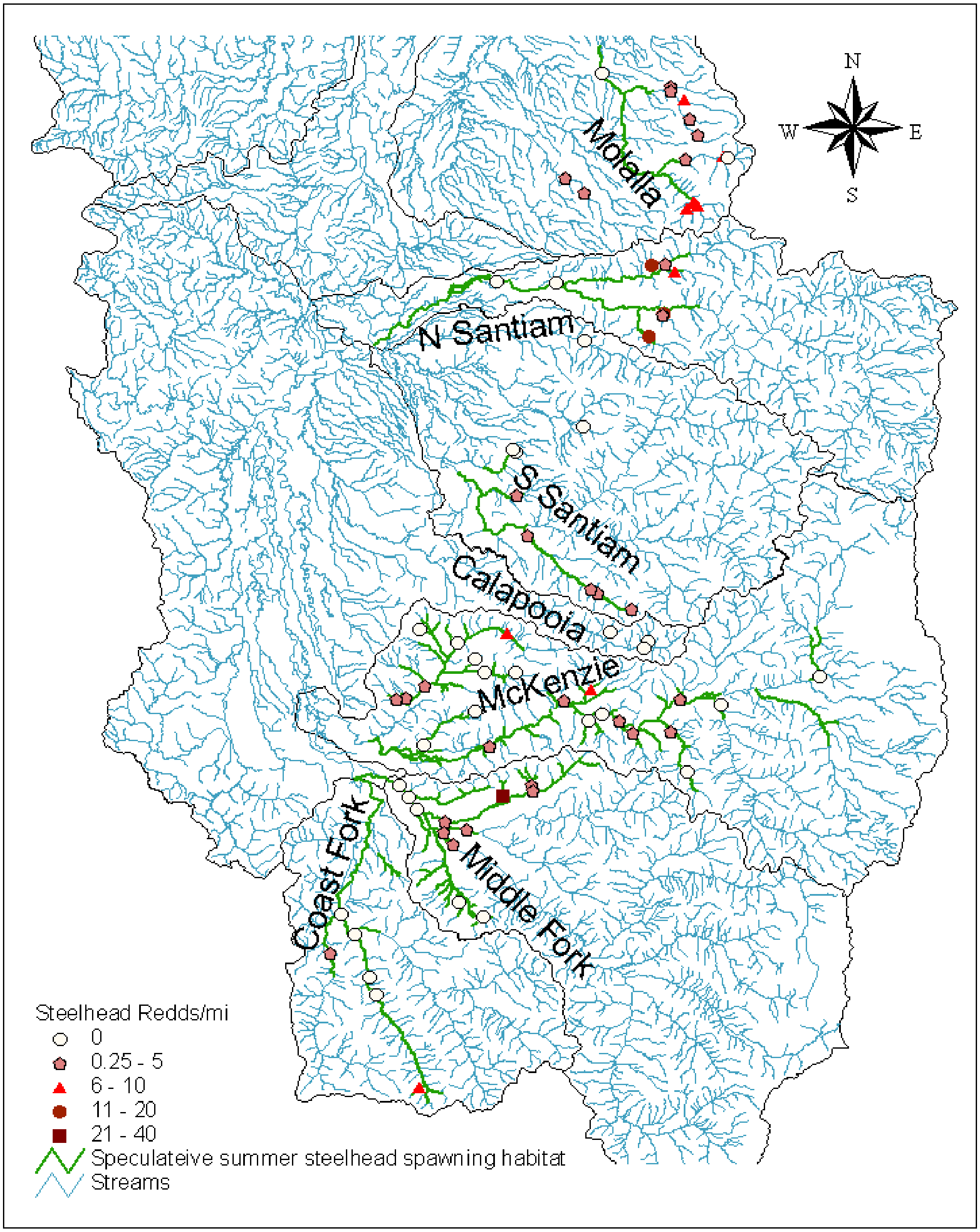

Figure 8. Summer steelhead redd densities in randomly selected surveys and traditional winter steelhead surveys; Upper Willamette ESU, 2003.

Most surveys had low densities of summer steelhead redds. In randomly selected surveys, 51% of sites had no summer steelhead redds, and almost 90% of the sites surveyed had fewer than 5 redds per mile surveyed (Figure 9). In traditional surveys, 62% of surveys had fewer than 5 redds, and at the 90th percentile there were 15 redds per mile surveyed. This result is not surprising considering that traditional surveys are located in areas believed to have the best winter steelhead spawning habitat. Since summer steelhead are likely to select similar spawning habitats to winter steelhead, we would expect to see more summer steelhead in areas with good winter steelhead spawning habitat.

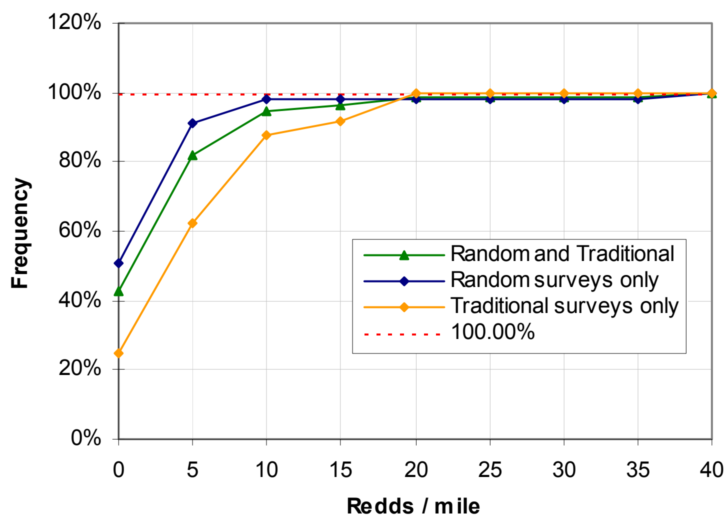

Figure 9. Cumulative frequency distribution of summer steelhead redds within the Upper Willamette ESU.

Activity 3.2.1 Conduct angler surveys to determine harvest of summer steelhead.

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

The angler survey on the lower South Santiam began on July 5, 2002 and ended July 31, 2002. The survey on the upper section (Sweet Home area) began July 5, 2002 and ended October 31, 2002. The survey on the McKenzie River was conducted from July 5, 2002 to September 1, 2002. In 2003, angler surveys are being conducted from April through October in the North Santiam, South Santiam and McKenzie, and from April through July in the Middle Fork Willamette. Each river was divided into appropriate sections with respect to ability to sample and management needs. On a sampled day, all sections within a river were sampled. All surveys were divided into early and late shifts. The start and end times of these shifts varied with day length in order to encompass the entire daylight period. Early shifts began at dawn and spanned a 10-hour period. Late shifts began 10 hours before dusk and continued until dusk. Angler surveys were conducted on two randomly selected days during the week, and on both days during the weekend. The time of the shift (early vs. late) was also randomly assigned. Data and analysis were stratified by day type (weekend/weekday), angler type (boat, bank), river, fishing location, and month.

Pressure counts were conducted three times within a shift at 3-hour intervals. During pressure counts, surveyors tallied numbers of anglers and vehicles while driving along the entire survey area. The pressure count is intended as an instantaneous count of the number of anglers on the river. Between pressure counts, surveyors interviewed groups of anglers, recording catch, time spent fishing, fishing location, and angling gear. Catch was identified by species, maturity and fin mark. Angler interviews were classified as complete if they were finished fishing, or incomplete if they were still fishing. Total pressure was estimated as the average daily pressure multiplied by the number of days in the stratum. Average daily angler effort was estimated by calculating the area under the curve (AUC) formed by the average pressure at different times of the day. Pressure was assumed to be zero at the legal start and end of the fishing day. The catch rate was estimated by summing catch and dividing by angler hours. Total catch was estimated by multiplying the catch rate by the hours of effort. Angler trips were estimated by dividing the estimated hours of effort by the average trip length from completed trips.

South Santiam and McKenzie Angler Surveys

Six hundred eighty three (683) marked spring chinook were harvested from the South Santiam during the period of the survey, with another 573 harvested in the McKenzie (Table 7). An additional 705 marked and 128 unmarked chinook were caught and released on the South Santiam, while 420 marked and 626 unmarked chinook were released on the McKenzie.

In the South Santiam, 1,447 marked steelhead were harvested during the period of the survey, and another 1,221 were removed in the McKenzie. An additional 329 marked and 106 unmarked steelhead were caught and released on the South Santiam. Four hundred ninety four (494) marked and 189 unmarked steelhead were caught and released on the McKenzie.

The greatest numbers of unmarked fish were caught in July for both chinook and steelhead (Figure 10a). However, proportions of unmarked chinook in the catch were highest in September, and proportions of unmarked steelhead in the catch were highest in August in the South Santiam River (Figure 10b). Fairly high proportions of unmarked steelhead in the catch were also seen in the South Santiam in October. Angler effort and catch were highest in July (Figure 10c), but catch rates were highest in September and October (where data are available; see Figure 10d). Most of the fish caught were marked.

Table 7. Total estimated catch

	McKenzie Spring Chinook	S Santiam Spring Chinook	McKenzie Steelhead	S Santiam Steelhead
No mark, released	626	128	189	106
Marked, kept	573	683	1,221	1,447
Marked, released	420	705	494	329
Released, mark unknown	24	186	0	0

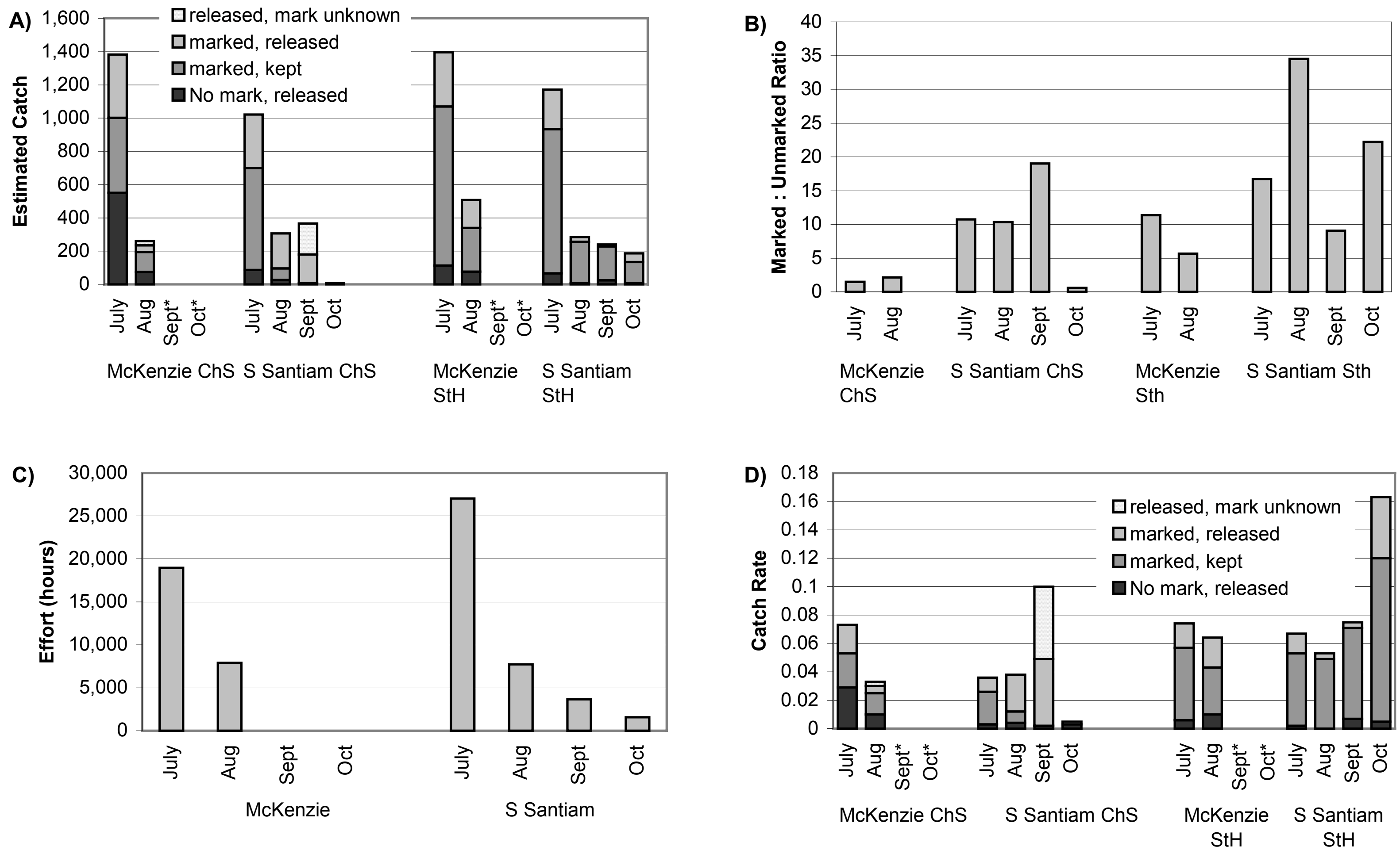

Figure 10. Results of angler surveys for spring chinook and steelhead in the South Santiam and McKenzie Rivers by month, 2002. A) Estimates of catch and retention of marked and unmarked fish. B) Ratio of marked to unmarked fish caught. C) Estimate of angler effort (hours spent fishing). D) Catch Rate (fish per hour fished).

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

The angler survey on Foster Reservoir began in February of 2002 and was conducted full time through the end of October. Survey methods are presented under task 3.3.

An estimated 908 naturally produced steelhead smolts were retained in the Foster Reservoir fishery in 2002 (Table 8). Another 168 were caught and released. If we assume 20% mortality on released fish, then we estimate that the fishery resulted in a take of 942 steelhead smolts. A total of 35,466 marked hatchery trout were caught, and 29,796 of these were kept. Thus, steelhead smolts made up approximately 3% of the catch and the harvest in Foster Reservoir in 2002.

Eighty-eight percent of the steelhead smolts caught were caught in February, March and April, with the greatest catch of steelhead smolts in April (Table 8; Figure 11,A,B). Most hatchery trout were caught in the months of April, May and June (86%), with the greatest catch occurring in May (Table 8; Figure 11,A). Angler effort was greatest in May and June (Table 8; Figure 11,C). The catch rate was highest in May for marked hatchery rainbow trout (Figure 11,D), and in February for unmarked steelhead smolts (Figure 11,F). The ratio of unmarked smolts to marked trout was greatest in February when approximately eight times as many unmarked steelhead than marked trout were caught (Figure 11,E). In every other month, anglers caught greater numbers of hatchery fish than steelhead smolts.

Table 8. Estimated angler effort and catch and harvest of unmarked, naturally produced steelhead smolts (Unmk), and marked hatchery rainbow trout in Foster Reservoir, 2002.

Month	Effort (hrs)	Unmk, kept	Marked, kept	Unmk, released	Marked, released
February	541	107	15	15	0
March	2,378	293	581	36	97
April	5,547	404	4,053	94	875
May	10,870	47	15,804	9	3,436
June	11,859	26	5,889	10	910
July	3,895	0	1,373	0	40
August	1,761	0	402	0	89
September	2,064	8	604	0	71
October	1,967	24	1,074	6	153
2002	40,882	908	29,796	168	5,670

Estimating the number of steelhead smolts entering the reservoir in order to determine the proportion of smolts that are impacted by the fishery is more challenging. Five hundred female steelhead were passed above Foster Dam in 2002. Buckley (1967) reported that the fecundity of Big Creek steelhead ranges from 1,827 to 3,996 eggs per female, with an average of 2,912 eggs per female. In Table 9 we present three scenarios of fecundity and survival used to estimate the number of steelhead smolts entering the reservoir in 2002. In the best-case scenario, we estimate fresh-water mortality at 90%, giving us an estimate of almost 200,000 smolts entering the reservoir. If freshwater mortality was as high as 98% and fecundity was at the lower limit observed by Buckley (1967), then we estimate that

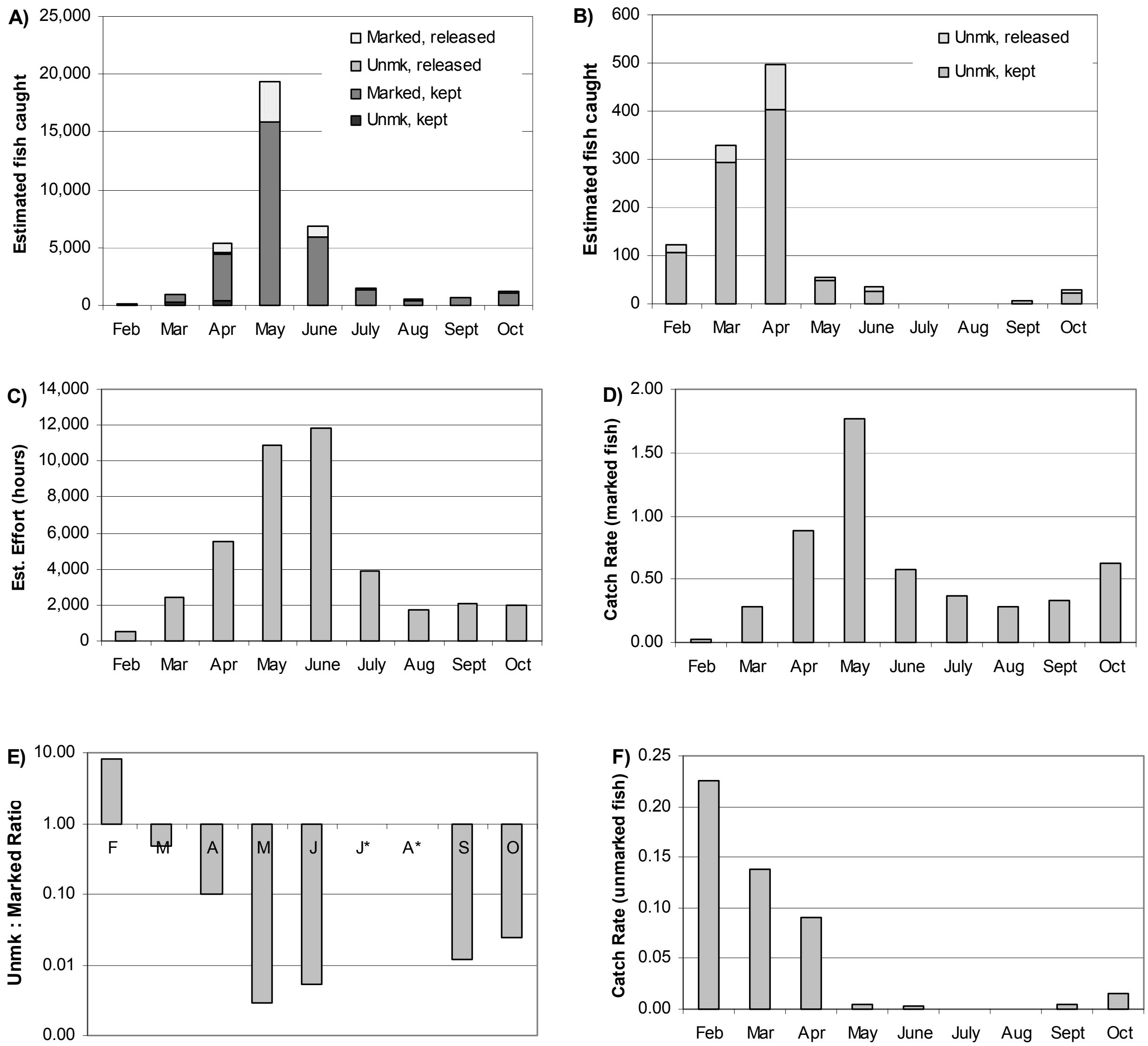

Figure 11. Results from Foster Reservoir angler survey by month. A) Catch and retention of hatchery-reared rainbow trout and naturally produced steelhead smolts. B) Fate of naturally produced steelhead smolts caught in the Foster Reservoir fishery. C) Estimated angler effort by month in hours fished. D) Catch rate for marked rainbow trout by month. E) Ratio of unmarked (steelhead smolts) to marked (hatchery trout) fish caught in the fishery (logarithmic scale). *No unmarked fish were caught in July or August. F) Catch rate for unmarked steelhead smolts by month.

approximately 20,000 smolts would enter the reservoir. In the moderate scenario we have used the average fecundity reported by Buckley (1967) and a 95% freshwater mortality rate, giving us an estimate of approximately 73,000 steelhead smolts entering Foster Reservoir in 2002. Using these various scenarios, the impact of the Foster Reservoir trout fishery on naturally produced summer steelhead is roughly between 1/2 percent and 5%.

Table 9. Estimates of impacts on naturally produced winter steelhead smolts entering Foster Reservoir:

Best	Worst	Moderate	
500	500	500	Number of female steelhead passed above Foster Dam
3,996	1,827	2,912	Fecundity. (from Buckley, 1967, Big Creek steelhead)
90.0%	98.0%	95.0%	Estimated freshwater mortality
199,800	18,270	72,788	Estimated smolts entering reservoir
908	908	908	Estimated harvest of smolts, Feb - Oct 2002
168	168	168	Estimated smolts released, Feb - Oct 2002 (20% mort)
33.6	33.6	33.6	20% Mort on released fish
941.6	941.6	941.6	Estimated Impact of fishery on smolts
0.47%	**5.15%**	**1.29%**	**Estimated impact (percent of run)**

Wild steelhead show up mainly in the spring and again in the fall, but there is considerable overlap in timing with current stocking schedules and catch of holdovers. Consequently, season manipulation is probably not a good protection option. There is also a great deal of size overlap between wild and hatchery O.mykiss (Figure 12), so size restrictions are not a practical option. Since this is a bait fishery, getting rid of bait is not a practical option. Changing the regulations to allow take of adipose clipped trout only may be the best conservation measure. Several reasons to propose this change are: consistency in regulations, saving take for other lower river fisheries, a small impact on allowable harvest (3% of harvest of trout), and providing a small but additional protection to wild fish.

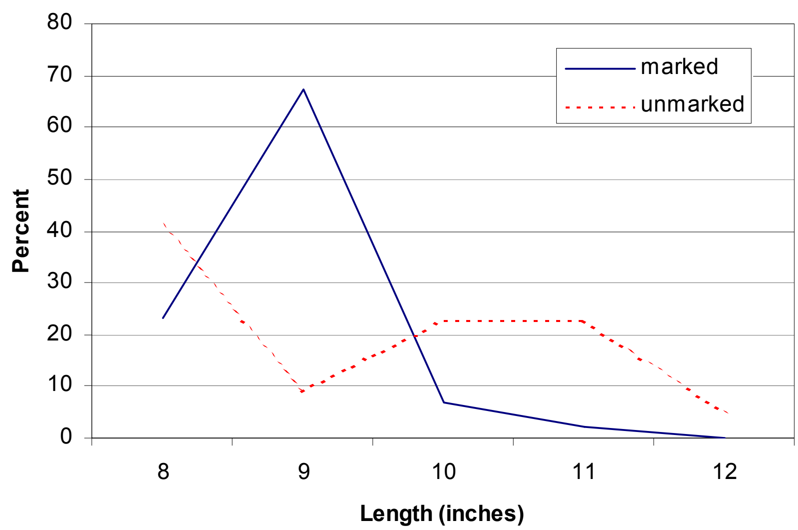

Figure 12. Length frequencies of stocked hatchery rainbow trout (marked) and naturally produced winter steelhead smolts (unmarked) retained in the Foster Reservoir angler survey, 2002.

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