SPAWNING DISTRIBUTION OF OUTPLANTED ADULT SUMMER CHINOOK SALMON IN THE SOUTH FORK SALMON RIVER, 1992-1994

Project Progress Report

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ABSTRACT

We studied the spawning distributions of adult chinook salmon *Oncorhynchus tshawytscha* outplanted in the Stolle Meadows reach of the South Fork Salmon River in 1992, 1993, and 1994. Adult salmon were held at the South Fork Salmon River trap for a period of time after capture, and were than trucked to the Stolle Meadows reach and released. Of the females outplanted and known to have spawned each year, 83% to 91% remained in the Stolle Meadows reach. Only 3% to 8% migrated downstream to spawn in the area near Knox bridge, where they likely originated (natural spawning) or were released as juveniles from the hatchery. Females typically spawned upstream and within 1.6 km of their release site. At least 10% and 15% of the tagged males outplanted in 1992 and 1993, respectively, migrated downstream of Stolle Meadows. Only 5% (1992) and 8% (1993) migrated as far downstream as the Knox bridge area. We conclude that outplanting of adult chinook salmon can be a viable tool to restore natural spawning to previously important production areas.

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INTRODUCTION

Hatchery-reared chinook salmon *Oncorhynchus tshawytscha* juveniles have been released annually in the upper reaches of Idaho's South Fork Salmon River since 1977. These releases were made because the number of wild summer chinook salmon spawning in the Stolle Meadows reach had been declining for many years. Adults for hatchery production were collected at two lower Snake River dams, Little Goose (1975-1978) and Lower Granite (1979 and 1980), and from the upper South Fork Salmon River (1980 to the present) (Idaho Department of Fish and Game et al. 1990). Adults collected at the dams were assumed to be summer-run, based on the timing of passage of summer chinook salmon. Progeny of the adults collected at the dams were used to bolster the indigenous upper South Fork Salmon River population while McCall Fish Hatchery was being built. The hatchery was completed in 1981 and has operated under the Lower Snake River Compensation Plan, authorized to compensate for fish and wildlife losses caused by four lower Snake River dams (Herrig 1990). The hatchery is located in McCall, Idaho (Figure 1). A satellite facility, including a temporary weir, trap, adult raceways, and spawning shed, is located on the upper South Fork Salmon River.

After the completion of hatchery and satellite facility construction in 1980, at least one-third of the adult chinook salmon trapped each year were released upstream of the weir to spawn; about two-thirds (up to the rearing capacity of the hatchery) were retained for hatchery production. Hatchery smolts have been released in the South Fork Salmon River at Knox bridge, approximately 1.6 km upstream from the satellite facility weir. Only a portion of the smolts were marked before their release; therefore, adult returns have been a mixture of marked hatchery-, unmarked hatchery-, and unmarked naturally-produced fish. All marked adults, along with some unmarked adults, have been retained for hatchery production. Only unmarked fish were released upstream of the weir.

Sankovich and Bjornn (1992) concluded that hatchery operations had altered the historic distribution of chinook salmon spawners in the upper South Fork Salmon River in 1991 and 1992. Before McCall Fish Hatchery began operations, most chinook salmon redds upstream from the present weir site were observed in the Stolle Meadows Reach, and few were made near Knox bridge (see Figure 1 for landmark locations). Because most hatchery- and naturally-produced adults (each identified using scale pattern analysis) spawned near Knox bridge in 1990 and 1991, Sankovich and Bjornn made three conclusions: 1) hatchery adults had a high fidelity to their juvenile release site before as well as during the study; 2) most naturally produced fish spawning near Knox bridge had some hatchery ancestry; and 3) the indigenous population had been well integrated into the hatchery operation.

In 1992 and 1993, a record high 2,848 and 2,703 chinook salmon, respectively, were trapped at the McCall Fish Hatchery satellite facility. In 1994, 527 adult salmon were trapped. To seed the Stolle Meadows reach area and reduce spawner density near Knox bridge, some adults that would otherwise have been released at the weir were trucked to and outplanted in the Stolle Meadows reach. We conducted a study to determine the spawning distribution of the outplanted adults in 1992, 1993, and 1994.

Figure 1. Locations of the McCall Fish Hatchery, the McCall Fish Hatchery spawning facility and weir, and landmarks and unit sections in the South Fork Salmon River study area.

METHODS

Outplanting

In 1992, 1993, and 1994, we outplanted 200, 207, and 53 adult chinook salmon, respectively, in the Stolle Meadows reach of the South Fork Salmon River (Table 1). All of the females were tagged with uniquely numbered Petersen discs. We tagged all of the males in 1992, about one-half of the males in 1993, and no males in 1994. Our primary interest became the behavior and distribution of the females after we learned that most males would remain in the Stolle Meadows reach and be available to spawning females.

We suspected adults that were physiologically close to spawning would be more likely than others to remain in the Stolle Meadows reach when outplanted. Because chinook salmon in the upper South Fork Salmon River spawn in August and early September, we outplanted the adults in August in 1992 and 1993 (Table 1). In 1994, when returns were low, we outplanted the adults in early July and August. We made the July releases because of National Marine Fisheries Service (Endangered Species Act) permitting constraints.

Table 1. Number of adult chinook salmon outplanted in the Stolle Meadows reach of the South Fork Salmon River, 1992-1994. All females were tagged; the number of tagged males is given in parentheses. Release site locations are shown in Figure 2.

			Number Outplanted		
Year	Tagging and Release Date	Release Site	Females	Males (number tagged)	Total
1992	Aug 7	3	15	17 (17)	32
	Aug 11	3	10	10 (10)	20
	Aug 14	4	10	10 (10)	20
	Aug 18	4	10	10 (10)	20
	Aug 21	3	20	20 (20)	40
	Aug 25	2	20	20 (20)	40
	Aug 28	1	15	20 (20)	35
			100	107 (107)	207
1993	Aug 3	2a	20	20 (20)	40
	Aug 5	3	8	8 (8)	16
	Aug 5	1	22	20 (20)	42
	Aug 16	4	30	30 (0)	60
	Aug 18	2a	20	22 (0)	42
			100	100 (48)	200
1994	Jul 7	3	4	0 (0)	4
	Jul 8	3	2	1 (0)	3
	Jul 9	3	3	3 (0)	6
	Jul 10	3	3	5 (0)	8
	Aug 3	4	15	17 (0)	32
			27	26 (0)	53

We attempted to select fish for release that were at least three days from spawning. Females would then have time to find spawning sites, and their eggs would be less likely to be spent or damaged during transport. In 1992, we selected adults in the satellite facility's two raceways (one each for males and females). This included fish that had arrived at the weir from June 5, the start of the run, through August 28. In 1993, we selected fish from the raceways and the trap. The fish in the raceways had arrived at the weir from July 2, the start of the run, through August 16. Adults were selected from the trap on August 5 and 18. In 1994, we again selected fish from the raceways and trap. The fish in the raceways had arrived at the weir from June 13, the start of the run, through August 3. Adults were selected from the trap from July 7 through 10.

We used the same methods as Sankovich and Bjornn (1992) to tag the adults with Petersen discs. Once tagged, each fish was placed in an adult net, transferred to a 3,784 L fish distribution truck, and left to recover. Males that were not tagged were measured (fork length) and transferred to the truck.

After we had processed all of the fish to be outplanted each day, we trucked them to the Stolle Meadows reach. We released the fish either by placing them in an adult net and carrying them a short distance to the river, or by passing them through a watered, 20.3 cm diameter hose running from the truck to the river. We used two to four release sites each year; the sites were between 10.4 km and 14.4 km upstream from the weir (Figure 2). We selected each site based on accessibility and availability of nearby "holding water" and spawning habitat.

Spawning Distribution

We began monitoring the adults immediately after the first group was outplanted each year. In 1992 and 1994, fish started spawning about two weeks and six weeks, respectively, after we outplanted the first group of adults. We snorkeled or walked portions of the study area daily to monitor the adults before spawning began in 1992. In 1994, we snorkeled the study area three times between early July and August and walked the river daily beginning in mid-August to monitor the adults before spawning began. Spawning had begun when the first adults were outplanted in 1993, so we started our spawning ground surveys immediately.

We used methods similar to those of Sankovich and Bjornn (1992) to conduct the prespawning and spawning ground surveys. To summarize, we divided the study area into units of approximately 1.6 km each (Figure 1). During the prespawning surveys, we recorded the unit locations of tagged and untagged adults and sampled dead fish to determine if the fish spawned. When snorkeling, we proceeded downstream and surveyed the entire study area in two to four days. For the spawning ground surveys, we walked all or part of the river daily and recorded the locations of new redds and any fish, and whether the fish we observed were tagged or untagged. We flagged the location of each redd and identified it with a unique number written on the flagging and recorded it in a notebook. We recorded the sex (if it could be determined), activity, and disposition of each fish observed near the redd, and the condition of each redd (complete or incomplete). We refined the locations of observations made within a unit by estimating the distance to unit boundaries, landmarks, or existing redds.

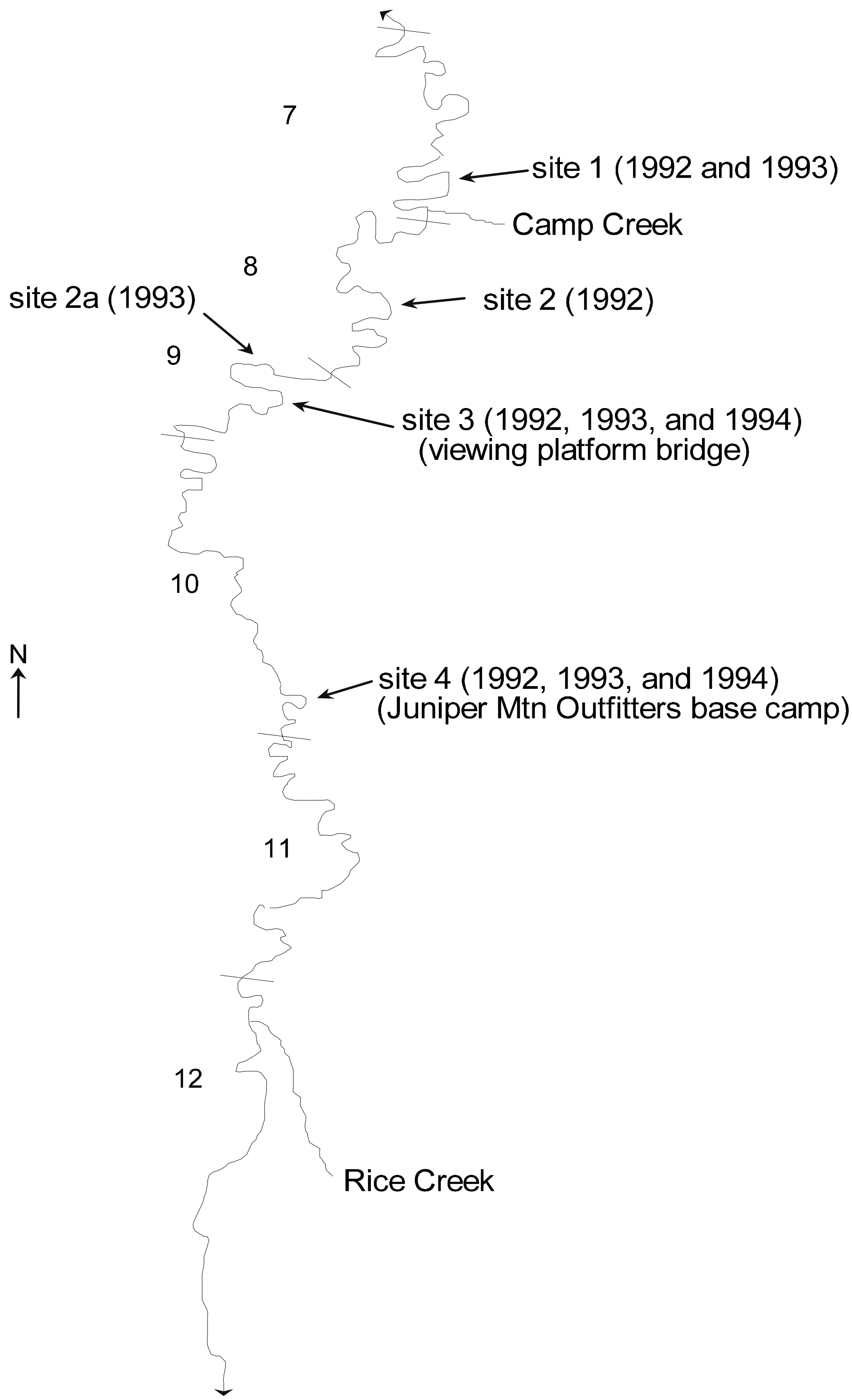

Figure 2. Locations of release sites used to outplant adult chinook salmon into the Stolle Meadows reach of the South Fork Salmon River, 1992-1994.

Data Analysis

We determined the spawning distributions of female and male salmon differently. We could not account for some females outplanted each year. Therefore, female spawning distributions were based on the distributions of females known to have spawned (females were observed on a redd and/or were recovered and had spawned). For the male spawning distributions, we merely determined the number and distribution of males that migrated downstream of Stolle Meadows. We took this approach for two reasons: 1) as noted above, our primary concern was the behavior of females and simply if males would remain in the Stolle Meadows reach; and 2) the distribution of males that remained in the Stolle Meadows reach would have been largely dependent on the distribution of females spawning in that area.

We recovered some spent, outplanted females that were not observed on a redd. If we recovered such a female within 100 m downstream of a single redd upon which no female was observed, we assumed the female was responsible for that redd. Typically, we recovered females within 100 m downstream of redds upon which they were identified. If we could not determine the redd for which a recovered female carcass was responsible (i.e., two or more redds upon which no female had been observed were located upstream of the recovery site), we assumed the female spawned at the recovery site.

Except the redds described above, assumed to have been made by outplanted females, we attributed all other redds upon which no female was observed to be from females released at the weir. We usually attributed redds upon which untagged females were observed to females released at the weir. Exceptions occurred when a female had obviously been tagged, because of circular marks (from the disc tags) or a hole (from the nickel pin) beneath the dorsal fin.

RESULTS

Spawning distributions of outplanted females varied among years, but at least 83% of the females were known to spawn in the Stolle Meadows reach each year (Table 2, Figures 3 and 4). Seventy-four percent, 72%, and 44% of the females outplanted in 1992, 1993, and 1994, respectively, were observed on a redd or were recovered and had spawned (Table 2, Figure 3). Of the outplanted females that left the Stolle Meadows reach and were observed to spawn, most did not migrate far downstream. Only 3% (1992), 7% (1993), and 8% (1994) of these outplanted females spawned near the juvenile release sites in units 1 and 2 and lower Curtis Creek (only one female in 1992) (Figure 4).

Overall, females spawned upstream and within 1.6 km of their release site. Sixty-three percent and 56% of the females outplanted in 1992 and 1993, respectively, spawned upstream of their release site, compared with 30% of the females outplanted in 1994 (Figure 5). Seventy-five percent and 60% of the females outplanted in 1992 and 1994, respectively, spawned within 1.6 km of their release site, compared with 45% of the females outplanted in 1993 (Table 2, Figure 5). Females outplanted in 1993 dispersed more within the Stolle Meadows reach, perhaps because most females released at the weir that year spawned in the Stolle Meadows reach (Figure 4, Appendix A), reducing the amount of available spawning habitat near the release sites.

In 1992 and 1993, at least 10% and 15% of the tagged males, respectively, migrated downstream of Stolle Meadows (Table 3). These proportions were similar to those for the respective groups of females. At least 12% of the females left the Stolle Meadows reach in 1992 (Table 2). In 1993, at least 14% of the females released on August 3 and 5, the dates of release for tagged males in that year, left the Stolle Meadows reach (Table 2). Five percent (1992) and 8% (1993) of the tagged males were observed near the juveniles release site.

Table 2. Spawning success and general distribution of various groups of female chinook salmon outplanted in the Stolle Meadows reach of the South Fork Salmon River, 1992-1994.

			Females that spawned[a]			
Year	Tagging and release date(site)	Number of females released	Number (percent of those released)	Percent in Stolle Meadows (percent within 1.6 km of release site) [b]	Percent that left Stolle Meadows[c]	Percent that spawned among those recovered(n)[d]
1992	Aug 7 (3)	15	7 (47)	100 (71)	20	67 (6)
	Aug 11 (3)	10	5 (50)	100 (80)	0	67 (6)
	Aug 14 (4)	10	4 (40)	100 (100)	10	33 (3)
	Aug 18 (4)	10	10 (100)	100 (100)	0	100 (3)
	Aug 21 (3)	20	19 (95)	84 (63)	15	100 (4)
	Aug 25 (2)	20	13 (65)	85 (69)	10	- (0)
	Aug 28 (1)	15	13 (87)	85 (69)	20	100 (1)
	unknown[e]	-	3 (-)	100 (-)	-	100 (1)
		100	74 (74)	91 (75)	12	75 (24)
1993	Aug 3 (2a)	20	12 (60)	92 (42)	10	90 (10)
	Aug 5 (3)	8	4 (50)	100 (25)	0	100 (2)
	" (1)	22	14 (64)	71 (21)	23	100 (6)
	Aug 16 (4)	30	24 (80)	92 (54)	7	100 (13)
	Aug 18 (2a)	20	17 (85)	100 (59)	0	100 (11)
	unknown[e]	-	1 (-)	100 (-)	-	- (0)
		100	72 (72)	90 (45)	9	98 (42)
1994	Jul 7 (3)	4	1 (25)	100 (0)	25	100 (1)
	Jul 8 (3)	2	1 (50)	0 (0)	50	- (0)
	Jul 9 (3)	3	0 (0)	- (-)	67	0 (2)
	Jul 10 (3)	3	1 (33)	100 (100)	0	50 (2)
	Aug 3 (4)	15	7 (47)	100 (71)	7	88 (8)
	unknown[e]	-	2 (-)	50 (-)	-[f]	100 (1)
		27	12 (44)	83 (60)	22[g]	71 (14)

[a] Includes only those females known to have spawned (observed on a redd and/or recovered and had spawned); other females may also have spawned.

[b] Percent of the total number that spawned (previous column) that were known to have spawned within the Stolle Meadows reach.

[c] Includes only females spawning outside of the Stolle Meadows reach and female carcasses recovered outside of the Stolle Meadows reach (and assumed to have spawned at or near the recovery site).

[d] Includes only those female carcass recoveries where condition could be determined; the condition of one female recovered in 1992 and one female recovered in 1993 could not be determined.

[e] Some females that had lost their tags were identified as having been tagged based on circular marks (from the Petersen discs) and/or holes (from the nickel pins) beneath the dorsal fin. The release site and date of such females was unknown.

[f] One unknown (untagged) female spawned downstream of Stolle Meadows, but this calculation is not applicable

because the release group to which the female belonged was unknown.

[g] Includes one unknown female that spawned downstream of Stolle Meadows.

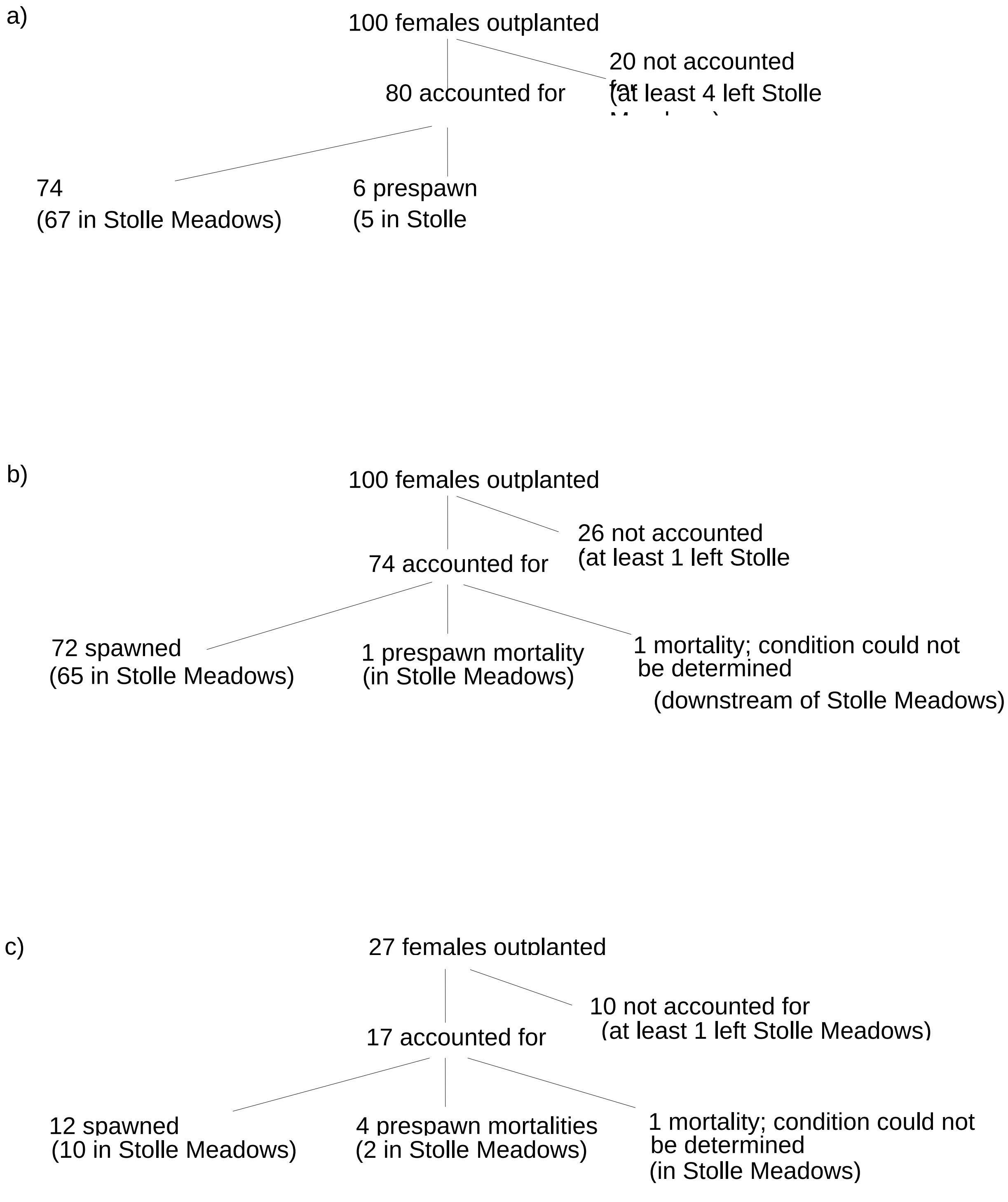

Figure 3. Fates of female chinook salmon outplanted into the Stolle Meadows reach of the South Fork Salmon River in 1992 (a), 1993 (b), and 1994 (c). Females that were not accounted for were never observed on a redd or recovered.

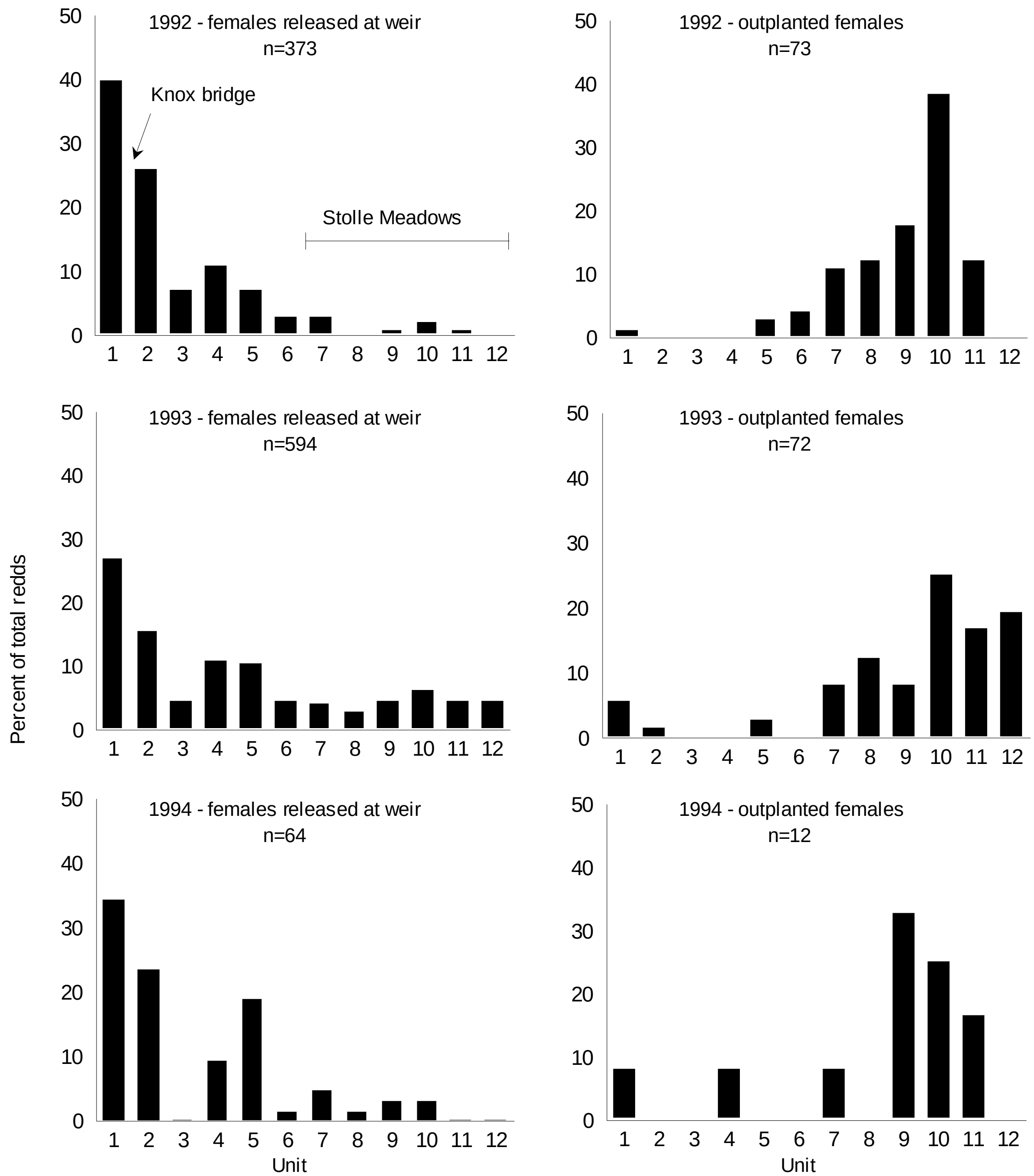

Figure 4. Distribution of redds made by female chinook salmon released at the South Fork Salmon River weir and outplanted in the Stolle Meadows reach of the South Fork Salmon River, 1992-1994. Redds in Curtis Creek, a tributary entering the South Fork Salmon River in mid-unit 2, are not included. Unit locations are shown in Figure 1.

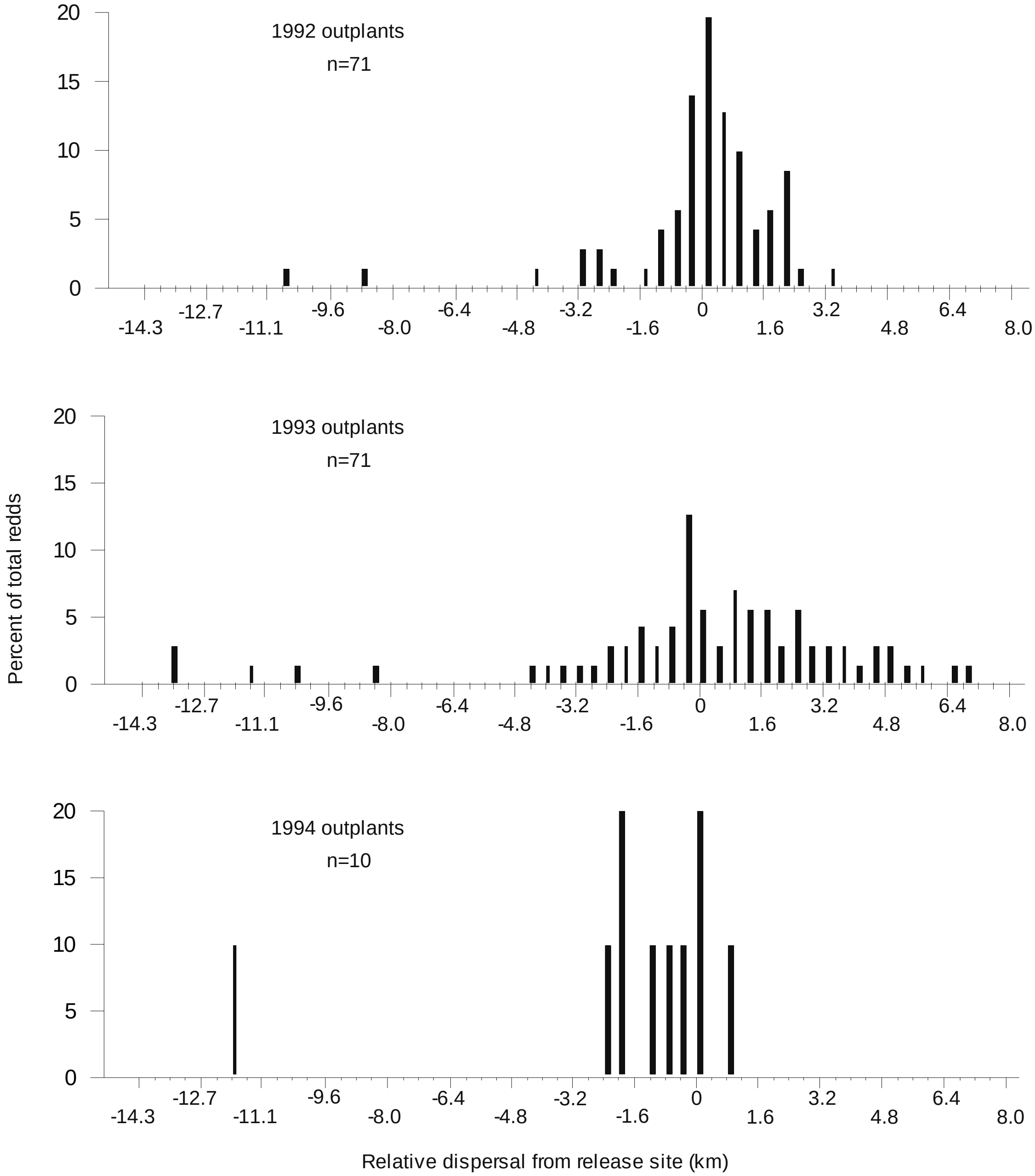

Figure 5. Relative dispersal of redds made by female chinook salmon outplanted at various sites in the Stolle Meadows reach of the South Fork Salmon River in 1992, 1993, and 1994. Positive and negative numbers along the X-axis correspond to distances up and downstream, respectively, of each release site. Females that lost their tags and made redds (release site unknown) are not included.

Table 3. Percentages of tagged, outplanted chinook salmon males that migrated downstream of Stolle Meadows in 1992 and 1993. Release site locations are shown in Figure 2.

Year	Tagging and release date	Release site	Number of males released	Percent that left Stolle Meadows
1992	Aug 7	3	17	12.5
	Aug 11	3	10	10.0
	Aug 14	4	10	—-
	Aug 18	4	10	10.0
	Aug 21	3	20	20.0
	Aug 25	2	20	5.0
	Aug 28	1	20	10.0
			107	10.0
1993	Aug 3	2b	20	10.0
	Aug 5	3	8	12.5
	Aug 5	1	20	20.0
			48	15.0

[a] Does not include males that had lost their tags and were observed downstream of Stolle Meadows. A male who lost his tag could have been observed on more than one occasion and/or a male might have been identified downstream of Stolle Meadows before losing his tags. Six and three untagged males were observed downstream of Stolle Meadows in 1992 and 1993, respectively.

DISCUSSION

Few, if any, of the adult chinook salmon outplanted during this study into the Stolle Meadows reach of the South Fork Salmon River probably originated there. Most were probably hatchery-origin fish released as smolts at Knox bridge, from 8.4 to 12.4 km downstream of the adult release sites used in our study. Hatchery fish made up an estimated 90% (1992), 94% (1993), and 95% (1994) of the runs from which the outplanted adults were selected (D. Cannamela and P. Sankovich, Idaho Department of Fish and Game, unpublished data). Because most naturally produced fish in the upper South Fork Salmon River have some hatchery ancestry, and hatchery fish have spawned near Knox bridge (Sankovich and Bjornn 1992), most of any naturally produced adults outplanted probably originated near Knox bridge. Nearly all of the outplanted adults, then, either were released as juveniles at Knox bridge or originated in that area.

Most of the adults we outplanted, and were later able to observe, spawned in the Stolle Meadows reach, though they had been displaced (transported and released in an area different from where they were expected to home). Several factors might influence the subsequent movement and distribution of displaced adults. Factors documented for steelhead trout *Oncorhynchus mykiss* include the direction adults are transported relative to their juvenile release site (Reingold 1975), the distance between the adult and juvenile release sites (Reingold 1975; Kramer 1981), and the physiological state of adults (i.e., how close adults are to spawning) at the time of outplanting (Reingold 1975). We did not design our study to determine the factors that influenced the distribution of adults, or the relative importance of such factors. However, we believe fewer adults would have remained in the Stolle Meadows reach had most not been close to spawning, and those adults that did leave did not migrate solely (if at all) because they were displaced a critical distance upstream from their juvenile release site or area of origin. Adult steelhead trout transported more than twice as far upstream of their juvenile release site as were adults in our study (26 km versus 8.4 to 12.4 km, respectively), but several months before spawning, were more likely to return to their juvenile release site than to remain at the adult release location (Kramer 1981). Results from the two studies might not be comparable to our study because of species or system differences, but our study does provide some evidence that the physiological state of adults influenced their dispersal.

In 1994, 44% (4 of 9) of the females outplanted in July and later observed had migrated at least 4.5 km downstream of their release site (and out of the Stolle Meadows reach), compared with 9% (1 of 11) of the females outplanted in August and later observed. This movement behavior difference might have been a result of physiological differences between the two groups of females for three reasons: 1) ample staging areas should have been available near both release sites. Twenty-one and 32 adults were outplanted at sites 3 and 4, respectively, and only two untagged adults (presumably released at the weir) were observed when the Stolle Meadows reach was last snorkeled on August 1 and 2; 2) all of the females that migrated at least 4.5 km downstream of their release site did so before the spawning period; therefore, their dispersal could not have been influenced by the distribution of spawners or competition for spawning sites; 3) though the females outplanted in July were not released as far upstream from the juvenile release site as were the females outplanted in August (10.2 km versus 12.4 km, respectively), the effect of release location on dispersal was probably similar for both groups of females. No obvious difference due to release location was apparent for females outplanted at sites 3 and 4 (10.2 km and 12.4 km upstream from the juvenile release site, respectively) in August 1992 and 1993 (Table 2).

Though a vast majority of the females known to have spawned each year made their redds in the Stolle Meadows reach, that area probably was seeded less effectively in 1994 than in 1992 and 1993. Among these years, the proportion of females that spawned in the Stolle Meadows reach was lowest in 1994 (Table 2, Figure 4). The observed and actual spawning distributions may have differed each year, particularly in 1994, when only 44% of the total females outplanted and 25% and 47% of the females outplanted in early July and August, respectively, were known to have spawned (Table 2). However, if spawning distributions were influenced by the physiological state of females at the time of outplanting, it is reasonable to assume that the observed differences in distributions (1994 versus 1992 and 1993) were not attributable solely to sampling error. A real difference might have existed because some females outplanted in 1994 were released in early July, when they were physiologically farther from spawning and more likely to leave the Stolle Meadows reach than the groups of females released in August. If this were true, it would follow that the Stolle Meadows area would have been, and will be, seeded most efficiently by outplanting adults only in August.

Before hatchery operations altered the distribution of spawners in the upper South Fork Salmon River, most salmon returning to that area spawned in the Stolle Meadows reach. Therefore, it is likely the productivity (the number of offspring and adults produced per female spawner) in the Stolle Meadows reach is higher than in other areas upstream from the weir, and that production benefits may result from adult outplants. Managers should be aware, however, that production benefits would not be guaranteed if the adult offspring of outplanted adults were also outplanted <u>and</u> critical reductions in reproductive success resulted from outplanting-related mortality of adults and/or reductions in the viability of their gametes (e.g., due to acute stress) (Appendix B). We do not know whether, or to what extent, outplanting procedures might affect the viability of gametes. Outplanting-related mortality appeared to occur in at least one of three years during the present study (Appendix C), so concern may be warranted if adult outplants continue indefinitely.

RECOMMENDATIONS

1. The historic distribution of redds in the area upstream of the fish weir should be restored to utilize the production potential of the Stolle Meadows reach.

2. Continue outplanting adults only until sufficient numbers of adults annually return to the Stolle Meadows reach of their own volition and future returns are assured. Outplanted fish should include only those adults returning from ongoing supplementation programs. Natural-origin adults captured at the hatchery weir should be allowed to move upstream on their own volition.

3. When outplanting fish, consideration should be given to the adult spawner and juvenile carrying capacity of the Stolle Meadows reach. In determining the number of salmon (particularly females) to outplant, the following factors, all of which relate to the carrying capacity for redds in the Stolle Meadows reach, should be considered: 1) whether fish will be released at the weir and, if so, the number expected to spawn in the Stolle Meadows reach; 2) the number of outplanted fish expected to spawn in the Stolle Meadows reach; 3) the prespawning mortality rate of liberated fish (both outplanted and released at the weir), which influences the two previous factors; 4) the size of females expected to spawn in the Stolle Meadows reach (larger females tend to make larger redds); and 5) summer flows, which influence the amount of available spawning habitat.

4. All adults should be outplanted in August to maximize the number that spawn in the Stolle Meadows reach and to increase the likelihood that the group of fish spawning in the Stolle Meadows reach will represent the run. If, for example, early- and late-arriving fish were outplanted in July and August, respectively, the group of fish that would spawn in the Stolle Meadows reach would probably be biased toward late-arriving fish.

5. Outplanted adults should represent, in terms of arrival timing, age structure, and sex ratio, the run from which they are selected.

6. Releases of hatchery-reared juvenile fish, as an alternative to using adult outplants, could be made to promote fish returns to the Stolle Meadows reach. Research should be conducted on the homing and adult return performance of juvenile fish released in the Stolle Meadows reach.

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APPENDICES

Appendix A

Distribution of redds made by females outplanted in the Stolle Meadows reach of the South Fork Salmon River and by females released upstream of the South Fork Salmon River weir, 1992-1994**.**

Table A1. Number of redds in each unit and total redds made by females released at the South Fork Salmon River weir and outplanted in the Stolle Meadows reach of the South Fork Salmon River, 1992-1994. The numbers reported were based on two assumptions: 1) each redd upon which no female was observed was made by a female released at the weir; and 2) any untagged female (except those that could be identified as having lost their tags) observed on a redd had been released at the weir. The locations of the units and Curtis Creek are shown in Figure 1.

	Number of redds								
	1992			1993			1994		
Unit	Females released at weir	Females outplanted	Total	Females released at weir	Females outplanted	Total	Females released at weir	Females Outplanted	Total
1	151	1	152	159	4	163	22	1	23
2	96	0	96	92	1	93	15	0	15
3	27	0	27	26	0	26	0	0	0
4	41	0	41	66	0	66	6	1	7
5	26	2	28	63	2	65	12	0	12
6	10	3	13	26	0	26	1	0	1
7	10	8	18	25	6	31	3	1	4
8	0	9	9	18	9	27	1	0	1
9	3	13	16	28	6	34	2	4	6
10	7	28	35	38	18	56	2	3	5
11	2	9	11	27	12	39	0	2	2
12	0	0	0	26	14	40	0	0	0
Curtis Creek	7	1	8	28	0	28	0	0	0
Total	380	74	454	622	72	694	64	12	76

Appendix B

An analysis of the outplanting-related mortality of salmon in 1992, 1993, and 1994.

To estimate outplanting-related mortality rates, we compared the spawning success (or prespawning mortality) of outplanted females to that of the respective females released at the weir (hereafter referred to as WR females for brevity). Carcass-recovery data were used to measure spawning success. We chose this method, as opposed to comparing redd production data (i.e. the percentage of females that made redds among those released), for two reasons: 1) outplanted females typically were selected from groups of fish that had survived into August (the females outplanted in July 1994 were exceptions), whereas the groups of WR females included individuals destined to die in June or July, and 2) some redds made by outplanted females probably were attributed to WR females (i.e., some outplanted females probably lost their tags, made a redd, and were not recognized as having been tagged; others may have spawned, yet were not recovered or observed on a redd). By using carcass-recovery data, we were able to compare the spawning success of outplanted and WR females that had survived until outplanting and monitoring began, and we negated the bias caused by attributing redds made by outplanted females to those released at the weir. Still, the analyses had several real or potential limitations: 1) when recovered, some outplanted females that had lost their tags may have been misclassified as WR females; 2) some WR females may have been on the verge of death when we began monitoring the study area, whereas we outplanted females that, for the most part, appeared to be in good health; 3) only 14 outplanted females were recovered in 1994; and 4) we made comparisons between carcass-recovery data for entire groups of outplanted and WR females (within years). If sample sizes were larger, it would have been more appropriate to make comparisons between carcass-recovery data for within year groups of outplanted females (e.g., groups outplanted on August 3, 5, 16, and 18, 1993) and the groups of WR females recovered after each outplanting date. For example, carcass-recovery data for females outplanted on August 16, 1993, should have been compared to carcass-recovery data for WR females recovered after that date so that the comparison involved only females alive (theoretically) on August 16.

Outplanting-related mortality appeared to occur only in 1994, when 29% and 7% of the outplanted and WR females, respectively, that were recovered had not spawned (Table B1). Assuming the analysis was not biased, 22% (29% minus 7%) of the outplanted females died due to outplanting-related causes.

Appendix B. Continued.

Table B1. Spawning success of chinook salmon females outplanted into the Stolle Meadows reach of the South Fork Salmon River and females released at the South Fork Salmon River weir, 1992-1994.

Year	Release group	Percent that made redds among those released (n)[a]	Percent that made redds among those accounted for (n)[b]	Percent that had spawned among those recovered (n)[c,d]
1992	outplants	74 (100)	93 (80)	75 (24)
	weir	61 (623)		74 (159)
1993	outplants	72 (100)	97 (74)	98 (42)
	weir	70 (890)		93 (154)
1994	outplants	44 (27)	71 (17)	71 (14)
	weir	62 (104)		93 (44)

[a] This measure is a minimum estimate for outplanted females, and a maximum estimate for females released at the weir. Any redd upon which no female, or an untagged female, was observed was attributed to a female released at the weir. Redds made by untagged females that could be identified as having lost their tags were exceptions.

[b] Females that were "accounted for" were observed on a redd and/or recovered.

[c] This measure was used to compare the spawning success of outplanted females to that of females released at the weir.

[d] Includes only those mortalities whose condition could be determined.

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