FISHERY RESEARCH

CARCASS DISTRIBUTION OF OUT-PLANTED AND WEIR-RELEASED ADULT SUMMER CHINOOK SALMON IN THE SOUTH FORK SALMON RIVER, 1995-1997

Project Completion Report

Report Period January 1, 1995—December 31, 1997

Jeff Abrams
Senior Fisheries Technician

Peter F. Hassemer
Principal Fisheries Research Biologist

IDFG Report Number 03-43
July 2003

Carcass Distribution of Out-planted and Weir-Released Adult Summer Chinook Salmon in the South Fork Salmon River, 1995-1997

Project Completion Report

By

Jeff Abrams
Peter F. Hassemer

Idaho Department of Fish and Game
600 South Walnut Street
P.O. Box 25
Boise, ID 83707

To

U.S. Fish and Wildlife Service
Lower Snake River Compensation Plan Office
1387 S. Vinnell Way, Suite 343
Boise, ID 83709

Cooperative Agreement
14-48-0001-96503

IDFG Report Number 03-43
July 2003

TABLE OF CONTENTS

Page

LIST OF TABLES

List of Tables, continued.

Page

LIST OF FIGURES

List of Figures, continued.

Page

LIST OF APPENDICES

ABSTRACT

In return years 1995-1997, we out-planted (tagged, transported, and released) adult summer chinook salmon Oncorhynchus tshawytscha that were trapped at a weir operated by the McCall Fish Hatchery on the South Fork Salmon River. This effort was initiated in 1992 to restore a more normative spawner distribution in the upper South Fork Salmon River. Out-planted fish were relocated 13 km upstream to the Stolle Meadows area of the South Fork Salmon River, an historically important production area. In 1996 and 1997, we also released hatchery-produced and naturally-produced adult salmon directly above the weir to volitionally migrate and spawn. Each year, fish were differentially tagged to distinguish adult release strategy. We conducted spawning ground surveys and recorded the location of recovered female chinook carcasses to identify spawning locations and to establish spawner fidelity to adult release location.

Carcass recoveries indicated that most out-planted females remained in or above the Stolle Meadows area in all years, with a maximum dispersal rate of 25% in 1995. During spawn years 1995-1997, proportions of carcasses recovered from out-planted females that had migrated out of the Stolle Meadows area were 25%, 0%, and 18%, respectively. In only one year (1997) did any out-planted females migrate downstream to their juvenile release location to spawn in the area within 1.6 km of Knox Bridge. Carcass recoveries of marked (hatchery-produced) females passed above the weir and allowed to volitionally migrate were heavily concentrated in the area of their release as juveniles—between Knox Bridge and the weir. Carcass recoveries of unmarked (naturally-produced) females passed above the weir indicated higher rates of dispersal than for hatchery-produced and out-planted females. Our data indicate that out-planting efforts have been effective in increasing the numbers of spawners in the Stolle Meadows area of the South Fork Salmon River that would have otherwise been utilized to a much lesser degree.

Authors:

Jeff Abrams
Senior Fisheries Technician

Peter F. Hassemer
Principal Fisheries Research Biologist

INTRODUCTION

Summer chinook salmon *Oncorhynchus tshawytscha* broodstock for the McCall Fish Hatchery program, which is operated under the guidance of the Lower Snake River Compensation Plan, are collected at a trapping facility east of Cascade, Idaho, on the South Fork Salmon River (SFSR), (Figure 1). This trapping facility has been in operation since 1980. Initial broodstock collections for production at the McCall Fish Hatchery were made at Little Goose (1975-1978) and Lower Granite (1979-1980) dams, as well as the upper South Fork Salmon River (1980 to present).

Each year, a proportion of the adult return has been passed above the weir and allowed to spawn naturally. The number and relative proportion of hatchery-produced and naturally-produced adults designated for release, where distinguishable, have through time been adjusted to satisfy Idaho Department of Fish and Game (IDFG) fish management objectives and have evolved to accommodate federal guidelines relating to the Endangered Species Act (ESA). Since the 1995 adult return year, hatchery-produced adults developed to fulfill mitigation responsibilities associated with the Lower Snake River Compensation Plan have been recognized as such by the presence of an external fin clip. Prior to 1995, only a portion of all fish produced to meet mitigation responsibilities were externally marked, so adults passed over the weir were an unknown aggregate of marked hatchery, unmarked hatchery, and naturally-produced returns.

In 1990 and 1991, Sankovich and Bjornn (1992) found that most hatchery-produced adults released above the weir spawned within 1.6 km upstream or downstream of their juvenile release site at Knox Bridge, approximately 1.6 km upstream of the SFSR trapping facility. Only 13% and 8% of redds constructed above the weir were located in the Stolle Meadows area in 1990 and 1991, respectively. This reach is approximately 13 km upstream of the weir and historically supported most of the spawning activity in the upper SFSR. The authors concluded that historic spawner distribution had been altered subsequent to operation of the McCall Fish Hatchery satellite facility.

In 1992, the IDFG began transporting and releasing (out-planting) adult summer chinook salmon to the Stolle Meadows area of the SFSR. This action was implemented to restore spawning in this historically important but underutilized production area. This initiative continued through return year 1997. During this period, rack returns of naturally-produced and hatchery-produced summer chinook salmon were passed directly over the weir in proportions consistent with IDFG management objectives and current National Oceanic and Atmospheric Administration (NOAA) Fisheries Section 10 permitting protocols. Spawning ground surveys were conducted from the ground each year to monitor and evaluate out-planting operations.

Sankovich and Hassemer (1999) described findings relating to prespawn mortality, fidelity to adult release site, and spawn success of out-planted fish for spawn years 1992-1994 (Phase I evaluations). Out-planting operations and evaluations continued in return years 1995-1997 (Phase II evaluations). During this period, fidelity to adult release location and spawn efficiency of recovered carcasses were recorded for out-planted fish and compared to similar data collected for fish that were passed directly over the SFSR weir. Findings for Phase II evaluations are presented in this report.

METHODS

Snorkel Surveys

In 1995, an unknown number of adult summer chinook salmon were suspected to have escaped upstream of the weir on the SFSR before installation was complete. A snorkel survey was conducted on July 11 to estimate abundance and distribution of adults that had potentially migrated upstream of the weir. Three snorkel teams of two people each surveyed approximately 80% of the stream from the Stolle Meadows area downstream to the trapping facility. Selection of snorkel sites was based on prior knowledge of the habitat within the study area typically used by staging fish. In return years 1996 and 1997, no snorkel surveys were conducted.

Releases of Fish

Adult summer chinook salmon trapped at the SFSR weir were transported approximately 13 km upstream to the Stolle Meadows area in return years 1995-1997 (Figure 1). In these years, 85 (35 females), 73 (32 females), and 92 (46 females) fish were out-planted, respectively (Table 1). In all three years, these fish were selected from the two facility raceways and from the trap itself (before ponding) based on arrival timing of individuals and IDFG supplementation and anadromous management objectives. In return years 1995-1997, adults began arriving at the SFSR weir on July 15, July 11, and July 8, respectively.

In addition to out-planted fish, 102 fish (including 19 females) and 257 fish (including 193 females) were released immediately upstream of the weir in 1996 and 1997, respectively (Table 1). All releases of unmarked fish occurred immediately after trapping. Releases of marked fish occurred immediately after trapping (released from trap box) or following ponding. No fish were released directly upstream of the weir in 1995 due to low escapements.

Adult returns to this basin during Phase II of the study were sufficient to allow most out-plants to occur during the targeted period of mid-August each year when females were relatively close to spawning. Prior to release, fish were tagged with small Tyvek®-style plastic tags, uniquely numbered and fixed with a stainless steel staple to the opercle, as opposed to previous years when Petersen disc tags were used (Sankovich and Hassemer 1999). Fish were selected for release and transported to the Stolle Meadows area using the same criteria established during the first phase of the study (Sankovich and Hassemer 1999). All fish were out-planted in the second week of August at the Stolle Meadows viewing platform (Table 1, Figure 1). Fish transport and release protocols were similar to those described in the Phase I study report (Sankovich and Hassemer 1999). As in the Phase I study, Phase II investigations focused on the distribution of female summer chinook salmon.

Spawner Surveys

Spawner surveys were designed to establish a baseline date within each year, when redd construction had been initiated by natural spawners within the out-planted and weir-released populations. Each survey was conducted in accordance with guidelines established by Sankovich and Bjornn (1992) and described in the IDFG Chinook Salmon Redd Count Manual (IDFG 1993). The physical boundaries of the study area remained exactly as established during the Phase I investigation (Sankovich and Hassemer 1999). Redd locations and their degree of completion were noted. Location and gender of live fish and recovered carcasses were

recorded, as well as opercle-tag retention and spawning condition (% spawned/unspawned). All redd and spawning observations for this study were made using ground surveys.

In 1995, preliminary redd scouting surveys were initiated in the expanded Stolle Meadows area (study units 5-11) on August 15 and August 22 after most of the out-planting had been completed. Study units 4-7 were also walked on August 22 (Figure 1). Comprehensive redd surveys were conducted in all study units on August 29 and August 30 by four different surveyors. Additional comprehensive redd surveys were conducted in all study units on September 8. In 1996, spawning surveys began on July 30. From July 30 through August 20, the study area was surveyed on a weekly basis. The entire study area (study units 1-12) was surveyed three times per week during the period of significant spawning, from August 20 to September 6. A final survey was conducted on September 12. In 1997, spawning surveys were initiated on July 23. Intensive surveys were conducted between August 12 and September 5, when the entire study area was covered twice each week. A final survey was conducted on September 15. In each year, no live females were observed on the final survey date.

Data Analysis

Based on rationale described by Sankovich and Hassemer (1999), only spawning distributions and carcass recoveries of females (out-planted and weir-released) were used to evaluate out-planting success. Numbered Tyvek® opercle tags were generally not identifiable on live fish during redd construction. Accordingly, fish were identified, by tag number, after carcasses were recovered. Therefore, only data from carcass recoveries were used to evaluate out-plant success.

We determined out-planting success using criteria that we modified from Phase I of the study. An expanded definition of the Stolle Meadows area, to include an additional 3.2 km of habitat downstream of the boundary between study units 6 and 7, was used in the Phase II study. Habitat available to spawners from the Stolle Meadows area downstream to the boundary between study units 4 and 5 (upstream of the area referred to as the canyon) was designated as the lower Stolle Meadows area (study units 5 and 6), (Figure 1). Carcasses from out-planted adults that were recovered within study units 5 and 6 were regarded as successful out-plants, since they did not migrate downstream to the area of less desirable spawning habitat following release (e.g., from the weir through the canyon; study units 1 through 4).

RESULTS

In 1995 and 1996, 307 and 1,199 summer chinook salmon, respectively, were trapped at the SFSR weir. In 1997, a record high 3,659 fish were trapped (Table 2). From 1995 through 1997, a total of 61, 78, and 264 redds, respectively, were counted upstream of the SFSR weir (Table 3, Figure 2). The proportion of redds located upstream of study unit 5 in these years was 75%, 67%, and 52%, respectively. The proportion of redds located in the section of stream from the weir upstream to the beginning of the canyon (study units 1 and 2) in each year was 15%, 28%, and 39%, respectively (Table 4).

In spawn years 1995-1997, the proportion of out-planted females recovered that successfully built redds and spawned ranged from 90%-96%. Only one of ten female carcasses

recovered in 1995 had not spawned. In 1996, one of 13 females recovered had not spawned. In 1997, one of 28 females recovered had not spawned (Table 5).

Of the females out-planted in spawn years 1995-1997 that were known to have spawned, a minimum of 75% and a maximum of 100% remained in or above the lower Stolle Meadows area (upstream of the boundary between study units 4 and 5). Up to 25% of the female carcasses recovered in these three years had migrated out of the expanded Stolle Meadows area (1995 = 25%, 1996 = 0%, 1997 = 18%), (Table 5).

Ten carcasses were recovered out of 33 out-planted females in 1995. No female carcasses were recovered within 1.6 km of their adult release site; however, six of eight recoveries remained in the Stolle Meadows area (specific recovery locations for two other tagged females were not recorded). Two females did leave the Stolle Meadows area (study units 7 through 11) and were recovered in the lower Stolle Meadows area (study units 5 and 6). The highest proportion of out-planted females that were recovered within 1.6 km of their adult release site occurred in 1996, when recovery of carcasses within the area of out-planting was 79% (13 of 32). In 1997, 32% (9 of 28) of carcasses were recovered within 1.6 km of the adult release site (Table 6).

1995 Activities

The SFSR adult weir installation was delayed two to four weeks compared to previous years due to high stream flows (McPherson et al. 1995). The trap was opened on June 21 of the 1995 migration season. However, weir installation did not occur until July 11 when one-third of the pickets were in place. The remaining pickets were installed on July 15. No adult chinook salmon were observed during snorkel surveys in 1995. However, McCall Fish Hatchery personnel observed six to eight fish staging approximately 300 m upstream of the weir on July 10, indicating that some level of unintended adult escapement had occurred (J. Patterson, IDFG, personal communication).

Three hundred seven adult summer chinook salmon were trapped from the time the trap was functional to the final day of weir operation on September 12. This total included 99 females, 107 males, and 101 jacks. Hatchery personnel categorized jacks at the time of trapping as males <67 cm fork length. The first fish were trapped on July 11 (three fish). The peak seven-day arrival period occurred between July 20 and July 26 when 126 fish entered the facility. The total number of fish that arrived by the peak day (July 23) was 142. The final day any fish were trapped was September 4 (two fish).

Eighty-five fish (35 females, 40 males, and 10 jacks) were out-planted into the SFSR at the Stolle Meadows viewing platform site between July 20 and September 12. Of these, 73 fish were opercle tagged, including 33 females, 33 males, and seven jacks (no immediate mortalities resulted from the tagging procedure). All out-planted females were transported on August 10. As previously mentioned, no fish were passed directly over the weir in 1995.

We counted 61 completed redds within the study area between August 15 and September 8. Fifty percent of these had been completed by August 29 with the balance completed by September 8. Seventy-five percent of observed redds were located in the expanded Stolle Meadows area or upstream (study units 5 through 12), and 15% were observed in the section from the weir upstream to the beginning of the canyon (study units 1 and 2), (Table 4).

A total of 62 carcasses were recovered: 24 fish (10 females, 13 males, and one jack) that were tagged or had lost their tags, 21 untagged (escaped) fish (nine females, seven males, and five jacks), and 17 fish (two females, four males, one jack, and 10 of undetermined sex) whose tagging disposition could not be determined (Table 6, 7, Figure 3). Of the 21 untagged carcasses recovered, 14 were adipose fin-clipped, two were ventral fin-clipped (one left, one right), four were not clipped (two four-year-olds and two jacks), and the fin clip disposition of one carcass could not be determined (badly decomposed). Seventy-five percent (six of eight) of carcass recoveries of tagged, out-planted females and 78% (seven of nine) of carcass recoveries of untagged, out-planted females occurred in the expanded Stolle Meadows area (study units 5 through 11), (Table 6, 7, Figure 3, 5). Specific recovery locations for two tagged females that were recovered were not recorded. One of these carcasses was a prespawn mortality, and the other was located between study units 4 and 7. Two carcasses from out-planted females were recovered in the canyon stretch (study units 3 and 4), and no carcasses within this group were recovered within the weir to canyon reach (study units 1 and 2).

1996 Activities

The installation of the SFSR adult weir was delayed in 1996 due to high stream flows. Weir installation was complete on July 10 (McPherson et al. 1996). A total of 1,199 summer chinook salmon were trapped through the final day of operation on September 5. This total included 181 females, 280 males, and 738 jacks. Following the pattern observed in 1995, 18 fish were trapped the day operations began, suggesting that some level of unintended adult escapement occurred prior to the completion of the weir installation. The peak seven-day arrival period occurred between July 22 and July 29 when 482 fish entered the facility, or 40.2 % of the run. The total number of fish that arrived by the peak day (July 25) was 737. The final day any fish were trapped was August 30.

Seventy-three fish were transported upstream and released into the SFSR at three sites in the Stolle Meadows area (study sites 7 through 11) on August 9 and August 13, all of which were opercle tagged. Releases included 32 females, 29 males, and 12 jacks. One hundred two fish were released directly upstream of the weir. These fish were also tagged and included 19 females, 60 males, and 23 jacks (Table 1).

We counted 78 complete redds within the study area between July 30 and September 5. Fifty percent of these had been completed by August 29. Sixty-seven percent of the redds observed were located in the expanded Stolle Meadows area or upstream (study units 5 through 12), and 28% were observed in the section from the weir upstream to the beginning of the canyon (study units 1 and 2), (Table 4).

Seventy-seven carcasses were recovered during spawner surveys (25 females). Thirteen female carcasses were from out-planted fish; six females were recovered from weir releases, and 21 carcasses were from fish that had never been tagged (six females, six males, and nine jacks). The tagging disposition could not be determined for four of the carcasses. All carcasses of out-planted females (13 of 13) were recovered within or upstream of the expanded Stolle Meadows area (study units 5 through 12), (Figure 6), and 33% of the weir-passed female carcass recoveries (two of six) occurred in this same area (Table 6, 8, Figure 3). No female carcasses from out-planting efforts were recovered within the weir to canyon reach or in the canyon itself.

1997 Activities

Stream flow during the spring/summer period of 1997 was similar to 1995 and 1996. The weir installation on the SFSR was complete on July 7. A total of 3,659 summer chinook salmon were trapped through the final day of operation on September 10. This total included 1,598 females, 2,016 males, and 45 jacks (McPherson et al. 1997). Thirty-one fish were trapped on July 8, once again indicating that an unknown proportion of the return had likely migrated upstream of the weir prior to the time that installation was complete. The peak seven-day arrival period occurred between July 15 and July 22 when 1,545 fish, or 42.2% of the run, entered the facility. The total number of fish that arrived by the peak day (July 16) was 581. The final day any fish were trapped was September 2.

Forty-six females and 46 males were transported upstream and released into the SFSR at the Stolle Meadows viewing platform site on August 12 and 14. All out-planted fish were opercle tagged and had right ventral fin clips. A total of 451 fish were released directly upstream of the weir. These fish were also opercle tagged and included 193 females and 258 males.

We counted 264 complete redds within the study area between August 4 and September 15. Fifty percent of these had been completed by August 28. Fifty-two percent of these redds were located in the expanded Stolle Meadows area or above (study units 5 through 12), and 39% were observed from the weir upstream to the beginning of the canyon (study units 1 and 2).

Three hundred ninety-three carcasses were recovered during spawner surveys (159 females, 217 males, five jacks, and two whose sex could not be determined). Twenty-eight carcasses were from out-planted females, 104 were from weir-released females, and 80 carcasses had never been tagged (27 females, 48 males, and three jacks, two unknown sex). The tagging disposition could not be determined for ten of the carcasses (Figure 6, Table 9, Figure 3). Eighty-two percent (23 of 28) of carcasses from out-planted females were recovered within or upstream of the expanded Stolle Meadows area (study units 5 through 12), (Figure 7). Thirty-nine percent (41 of 104) of the weir-passed female carcasses were recovered in this same area (Table 9). Three of 28 carcasses from out-planted females were recovered within the weir to canyon reach (study units 1 and 2) and two within the canyon itself (study units 3 and 4). Sixty-eight percent and 34% of the total number of female carcasses recovered between the weir and the canyon (study units 1 and 2) from the weir-released group were of hatchery- and natural-origin, respectively. Forty-four percent (12 of 27) of the female carcasses recovered from fish suspected to have escaped upstream of the weir prior to installation also occurred in this area (Table 9).

DISCUSSION

During the first phase of this study, Sankovich and Hassemer (1999) reported that in the three return years of 1992, 1993, and 1994, 83% to 91% of the out-planted females known to have spawned did so in the Stolle Meadows area of the SFSR. Migration out of the Stolle Meadows area was comparable for Phase I and II components of the investigation (e.g., 9%-17% for Phase I compared to 0%-25% for Phase II). However, dispersal of adults from the adult release location was greater in two of three years of the Phase II work compared to results from Phase I. Proportions of carcasses that were recovered within 1.6 km of their adult release site ranged between 0%-79% in these years, whereas in the years from 1992-1994, Sankovich and

Hassemer (1999) found that 75%, 45%, and 60% of out-planted adults remained within 1.6 km of their out-planting site, respectively. While this finding is noteworthy, it should not detract from the fact that most female out-plants during the Phase II study remained in the expanded Stolle Meadows area or upstream (study units 5 through 12).

No carcasses from out-planted females were recovered within the weir to Stolle Meadows area in 1995 or 1996. The only year that out-planted females were recovered near their juvenile release location at Knox Bridge was 1997 (11%). However, more than three times as many redds were observed that year compared to surveys conducted in 1995 and 1996 (Table 5), suggesting displacement of out-planted females potentially occurred due to increased spawner densities.

Overall, fidelity rates of out-planted females in 1995-1997 were comparable to the rates observed in 1992-1994. During Phase I of this study, Sankovich and Hassemer (1999) found that 3%-8% of out-planted females migrated downstream to spawn in the area near Knox Bridge. Even with slightly lower observed rates of fidelity in 1997, less than 4% (3 of 83) of all female carcasses recovered in study units 1 and 2 had been out-planted.

Adults that were passed directly above the weir in 1997 again demonstrated the previously documented trend for females to return to and spawn within 1.6 km of their juvenile release site. This was the only year that both hatchery-produced and naturally-produced females were passed directly above the weir. Of all the carcasses recovered from female spawners that were trapped and released above the weir (either passed directly upstream of the weir or transported to the Stolle Meadows area), 91 were hatchery-produced. Forty-six of these carcasses were recovered in study units 1 and 2. Only three of these 46 carcasses were from fish that had migrated back downstream after having been released in the Stolle Meadows area (Figure 7, 8).

Hatchery-produced adults exhibited the same tendency as naturally-produced adults to return to the area of their origin or juvenile release site. Spawn year 1997 was the first year that age-4 and age-5 progeny from the first out-planted fish in 1992 and 1993 could have returned to the SFSR. As such, any unmarked fish passed above the weir in 1997 and allowed to seek out spawning habitat could have been produced within the Stolle Meadows area. Of the carcasses recovered from hatchery-produced fish that were passed directly over the weir in 1997, 68% were found within 1.6 km of Knox Bridge, the location of their juvenile release site. In contrast, only 34% of the carcasses were recovered within 1.6 km of Knox Bridge from naturally-produced fish released immediately upstream of the weir. Redd distributions of spawners in the 1992 and 1993 brood years were heavily skewed towards study units 1 and 2 (Sankovich and Hassemer 1999), suggesting that most naturally-produced fish that were passed above the weir probably originated from spawning events that occurred in the area of Knox Bridge. However, naturally-produced adults returning in 1997 from 1992 and 1993 spawn years tended to disperse more evenly throughout the upper SFSR, possibly indicating that: 1) spawner capacity in the historically marginal spawning habitat near the weir and Knox Bridge may have been exceeded, or 2) out-planted spawners in 1992 and 1993 that did take advantage of higher quality habitat available within Stolle Meadows area may have experienced higher egg-to-fry survival relative to adults that spawned in study units 1 and 2.

This study was not designed to evaluate the factors that influence the distribution of adults. However, as chronicled in the evaluation of Phase I, the maturation status of out-planted adults most likely plays an important role in determining the degree of fidelity fish exhibit to their adult release location. The possibility exists that adult dispersal from release locations would

have been higher in Phase I of this study if fish had been out-planted earlier. As such, all out-plants during the Phase II study (1995-1997) occurred during the middle of August, approximately 10 days prior to the peak of spawning.

Reingold (1975) and Kramer (1981) described factors that could potentially influence the dispersal (degree and magnitude of movement from out-plant site) of out-planted adult steelhead trout *O. mykiss*. In addition to the factors discussed by these authors, river flow during staging and spawning periods could also affect adult displacement. Mean stream flows measured at the Krassel Guard Station (approximately 50 km downstream of the weir) for the month of June in water years 1991-1993 (spawn years 1992-1994) were 336 cfs, 1,760 cfs, and 462 cfs, respectively. In 1995-1997, however, corresponding mean June flows were 2,307, 2,611, and 2,321 cfs, respectively. Higher flows may have influenced the dispersal pattern observed in 1995-1997. It is interesting to note that during the 1992-1994 study, dispersal rates were highest in the year that near-normal flows were observed (1993). In that year only 45% of females spawned within 1.6 km of their adult release site compared to the low flow years of 1992 and 1994 when 75% and 60% spawned within the same area, respectively. These data suggest that elevated flows may contribute to increased rates of adult dispersal.

In addition to the desire to minimize dispersal rates and prespawn mortality, mid-August out-plant release timing was selected to maximize spawn time synchrony between out-planted and weir-released adults (e.g., out-planted adults were initially ponded while weir-released adults were passed over the weir immediately after being trapped). In years 1995 and 1996, spawner densities were not sufficient to determine whether differences in spawn timing occurred. Although actual spawn timing of out-planted females (on redds) was not documented in 1997, the collection timing of post-spawn carcasses recovered from out-planted females was similar to the collection timing of weir-released and non-handled (escaped) females (Figure 4).

In 1995, all fish released from the trapping facility were transported to the Stolle Meadows area of the river; no fish were passed directly over the weir. Therefore, the number and location of redds observed upstream of the weir should have resulted directly from spawning events of adults that were out-planted in the Stolle Meadows area. Thirty-five females were out-planted to this location in 1995. Accounting for prespawn mortality (approximately 10%) and assuming zero unintentional escapement upstream of the weir, we estimated that out-planted females would construct between 25-30 redds, mostly within 1.6 km of the release site. However, the number of redds observed (61) and the fact that they were widely distributed supported our hypothesis that substantial escapement of untrapped adults had occurred. This supposition prompted us to examine the issue of unintended weir escapement as it pertained to our goal of re-establishing a more normative spawning distribution in the study area (e.g., Stolle Meadows area). Therefore, we attempted to quantify unintended escapement using the two methods described in Appendix A. Obviously, had redd production as correlated to out-plant behavior been used as a mechanism to evaluate the success of the study, the issue of unintended escapement would have confounded our evaluation. However, since the measure of carcass recoveries was used instead, results of the evaluation were not compromised by the presence of spawners in the study area that had not been handled at the weir.

Our estimates of unhandled escapement upstream of the weir appear reasonable using either recovery rates of female carcasses or arrival timing graphs. From run years 1983 to 1987, an average of 23% of returning adults had been trapped by July 15. From 1988 to 1994, an average of 52% of the run had arrived by that same date. Using arrival-timing graphs, we estimated that 61-77 individuals escaped upstream of the trap in 1995, 179 in 1996, and 131 in 1997. The discovery of carcasses that had never been opercle tagged explained much of the

disparity between the number of out-planted fish expected to construct redds and the actual number of redds observed during these three years. Redd counts during this period supported our supposition that females had moved upstream of the weir before installation or managed to negotiate the weir following installation. These suspicions were substantiated after spawning ground surveys were completed. Accounting for prespawn mortality and including unintended weir escapement, we estimated that approximately 58, 60, and 251 females were responsible for constructing redds upstream of the weir from 1995 to 1997, respectively.

Several limitations are associated with evaluating carcass recovery information. In order to use carcass recoveries to evaluate the success of the out-planting program, we assumed that recovery rates were uniformly impacted by external factors throughout the study area such as post-mortem predation and human disturbance. We also assumed that structural debris and other hydrologic conditions affected carcass transport and recovery rates equally. The timing and frequency of spawning ground surveys and retention rates of opercle tags could also affect the quality of the data collected. Ideally, surveys should be conducted as frequently as possible.

RECOMMENDATIONS

1) Continue to monitor use of traditional upper South Fork Salmon River spawning habitat by summer chinook salmon.

2) Develop an implementation plan to transport wild/natural summer chinook salmon adults to the Stolle Meadows area of the South Fork Salmon River if spawning habitat use by weir-passed adults falls below management expectations. Any out-plant planning should consider potential impacts on other IDFG management activities (e.g., Idaho supplementation studies project).

CONCLUSIONS

The results of Phase II of this investigation indicate that out-planting actions conducted between 1995 and 1997 were successful and contributed to summer chinook salmon utilizing traditional spawning habitat in the upper SFSR. It should be recognized that there are some tradeoffs when contemplating handling fish for out-planting efforts. The balance to strike should lie in evaluating the benefits of enabling adults to access higher quality habitat and the risks associated with this additional handling (tagging and transporting fish). The distribution and mortality of fish released at the weir immediately after trapping should remain an important consideration when making decisions concerning whether adults should be out-planted. Mortality such as predation, associated with staging time for weir-released fish, should also continue to be assessed in relation to potentially elevated mortality due to handling of out-planted fish. Prespawn mortality during 1992-1994 (Phase I) was not determined to be excessive and, therefore, supported our decision to continue studies in 1995-1997.

Table 1. Number of female chinook salmon out-planted in the Stolle Meadows area of the South Fork Salmon River and released immediately upstream of the weir from 1995-1997.

Return year	Release date	No. females out-planted (number tagged)[a]	No. Females passed above weir (number tagged)[a]
1995	Aug 10	35 (24AD, 5RV, 6 Unmk)	0
1996	Aug 9, 13	32 LV (32)	19 Unmk (19)
1997	Aug 12, 14	46 RV (46)	193 (117RV,2LV, 74 Unmk) (193)

[a] AD, LV, RV and Unmk refer to adipose, left ventral, right ventral fin clips. Unmk refers to unmarked.

Table 2. South Fork Salmon River summer chinook salmon trapping data (1995-1997).

Return year	Trapping totals	Arrival date (median)	Females trapped	Prespawn mortality (females)
1995	307	7/24	98	6.1%
1996	1,199	7/24	181	14.6%
1997	3,659	7/19	1,598	9.4%

Table 3. South Fork Salmon River summer chinook salmon redd construction data for 1995-1997. Study sections are: weir to canyon (study units 1 and 2), canyon (study units 3 and 4), lower Stolle Meadows (study units 5 and 6), upper Stolle Meadows (study units 7-11), and Vulcan Hot Springs (study unit 12 and upstream).

Return year	No. females out-planted	No. females passed above weir	Number of redds observed by study section					
			Weir to canyon	Canyon	Lower Stolle Meadows	Upper Stolle Meadows	Vulcan H.S.	Total
1995	35	0	9	6	15	29	2	61
1996	32	19	22	4	11	38	3	78
1997	46	193	103	24	37	78	22	264

Table 4. South Fork Salmon River summer chinook salmon redd counts by study unit number (1995-1997).

Study unit	1995		1996		1997	
	No. of redds [%]		No. of redds [%]		No. of redds [%]	
1	6	[10]	16	[20]	75	[28]
2	3	[5]	6	[8]	28	[11]
3	1	[2]	0	[0]	8	[3]
4	5	[8]	4	[5]	16	[6]
5	11	[18]	6	[8]	26	[10]
6	4	[7]	5	[6]	11	[4]
7	4	[7]	6	[8]	15	[6]
8	4	[7]	6	[8]	10	[4]
9	4	[7]	11	[14]	13	[5]
10	9	[15]	14	[18]	23	[9]
11	8	[13]	1	[1]	17	[6]
12	2	[3]	3	[4]	22	[8]
Totals	**61**	**[100]**	**78**	**[100]**	**264**	**[100]**

Table 5. Out-plant fidelity of summer chinook salmon females transported and released in the Stolle Meadows area of the South Fork Salmon River (1995-1997).

				Out-planted females that were recovered						
Return Year	Release Date	No. females out-planted		Total	[%]	(Percent recovered in Stolle Meadows area – study units 5-12) [Percent recovered within 1.6 km of release site – study units 8-10]		Percent of out-plants that migrated out of Stolle Meadows area	No. of female carcasses recovered and percent that spawned ( )	
1995	Aug 10	35	(33)[a]	10	[30]	75	[0][b]	25	9	(90)
1996	Aug 9, 13	32		13	[41]	100	[79]	0	12	(92)
1997	Aug 12, 14	46	(43)[c]	28	[63]	82	[32]	18	27	(96)

[a] Number of females tagged
[b] Recovery location was not noted on two of the 10 carcasses recovered
[c] Tag identifications were not recorded for three of the recovered carcasses

Table 6. Summer chinook salmon carcass recovery summary for females out-planted in the Stolle Meadows area of the South Fork Salmon River (1995-1997).

Reach	Study unit	1995 No. of females recovered [%]		1995 No. of opercle-tagged females recovered [%]		1996 No. of females recovered [%]		1996 No. of opercle-tagged females recovered [%]		1997 No. of females recovered [%]		1997 No. of opercle-tagged females recovered [%]	
Weir to	1	0	[0]	0	[0]	5	[20]	0	[0]	69	[38]	3	[11]
Canyon	2	1	[6]	0	[0]	1	[4]	0	[0]	14	[8]	0	[0]
Canyon	3	0	[0]	0	[0]	0	[0]	0	[0]	3	[2]	2	[7]
	4	3	[18]	2	[25]	0	[0]	0	[0]	9	[5]	0	[0]
Lower	5	5	[29]	2	[25]	1	[4]	1	[8]	16	[9]	3	[11]
Stolle	6	1	[6]	1	[13]	1	[4]	0	[0]	11	[6]	2	[7]
Upper	7	4	[22]	3	[38]	3	[12]	1	[8]	11	[6]	4	[14]
Stolle	8	0	[0]	0	[0]	2	[8]	1	[8]	7	[4]	4	[14]
	9	0	[0]	0	[0]	6	[24]	6	[46]	9	[5]	4	[14]
	10	0	[0]	0	[0]	5	[20]	3	[23]	11	[6]	1	[4]
	11	3	[18]	0	[0]	0	[0]	0	[0]	10	[5]	2	[7]
Vulcan Hot Springs	12	0	[0]	0	[0]	1	[4]	1	[8]	12	[6]	3	[11]
TOTALS		**17**[a, b]	**[100]**	**8**[a]	**[100]**	**25**	**[100]**	**13**	**[100]**	**182**	**[100]**	**28**	**[100]**

[a] Ten out-planted carcasses from females were recovered. Specific recovery location of an additional two carcasses was not recorded (both were located in Units 4-7).

[b] Two additional females were recovered for which release disposition could not be differentiated.

Table 7. Number of female summer chinook salmon carcasses recovered in 1995 from out-planted females, weir passed females, and females that escaped the South Fork Salmon River weir. Unmk, RV, and AD refer to no mark, right ventral, and adipose fin marks.

1995 Study unit	Stolle Meadows releases: No. of opercle-tagged females recovered [%]		Unintended escapement: No. of females recovered (by mark type) [%] Unmk		RV		AD	
1	0	[0]	0	[0]	0	[0]	0	[0]
2	0	[0]	0	[0]	0	[0]	1	[17]
3	0	[0]	0	[0]	0	[0]	0	[0]
4	2	[25]	1	[100]	0	[0]	0	[0]
5	2	[25]	0	[0]	1	[100]	1	[17]
6	1	[13]	0	[0]	0	[0]	0	[0]
7	3	[38]	0	[0]	0	[0]	1	[17]
8	0	[0]	0	[0]	0	[0]	0	[0]
9	0	[0]	0	[0]	0	[0]	0	[0]
10	0	[0]	0	[0]	0	[0]	0	[0]
11	0	[0]	0	[0]	0	[0]	3	[50]
12	0	[0]	0	[0]	0	[0]	0	[0]
TOTALS	8	[100]	1	[100]	1	[100]	6	[100]

Table 8. Number of female chinook salmon carcasses recovered in 1996 from out-planted females, weir passed females, and females that escaped the South Fork Salmon River weir. Unmk, RV, and AD refer to no mark, right ventral, and adipose fin marks.

1996	Weir-passed releases		Stolle Meadows releases		Unintended escapement					
	No. of unmarked females recovered [%]		No. of opercle-tagged females recovered [%]		No. of females recovered by mark type [%]					
Study unit					Unmk		LV		AD	
1	3	[50]	0	[0]	0	[0]	0	[0]	2	[100]
2	1	[17]	0	[0]	0	[0]	0	[0]	0	[0]
3	0	[0]	0	[0]	0	[0]	0	[0]	0	[0]
4	0	[0]	0	[0]	0	[0]	0	[0]	0	[0]
5	0	[0]	1	[8]	0	[0]	0	[0]	0	[0]
6	1	[17]	0	[0]	0	[0]	0	[0]	0	[0]
7	0	[0]	1	[8]	2	[66]	0	[0]	0	[0]
8	1	[16]	1	[8]	0	[0]	0	[0]	0	[0]
9	0	[0]	6	[46]	0	[0]	0	[0]	0	[0]
10	0	[0]	3	[23]	1	[33]	1	[100]	0	[0]
11	0	[0]	0	[0]	0	[0]	0	[0]	0	[0]
12	0	[0]	1	[8]	0	[0]	0	[0]	0	[0]
TOTALS	6	[100]	13	[100]	3	[100]	1	[100]	2	[100]

Table 9. Number of female chinook salmon carcasses recovered in 1997 from out-planted females, weir passed females, and from females that escaped the South Fork Salmon River weir.

1997	Weir-passed releases				Stolle Meadows releases		Unintended escapement							
	No. of unmarked females recovered [%]		No. of RV and LV clipped females recovered [%]		No. of RV clipped females recovered [%]		No. of females recovered [%]		No. of females recovered by mark type [%]					
Study unit									RV		Unmk		AD	
1	11	[27]	36	[57]	3	[11]	9[a]	[33]	3	[75]	1	33	4	[21]
2	3	[7]	7	[11]	0	[0]	3	[11]	1	[25]	0	0	2	[11]
3	1	[2]	0	[0]	2	[7]	0	[0]	0	[0]	0	0	0	[0]
4	5	[12]	0	[0]	0	[0]	3	[11]	0	[0]	0	0	3	[16]
5	5	[12]	5	[8]	3	[11]	2	[7]	0	[0]	0	0	2	[11]
6	0	[0]	4	[6]	2	[7]	3	[11]	0	[0]	0	0	3	[16]
7	3	[7]	0	[0]	4	[14]	1	[4]	0	[0]	1	33	0	[0]
8	1	[2]	0	[0]	4	[14]	0	[0]	0	[0]	0	0	0	[0]
9	4	[10]	1	[2]	4	[14]	0	[0]	0	[0]	0	0	0	[0]
10	4	[10]	3	[5]	1	[4]	3	[11]	0	[0]	1	33	2	[11]
11	3	[7]	3	[5]	2	[7]	1	[4]	0	[0]	0	0	1	[5]
12	1	[2]	4	[6]	3	[11]	2	[7]	0	[0]	0	0	2	[11]
TOTALS	41	100	63	100	28	100	27	100	4	100	3	100	19	100

[a] Clip disposition was not recorded or decipherable on one recovery

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.

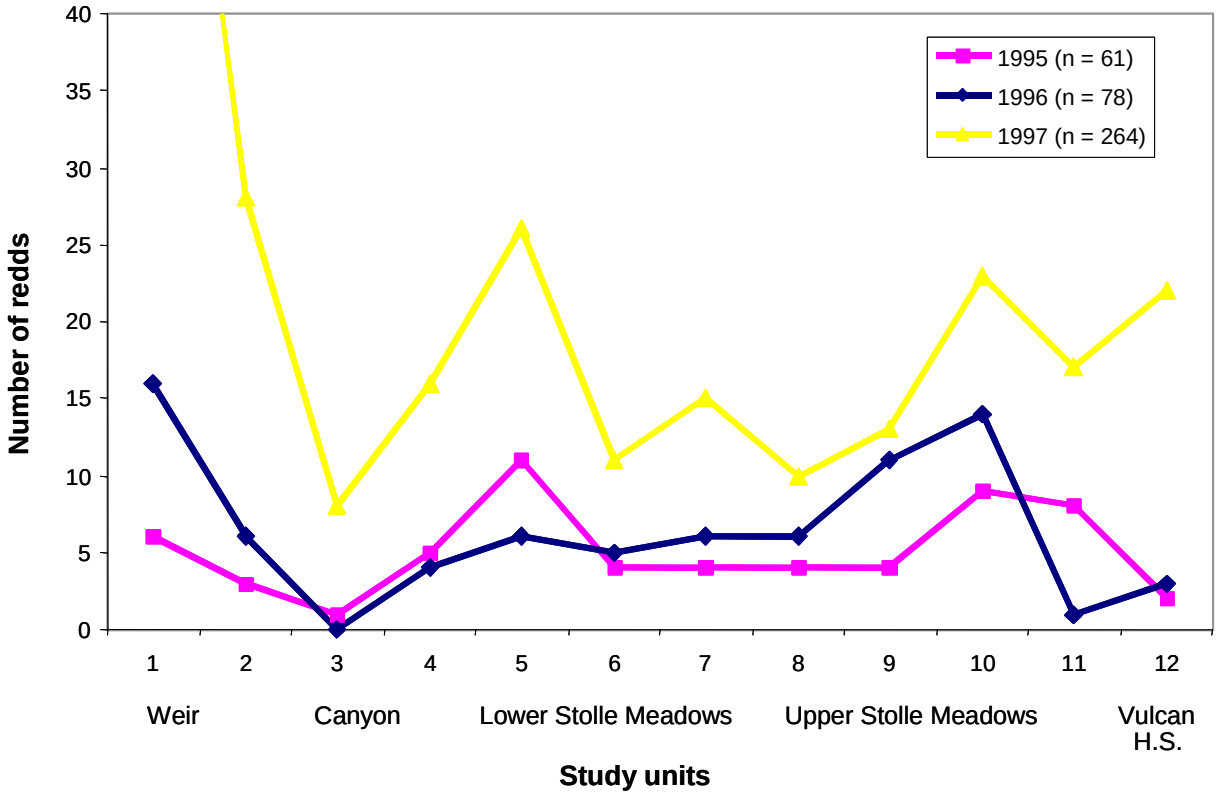

Figure 2. South Fork Salmon River summer chinook salmon redd construction data for 1995-1997. Study sections are: weir to canyon (study units 1 and 2), canyon (study units 3 and 4), lower Stolle Meadows (study units 5 and 6), upper Stolle Meadows (study units 7-11), and Vulcan Hot Springs (study unit 12 and upstream).

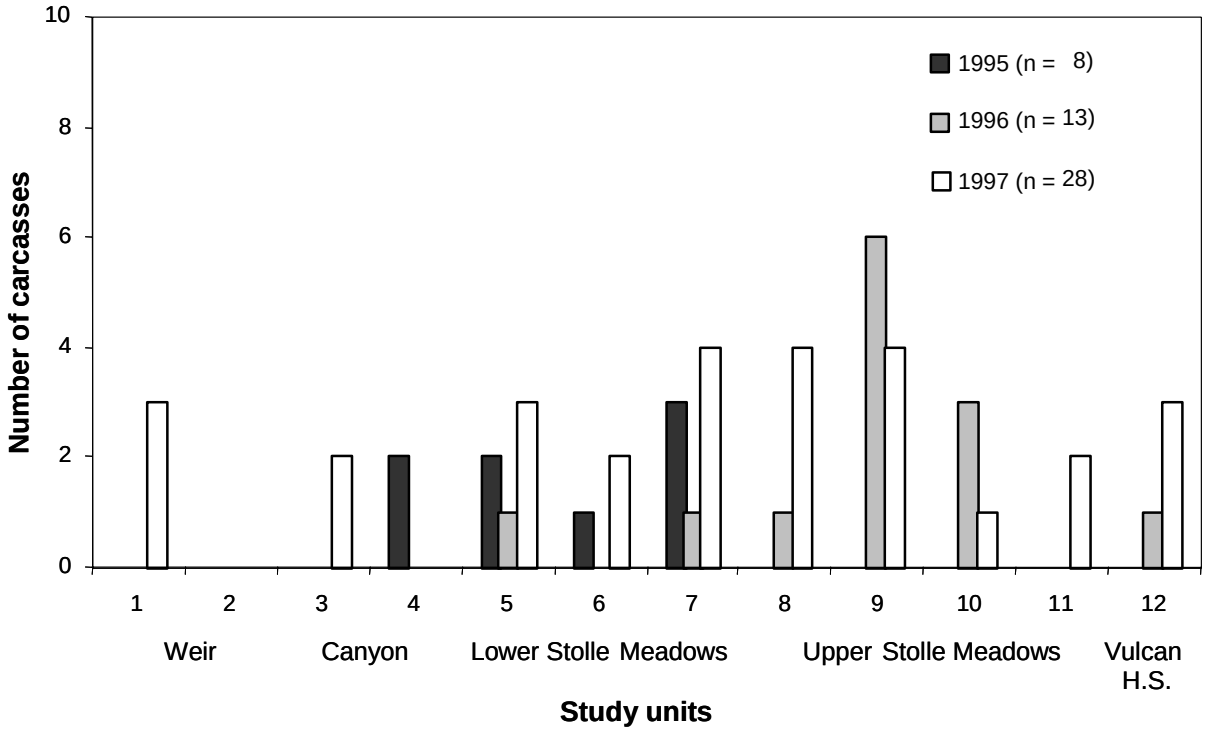

Figure 3. Summer chinook salmon carcass recovery summary for females out-planted in the Stolle Meadows area of the South Fork Salmon River (1995-1997). Study sections are: weir to canyon (study units 1 and 2), canyon (study units 3 and 4), lower Stolle Meadows (study units 5 and 6), upper Stolle Meadows (study units 7-11), and Vulcan Hot Springs (study unit 12 and upstream).

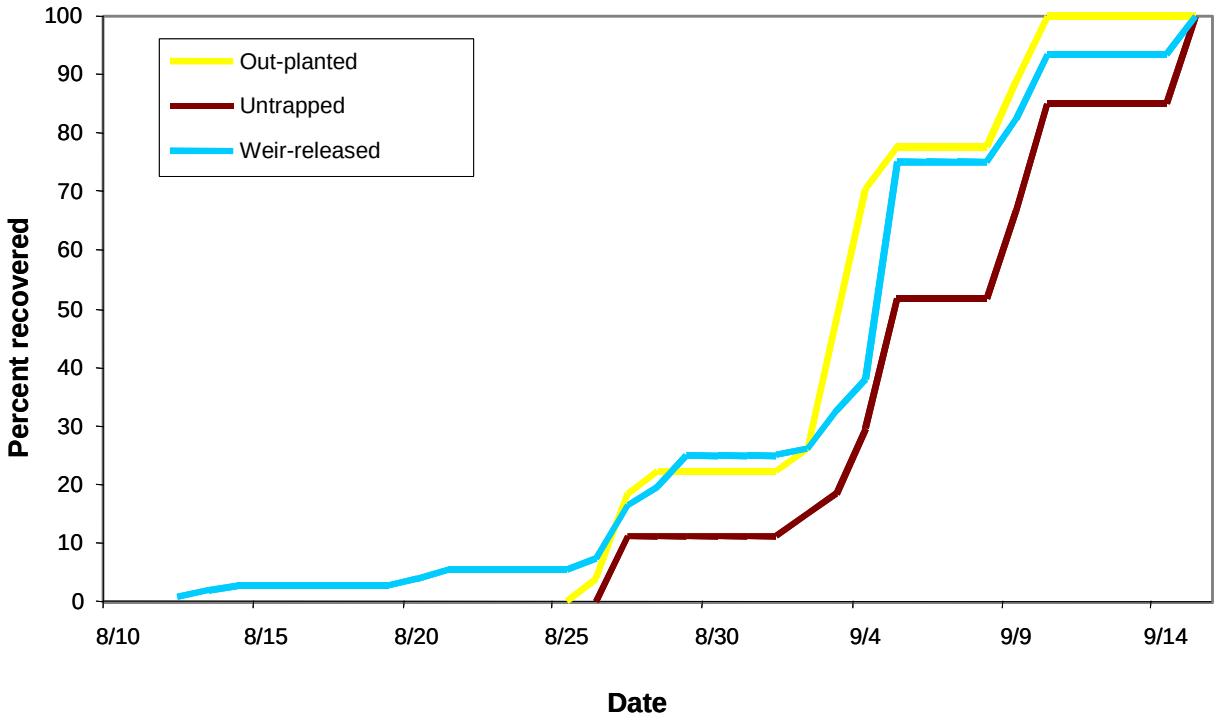

Figure 4. Recovery timing of female summer chinook salmon carcasses collected in 1997 from out-planted females, weir-released females, and females that escaped the South Fork Salmon River weir.

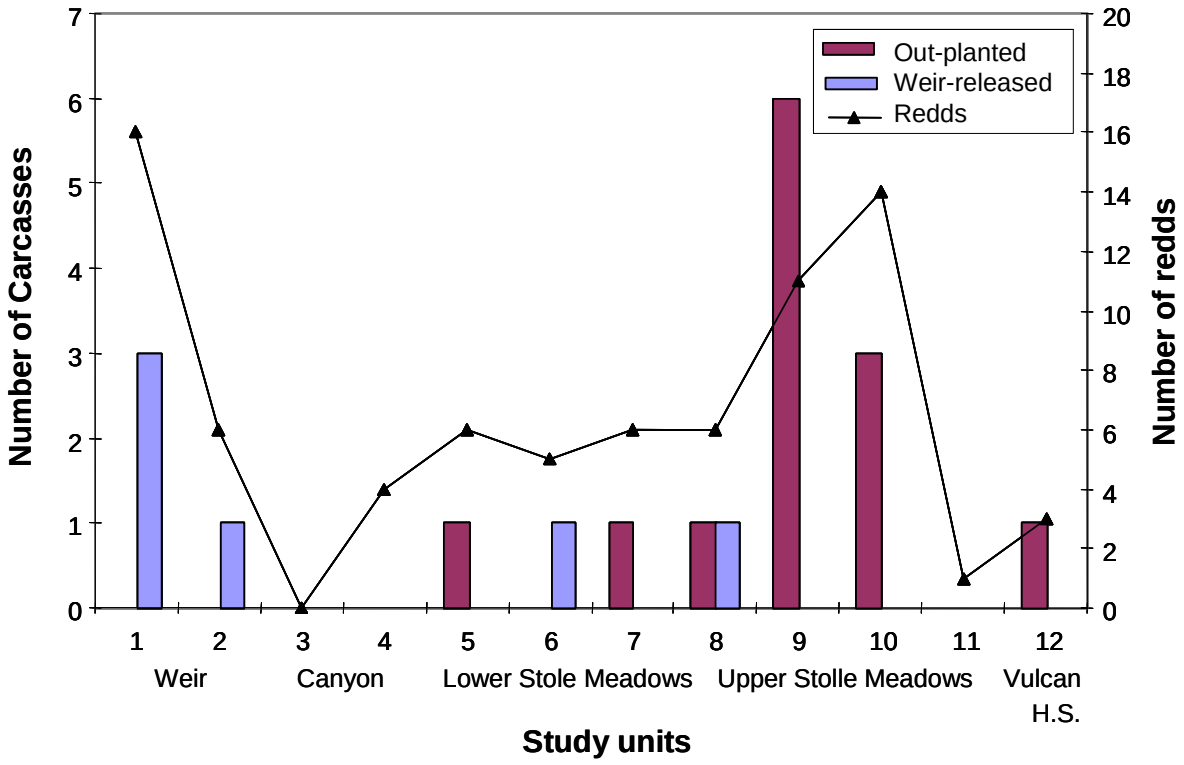

Figure 5. Recovery locations of female summer chinook salmon carcasses collected in 1996 from out-planted females and weir released females passed upstream of the South Fork Salmon River weir. The frequency and distribution of redd locations are also provided.

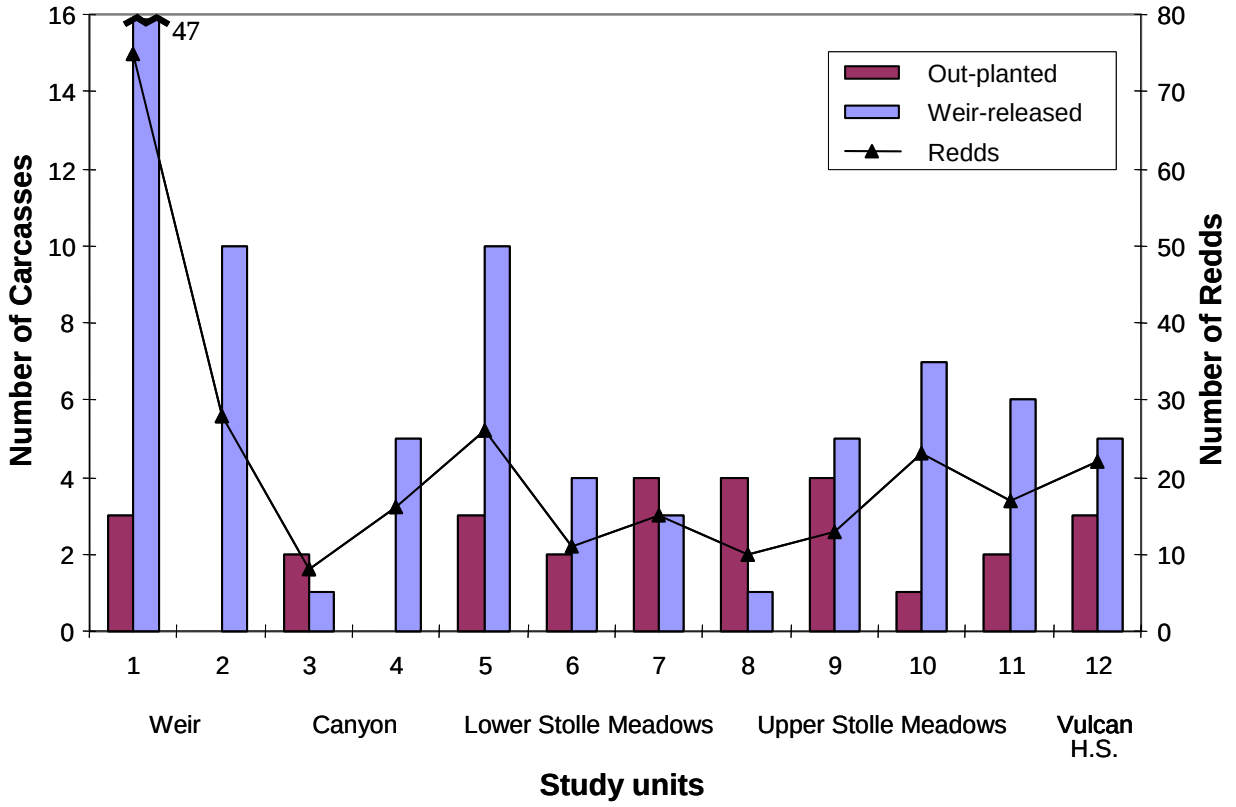

Figure 6. Recovery locations of female summer chinook salmon carcasses collected in 1997 from out-planted females and weir-released females passed upstream of the South Fork Salmon River weir. The frequency and distribution of redd locations are also provided.

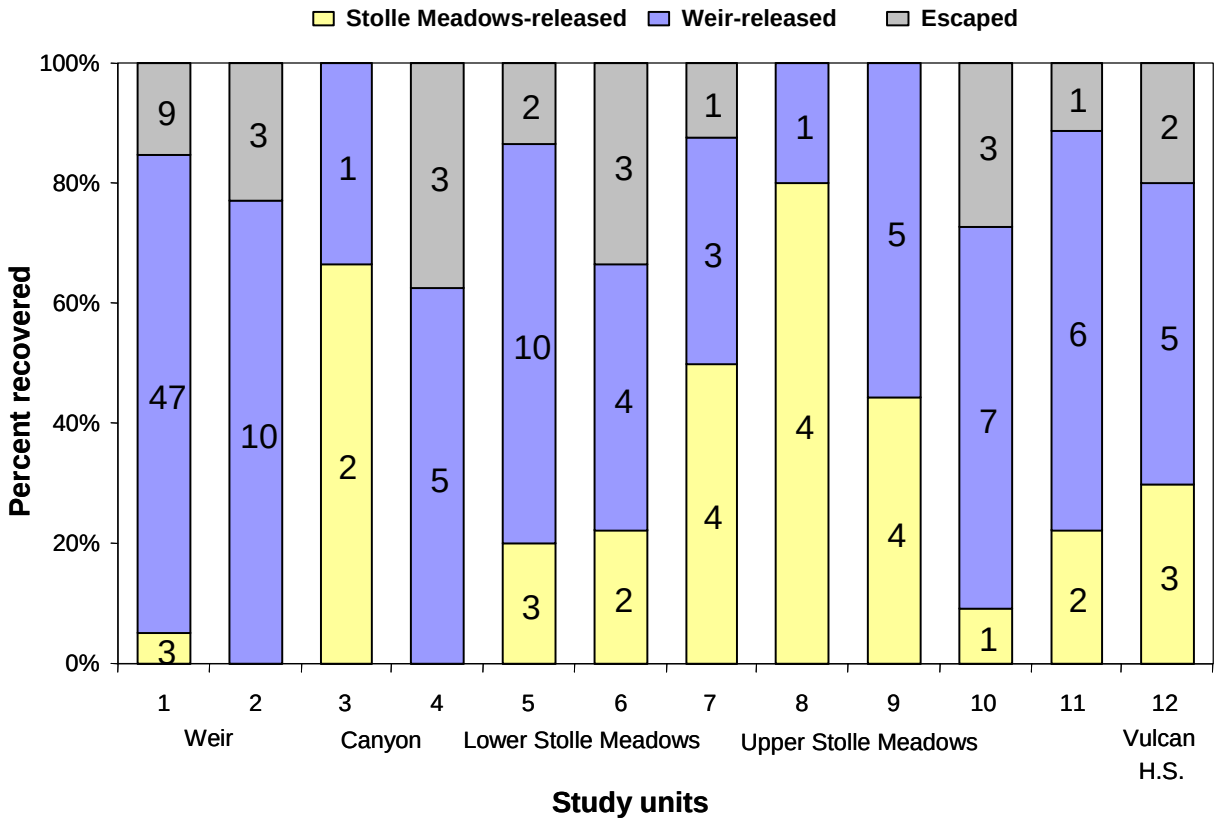

Figure 7. Recovery locations and proportions by disposition of female summer chinook salmon carcasses collected in 1997 from out-planted females, weir-passed females, and females that escaped the South Fork Salmon River weir. Numbers on bars represent actual numbers of carcasses collected.

LITERATURE CITED

Idaho Department of Fish and Game. 1993. Chinook Salmon Redd Count Manual. Idaho Department of Fish and Game, Boise, Idaho.

Kramer, D. P. 1981. Effect of smolt release location and displacement of adults on distribution of summer steelhead trout. The Progressive Fish Culturist, 43:8-11.

Lutch, J., C. Beasley, and K. Steinhorst. Evaluation and Statistical Review of Idaho Supplementation Studies, 1991-2001. Idaho Department of Fish and Game, Report #03-16, Boise, Idaho.

McPherson, D., S. Kammeyer, and D. Munson. 1995. McCall Fish Hatchery 1995 Summer Chinook Salmon Brood Year Report. Idaho Department of Fish and Game, Report #98-11, Boise, Idaho.

McPherson, D., S. Kammeyer, J. Patterson, and D. Munson. 1996. McCall Fish Hatchery 1996 Summer Chinook Salmon Brood Year Report. Idaho Department of Fish and Game, Report #98-37, Boise, Idaho.

McPherson, D., S. Kammeyer, J. Patterson, and D. Munson. 1997. McCall Fish Hatchery 1997 Summer Chinook Salmon Brood Year Report. Idaho Department of Fish and Game, Report #99-12, Boise, Idaho.

Reingold, M. 1975. Effects of Displacing, Hooking, and Releasing on Migrating Adult Steelhead Trout. Transactions of the American Fisheries Society 104:458-460.

Sankovich, P., and T. C. Bjornn. 1992. Distribution and Spawning Behavior of Hatchery and Natural Adult Chinook Salmon Released Upstream of Weirs in Two Idaho Rivers. Idaho Cooperative Fish and Wildlife Research Unit, Technical Report 92-7, Moscow, Idaho.

Sankovich, P., and P. F. Hassemer. 1999. Spawning Distribution of Adult Chinook Salmon Outplanted into the Stolle Meadows Reach of the South Fork Salmon River, 1992-1994. Idaho Department of Fish and Game Fisheries Research, Report Number #99-04, Nampa, Idaho.

Steinhorst, K., Y. Wu, B. Dennis, and P. Kline. In Press. Confidence Intervals for Fish Out-migration Estimates using Stratified Trap Efficiency Methods. Journal of Agricultural, Biological, and Environmental Statistics.

APPENDICES

Appendix A. Methods used to estimate unintended weir escapement.

We used two methods to estimate the escapement of adults above the weir prior to installation:

1) We estimated total female escapement using mark-recapture methods described by Steinhorst et al. (in press). Fish that had lost opercle tags were obvious because of staple holes or a tag-shaped discoloration on the opercle. We applied carcass recovery rates for tagged female chinook salmon to the number of untagged chinook salmon recovered from that same group. This provided an estimate of the number of females that could have migrated past the weir. We then factored in prespawn mortality (number of spawned females recovered / number of females recovered whose spawning condition could be determined) to provide an estimate of the number of females that could have constructed redds.

2) Based on the arrival timing graphs (Figure 2), we estimated the number of fish missing from the front end of what would be considered the normal arrival timing curve for this watershed. We then used arrival-timing graphs from previous years (1986-1989; 1992-1993) to determine if our estimate was reasonable.

In 1995, we estimated, based on carcass recovery rates (30.3% for females), that 34 females (95% C.I. 1 to 94) escaped the weir. We also estimated, based on arrival timing graphs and our perception of a normal distribution, that 61-77 adults (20-25% of the run), including about 25 females, 30 males, and 15 jacks, escaped the weir. Applying a prespawn mortality rate of 10% to both methods, we predicted that between 22 and 31 adult females could have escaped the weir and would have been available to construct redds. These estimations were consistent with the number of redds observed.

In 1996, we estimated that 16 females (95% C.I. 0 to 49) escaped to the spawning area before the weir was closed or after it was installed. The recovery rate for tagged female carcasses was 37.3%. Therefore, approximately 60 females would have been available to construct redds above the weir after accounting for prespawn mortality (10%).

Our second method of estimating the number of fish available to spawn above the trap site was based on run timing curves and arrival time trend data that indicate that 23% of the run passes the weir site before July 15. Using this method, we estimated that 179 adults, including 27 females, 41 males, and 111 jacks, escaped above the weir prior or subsequent to its installation. Assuming an equal rate of prespawn mortality and including the 51 out-planted females (transported plus direct release), 70 females would have been present to construct redds above the weir. In 1997, using the recovery rates of tagged carcasses (63.7% for females), we estimated that 50 females (95% C.I. 8 to 98) escaped to the spawning area before or after the weir was installed. We estimated that 279 females were above the weir during the spawning season. After accounting for 10% prespawn mortality, we estimated 251 females would have been available to construct redds.

Prepared by:

Jeff Abrams
Senior Fishery Technician

Peter F. Hassemer
Principal Fisheries Research Biologist

Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

Virgil K. Moore, Chief
Bureau of Fisheries

Dan Schill
Fisheries Research Manager