Distribution, Behavior, and Reproductive Success of Outplanted Hatchery Spring Chinook Salmon in Shitike Creek, OR

Progress Report for 2004
And
Work Plan for 2005

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Introduction

In the late summer of 2000 the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) and the United States Fish and Wildlife Service (Service) initiated an adult spring Chinook salmon (*Oncorhynchus tshawytscha*) outplanting program in Shitike Creek, a tributary of the Deschutes River located entirely within the Warm Springs Indian Reservation. Outplanting of adults was scheduled to continue for five brood years, brood years 2000-2004, with extension of the outplanting beyond 2004 dependant on an evaluation of the effectiveness of the program. The Service and the CTWSRO developed and implemented an evaluation program in 2002 to assess the outplanting program. One part of the evaluation program was designed to monitor potential impacts to juvenile fish populations in Shitike Creek. Results to date of the juvenile monitoring program are presented in Engle et al. (2005). The second component of the evaluation program was designed to evaluate the distribution, behavior, and reproductive success of outplanted hatchery spring Chinook salmon in Shitike. This report summarizes the progress made during 2004 towards meeting the study objectives.

Objective 1: Assess the distribution and behavior of outplanted spring Chinook salmon in Shitike Creek using radio-telemetry.

Objective 2: Estimate the reproductive success of natural-origin and outplanted hatchery-origin spring Chinook salmon in Shitike Creek using pedigree analyses.

Background

Shitike Creek flows approximately 61 rkm from its headwaters near Mt. Jefferson before entering the Deschutes River at rkm 155 (Figure 1). Shitike Creek and the Warm Springs River are the only tributaries of the Deschutes River that currently support natural spawning populations of spring Chinook salmon. Warm Springs National Fish Hatchery, located on the Warm Springs River (Figure 1), produces a hatchery run of spring Chinook salmon that supports both Tribal and sportfishing harvest opportunities in the Deschutes River and in the main-stem of the Columbia River. The hatchery is cooperatively managed by the Service and the CTWSRO to protect wild spring Chinook and steelhead (*Oncorhynchus mykiss*) populations in the Warm Springs River subbasin. As part of this management plan, the majority of returning adult hatchery fish are harvested or taken into the hatchery. Returns of wild spring Chinook salmon to a fish ladder located at Warm Springs National Fish Hatchery (rkm 16) from 1978 to 2002 averaged 1,313 fish (SD=659, range of 237 to 2,705). The density, or redds per mile, of spawning spring Chinook in Shitike Creek is much lower than in the Warm Springs River and it is thought that the habitat in Shitike Creek is under-seeded (Lindsay *et al*. 1989). A water intake dam was built on Shitike Creek (rkm 11.5) in the mid-1960's that blocked upstream movement of adult

salmon and restricted spring Chinook spawning to the lower section of the creek. The water intake dam was removed in 1983. Habitat improvements and fish passage projects have been ongoing in Shitike Creek since removal of the intake dam. Despite these efforts, natural production of spring Chinook salmon in the drainage remained at relatively low levels. Between 1986 and 1999, indexed redd counts in Shitike Creek ranged from a low of six in 1996 to a high of 33 in 1997 (CTWSRO unpublished data; Figure 2).

Shitike Creek also supports a population of summer steelhead that is part of the Mid-Columbia ESU listed as a threatened species, resident rainbow trout (*Oncorhynchus mykiss*), and bull trout (*Salvelinus confluentus*) that are part of the Columbia River distinct population segment listed as a threatened species. The CTWSRO have monitored summer steelhead populations in Shitike Creek since the early 1990's and bull trout populations since 1998 (Brun and Dodson 2001; CTWSRO unpublished data). Summer steelhead appear to spawn and rear throughout the lower 40 rkm of the creek while bull trout spawn and rear primarily in the upper sections of the creek, above approximately rkm 30 (Brun and Dodson 2001). Based on spring Chinook indexed redd counts and snorkel surveys conducted by the CTWSRO, spring Chinook primarily spawn and rear in habitats below rkm 40, in approximately the same distribution as summer steelhead.

During the summer of 2000 the Service and the CTWSRO initiated an adult outplanting program. The outplanting program is designed to boost the spawning population of spring Chinook salmon in Shitike Creek by releasing adult hatchery spring Chinook salmon, which returned to Warm Springs National Fish Hatchery and were held in the hatchery brood ponds, into Shitike Creek just prior to the spawning period. The hatchery has a broodstock collection goal of 630 spring Chinook salmon for normal hatchery operations. In 2000, the hatchery began holding approximately 200 additional hatchery spring Chinook salmon for the outplanting program. Returning hatchery fish are collected for broodstock and outplanted proportionately throughout the run based on wild Warm Springs River stock run-timing (Warm Springs NFH Operational Plan 2002-2006). During spawning days at the hatchery, usually in late August and early September, the CTWSRO loads fish for outplanting into an aerated tank truck and hauls them to one of five sites on Shitike Creek (Figure 3). The hatchery fish are released into the stream and are allowed to spawn naturally.

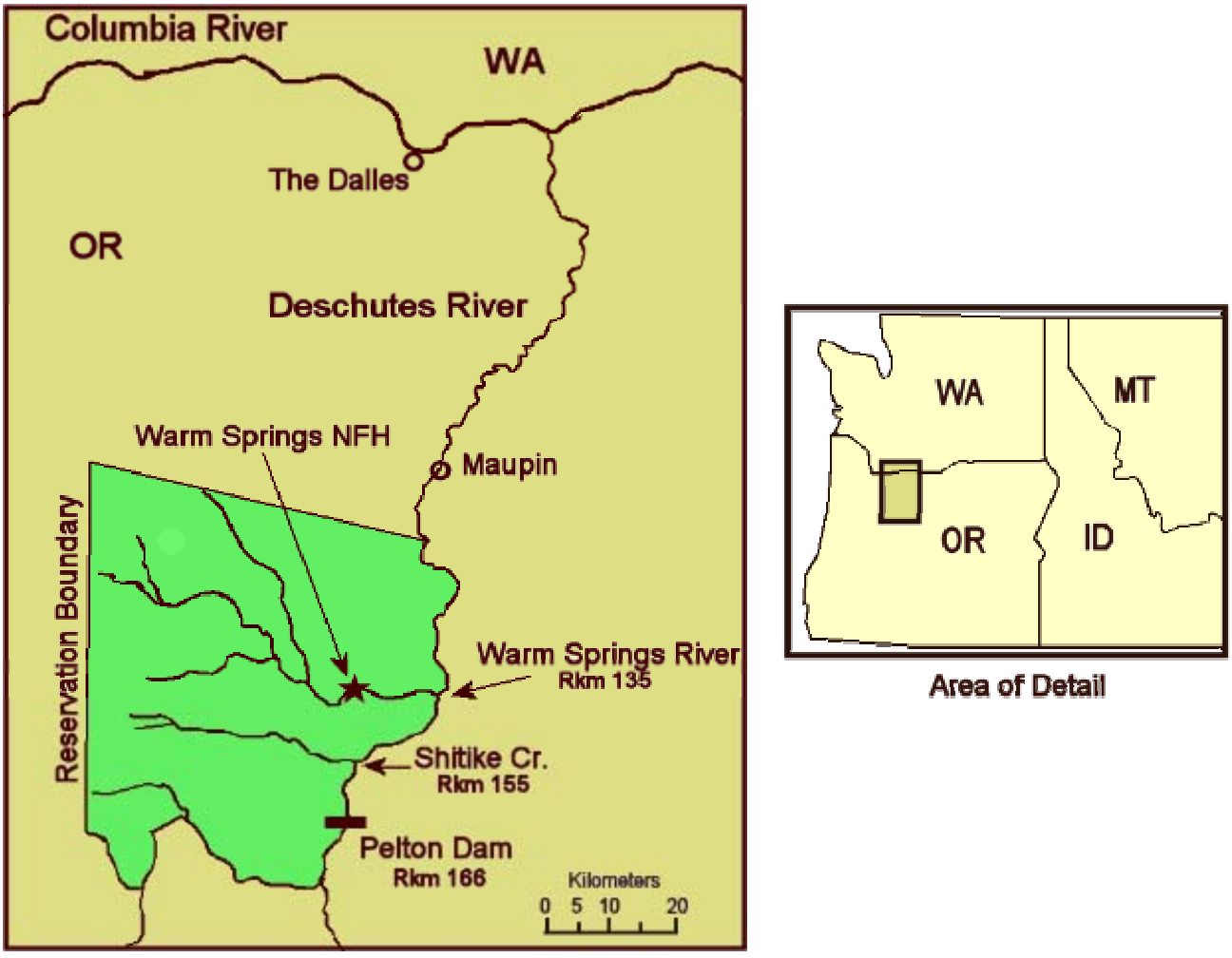

Figure 1. Map of Shitike Creek, the Warm Springs River, Warm Springs National Fish Hatchery, and boundaries of the Warm Springs Indian Reservation.

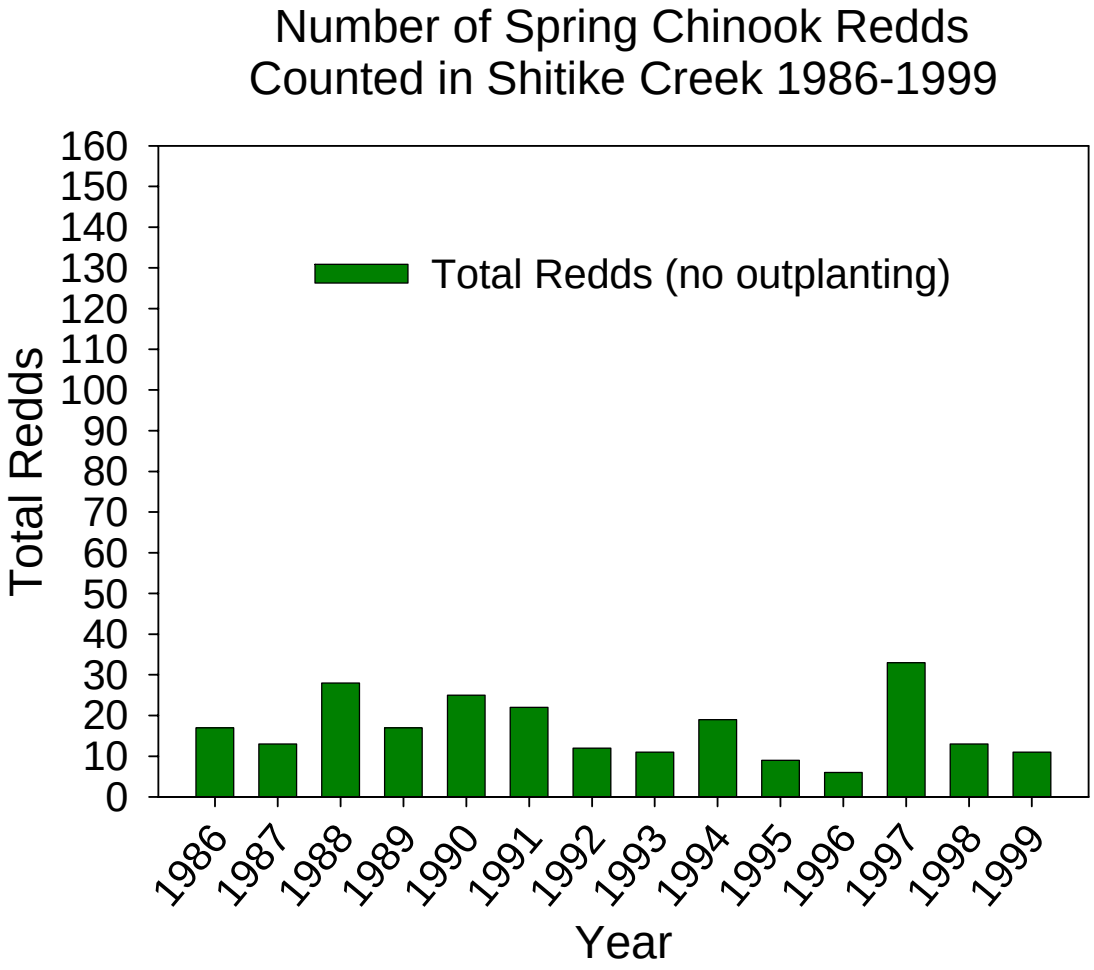

Figure 2. Number of redds counted in Shitike Creek 1986-1999 (CTWSRO unpublished data).

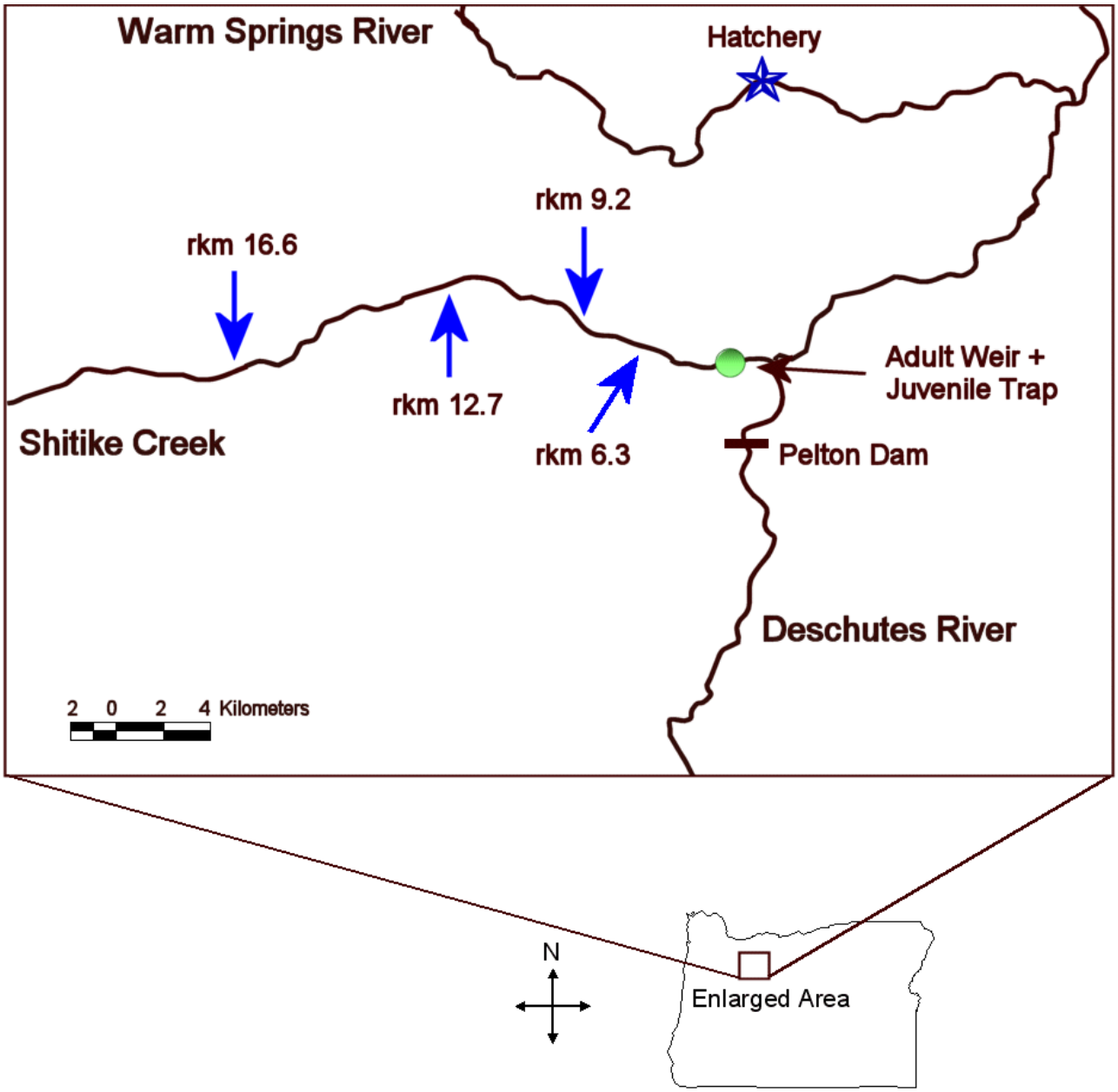

Figure 3. Outplanting locations, location of the adult weir and juvenile trap, and the location of Warm Springs NFH. The outplanting location at rkm 40 (Peter's Pasture) is not shown on this map.

In 2000, a total of 159 hatchery spring Chinook salmon were released at five outplant sites in Shitike Creek. The five sites were selected by the CTWSRO based on access considerations and an estimation of available spawning habitat in different reaches of the creek. The five outplant sites, shown in Figure 3, are located at rkm 6.5 (Thompson's Bridge), rkm 9.2 (Headworks), rkm 12.7 (Bennetts), rkm 16.6 (Upper Crossing),and rkm 40 (Peter's Pasture). The goal of the program is to annually release 200 hatchery spring Chinook salmon into Shitike Creek, although the actual number outplanted has varied according to returns to the hatchery and broodstock needs. Since hatchery broodstock fish and fish for outplanting are collected throughout the run, the sex-ratio of the outplanted fish reflects the sex-ratio of returning Warm Springs River hatchery fish.

The contribution of the outplanted hatchery fish to the spawning population is not known but it is assumed that some of the outplanted fish successfully spawned. Outplanted hatchery fish are selected from hatchery fish at Warm Springs National Fish Hatchery, whose life history traits closely mimic those of the wild population in the Warm Springs River (Olson and Spateholts 2001). The spawning success of hatchery spring Chinook salmon from the Warm Springs hatchery in the natural environment is not known. Several studies have shown a difference in performance and behavior between wild and hatchery adult fish (Reisenbichler and Rubin 1999). Burgert *et al*. (1991) reported that wild spring Chinook adults behaved differently from hatchery adults in the Tucannon River and selected spawning sites further upstream than hatchery fish. Since salmon mating is non-random, any differences in aggressiveness, size, spawning time, or other life history trait between hatchery and wild fish could potentially limit the amount of interbreeding (Quinn 1997). A monitoring and evaluation program has been developed to evaluate the outplanting program in Shitike Creek and provide information on the morphological, behavioral, and life-history characteristics of both the outplanted hatchery fish and natural-origin fish. In addition, genetic analysis techniques have been developed to estimate the reproductive success of hatchery fish outplanted into the natural environment.

Methods

Shitike Creek Outplanting

Warm Springs National Fish Hatchery has an annual broodstock collection goal of 630 spring Chinook salmon for normal hatchery operations and 200 spring Chinook salmon for the Shitike Creek outplanting program. Returning hatchery fish are collected proportionately throughout the run, based on wild Warm Springs River stock run timing, for the hatchery broodstock (Warm Springs NFH Operational Plan 2002-2006). In past years, fish for outplanting in Shitike Creek were selected from the hatchery brood ponds and therefore reflected the age, sex, and run-timing of the hatchery broodstock population (see Hand *et al.* 2004). In 2004, fish used in the outplanting program were selected from a different population than the hatchery brood population.

A portion of the hatchery's brood year 2000 production was used as part of a hatchery-wild performance and stock productivity study conducted by the Western Fisheries Research Center of the U. S. Geological Survey (USGS) and funded by the Bonneville Power Administration (Project No. 90-052). The goal of the study is to investigate differential survival between hatchery and wild spring Chinook salmon. As part of the study, crosses of hatchery x hatchery, hatchery x wild, and wild x wild parents were placed into three raceways and reared at Warm Springs National Fish Hatchery. The study fish were externally marked with an adipose and left ventral (ADLV) fin-clip so they could be distinguished from standard (adipose only clipped) hatchery fish. A total of 93,257 study fish were reared at the hatchery and released into the Warm Springs River. The rearing and release of the study fish did not differ from standard rearing and release practices at the hatchery (Warm Springs NFH Operational Plan 2002-2006). As adults from the study releases returned to the hatchery they were hand sorted (by ADLV fin-clip) and tissue samples were collected. The parental crosses of the returning study fish will be determined by genetic analyses of the tissues samples. When the returns from brood year 2000 are completed the survival rate of the various crosses will be compared.

Study fish from the 2000 brood returned to the hatchery in 2004 as four-year-old adults. Following discussion among the Service, CTWSRO, and the USGS a plan was developed to use the four-year-old returning adults from the differential survival study, identified by having an ADLV fin-clip, as the primary source of fish for the Shitike Creek outplanting program in 2004. Outplanting adult fish of different parental crosses (hatchery x hatchery, hatchery x wild, and wild x wild) into the stream will provide an opportunity to determine if behavior and reproductive success in Shitike Creek is influenced by parental origin. The goal of the hatchery in 2004 was to collect and hold in the brood ponds 200 ADLV fin-clipped fish for outplanting and 630 adipose only clipped for normal broodstock purposes.

On days when fish were outplanted, hatchery staff sorted fish in the hatchery brood ponds and selected ADLV clipped fish for outplanting. Selected fish were crowded (2-8 fish at a time) into a hydraulic basket filled with water and a mixture of MS-222 anesthetic and buffer solution. Once fish were anesthetized, the hydraulic basket was raised up and fish were sent, one at a time, to a measuring table. All outplanted fish were measured, a small fin-clip was collected for a genetic sample, the right operculum was given a small hole punch, and a colored floy-tag was attached to the dorsal fin. Fish that were not radio-tagged were immediately placed into a 300 gallon, aerated tank-truck operated by the CTWSRO. The total time that fish were out of the water for measuring and floy-tagging was less than 45 seconds. Approximately 30 fish per load were trucked from the hatchery to an outplanting location.

Adult Radio-Telemetry

A sub-sample of the outplanted fish were affixed with radio-transmitters in order to track their movements upon release into the stream. Radio-tagging was weighted towards females in a three to one female to male tagging ratio so that the probability of finding a fish on a redd was maximized. Coded radio-transmitters (Lotek Wireless; model MCFT-3CM), weighing 6.7 grams and having an estimated operational life of 65 days were used for this study. Fish selected for radio-tagging were processed in the same manner as fish that were not radio-tagged, except a floy-tag was not attached. Once the fish was measured and a fin sample was taken, the fish was placed, dorsal side up, in a v-shaped aluminum holder. The holder had a plastic covering at one end that draped over the head of the fish and helped calm the fish while the radio-transmitter was attached. Radio-transmitters were externally attached just below the anterior portion of the dorsal fin, with the antenna directed posteriorly (Nigro and Ward 1985). Two septum-surgical needles were used to thread a narrow-gauge wire through the base of the dorsal fin and through holes drilled in the radio-transmitter. The needles were pulled through and two red Peterson disk-tags were threaded on the wire. The protruding end of the wire was then twisted to secure the radio-transmitter against the fish's dorsal fin (Figure 4).

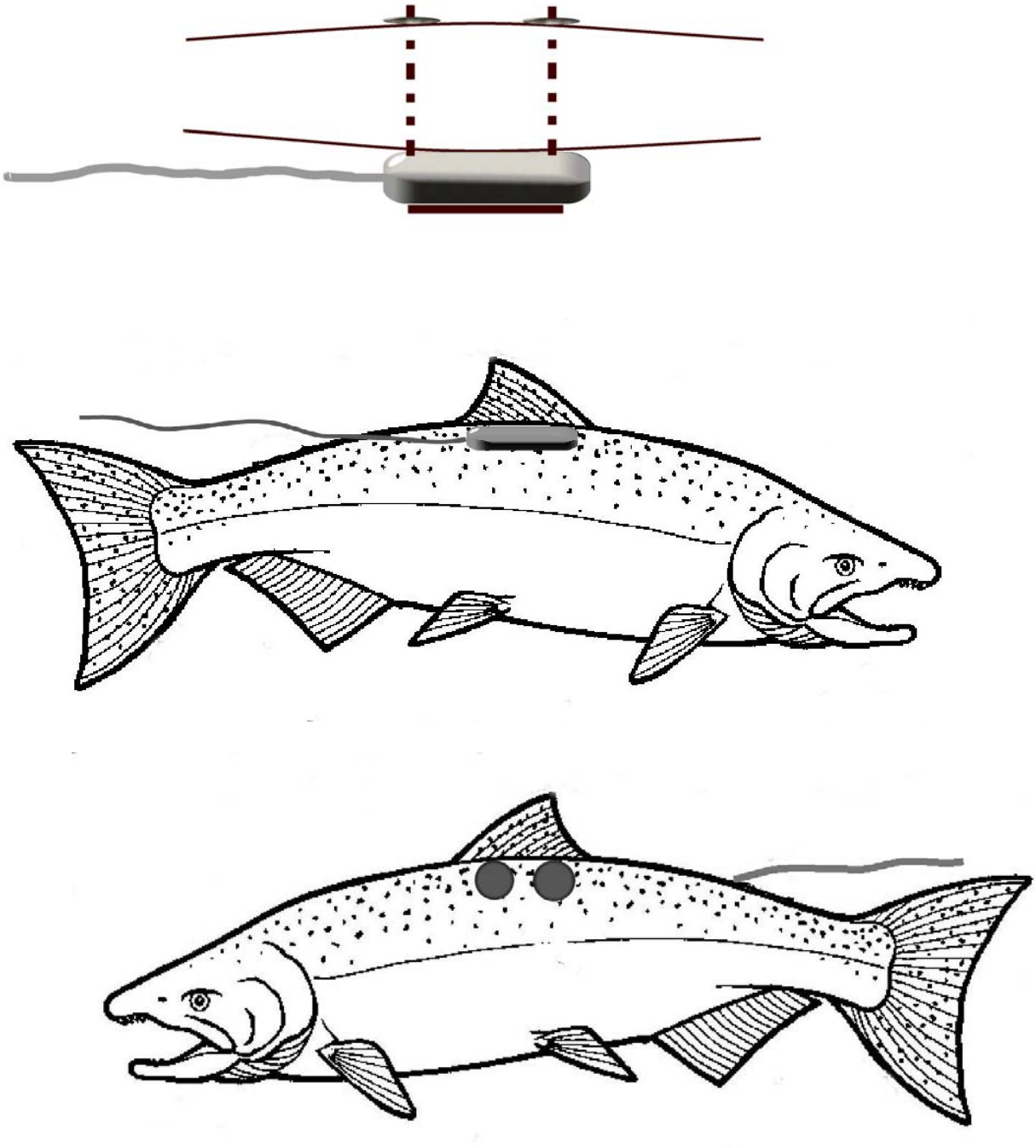

Figure 4. Overhead, right, and left side view of radio-transmitter attachment. Radio-transmitters were Lotek Wireless model MCFT-3CM. A narrow gauge wire was threaded through holes drilled in the transmitter and then through the base of the dorsal fin and two Peterson disk-tags on the other side of the fish.

Once the tank truck was loaded with approximately 30 fish, the fish were transported to one of the five outplant locations and released into the stream (Figure 3). Fish were released into the stream by attaching a flexible tube to the back of the tank truck and flushing the water out of the tank truck. Outplanting occurred during the morning hours, when water temperatures were lower, in order to reduce stress on outplanted fish.

One telemetry fixed-site station was set up near the mouth of Shitike Creek (rkm 0.5) in order to monitor movement of radio-tagged fish out of Shitike Creek. A second fixed-site station was placed on top of a canyon wall at approximately rkm 21 in order to record fish moving between the lower and upper sections of the creek. The fixed-site stations consisted of a four-element Yagi antenna mounted in a tree approximately 15 feet above the creek and a Lotek SRX-400 continuous data-logging receiver (W7 Firmware). A solar-panel battery-charging system was used to power the upper site while the lower site was powered by an extension cord running from the Warm Springs Forest Products building. Mobile tracking of tagged fish occurred two to three days per week using a foldable three-element Yagi antenna and a Lotek SRX-400 receiver (W5 Firmware). Sections of the stream, ranging from 2-8 km in distance, would be walked by a pair of surveyors during tracking days. Radio-tagged fish were mobile tracked in order to determine movement from outplant sites, redd locations, and fish behavior. When possible, fish locations were triangulated and visual observations of radio-tagged fish were recorded. Approximate locations of fish were recorded using a Garmin eTrex Vista handheld GPS unit, when coverage was available, and recorded on a map.

If a fish was located actively using or near a redd, redd locations were recorded and flagged. The origin, sex, and behavior of any other spring Chinook salmon in the vicinity of the radio-tagged fish was also recorded. In situations where a visual observation of the fish was not possible, fish position was estimated and no behavior was recorded. Radio-tagged fish were tracked until the fish was presumed to have died. An attempt was made to recover carcasses of radio-tagged fish and estimate the extent of spawning based on gamete retention. The extent of spawning was classified as either spawned out, partially spawned out, unspawned, or unknown. Mobile tracking and fixed-station monitoring began on August 27th, the first outplanting day, and finished on September 14th, when all radio-tagged fish were presumed to have died. During outplanting days, fish were tracked immediately upon release in order to determine the time it took fish to begin migrating away from the release location or initiate spawning activity.

The distance that a radio-tagged fish traveled from an outplant site was estimated using GPS coordinates or by estimating the fish location on a map and interpolating between known distances. Median travel distances were calculated for radio-tagged fish based on sex, outplant location, and outplant time. Due to unequal variances between samples, distances were compared using the Kruskal-Wallis single factor analysis of variance.

Adult Weir and Reproductive Success

A genetic monitoring program designed to evaluate the reproductive success of outplanted hatchery-origin and natural-origin spring Chinook salmon in Shitike Creek has been developed in cooperation with the Service's Conservation Genetics Lab in Abernathy, WA. Details of the monitoring program's initial sample design can be found in the 2002 and 2003 Progress Reports and Work Plans. Initially, genetic samples from natural-origin adult spring Chinook salmon were to be collected at an adult weir located near the mouth of Shitike Creek. Problems with weir placement, water flows and temperatures, and operational constraints during the 2001 to 2003 sampling seasons led to a small and unrepresentative sampling of natural origin fish. In 2004, emphasis was shifted from attempting to handle and collect genetic samples from natural origin fish in Shitike Creek to accurately estimating the population size of the natural spring Chinook salmon population. In 2004, the location of the adult weir was again moved to a new location. The weir was placed below a footbridge adjacent to the offices of Warm Springs Forest Products Industries, approximately 1 rkm upstream from the confluence with the Deschutes river. The weir was a picket design with upstream and downstream live-boxes (Figure 5). The operational plan called for the weir to be fished Monday through Friday. On weekends or when daytime water temperatures exceeded 17 degrees Celsius, the ends of the live boxes were removed and fished were able to move upstream or downstream without being trapped. Once stream temperatures consistently rose above the 17 degree threshold a video-camera system was installed in the live boxes. The video-system was designed to take digital images of fish as they passed through the weir. The camera system consisted of a SpalshCam Deep Blue Pro Color underwater camera that was connected to a Sanyo Digital Video Recorder DSR-3000. Two underwater pond lights were attached to the underside of the live-box top to provide lighting during nighttime hours. Video images captured on the video recorder were reviewed and the number of fish passing upstream and downstream was recorded. The digital video recorder was equipped with a motion detection algorithm that was used to only record images in which motion (defined as a change in contrast or light level in a portion of the screen) was detected. It was thought that using the motion detection software would reduce the amount of video that would need to be reviewed.

Figure 5. Picket weir at rkm 1 on Shitike Creek. Downstream live box is pictured with the top opened for removal of fish.

In 2004, the weir was operated Monday to Friday from April 20th to June 25th, when water temperatures began to rise above the 17 degree limit. The weir was fished intermittently throughout the summer when stream temperatures dropped, although few fish were trapped during this time. The weir was again fished between September 1st and the 16th. The video system was installed on June 25th and was operated through September 1st. Problems with the video recording system made it difficult to accurately estimate the number of fish passing upstream during the summer months. Water clarity and changes in stream flow often affected the field of view of the camera and made reviewing the video and identifying fish difficult. The motion detection system was often triggered by air bubbles in the water column, changes in light level during sunrise and sunset, and by debris passing downstream. The sensitivity of the system was adjusted throughout the summer in an attempt to only record motion of fish passing by but we were unable to develop a reliable combination of settings and camera placement. On several occasions the video recorder's storage capacity was filled and images were overwritten. The 2004 counts of fish obtained by reviewing video should be considered a minimum count and it is likely that were fish that passed upstream without being recorded by the video system.

Genetic samples have been collected from all outplanted spring Chinook salmon since 2002. Prior to fish being outplanted into Shitike Creek, a fin-clip is collected from each outplanted fish and stored in individually numbered ethanol filled vials. In 2004, increased effort was put into conducting redd counts and collecting genetic samples from non-outplanted spring Chinook on the spawning grounds. Redd counts, with each count encompassing most of the known

spawning areas in Shitike Creek, were conducted on September 10th, 15th, and 24th. Genetic samples were collected from all non-outplanted carcasses that were found during the redd surveys and carcasses were classified as either wild (unmarked), ADLV fin-clipped, AD only fin-clipped, or unknown. Genetic samples from carcasses were not analyzed, however, due to problems with data recording methods. Individual vials could not be matched up with information recorded on data sheets so carcass samples were excluded from further analysis.

A rotary screw trap, located just upstream of the adult weir, was used to collect genetic samples from downstream migrating juvenile spring Chinook salmon. Juvenile spring Chinook salmon in Shitike Creek typically either emigrate out of the creek in the fall of their first year, as age 0+, or in the spring of the following year, as age 1+. The behavior of the age 0+ fall outmigrants is not entirely understood but it is believed that the majority of the fish overwinter in the Deschutes River before migrating to the ocean the following spring, although a small proportion may migrate all the way to the ocean as age 0+. In 2004, the rotary screw trap was operated five days a week, Monday through Friday, during a spring period (March-June) and fall period (September-December) to estimate the outmigration population of age 0+ and 1+ juvenile spring Chinook salmon. The outmigrant population was estimated using a mark-recapture method in which fish were marked by removing a small piece of the caudal fin and then released upstream of the screw trap. Marking occurred on Tuesdays and Wednesdays. On subsequent days, fish trapped in the live box were examined for marks.

As part of the reproductive success study, a subsample of caudal fin-clips were collected and stored in individually labeled vials containing 100% ethanol. Genetic samples were collected from 366 age 1+ spring Chinook at the rotary screw trap between March 2nd and April 29th of 2004. Another 466 samples were collected from age 0+ spring Chinook during the fall of 2003, along with 83 samples from adult outplanted spring Chinook salmon in 2002 (see Hand *et al*. 2004). Vials were sent to the Service's Conservation Genetics Lab in Abernathy, WA for analysis. Fin-clips were genotyped at 11 microsatellite loci and compared to the genotypes from adult outplanted fish in the appropriate brood year. Parentage analysis was used to determine whether none, one, or both parents of each sampled juvenile were of outplanted origin. A complete description of the genotyping methods and analysis techniques will be part of a manuscript developed by the Conservation Genetics Lab (Jason Baumsteiger, U.S. Fish and Wildlife Service, Abernathy WA).

Results

Outplanting program

A total of 171 hatchery spring Chinook salmon were outplanted in 2004 (Table 1). The goal was to outplant 200 ADLV fin-clipped fish, however 62 ADLV fish died in the brood ponds at the during the summer. Pre-spawning mortality is seen annually in both wild and hatchery populations, although the increased level seen in the brood ponds in recent years may be due to higher holding densities of fish in the ponds as fish are held for both hatchery broodstock purposes and outplanting. When it became apparent that the outplanting goal of 200 would not be met by using only ADLV fish, late arriving (after September 2nd) adipose fin-clipped fish were collected and outplanted as they came into the hatchery. A total of 137 ADLV and 34 adipose fin-clipped fish were outplanted in 2004.

Table 1. Number of hatchery spring Chinook salmon outplanted into Shitike Creek.

Year	*Male*	*Female*	*Total*
2000	49	110	159
2001	75	123	198
2002	63	20	83
2003	110	155	265
2004	76	95	171

Adult Radio-Telemetry

A total of 30 outplanted fish were radio-tagged in 2004 (Table 2). A summary of the radio-telemetry data for each individual fish can be found in Table 3. The behavior of radio-tagged fish in 2004 was similar to that in 2003. It appears that the most desirable stream habitat for outplanted fish is between rkm 12.7 (Bennetts) and rkm 16.6 (Upper Crossing) as radio-tagged fish moved upstream from the release location at rkm 12.7 and downstream of the release location at rkm 16.6 (Figure 6). Outplanted fish released at rkm 9.2 (Headworks) generally moved upstream while fish released at rkm 6.3 (Thompson) moved both upstream and downstream. The upstream movement of fish from rkm 9.2 may be due to water temperatures, as the stream just above rkm 9.2 consists of

a series of boulder cascades with deep pools and cooler water that emerges from subsurface flow. Radio-tagged males moved a greater and more variable distance than did radio-tagged females, consistent with radio-telemetry information in 2002 and 2003 (Figure 7).

Table 2. Number and location of adult hatchery spring Chinook salmon outplanted into Shitike Creek in 2004. The number of fish radio-tagged is in parentheses.

Location	*Male*	*Female*	*Total*
rkm 6.5	17 (1)	24 (6)	41 (7)
rkm 9.2	12 (2)	12 (4)	24 (6)
rkm 12.7	22 (2)	29 (5)	51 (7)
rkm 16.6	9 (1)	11 (4)	20 (5)
rkm 40.0	16 (1)	19 (4)	35 (5)
Total	76 (7)	95 (23)	171 (30)

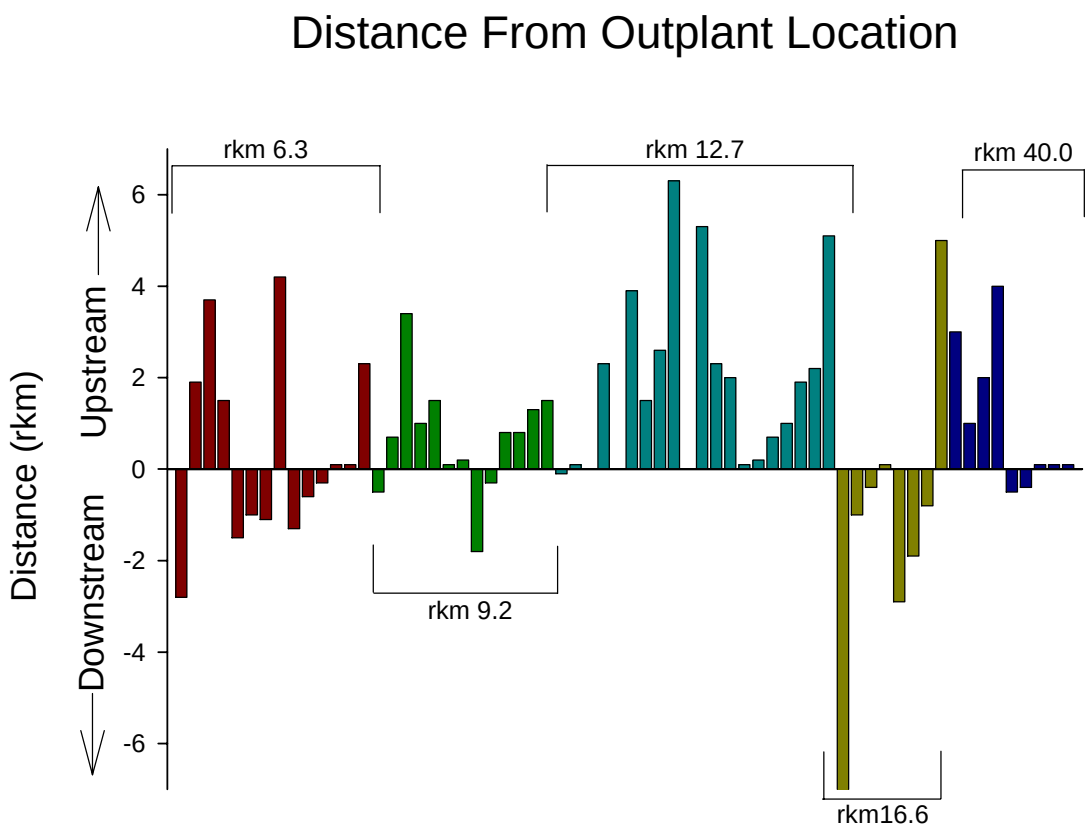

Figure 6. Maximum migration distance from outplant location of radio-tagged fish in Shitike Creek, 2003 and 2004 (n=64). Data is grouped by outplant location (rkm).

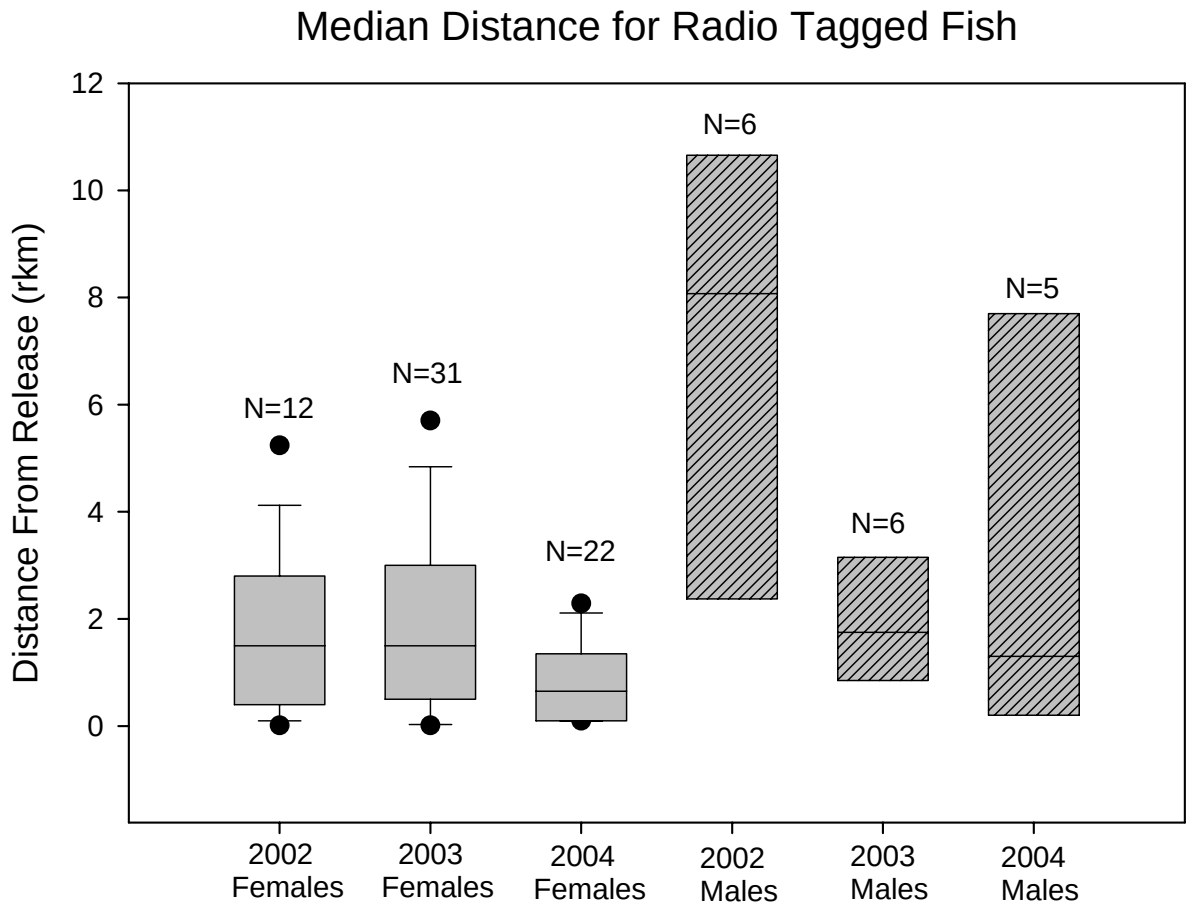

Figure 7. Median distance traveled by radio-tagged fish outplanted into Shitike Creek, 2002 to 2004. Boxes represent the 25th and 75th percentiles, whiskers represent the 10th and 90th percentiles, dots represent outliers.

Table 3. Summary of radio-telemetry information for 2004.

Code	Date Released	Release Location (rkm)	Distance Traveled (rkm)	Sex	Degree of spawning[A]	Date on Redd[B]	Days Detected	Comments
11	8/27/2004	9.2	1.3	M	U		2	carcass eaten by unknown animal
12	8/27/2004	6.3	-1.7	F	NS		3	
13	8/27/2004	9.2	-1.8	F	NS		3	
21	8/27/2004	9.2	0.8	F	NS		2	carcass recovered 20m from stream
22	8/27/2004	9.2	0.8	F	U		2	
23	8/27/2004	6.3	0.0	F	NS		1	full of eggs
51	8/27/2004	6.3	2.2	F	NS		2	
52	8/27/2004	9.2	1.5	F	U		2	
146	8/27/2004	6.3	-0.6	F	U		2	
147	8/27/2004	6.3	-0.3	M	U		1	tag recovered up on bank, no carcass
10	9/2/2004	12.7	0.2	F	S		2	
20	9/2/2004	12.7	2.2	F	U	9/8/2004	2	tag recovered up on bank, no carcass
53	9/2/2004	12.7	5.1	M	U		1	
148	9/2/2004	12.7	1.0	F	PS	9/8/2004	2	
149	9/2/2004	16.6	-10.3	M	U		1	
191	9/2/2004	16.6	-0.4	F	S		1	
196	9/2/2004	40.0	0.0	F	U		1	tag up in tree @ outplant site
198	9/2/2004	40.0	-	M	U		0	never detected
199	9/2/2004	16.6	-1.0	F	U		3	
202	9/2/2004	16.6	-1.0	F	U	9/7/2004	2	on redd with wild male
205	9/2/2004	40.0	0.0	F	NS		1	
209	9/2/2004	16.6		F	U		0	never detected
23b	9/2/2004	40.0	0.0	F	S		1	spawned out @ outplant site
51b	9/2/2004	40.0	-0.4	F	S		1	
54	9/2/2004	12.7	1.9	F	PS	9/8/2004	3	on redd with 2 wild males
203	9/8/2004	12.7	0.7	F	PS		2	
208	9/8/2004	12.7	0.0	M	U		1	likely died at outplant site
210	9/8/2004	6.3	-0.3	F	U		2	
13b	9/8/2004	6.3	-	M	U		1	tag recovered, no data recorded
147b	9/8/2004	6.3	0.0	F	U	9/9/2004	1	seen digging redd at outplant site

[A] Spawned, Partial Spawn, Not Spawned, Unknown
[B] First day detected on redd

Adult Weir and Reproductive Success

Due to the variable flows, high water temperatures, and logistical constraints found in 2004 the adult weir was not operated throughout the entire spring Chinook migration period and therefore the total number of wild or non-outplanted spring Chinook that migrated into Shitike Creek is not known. During times when the weir was operational or the video system was functioning, 104 spring Chinook salmon were counted passing upstream (Table 4). Based on carcass recovery information from redd surveys, the number of wild (unmarked) spring Chinook salmon was estimated as:

$$\text{\# of wild fish} = \frac{(\text{\# of wild carcasses recovered}) \times (\text{\# of ADLV fish outplanted})}{(\text{\# of ADLV carcasses recovered})}$$

A total of 137 ADLV fin-clipped fish were outplanted into Shitike Creek in 2004. During redd surveys, 50 wild (unmarked) and 19 ADLV fin-clipped carcasses were examined. Using these numbers, an estimated 360 wild (unmarked) spring Chinook salmon were in Shitike Creek during the redd survey period, September 10th to the 24th. An alternative method that provides a rough estimate of the number of non-outplanted spring Chinook salmon in Shitike Creek is to use known information of fish per redd numbers from the Warm Springs River. The number of adult spring Chinook salmon upstream of Warm Springs National Fish Hatchery on the Warm Springs River is known since all fish must pass through the hatchery ladder and are either hand counted or counted using video monitors. Comprehensive redd surveys on the Warm Springs River are conducted by CTWSRO staff and annual fish per redd numbers are calculated. In 2004, 2,319 adult sized fish passed upstream of the hatchery and 423 redds were counted (CTWSRO, unpublished data). During redd surveys in Shitike Creek 109 redds were counted in 2004, the highest number of redds counted since surveys began in 1986 (Figure 8). If the fish per redd numbers in Shitike Creek are similar to the fish per redd numbers in the Warm Springs River (5.5 adults/redd) then the 109 redds in Shitike Creek would equate to approximately 600 adults (Figure 9). Since 171 hatchery fish were outplanted, approximately 429 non-outplanted adults may have been in Shitike Creek. This estimate includes both wild adults and hatchery strays.

Table 4. The number of spring Chinook salmon captured and passed upstream (weir) or observed on video passing upstream in 2004. Counts are net number upstream of weir (# upstream - # downstream).

	Weir	*Video*	*Total*
Unmarked	18	83	101
Adipose fin-clipped	(- 3)	6	3
Total	15	89	104

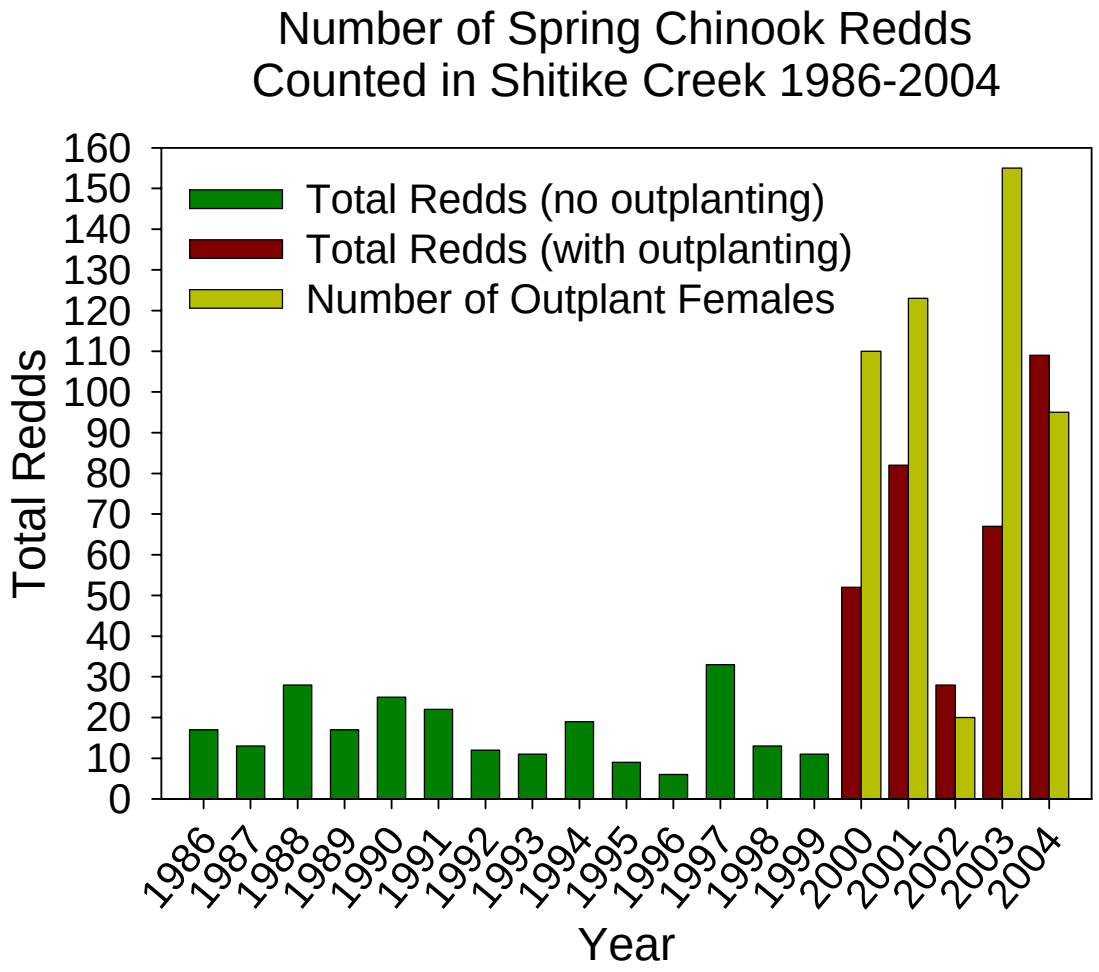

Figure 8. Number of redds and number of females outplanted into Shitike Creek, 1986-2004.

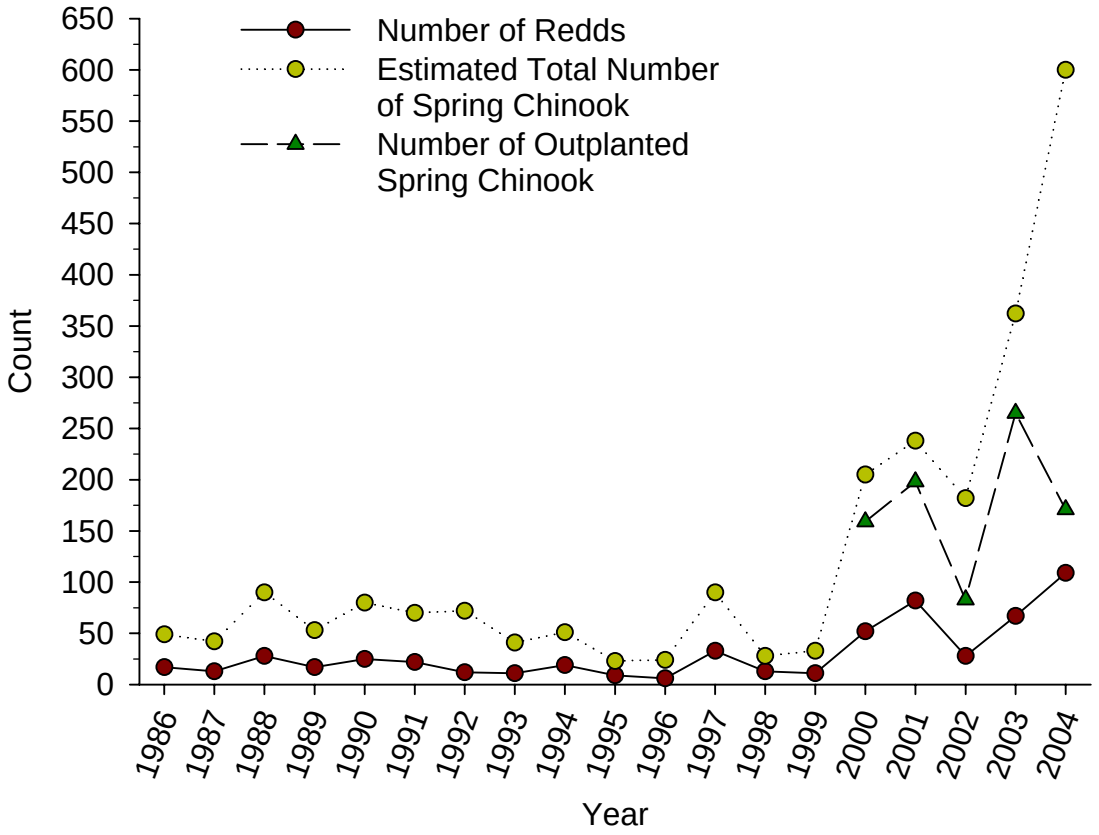

Figure 9. Number of redds, an estimate of the number of spring Chinook salmon (SCS), and the number of outplanted SCS in Shitike Creek by year. The number of SCS was estimated by multiplying the number of redds in a year by the number of fish per redd calculated for the Warm Springs River for the corresponding year (CTWSRO unpublished data).

During 2004, the USFWS Conservation Genetics Lab began to analyze genetic samples collected from the 2002 outplant brood year (Hand et al. 2004). Of the 832 ((466 age 0+ and 366 age 1+) total juvenile samples corresponding with the 2002 brood year that were sent to the Conservation Genetics Lab, 799 samples were successfully genotyped. All 83 of the adults outplanted in 2002 were also successfully genotyped. Preliminary analysis indicates that 15 of the 20 females and 18 of the 63 males outplanted in 2002 produced juvenile migrants sampled at the rotary screw trap (Figure 10). The lower percentage of males producing offspring indicates that females were limiting production in Shitike Creek in 2002. Outplanting a surplus of males without a corresponding number of females appears to have limited value in increasing the effective population size. Based on the analysis of juvenile samples, outplanted females produced almost twice as many juvenile migrants (100) as outplanted males (52). It also appears that outplanted fish intermixed with the non-outplanted population. Five of the outplanted females spawned with outplanted males, while

the other 10 successful females mated with non-outplanted males. A more detailed analysis of the results of the reproductive success of the brood year 2002 outplant will be described in a paper written by the Conservation Genetics Lab (Jason Baumsteiger, U.S. Fish and Wildlife Service, Abernathy WA).

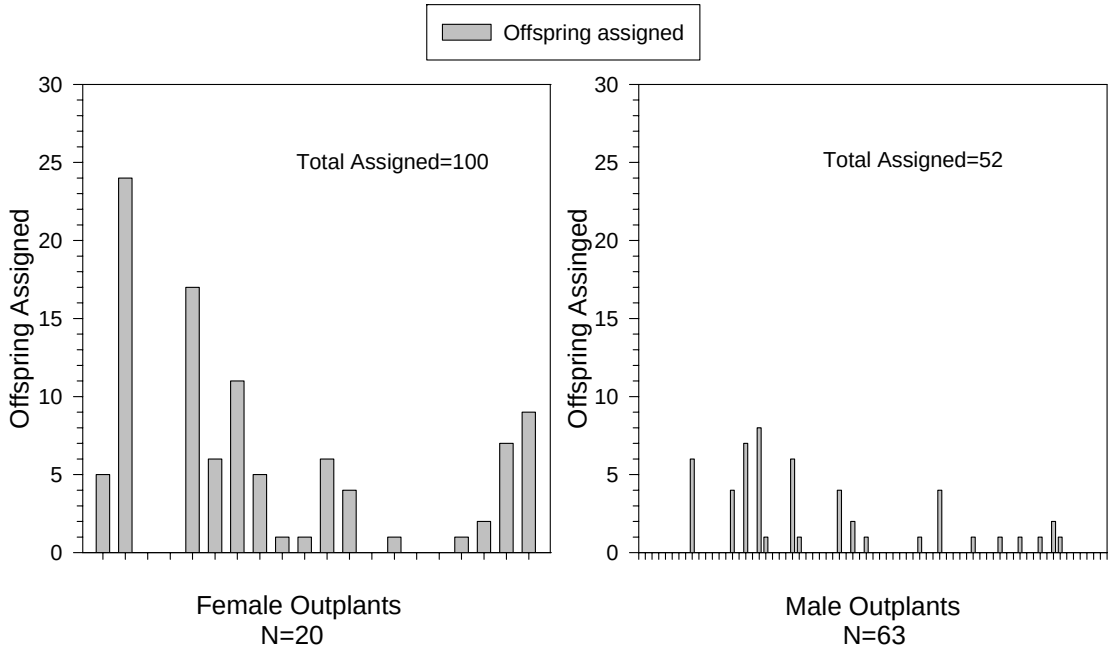

Figure 10. Number of sub-sampled juvenile outmigrants (age 0+ and age 1+) assigned to each outplanted female and male based on microsatellite DNA profiles, 2002 brood year. Out of the 83 adults outplanted, 15 females and 18 males produced offspring that were sub-sampled at the screw trap (rkm 1.0).

Acknowledgements

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Work Plan 2005

The outplanting program will likely change significantly in 2005. The 2004 outplanting was the fifth year of the original five year outplanting operational plan in Shitike Creek. Discussions between the Service and the CTWSRO have been ongoing as to the future direction of the outplanting program. While the establishment and supplementation of the spring Chinook salmon population in Shitike Creek remains a high priority for the CTWSRO, staff at the Warm Springs NFH have expressed concern that holding an additional 200 adult fish in the brood ponds over the summer period increases the pre-spawning mortality of the hatchery broodstock. An annual average of 256 spring Chinook have died in the hatchery brood ponds since 2000, the first year of the outplanting program.

In an effort reduce the holding densities of fish in the brood ponds while still supplementing the spring Chinook population in Shitike Creek, plans have been developed to change the outplanting program in 2005. Instead of holding hatchery fish in the brood ponds during the summer months and outplanting them into Shitike Creek in late August or early September, in 2005 hatchery fish will be outplanted into Shitike Creek as they return to Warm Springs National Fish Hatchery. The goal will be to outplant 200 hatchery fish, taken proportionately throughout the hatchery return. Approximately 85% of the hatchery run returns to Warm Springs National Fish Hatchery between May 1st and June 30th (Olson and Spateholts 2001). The goal will be to outplant approximately 170 spring Chinook into Shitike Creek prior to June 30th. Another 30 spring Chinook will be outplanted later in the run. The actual outplanting locations and timing will be determined as fish return to Warm Springs Natioanl Fish Hatchery. Outplanting in 2005 is also contingent on the availability of hatchery fish surplus to hatchery broodstock needs.

Radio-telemetry will be used in 2005 to monitor the behavior of outplanted fish as they are released into Shitike Creek. Approximately 30 outplanted fish will be affixed with radio-tags and tracked upon release. The focus of the telemetry will be on tracking movements out of Shitike Creek. Since hatchery fish from Warm Spring National Fish Hatchery will be put into the creek several months before spawning, there is the potential that outplanted fish will migrate out of the creek and attempt to return to the Warm Springs River. An adult weir will be operated near the mouth of Shitike Creek as part of a steelhead kelt study in 2005. The weir will be fished seven days per week, conditions permitting, through mid-June. Any outplanted fish leaving Shitike Creek theoretically will be caught in the weir. A plan on what to do with outplanted fish trapped in the weir as they move downstream will be developed. Once the weir is deactivated in mid-June, a fixed-site telemetry station at the mouth of Shitike Creek will record movements of radio-tagged fish out of Shitike Creek. Radio-tagged fish will be

tracked in the main-stem Deschutes and Warm Springs rivers if they move out of Shitike Creek. Fin-clips will again be collected from all outplanted fish and reproductive success will be monitored in subsequent years.

Objective: Assess the distribution and behavior of outplanted spring Chinook salmon in Shitike Creek.

Task 1.1. Tag hatchery spring Chinook salmon prior to outplanting with colored floy tags and/or radio-transmitters.

Activity: Externally radio-tag a subsample of outplanted hatchery spring Chinook salmon. Transmitters will be attached at the base of the dorsal fin using wire-gauge needles and colored disk tags as backing. A total of 30 radio-transmitters will be externally attached. Six to eight loads of fish (25-30 fish/load) will be outplanted into Shitike Creek. Four to six fish will be radio-tagged per load. A stratified random selection of fish will be tagged with fish stratified by sex. Tagging will be weighted towards females in order to increase the probability of finding radio-tagged fish on redds.

Schedule: May to August. Tagging will take place on all outplant days.
Personnel: 2 USFWS, 1 CTWSRO

Task 1.2. Determine the distribution of radio-tagged spring Chinook salmon in Shitike Creek.

Activity: Track radio-tagged fish using mobile-tracking equipment and fixed-site telemetry stations. Radio-tagged fish will be tracked upon release into Shitike Creek using a portable Lotek receiver and YAGI antenna. Once a fish is located, the location will be recorded using a GPS system and marked on a map. A fixed-site station will be located near the mouth of Shitike Creek (Rkm 0.5) to monitor movement out of the creek. Radio-tagged fish will be tracked until initiation of spawning activity. When fish move onto redds, redds will be flagged and recorded on a map.

Schedule: May through September, weekly. Fixed site stations will be checked weekly. Mobile tracking will be done every two weeks, May to August, tracking will increase during the spawning period.

Personnel: 1 USFWS, 1 CTWSRO

Task 1.3. Determine redd locations and extent of spawning of outplanted spring Chinook salmon.

Activity: Redd locations will be recorded for all radio-tagged fish. Once redds have been abandoned the redd characteristics (length, width, gravel size, water velocity) will be measured and recorded. The habitat in the areas surrounding the redds will also be characterized to determine if outplanted and natural origin fish spawn in similar habitats. If carcasses of fish are found, the carcasses will be examined in order to estimate spawning success based on gamete retention

Schedule: Late August through September, 2 days per week.
Personnel: 1 USFWS, 1 CTWSRO

Objective: Estimate the reproductive success of natural-origin and outplanted hatchery-origin spring Chinook salmon in Shitike Creek using genetic pedigree analyses.

Task 1.1. Collect fin-clips for genetic analysis from at least 50% of the natural-origin and 100% of the outplanted hatchery-origin spring Chinook salmon in Shitike Creek.

Activity: Install and operate an adult weir near the mouth of Shitike Creek. The adult weir will be installed and operated as soon as stream conditions permit, at least May through August. The goal is to sample at least 50% of the naturally migrating adult spring Chinook. Length measurements, scale samples, and fin clips will be collected from all adult spring Chinook passing through the weir. Fin-clips, approximately a 1 cm^2 area, will be taken from the caudal or pectoral fin and preserved in 100% ethanol. Fish will then be tagged with a numbered floy tag and an opercle punch. Fish will then be passed upstream. Fin-clips will also be collected from carcasses encountered during redd surveys if it can be determined that the fish were not previously sampled at the weir (based on opercle punch/floy-tag). A video monitoring system will be used to count fish passing the weir during times when the weir is not operated, including weekends and when water temperatures rise above 17 degrees Celsius.

Schedule: The adult weir will be operated seven days per week from May through mid June as part of a steelhead project. The

video monitoring system will be used once water temperatures increase.
Personnel: 2 CTWSRO

Task 1.2. Collect fin-clips from a minimum 1,000 juvenile spring Chinook outmigrants per brood year.

Activity: Juvenile spring Chinook outmigrants will be sampled at a rotary screw trap located near the mouth of Shitike Creek. Lengths will be used to determine brood year. Age 1+ and age 0+ juveniles will be sampled proportionately throughout the year according to the overall numbers of juveniles caught in the trap. At the screw trap, fin-clips will be collected on days when fish are marked for trap efficiency estimates. Fin-clips will be stored in Nalgene bottles filled with 100% ethanol. Samples will be placed in individually labeled containers.

Schedule: May-June, October-November (screw trap)
Personnel: 2 CTWSRO

Task 1.3. Determine genotypes of all adult spring Chinook upstream of the weir and a subsample of juveniles outmigrating from Shitike Creek.

Activity: Determine multi-locus genotypes at 10-15 micro-satellite nuclear DNA loci for each adult spring Chinook salmon upstream of the weir. Obtain similar data for a minimum of 1,000 progeny of each brood year and determine the parent of each juvenile fish via DNA assignment tests and pedigree analyses.

Schedule: Ongoing
Personnel: USFWS Conservation Genetics Lab, Abernathy WA

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