Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January to 31 December 1997

Section I
Evaluation of Reestablishing Natural Production of Spring Chinook Salmon in Lookingglass Creek, Oregon, Using a Non-Endemic Hatchery Stock

Section II
Assistance Provided to LSRCP Cooperators and Other Projects

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SECTION I

Evaluation of Reestablishing Natural Production of Spring Chinook Salmon in Lookingglass Creek, Oregon, Using a Non-endemic Hatchery Stock

Abstract

We trapped 81 unmarked spring Chinook salmon adults at the Lookingglass Hatchery trap between 27 May and 5 September 1997. We released 75 (plus 2 marked fish) of these into Lookingglass Creek from 10 July to 22 August above a temporary weir at river mile 6.5, about 4 river miles above the hatchery. Intensive spawning ground surveys were conducted above the temporary weir about 3 times a week beginning 10 July and ending 15 September. Dead and dying adult spring Chinook salmon were removed from the creek channel to reduce the amount of pathogens being shed into the hatchery water supply. We observed a total of 21 redds above the temporary weir and recovered a total of 55 spring Chinook salmon of the 77 fish released (71.4%). We also recovered 13 unmarked and 2 marked (ADRV) adults on spawning ground surveys that were never handled at the hatchery weir. Surveys were also completed in the lower areas of Lookingglass Creek and Little Lookingglass Creek on 6, 21, and 28 August, and 4, 8, and 15 September, and 10 October. During these surveys, an additional 4 redds and 10 carcasses were observed.

Movement of juveniles from the 1995 cohort past the rotary screw trap in Lookingglass Creek peaked in October of 1996, and March of 1997, with an estimated total of 9,215 juveniles passing the trap. The range of median monthly fork lengths of fish captured in the trap was 67 mm in August 1996 to 99 mm in March 1997.

To estimate trapping efficiency of the screw trap we made day (~1200 hours) and night (~1900 hours) releases of fish to determine if time of release affected trapping efficiencies. We found no significant difference in recapture rates of marked fish at the rotary screw trap between day and night releases.

Three groups of fish were PIT-tagged at the screw trap from July to September 1996, October to December 1996, and January to April 1997. The first fish from the three groups arrived at Lower Granite Dam the week of 8 April with the last fish arriving the week of 20 May 1997. All three groups had median arrival dates at Lower Granite Dam within 3 days of each other from 16-19 April 1997. Groups tagged later at the trap had higher minimum survival rates: 11.9, 22.2, and 40.4%. Minimum survival rates for months with at least 50 fish PIT-tagged (September 1996 through March 1997) ranged from 9.9 to 44.6%.

To determine if PIT-tagging affects survival or migration to the rotary screw trap on Lookingglass Creek or to Lower Granite Dam, a portion of the 1995 cohort (3,612) was divided into three different fork length groups; small, 55-59 mm; medium, 62-66 mm; and large, 69-72 mm. PIT-tagged fish were marked with Alcian blue dye. A control group of 3,638 fish from the same size groups was marked with dye only. Both treatments were divided equally and released into two areas of Lookingglass Creek (~river mile 10.25 and 7.00) and Little Lookingglass Creek (~river mile 2.75) in 1996. The control groups of small and medium fish tended to arrive earlier at the screw trap than

the PIT-tagged fish from the same groups. However, the larger PIT-tagged fish arrived earlier at the screw trap than the larger control group. There was no significant difference in survival indices to the rotary screw trap between the PIT-tagged and control groups from the small, medium, and large size categories. The median arrival date at Lower Granite Dam of the PIT-tagged small group was 22 April 1997, while that of the PIT-tagged medium and large groups was 15 and 16 April respectively. The minimum survival rate to Lower Granite Dam of the small group was significantly lower than both the medium and large groups, with no difference between the medium and large groups.

Introduction

The Grande Ronde River Basin historically supported large populations of fall and spring Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*) and coho (*O. kisutch*) salmon and steelhead trout (*O. mykiss*) (Nehlsen et al. 1991). The dwindling of Chinook salmon and steelhead populations and extirpation of coho and sockeye salmon in the Grande Ronde River Basin was, in part, a result of construction and operation of hydroelectric facilities, overfishing, and loss and degradation of critical spawning and rearing habitat in the Columbia and Snake river basins (Nehlsen et al. 1991). Anadromous salmonid stocks have declined in both the Grande Ronde River Basin (LSRCP Status Review Symposium 1998) and in the entire Snake River Basin (Nehlsen et al. 1991), many to the point of extinction.

Hatcheries were built in Oregon, Washington and Idaho under the Lower Snake River Compensation Plan (LSRCP) to compensate for losses of anadromous salmonids due to the construction and operation of the lowest four Snake River dams. Lookingglass Hatchery on Lookingglass Creek, a tributary of the Grande Ronde River, was completed under the LSRCP in 1982 and has served as the main incubation and rearing site for the Chinook salmon programs for the Grande Ronde and Imnaha rivers in Oregon. Despite these hatchery programs, natural spring Chinook populations continued to decline, resulting in the National Marine Fisheries Service (NMFS) listing spring/summer Chinook salmon as "threatened" under the federal Endangered Species Act (1973) on 22 April, 1992.

This study was designed to evaluate the potential for reestablishing spring Chinook salmon natural production in Lookingglass Creek using a hatchery stock (Lofy et al. 1994). The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Oregon Department of Fish and Wildlife (ODFW) developed the study in consultation with the Nez Perce Tribe. Fishery managers believed that Lookingglass Creek was a good location to evaluate reintroduction of a non-endemic stock in the Grande Ronde River Basin. It was assumed that the relatively good quality habitat that was available in Lookingglass Creek would provide an adequate opportunity for success, and the existence of the weir provided the ability to easily control and document adult escapement. There was also a database on the life history and success of the endemic spring Chinook salmon in Lookingglass Creek from 1964 to 1974 (Burck 1993; Burck 1964-1974) that would aid in the evaluation of the relative success of a non-endemic stock.

Until this study was initiated in 1992, no adult spring Chinook salmon captured at the Lookingglass Hatchery weir were placed upstream of the hatchery with the exception of a few fish released above the hatchery in 1989. The upstream migration has been almost completely blocked by a picket or floating weir located at the hatchery (Figure 1). Some fish escaped above the weir each year as evidenced by redd counts during spawning surveys (ODFW, unpublished data).

From 1992 to 1994, adults were placed above the Lookingglass Hatchery weir (Lofy and M^{c}Lean 1995a; Lofy and M^{c}Lean 1995b; and M^{c}Lean and Lofy 1995). In the fall of 1994 a disease outbreak at Lookingglass Hatchery affected the 1993 cohort that was being reared at the hatchery. This incident created increased concern about the potential negative effects of supplementation with adult salmon in the Lookingglass Hatchery water supply. Because of these concerns, the release of adults above the Lookingglass Hatchery weir did not take place in 1995 (M^{c}Lean and Lofy 1998). Instead, CTUIR and co-managers used the progeny of unmarked spring Chinook salmon that returned to Lookingglass Hatchery in 1995 for supplementation as parr (i.e., artificial spawning/ incubation/

early rearing at Lookingglass Hatchery and release in 1996 as parr in Lookingglass Creek) (M^{c}Lean and Lofy 1998, 1999).

With continued concern about pathogen load in the water taken into Lookingglass Hatchery, co-managers decided to release 50 adults above the weir in 1996, fewer than the numbers released from 1992 to 1994 (M^{c}Lean and Lofy 1999). As a condition of the release of adults above the weir in 1996, CTUIR personnel made an increased effort to recover carcasses and remove them from the active stream channel (M^{c}Lean and Lofy 1999). This was done to reduce the number of carcasses in the water, which would presumably reduce the potential pathogen load in the water supply (Letter from William Stelle, NMFS, to Michael Spear, USFWS, 16 August, 1996) (M^{c}Lean and Lofy 1999). In 1997 the strategy to release adults and the survey frequency was the same as in 1996 (M^{c}Lean and Lofy 1999).

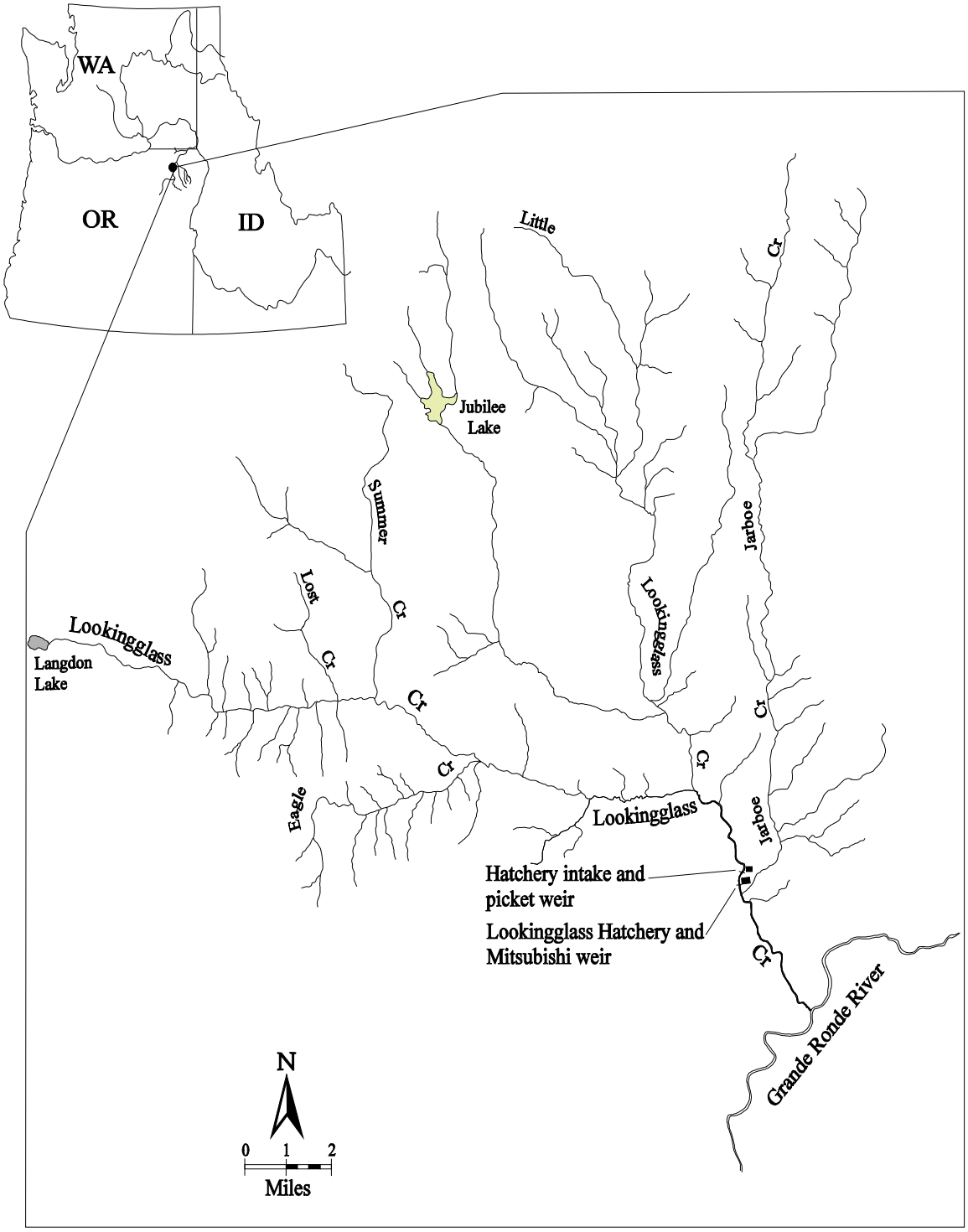

Figure 1. Map of the Lookingglass Creek basin showing the location of major tributaries and the Lookingglass Hatchery complex.

Study Area

The Lookingglass Creek basin is located in the Blue Mountains of northeast Oregon with the headwaters originating at an elevation of about 4,870 ft above sea level (Figure 1). Lookingglass Creek flows to the southeast approximately 15.5 river miles (rm) through the Umatilla National Forest then through private land where it enters the Grande Ronde River at approximately rm 85, at an elevation of about 2,355 ft above sea level. Lookingglass Creek has five major tributaries, Lost Creek (about rm 10.75), Summer Creek (about rm 10.25), Eagle Creek (about rm 8.25), Little Lookingglass Creek (just below rm 4.25), and Jarboe Creek (just below rm 2.25) (Figure 2). Lookingglass Creek and Little Lookingglass Creek (the largest tributary) are the only major portions of the basin where adult spring Chinook salmon spawning takes place with any regularity. During the previous study (Burck 1993) these two streams were divided into four geographic units for evaluation of spring Chinook salmon production (Figure 2). We used these same units and landmarks in our study, but we further divided unit 3 into upper and lower sections (Figure 2).

Lookingglass Hatchery is located at about rm 2.50 on Lookingglass Creek (Figure 2). In 1997 we were restricted to a single entry by the landowner to a portion of Lookingglass Creek that ran through his private property (Figure 2).

Methods

Stream Flow and Temperature

We obtained and summarized 1997 stream flow data collected by the United States Geological Survey (USGS) for comparison to stream flows recorded in Lookingglass Creek from 1964 to 1971 (at about rm 2.50) (Burck 1993) (Figure 3). The mean daily stream flows (0.5-hour sample interval) in Lookingglass Creek for 1997 were estimated from an electronic stream gauging station located just below the Mitsubishi weir (Figure 3). The data were obtained from the USGS (personal communication, Jo Miller, USGS, Walla Walla District, WA, unpublished data) that maintained and operated the station. Maximum and minimum daily mean flows for each week of the year were reported here using methods described in M^{c}Lean and Lofy (1995).

Stream temperature data were collected for comparison to stream temperatures recorded in Lookingglass Creek from 1964 to 1971 at rm 4.25 by Burck (1993) (Figure 3). The daily range of hourly stream temperatures for 1997 were obtained from summaries completed by ODFW (personal communication, Debbie Eddy, Portland, Hatchery Management Information System) and from two electronic thermographs (Ryan Tempmentor®2000) operated by CTUIR. Stream temperature data collected in 1997 were recorded by ODFW at the hatchery intake (at about rm 2.50) and by CTUIR at approximately rm 3.75 of Lookingglass Creek and inside the livebox of our rotary screw trap (at about rm 2.50) (Figure 3). We summarized all hourly stream temperature data as a weekly range (M^{c}Lean and Lofy 1995).

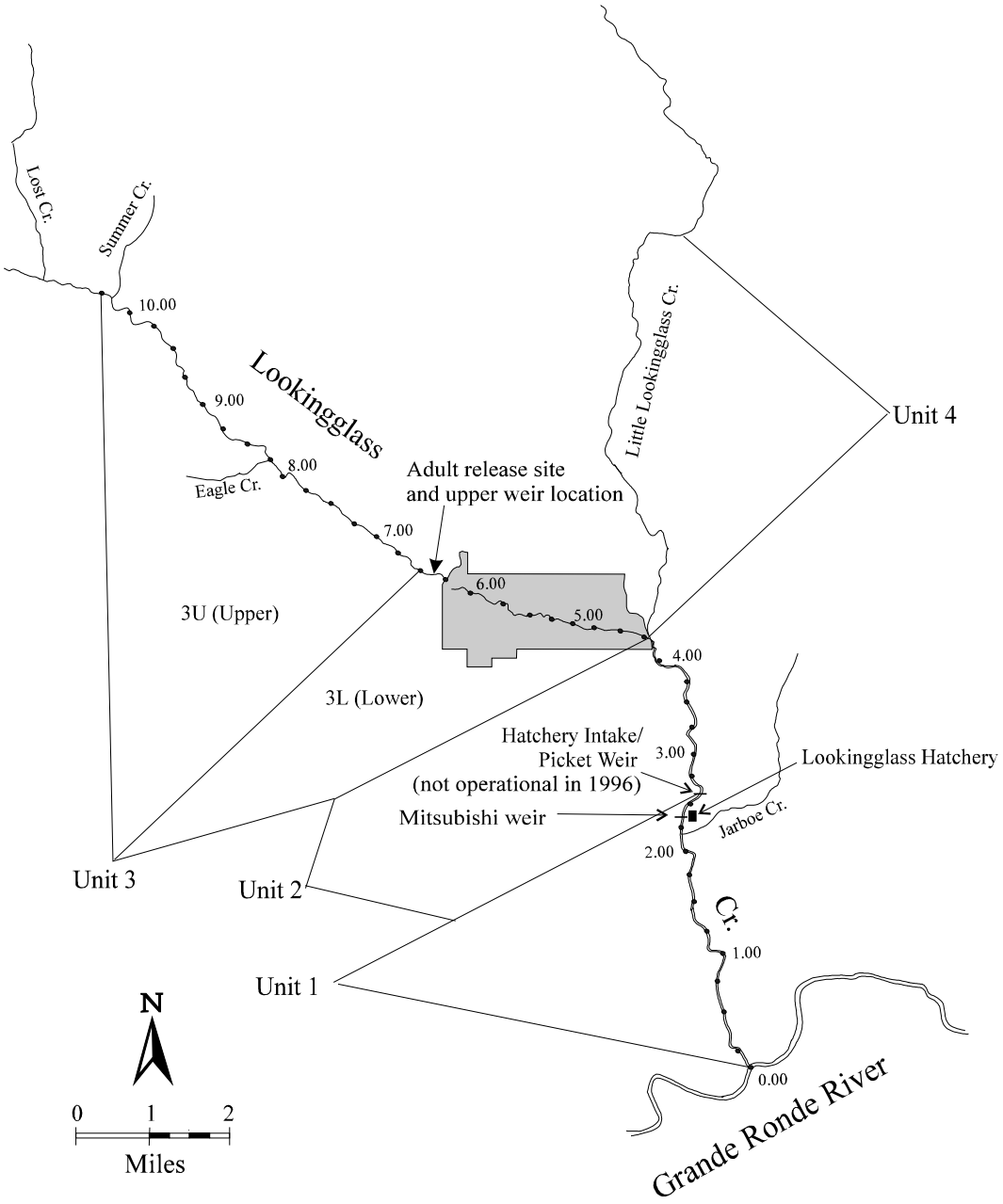

Figure 2. Unit Designations, adult spring Chinook salmon release site in 1997, and 0.25-river mile sections of Lookingglass Creek. The shaded area is the private property where access was restricted by the landowner to a single spawning ground survey conducted by CTUIR in 1997.

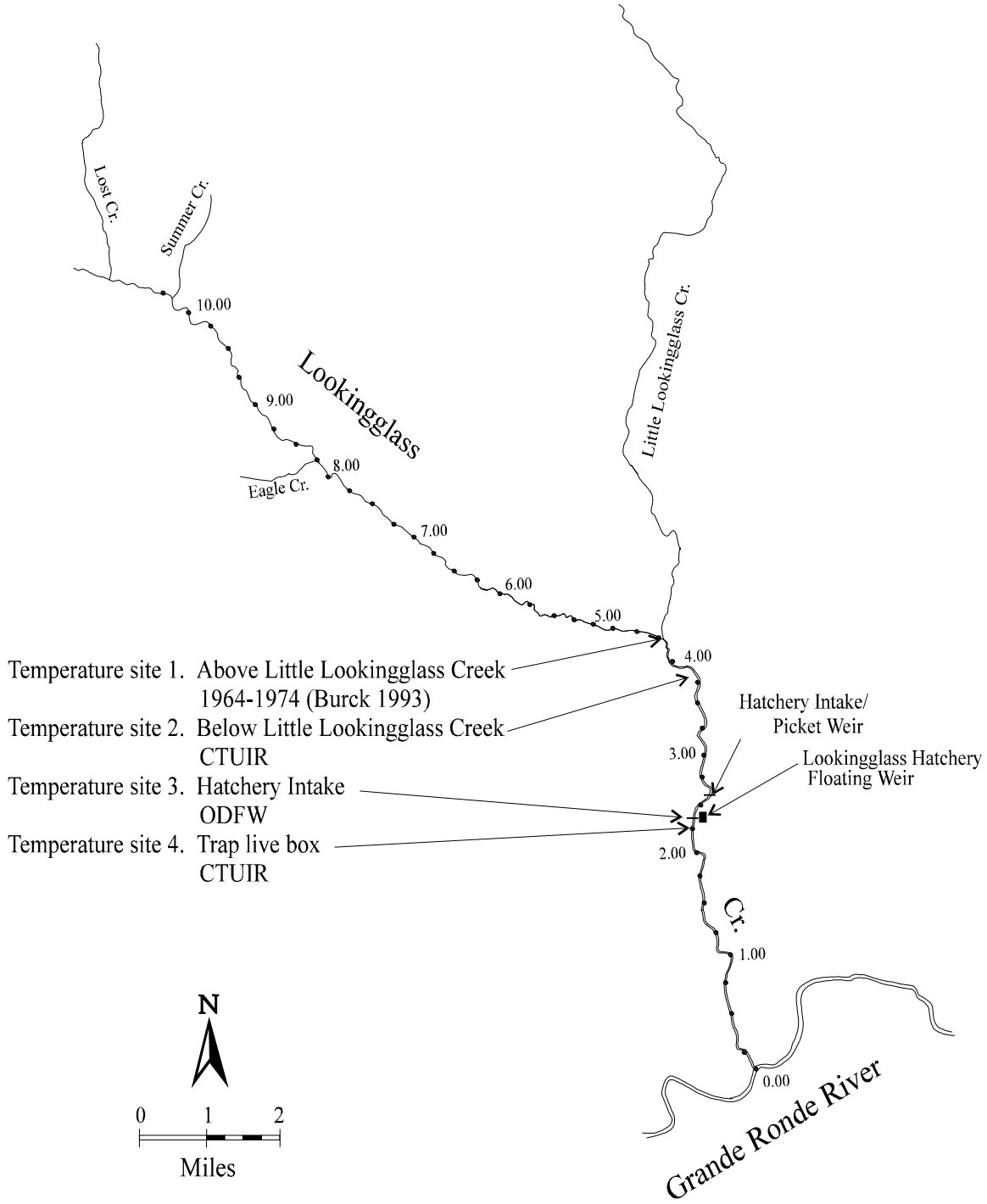

Figure 3. Location of temperature data recorders in Lookingglass Creek in 1997.

Adult Returns to Lookingglass Hatchery

In order to evaluate the relative success of adult releases in 1992, 1993, and 1994 (Lofy and M^{c}Lean 1995a, Lofy and M^{c}Lean 1995b, and M^{c}Lean and Lofy 1995), progeny-per-parent ratios were calculated using the unmarked adult spring Chinook salmon intercepted at Lookingglass Hatchery and recovered during spawning ground surveys. The fish were enumerated, and then aged using scales to determine cohort origin.

Unmarked and marked adult spring Chinook salmon returning to the hatchery were enumerated by CTUIR and ODFW. Returning fish were diverted into the hatchery trap using Mitsubishi (primary) and picket (secondary) weirs (Figure 3). The traps were checked once a week for the duration of the return to Lookingglass Creek (until no spawning was observed in Lookingglass Creek below the hatchery). All fish in the trap were checked for fin clips, measured, tagged with colored and numbered plastic jaw tags secured with hog rings, and injected with antibiotics. The marked Rapid River stock that returned to Lookingglass Hatchery in 1997 were trucked to Wallowa Hatchery for spawning due to the lack of adult holding space at Lookingglass Hatchery. Twenty one unmarked fish that were captured in excess to our intended release group of 50 fish (by 10 July) were trucked to Wallowa Hatchery for spawning. After the 10 July release, unmarked fish were tagged and released as they swam into Lookingglass Hatchery and were not trucked to Wallowa Hatchery.

Progeny-Per-Parent Ratios

The progeny-per-parent ratio was calculated using the number of unmarked progeny that returned to the Lookingglass Hatchery weir from the 1992, 1993, and 1994 cohorts divided by the estimated number of adults above the weir in 1992, 1993, and 1994 (Lofy and M^{c}Lean 1995a, Lofy and M^{c}Lean 1995b, and M^{c}Lean and Lofy 1995). We generally tried to place an equal proportion of males and females above the weir in Lookingglass Creek each year. Sex ratio may influence production by affecting the number of eggs available for fertilization, and production of progeny. Progeny-per-parent calculations assumed either no straying from other tributaries, or equal numbers of strays between Lookingglass Creek and other tributaries. Individuals of naturally-produced fish from Lookingglass Creek and those from other tributaries cannot be distinguished from one another.

Progeny-per-parent ratios of other Grande Ronde River basin tributaries were calculated for comparison to Lookingglass Creek. Because there were no weirs or actual counts of adult returns escaping to any other Grande Ronde River basin tributaries, expanded redd counts in each of these tributaries was multiplied by the average fish-per-redd estimate of 3.26 from 1992 to 1994 in Lookingglass Creek (Lofy and M^{c}Lean 1995a, Lofy and M^{c}Lean 1995b, and M^{c}Lean and Lofy 1995) to obtain an estimate of adult escapement. The age structure from all adults recovered on spawning grounds throughout the Grande Ronde River basin was based on scales. It was applied to all natural populations to calculate the contribution from each cohort for each return year (ODFW, unpublished data).

The redd counts from 1992 to 1997 were expanded by section using the average (1986-1997) percentage of redds in each section of all redds counted on the last date that all sections were surveyed. Only counts with more than 15 redds were used. Redd counts smaller than 15 were not used because they may have produced unusual redd distributions when percentages were apportioned to individual sections. This percentage for each section was then applied to sections where the redd counts were not complete (not surveyed on the final survey of the year).

Release of Adult Spring Chinook Salmon Above the Weir

We released 49 unmarked adult spring Chinook salmon above the Lookingglass Hatchery on 10 July, 5 on 16 July, 2 on 5 August, and 21 on 22 August 1997 (total of 77 adults). The fish released on 22 August were unmarked adults from Wallowa Hatchery (see Adult Return to Lookingglass Hatchery). The releases on 5 August and 22 August each had 1 marked fish in the release group. Co-managers decided to release the remainder (number captured minus mortality) of the unmarked returns that were being held at Wallowa Hatchery after significant post-release mortality decreased the size of the initial release group. Twenty- eight of fifty-six fish released by 5 August were observed as prespawning mortalities before 22 August. It was felt that releasing the remaining unmarked fish from Wallowa Hatchery into Lookingglass Creek would not substantially increase the potential pathogen load in Lookingglass Creek, because prespawning mortality had already been removed from the stream.

All unmarked fish that returned to Lookingglass Hatchery before 10 July were held in the intake trap area until release on 10 July. Subsequent releases were made above the weir as the fish swam into the hatchery trap, with the exception of the late release on 22 August from Wallowa Hatchery (see Adult Return to Lookingglass Hatchery). The presumptive sex of the fish was determined by hatchery personnel using the physical appearance of the fish at the time of release. The fish were measured (fork length, mm), weighed (kg), re-jaw-tagged (if necessary) for primary identification, and opercle punched for secondary identification (different punches for each sex). Scale samples were taken before fish were loaded into the truck for transport to the release area. All of the fish were injected with erythromycin upon arrival at the trap by ODFW hatchery personnel to decrease the probability of dying from bacterial kidney disease (BKD) before spawning. None of the unmarked fish that were held in the intake trap holding area were treated with formalin. We noted that many of the fish released on 10 July were heavily fungused. We removed some caudal fin tissue using a paper hole punch for genetic analysis by the NMFS (see Genetic Monitoring).

The release site was in the same location as in 1996, just below rm 6.50 (M^{c}Lean and Lofy 1999) (Figure 2). The site was chosen because it was the only site above the private property with restricted access that was accessible by vehicle. We did not release the fish below the restricted area because we did not want fish from the release group spawning just above the hatchery intake or in the restricted area because it was anticipated we would have very limited (perhaps only a single) opportunity to count redds or recover carcasses in that area. This would be insufficient to remove a majority of the carcasses, as we preferred.

Five days before release of the first group of fish, we installed a picket weir (upper weir) across the stream just below rm 6.50 to prevent downstream movement into the restricted area or near the hatchery intake. The upper weir was constructed from hole-punched angle iron (1" gap between holes) laid across wooden tripods. Electrical conduit (3/4" wide) was placed through the punched holes to form the panels of the weir. The weir was then positioned in an upstream pointing "V" configuration. There was a 4-inch opening between the 2 sections of the weir in the middle of the "V" so that any fish that escaped above the hatchery weir would be guided to the opening for easy passage above the weir. The small opening would make it highly unlikely that salmon could get downstream. This upper weir was kept in the creek until one week after no live adult salmon were observed above it.

Spawning Ground Surveys

We conducted spawning ground surveys above the release site (Unit 3U, Figure 2) about three days a week to count completed redds and quickly remove spawned out adult spring Chinook salmon from the active stream channel. We removed carcasses, spawned out females, and weak-swimming males from the river channel in order to reduce the potential pathogen load in the creek. Determination of whether or not a fish should be gaffed and killed was made by visual inspection of the females (flaccid abdomen and tail erosion was interpreted as a spawned fish), and length of time the female had been observed on a redd. For males we used their ability swim or escape capture (if they were easily approached and captured by hand), or if there were surplus males available (most of the females had finished spawning). If there was any question that the fish may not be finished spawning it was not gaffed.

In Unit 3U, spawning surveys were usually conducted on Mondays, Wednesdays, and Fridays. We continued to survey until no live fish were observed. During each survey, only new completed redds were flagged and counted using methods described in M^{c}Lean and Lofy (1995). Additional surveys were conducted in Units 1, 2, 3L, and 4 (Figure 2). These surveys were done to complete the ODFW spring Chinook salmon spawning ground index counts for Lookingglass Creek, as well as recover more carcasses and document all spring Chinook salmon that returned to Lookingglass Creek.

Sampling Adult Chinook Salmon Carcasses for Pathogens

Kidney tissues were taken from adult spring Chinook salmon recovered during spawning ground surveys in 1997 to document levels of bacterial infection in fish spawning above the hatchery in the natural environment. The kidney tissues that were removed were kept on ice until the tissue could be transferred to a freezer. Whole carcasses recovered from Lookingglass Creek near the hatchery were frozen as soon as possible. The kidney tissue was analyzed by ODFW fish health, La Grande, OR, for the level of *Renibacterium salmoninarum* (bacterial kidney disease), and presence of aeromonad/pseudomonad bacteria (general septicemia), *Flexibacter psychrophilus* (coldwater disease), and *Yersinia ruckeri* (enteric redmouth disease). The data provided by ODFW were summarized in this report.

Genetic Monitoring

As part of an ongoing genetic monitoring program, the NMFS requested that we collect tissue samples from unmarked adult spring Chinook salmon that returned to Lookingglass Hatchery. The caudal fin tissue was taken from all unmarked fish that returned to the hatchery or were recovered on spawning ground surveys. A paper hole punch was used to remove a portion of the caudal fin. These samples were placed in small vials of 95% ethanol for storage until funding becomes available to analyze them.

Release of 1996 Cohort Juvenile Spring Chinook Salmon From Lookingglass Hatchery

Co-managers released 50 unmarked adult spring Chinook salmon above the hatchery weir in 1996. The remaining 41 (1 jack, 20 males, and 20 females) unmarked spring Chinook salmon trapped at Lookingglass Hatchery were retained for a traditional hatchery program to be released as yearling smolts in the spring of 1998. The spawning and incubation of the unmarked fish was done at Lookingglass Hatchery. The eggs from each of 20 unmarked Rapid River stock females were placed in individual egg trays and spawned with unmarked males. The progeny were split into two raceways, with one targeted for release at 20 fish/lb (18,444 fry, pond 10) and the second at 42 fish/lb (52,594 fry, pond 9) the latter of which approximates the size of naturally-produced fish from Lookingglass Creek (M^{c}Lean and Lofy 1998). We used 7,206 fish from pond 9 for early release into Lookingglass Creek (see PIT-Tagging Effects on Survival and Migration Timing of the 1996 cohort) and 400 from pond 9 were used by the ODFW captive brood program. These fish did not contribute to the final loading densities. We attempted to equalize loading densities at smolt release in the two raceways by splitting the fish so as to end up with equal poundage in each raceway at release in the spring of 1998. The fish were transferred to outside raceways during the last week of April and the first week in May 1997. The fish were coded-wire-tagged (CWT) with 2 different codes (1 per pond) and had only their adipose fins removed on 26 June 1997 to identify them as hatchery fish and progeny of unmarked parents. All progeny of marked Rapid River stock parents held at Lookingglass Hatchery were CWT'd and had their adipose fins removed. An additional RV clip identified them as progeny of marked parents. Hatchery-spawned fish from the 1996 cohort are scheduled for release from Lookingglass Hatchery the first week of April 1998.

PIT-Tagging Effects on Survival and Migration Timing of the 1996 Cohort

Using the 1996 cohort, we began the second year of evaluation of PIT-tagging effects on survival and migration timing. We used methods similar to those for the 1995 cohort described in M^{c}Lean and Lofy (1999) for the 1996 cohort with a few exceptions. For the 1996 cohort we used an ultraviolet-light reactive non-toxic latex paint (photonic paint) as the secondary mark instead of Alcian Blue dye. We marked 3,600 fish with PIT tags and green photonic paint and 3,606 fish with yellow photonic paint only. On the dates of tagging (23-28 July, 1997) the fish were netted from the raceways and lightly anaesthetized with (40-60 mg/l) of MS-222 (tricaine methanesulfonate). The fish were sorted by fork length into one of 15 containers, with each container representing a fork length. The fork lengths used were 1-mm increments but represented three size categories: 55 to 59 mm (small), 62 to 66 mm (medium), and 69 to73 mm (large). We did not use the 2-mm intervals between each group to reduce the possibility of category overlap. Fish that were not within a targeted length category were returned behind divider in pond 9. The experimental group was PIT-tagged. The PIT tag was scanned. Then the fish was weighed. The data were entered into a computer file. The fork length of the fish was hand entered using the length on the individual container from which it came. The experimental group was then marked with photonic paint (green) using a Syrijet® injector at the base of the fin rays. All control and experimental fish were marked in three different locations representing one of the three size groups. Fish from the "small size category" were marked on the caudal fin. The fish from the "medium size category" were marked on the anal fin. The fish from the "large size category" were marked on either pelvic fin. The sample sizes for the 1996 cohort experimental group of PIT-tagged fish were 1,188, 1,217, and 1,195 for the

small, medium, and large categories. The control group for the 1996 cohort was treated in the same manner, except no PIT-tag was injected (and the color of the dye differed). The sample sizes for the control group were 1,189, 1,220, and 1,197 for the small, medium, and large categories, respectively.

All treatment and control fish were mixed in a fish transport truck and taken to or near the release sites. The fish were scatter planted on 30 July 1997 using horses with saddlebag containers and a release tube from the transport truck. The horses were used to access the remote areas of Lookingglass Creek from rm 8.00 to rm 10.25 (2 trips to Lookingglass Creek). The liberation truck was used to make a release at rm 6.50. The trips to the river using horses took longer than expected. At release for the second trip in the afternoon, the fish appeared stressed and slightly anoxic at release.

Population Estimates and Timing Past the Rotary Screw Trap for the 1995 Cohort

To evaluate the survival of juvenile spring Chinook salmon from the 1995 cohort, which were released above the weir in 1996, we operated a fyke net trap from 27 July to 3 August 1996 at the hatchery intake and a screw trap from 4 August 1996 to 31 December 1997 in the flume hole about 130 meters below the hatchery intake. We captured fish to estimate the timing to the trap and total number of fish moving past the trap site on Lookingglass Creek. From January 1997 to December 1997, we also captured fish from the 1996 cohort. Differences in fork length ranges made it possible to differentiate the two cohorts. We used the fyke net and trap when there was not enough flow to operate the screw trap. We began operating the screw trap on 3 August 1996 after modifications were made in the creek to divert the flow into the screw trap to allow it to turn.

Most of the juvenile spring Chinook salmon captured in our rotary screw trap were measured (fork length, mm), weighed (g) and enumerated similar to M^{c}Lean and Lofy (1998). At times we just counted fish because they appeared injured or there were many fish in the trap, and measurement of such a large sample size was unnecessary. Occasionally, small fry that were dipped out of the trap box were presumed to have been eaten when they weren't found when the fish were sampled out of the bucket. Only fork lengths from fish captured in the trap on or around the 20th ($\pm$ 5 days) of each month were used in calculating the range and median fork length for comparison with fish captured in the creek (M^{c}Lean and Lofy 1998).

We expanded the number of fish captured each month using trap efficiency estimates (M^{c}Lean and Lofy 1998). All months were totaled to obtain the overall population estimate of fish moving past the trap. We used PIT tags as marks for estimating the trapping efficiency of the 1995 cohort in order to track individual fish and increase our sample size of PIT-tagged fish for mainstem dam detections. Every healthy juvenile spring Chinook salmon captured at the trap that was at least 60 mm was tagged and released for trap efficiency estimation. Because we were not always able to differentiate between PIT-tagged fish from our releases in the upper reaches of Lookingglass Creek that were recaptured in the trap and the recaptured fish that were recently tagged and used to estimate the trap efficiency, we used a secondary mark of Alcian blue dye applied with a battery operated tattoo pen on the caudal peduncle. The secondary mark was used so that we could recognize fish released for trap efficiency and refrain from using them for trap efficiency multiple times. To calculate the variance around the estimate of total migration and the estimated numbers of fish trapped each month for the 1995 cohort, we used a bootstrap method described in M^{c}Lean and Lofy (1998).

Time and Distance of Trap Efficiency Release

In order to determine if the time of day we released the trap efficiency fish had any effect on the rate of recapture at the trap, we conducted releases of trap efficiency fish during the day (~1200 hours) and night (~1900 hours) at two different distances above the screw trap (50 and 200 m). We used the 50 m site early in the trapping season because we were concerned about recapturing more fish (lower trap efficiencies). We shifted to the 200 m site as more fish were being captured in the trap. We tried to release equal numbers of fish during the day and at night. At each trap check about half of the fish captured and PIT-tagged were released during that day and the other half were released that evening. A Chi-square test (α 0.05, df=1) was used to test for significant differences in recapture rates between the two times of release at each release location.

PIT-Tagging of the Hatchery-reared 1995 Cohort

Three groups of juvenile spring Chinook salmon from the 1995 cohort released into Lookingglass Creek and recaptured at the screw trap were PIT-tagged to determine arrival timing at, and the minimum survival rate to Lower Granite Dam. The three groups were categorized by initial arrival timing at the screw trap. The "fall group" was PIT-tagged from 27 June 1996 (two days after release into Lookingglass Creek) to 30 September 1996. The "winter group" was tagged from 1 October 1996 to 31 December 1996. The "spring group" was tagged from 1 January 1997 until the last non-precocial juvenile (defined in McLean and Lofy 1998) from the 1995 cohort was captured in the screw trap. In 1997 this date was 1 July. All of the fish were PIT-tagged using methods described in M^{c}Lean and Lofy (1998).

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

We used weekly arrival timing and minimum survival rate to Lower Granite Dam of the three groups of PIT-tagged fish from the Lookingglass Creek 1995 cohort to describe the outmigration timing and to determine if a trend in survival was evident over time. The daily detections of these groups at Lower Granite Dam were downloaded from the PIT Tag Information System (PTAGIS).

For the arrival timing, the daily detections were expanded for spill using a daily expansion factor [(Powerhouse Flow + Spillway Flow) / Powerhouse Flow] calculated from data provided by the United States Army Corp of Engineers (USACE) River Information. The expanded daily detections (rounded to the nearest 0.1 fish) were then summed each week and rounded to the nearest whole number. Arrival timing at Lower Granite Dam for each group was graphed using the expanded weekly detections as a percentage of the total expanded number of fish for that group.

To determine the minimum survival rates to Lower Granite Dam of juvenile outmigrants from the three groups from Lookingglass Creek, the total unique detections at all Snake and Columbia River dams were used. Survival rates were calculated for tagged fish by dividing the total number of unique detections by the total number of the juveniles tagged during that month or for that group. Confidence intervals (95%) for total detection percentages were calculated using methods described in Ott and Mendenhall (1985) to determine differences among or between groups based on the

overlap of these intervals. Only the upper bound of the confidence interval was used for determining overlap, because the point estimate was an actual observed minimum, and was not estimated.

PIT-Tagging Effects on Survival and Migration Timing of the 1995 Cohort

In 1997 we summarized data collected on the 1995 cohort from three size groups of fish used in the evaluation of PIT-tagging effects on survival and migration timing (M^{c}Lean and Lofy 1999). To determine if there were differences in weekly arrival timing at and survival to the screw trap and Lower Granite Dam between fish of different size categories, we marked a portion of the 1995 cohort hatchery-reared Rapid River stock juvenile spring Chinook salmon between 54 and 74 mm FL with PIT tags and Alcian blue dye. To determine if there was a difference between PIT-tagged and non-PIT-tagged survival rates to the screw trap on Lookingglass Creek, we compared them with a control group with only dye (M^{c}Lean and Lofy 1999).

Monthly Arrival Timing and Survival to the Screw Trap for the 1995 Cohort

We used the three size groups of PIT-tagged and control groups of juvenile spring Chinook salmon released into Lookingglass Creek to evaluate the effects of the PIT tag on migration timing and survival to the screw trap.

We expanded the PIT-tagged and control group recaptures at the trap for the 1995 cohort based on the trap efficiency estimates during the period the fish were initially captured (M^{c}Lean and Lofy 1998) (see Population Estimates And Timing Past The Rotary Screw Trap For The 1995 Cohort). We further expanded the control group for the loss of the secondary Alcian Blue dye mark (the only mark identifying them as a member of the control group) using the Alcian Blue mark loss rate of the PIT-tagged fish. Previous data have shown that there is very low PIT tag loss (<1%) during 24-hour tag retention checks for field groups from the 1992, 1993, and 1994 cohorts (Lofy and M^{c}Lean 1995a; Lofy and M^{c}Lean 1995b; M^{c}Lean and Lofy 1995; and M^{c}Lean and Lofy 1998).

Because of the low numbers of monthly trap catch for each size group, we combined the mark loss expansions into two time categories for each size group. The period July through November was used as the first category. December through April was used as the second category. The number of control fish trapped was then expanded by this proportion using the bootstrap program. The actual number of control fish trapped was also expanded for trapping efficiency using a bootstrap method. These two estimates, as well as their variance, were then added together to obtain the total estimated numbers of control fish that passed the trap site.

We described arrival timing for each size group by graphing the 95% confidence interval of the estimated number trapped and the expanded cumulative percent of the estimated total trapped for each month.

Survival rates were calculated for each size group of fish by dividing the expanded total number of recaptures by the total number of the juveniles released. The 95% confidence interval for the survival estimate was calculated using the variance of the expanded total number of fish trapped for the year for each size group, which was calculated using a bootstrap method. We determined differences between the PIT-tagged and control groups based on the overlap of the 95% confidence intervals.

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

We described weekly arrival timing of the three groups (55-59 mm, small group; 62-66 mm, medium group; and 69-73 mm, large group) of PIT-tagged fish from Lookingglass Creek. Daily detections of these groups at Lower Granite Dam were downloaded from the Columbia River Basin PIT Tag Information System (PTAGIS). Daily detections were then expanded for spill using a daily expansion factor [(Powerhouse Flow + Spillway Flow)/Powerhouse Flow] calculated from data provided by the United States Corp of Engineers (USACE) River Information. The expanded daily detections (rounded to the nearest 0.1 fish) were then summed each week and rounded to the nearest whole number. Arrival timing at Lower Granite Dam for each group was graphed using the expanded weekly detections as a percentage of the total expanded number of fish for that group.

To determine the minimum survival rates to Lower Granite Dam of the three groups of PIT-tagged fish from Lookingglass Creek, the total unique detections at all Snake and Columbia River dams were used. Survival rates were calculated for each group by dividing the total number of unique detections by the total number of the juveniles tagged. Confidence intervals (95%) for total detection percentages were calculated using methods described in Ott and Mendenhall (1985). To determine differences among groups we used the overlap of these intervals. Only the upper bound of the confidence interval was used for determining overlap, because the point estimate was an actual observed minimum.

Results/Discussion

Stream Flow and Temperature

Increasing and fluctuating flows began in Lookingglass Creek in February 1997, and continued until the week of 27 May (Figure 4). Weekly maximum flows ranged from 1 to 33 m^3/s with four major peaks occurring the weeks of 7 January, 1 April, 22 April, and 13 May (Figure 4). Flow then decreased dramatically to a summer low of about one to two m^3/s after the week of 1 July (Figure 4). There were higher flows in the weeks from 11 March to 1 April than were seen historically from 1964 to 1971 (Figure 4).

Water temperature peaked at sites 2 and 3 in Lookingglass Creek for 1997 during the week of 5 August (17.0 and 19.4^{o}C) (Figure 4). This was 4 weeks after the peak in maximum water temperature observed from 1964 to 1971 (Figure 4). Maximum temperatures at site 2 in 1997 (Figures 3 and 4) were within the range of maximum temperatures observed among all years from site 1 from 1964 to 1971 (Figure 4). The minimum water temperatures for all sites in 1997 were very similar to one another, generally falling within the minimums observed from 1964 to 1971 (Figure 4). Maximum temperatures in 1997 at the hatchery intake (19.4^{o}C) were somewhat higher than those from locations upstream in 1997 (Figure 4).

Adult Return to Lookingglass Hatchery

Adult spring Chinook salmon that were trapped and passed above the weir on Lookingglass Creek in 1997 included 67 four-year-old, and 10 five-year-old adult spring Chinook salmon (Table 1). There were no three-year-old fish trapped. There were also 5 four-year-old, and 5 five-year-old unmarked adult spring Chinook salmon that died while being held at Lookingglass or Wallowa hatcheries (Table 1). We collected an additional 8 four-year-old, and 2 five-year-old adult spring Chinook salmon during spawning ground surveys conducted above the weir on Lookingglass Creek in 1997 that were not trapped at the hatchery weir (Table 1).There were 26 marked fish that swam into the Lookingglass Hatchery trap in 1997. the unmarked and marked portions of the return first arrived at the trap the week of 10 June with the peak arrival the week of 17 June (Figure 5).

Progeny-Per-Parent Ratios

The Lookingglass Creek progeny-to-parent ratio for the complete 1992 cohort (3, 4, and 5-year-old fish) was 0.58 (Table 2). The 1992 cohorts in Grande Ronde River tributaries ranged from 0.20 to 0.84 (Table 2). The ratio for the 1993 cohort, three and four-year-old fish, was 0.28 in Lookingglass Creek and ranged from 0.12 to 0.52 for the Grande Ronde River tributaries (Table 2). We did not capture any three-year-old fish in Lookingglass Creek in 1997 from the 1994 cohort, however, the 1994 cohort in Grande Ronde River tributaries ranged from 0.04 to 0.23 (Table 2).

It is possible that the unmarked fish returning to Lookingglass Creek are not from natural production in Lookingglass Creek but from other sources. Strays from other Grande Ronde River tributaries could be another source of unmarked adult spring Chinook salmon returning to the Lookingglass Creek basin. Since we could not mark (fin clip, PIT tag, CWT) every fish leaving Lookingglass Creek we have no way of being certain where the unmarked fish originated, some very well could be strays from other basins.

Another possible source of the unmarked fish returning to Lookingglass Creek could be Lookingglass Hatchery releases that were not fin clipped. Pre-release sampling of the Rapid River stock (the only stock released directly from Lookingglass Hatchery) conducted by ODFW suggest this is unlikely. The 1992, 1993, and 1994 cohorts, released from Lookingglass Hatchery, were 100% marked with either an adipose (AD) or right pelvic (RV) fin clip or a combination of the two (ADRV) (Table 3)(ODFW unpublished).

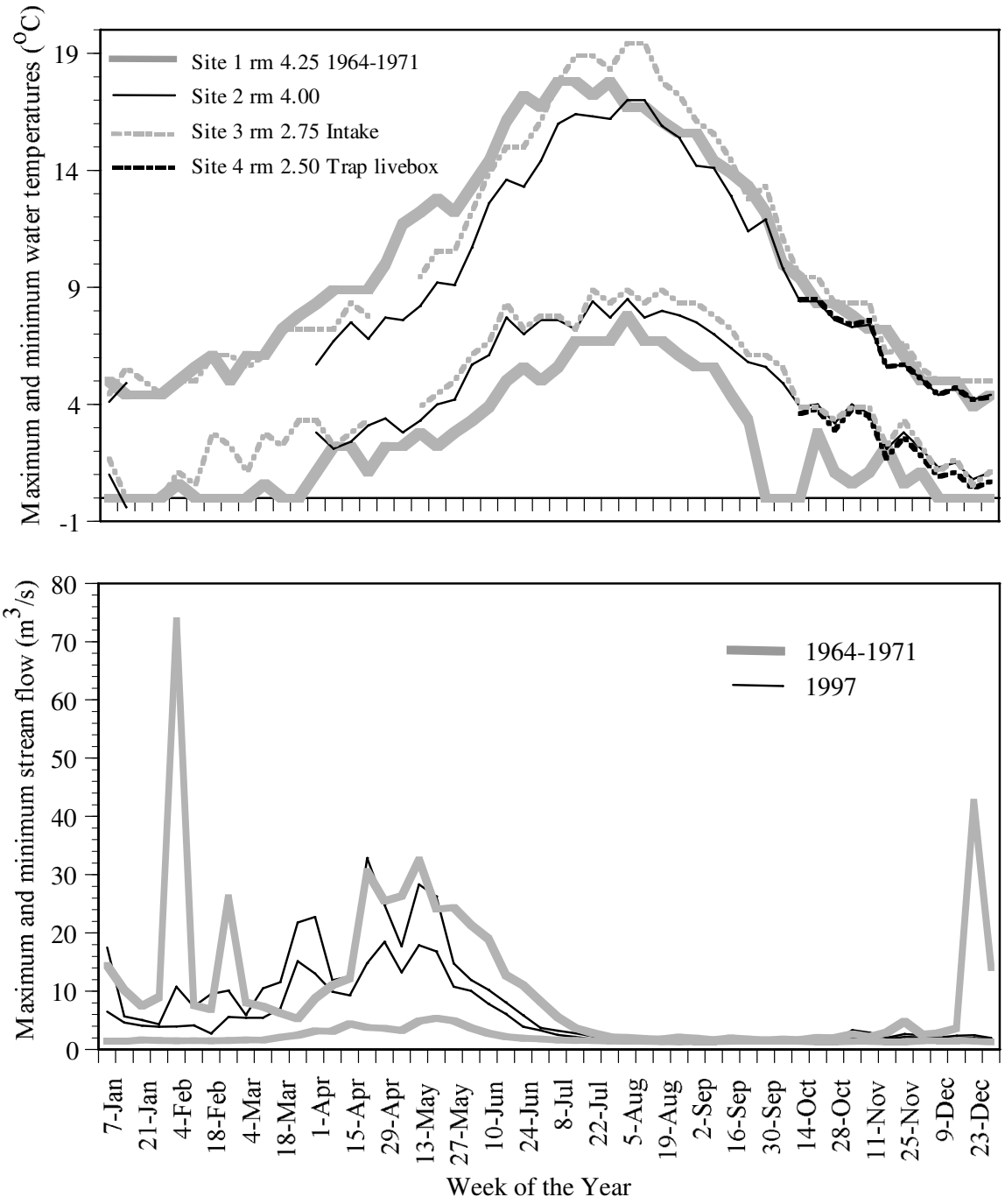

Figure 4. Historical (1964-1971) and 1997 ranges of weekly stream temperature and flow in Lookingglass Creek. Week of the year is represented by the last day of the week. Data for temperatures were provided by the USFS unpublished, Burck 1993, ODFW HMIS unpublished. Data for flows were provided by USGS unpublished and Burck (1964-1974).

Table 1. Disposition, age, sex, and fork length data from spring Chinook salmon that were passed above the weir on Lookingglass Creek, recovered above the weir but were not trapped at the hatchery, and unmarked spring Chinook salmon that died while being held at the Wallowa or Lookingglass hatcheries in 1997.

		Males[a]			Females[a]		
			Fork length (mm)			Fork length (mm)	
Disposition[b]	Age[c]	N	Range	Median	N	Range	Median
Passed	3	0	--	--	0	--	--
Passed	4	22	659-930	775	45	690-915	760
Passed	5	5	899-960	900	5	630-890	815
Mortality	3	0	--	--	0	--	--
Mortality	4	0	--	--	5	692-836	753
Mortality	5	3	850-920	896	2	800-902	--
Recovered	3	0	--	--	0	--	--
Recovered	4	5	725-890	765	3	715-805	785
Recovered	5	1	845	--	1	870	--

[a] *The sex of the dead and recovered fish was determined by internal inspection. The presumptive sex of the passed fish was judged by hatchery personnel using the physical appearance of the fish between 10 July and 22 August, which was the period of release.*

[b] *Disposition of the fish, Passed = placed above the upper weir from 10 July to 22 August, Recovered = found during spawning ground surveys, not trapped at weir, Mortality = died while at Lookingglass or Wallowa hatcheries.*

[c] *Age of the fish was determined by ODFW using scale reading.*

Table 2. Progeny-per-parent ratios for the 1992, 1993, and 1994 cohort spring Chinook salmon returning in 1995, 1996, and 1997 to Lookingglass Creek or other Grande Ronde River tributaries.

Cohort, Location	Expanded[a] redd count	Parent Population[b]	Returning progeny by age[c] 3	4	5	Progeny-per-Parent
1992,						
Lookingglass Ck.	49	220	9	101	17	0.58
Wenaha R.	192	626	2	399	33	0.69
Minam R.	278	906	4	399	32	0.48
Lostine R.	39	127	1	83	23	0.84
Catherine Ck.	94	306	4	49	22	0.25
Grande Ronde R.	127	414	1	74	8	0.20
1993,						
Lookingglass Ck.	132	297	3	79		0.28
Wenaha R.	113	368	12	181		0.52
Minam R.	169	551	12	179		0.35
Lostine R.	102	333	2	129		0.39
Catherine Ck.	124	404	1	121		0.30
Grande Ronde R.	110	359	2	42		0.12
1994,						
Lookingglass Ck.	40	121	0			0.00
Wenaha R.	68	222	11			0.05
Minam R.	83	271	11			0.04
Lostine R.	16	52	8			0.15
Catherine Ck.	29	95	7			0.07
Grande Ronde R.	4	13	3			0.23

[a] *The redd counts in each year from 1992 to 1997 were expanded by section using the average (1986-1997) percentage of the total redds by section. This was calculated using the redd counts from the survey or surveys when all sections of the stream were surveyed and more than 15 total redds were counted. These percentages were then applied to the totals of sections where the redd counts were not surveyed on the final survey of the year.*

[b] *The expanded redd counts were multiplied by the average fish-per-redd estimate of 3.26 (1992 to 1994) in Lookingglass Creek to obtain an estimate of adult escapement. The Lookingglass Creek parent population was based on a marked fish to unmarked fish ratio above the weir.*

[c] *The overall age structure from adults recovered on spawning grounds (calculated from reading scales) throughout the Grande Ronde River basin was applied to all natural populations to calculate the cohort returns for the estimated escapement in each return year (ODFW, unpublished data).*

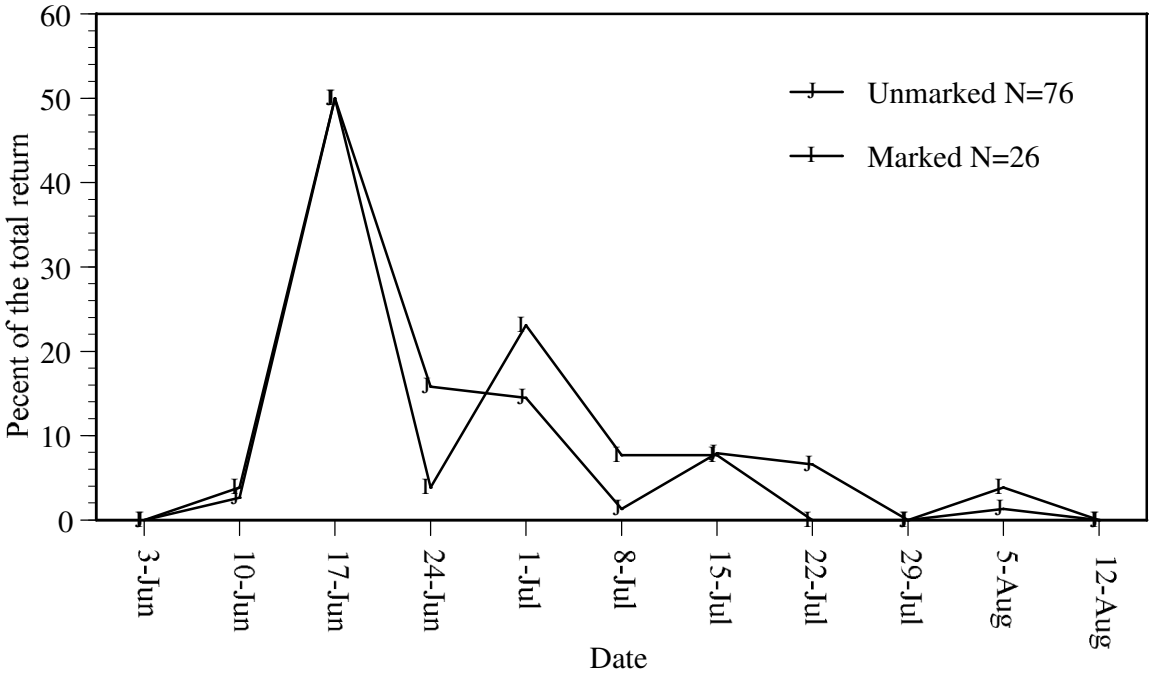

Figure 5. Arrival timing at the Lookingglass Hatchery adult trap of marked and unmarked spring Chinook salmon in 1997. N= total number of each mark type captured at the hatchery. We did not have the date of trapping for 4 fish that died while at the hatchery. The trap was opened on 11 March, 1997 and was closed on 15 September, 1997.

Table 3. Release and fin clip quality data for the Rapid River stock spring Chinook salmon released at Lookingglass Hatchery from the 1992 to 1994 cohorts.

Cohort	Number released	Pre-release fin clip		
		ADRV	AD or RV	None
1992	849,273	830,968	18,305	0
1993	658,230	645,413	12,817	0
1994	139,112	114,219	24,893	0

Source: ODFW Research, La Grande, unpublished data.

Release of Adult Spring Chinook Salmon Above the Weir

We released 49 unmarked adult spring Chinook salmon above the Lookingglass Hatchery on 10 July, 5 unmarked adults on 16 July, 1 unmarked and 1 marked adult on 5 August, and 20 unmarked and 1 marked adult on 22 August, 1997. The fish released on 22 August were adults that were being held at Wallowa Hatchery (Figure 6). The marked fish, released on 5 August, was released intentionally because we were not sure whether we would have enough fish to replace all of the prespawning mortality above the weir. The other marked fish released on 22 August was not realized until the snouts taken during spawning ground surveys revealed a coded wire tag in one fish from this group. Our total release group was comprised of 27 four- and five-year-old males and 50 four- and five-year-old females (Table 1). Hatchery personnel were 92.7% accurate at determining the sex of the fish at release based upon fish recovered on the spawning grounds (See Spawning Ground Surveys).

We saw extremely high pre-spawning mortality in 1997. Twenty-five of the first 54 fish released above the weir were recovered as prespawning mortalities (before 4 August, date of first redds counted). Because of the high mortality, all of the remaining unmarked spring Chinook salmon returns (21), which were being held at Wallowa Hatchery, were released above the weir to replace the mortality.

The mortality observed in the 1997 release group was probably due in large part to "head burn", a symptom which may be caused by high total dissolved gases in the water that are taken in through the gills. Dissolved gas is a measure of the pressure of dissolved gas in the water column. When spillway water plunges into the tailrace, nitrogen is forced into the water at higher than normal levels. This condition, called *supersaturation*, occurs when dissolved gas pressure in the water actually exceeds the atmospheric pressure. The dissolved gases come out of solution in the form of gas bubbles in the body cavities of fish, such as behind the eyes (causing exophthalmia) or between layers of skin tissue. Small bubbles can form within the vascular system, blocking the flow of blood and causing tissue death. Worse, bubbles can form in the gill lamellae and block blood flow, occasionally resulting in death by asphyxiation. It is likely that lack of formalin treatment exacerbated fungus development.

Spawning Ground Surveys

We observed 21 completed redds between 10 July and 15 September 1997 above the upper weir (Unit 3U), 3 completed redds in Unit 3L, and 4 completed redds below Lookingglass Hatchery in Unit 1 (Appendix Table A-2) (Figure 2). There were no redds observed in units 4 or 2 (Appendix Table A-2) (Figure 2). Peak counts of 4 new redds occurred on 15 and 20 August and 2 September in Unit 3U (Figure 6). Three dead fish were recovered during a survey of the lower 0.75 rm of Unit 3U on 10 July, the afternoon of the first release. Thirteen of 16 female carcasses on the upper weir had retained 100% of their eggs in the body cavity. Ten males were recovered on the upper weir before the first redd was counted on 4 August.

We recovered 55 (71.4%) spring Chinook salmon from the release group during our surveys in Lookingglass Creek with the peak number of fish being recovered on 30 July (Figure 6). We

recovered 9 fish in Unit 3U that were not tagged (not handled at the hatchery weir)(Figure 6). We recovered 10 fish during our surveys of units 4, 3L, 2, and 1. Four of these 10 fish were from the release group and were recovered in Units 2 and 3. The remaining 6 fish were not from the release group and were recovered in Units 1 and 3. Of the 55 release group recoveries 42 had retained the jaw tag (76.4%), but all were identifiable as fish we released by the opercle punches. The presumptive sex of these fish at the time of tagging, was verified by the data associated with jaw tags and opercle punches (right or left opercle indicating presumptive sex) of recovered fish, and was 92.7% accurate. Four of the 55 carcass recoveries that were called females at release were males.

The rate of recovery in Unit 3U in 1997 was lower (71.4%) than the previous year (88%) (M^{c}Lean and Lofy 1999). This reduction in recovery percentage is most likely a result of the fact that most of the fish were released earlier in the spawning season in 1997 (70% by 15 July, Figure 6) compared to 1996 (100 % on 26 August) (M^{c}Lean and Lofy 1999). The high prespawning mortality may have affected recovery. Recovery of prespawning mortalities is more difficult because fish are most likely hiding when they die (under logs, etc.) making there detection difficult. When the 1997 release is divided into two time periods, before and after 22 August, we only recovered 37 of 56 (66.1%) during the first time period and 16 of 21 (76.2%) during the second time period which was more similar to the release strategy in 1996. The increased time in the natural environment may have allowed predators and scavengers (e.g., bears, cougars, bobcats, coyotes, and raccoons) to capture more of the fish before, during, and after spawning making them unavailable for recapture. However, this may have accomplished our goal of removing carcasses from the stream. In casual observations, we have sighted more bears in and around Unit 4 in the last few years than previously. This may, however, be due to the fact that we have been walking the creek more often, thus increasing the probability of encounter.

Sampling Adult Chinook Salmon Carcasses for Pathogens

Personnel from ODFW Fish Health laboratory were provided with 66 Chinook salmon kidney samples or whole carcasses which were recovered during spawning ground surveys in 1997 (Appendix Table A-3). Of the 66 kidney samples collected from Lookingglass Creek, only 2 of the fish had clinical levels, 11 had moderate levels, and 53 had low levels of infection of *Renibacterium salmoninarum* by enzyme-linked immunosorbent assay (ELISA) (Appendix Table A-3). This bacterium species causes bacterial kidney disease (BKD). Only 64 of the 66 samples were used to culture various species of bacteria in 1997. *Aeromonad-pseudomonad* bacteria (general septicemia) dominated 24 of the cultures, 15 were negative for any bacteria in the culture, 12 had a mixed culture, 9 were dominated by *Aeromonas salmonicida* (furunculosis), 2 were dominated by *Yersinia ruckeri* (enteric redmouth disease), and 2 were dominated by a gram positive bacillus (Appendix Table A-3).

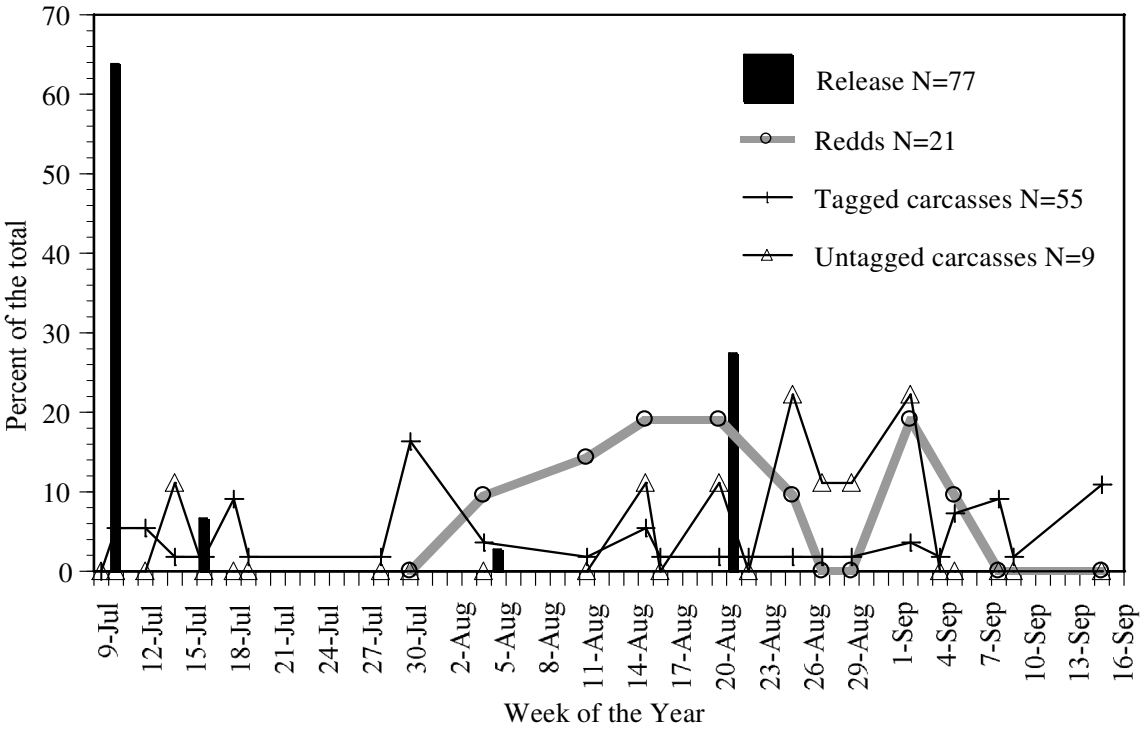

Figure 6. Percents of the total adult spring Chinook salmon released, completed redds, and carcass recovery by date of observation from Unit 3U of Lookingglass Creek. The tagged carcass recoveries (release group) are from the entire basin, while the untagged carcass recoveries are only from Unit 3U.

In 1997, 23% of the cultured samples were negative for any bacteria. From 1992 to 1995 (Lofy and M^{c}Lean 1995a, 1995b, M^{c}Lean and Lofy 1995,1998) pathologists found bacteria in all cultures from carcasses recovered above the weir on Lookingglass Creek. One possible explanation for this lower incidence of bacteria in 1997 may be that the sample size was higher (66) in 1997 than in 1992-1995 which ranged from 4 to19. In 1996 (M^{c}Lean and Lofy 1999) the sample size was also relatively large compared to 1992-1995. The pathology results showed an absence of bacteria in 19 of 47 cultures in 1996. Another possible explanation may be that the adult Chinook salmon in Lookingglass Creek are being exposed to bacteria in lesser concentrations than in previous years.

Genetic Monitoring

We collected 72 fin samples from the unmarked fish released above the weir in 1997. These samples can be analyzed when funding is obtained.

Population Estimates and Timing Past the Rotary Screw Trap for the 1995 Cohort

We captured 2,166 juvenile spring Chinook salmon from the 1995 cohort in the rotary screw trap through June of 1997 (Table 4). We captured the first of the presmolts within 2 days of release in 1996 into Lookingglass Creek (Appendix Table A-1). We captured the last of the 1995 cohort from our pre-smolt release on 10 September 1997 (Appendix Table A-1). The fish that were captured in the trap after 1 July 1997 appeared to be precocial fish. Most precocial fish were extruding milt and all had a dark coloration. Median monthly fork lengths of fish captured in the trap around the 20th of each month ranged from 67 mm for August, 1996, to 99 mm for March, 1997 (Figure 7). We estimated that 9,215 juveniles (29.8% of the release group) from the 1995 cohort moved past the rotary screw trap in Lookingglass Creek during 1996 and 1997 (Table 4).

Of the fish estimated to have passed the trap site, over half (64.5%) of the juveniles from the 1995 cohort migrated before January 1997 as sub-yearlings (Figure 8). Peak migration past the trap for the 1995 cohort occurred during the October and March trapping periods (Figure 8).

Time and Distance of Trap Efficiency Release

We released 135 juvenile spring Chinook salmon from the 1995 cohort during the day and 144 during the night about 50 m above the screw trap from 8 September to 8 October 1996. We recaptured 36 (26.7%) of the fish that were released during the day and 38 (26.4%) of the fish that were released at night. There was no significant difference in recapture rate for trap efficiency fish released just above the screw trap during the day or night (χ^2=3.841, P=0.96, df=1).

For our tests between day and night releases at the normal release site (about 200m above the screw trap) we released 840 fish during the day and 797 fish at night from 8 September 1996 to 16 April 1997. We recaptured 251 (29.9%) of the fish that were released during the day and 257 (32.2%) of the fish that were released at night. There was no significant difference between recapture rates for trap efficiency fish released at the normal site during the day and night (χ^2=3.841, P=0.30, df=1).

PIT-Tagging of the Hatchery-Reared 1995 Cohort

We PIT-tagged a total of 193 juveniles from the fall group, 1,014 juveniles from the winter group, and 470 juveniles from the spring group for the 1995 cohort at the screw trap (Table 5). We held a total of 1,411 fish overnight throughout the trapping season. Only 6 of these fish ended up as mortalities (0.4%).

Table 4. Juvenile spring Chinook salmon from the 1995 cohort captured in a rotary screw trap, releases and recaptures from trap efficiency tests, and the estimated number of migrants from Lookingglass Creek during 1996 and 1997. Estimates include both wild and hatchery fish captured.

Month	Total trapped	(wild)	Trap efficiency release	Trap efficiency recapture	% Trap efficiency[a]	Population Estimate	±95%CI
Jul	69	0	40	4	10.00	690	1,200
Aug	63	0	48	8	16.67	378	481
Sep	143	2	92	19	20.65	692	349
Oct	755	5	698	273	39.11	1,930	213
Nov	473	3	428	179	41.82	1,131	154
Dec	100	0	90	8	8.89	1,125	1,322
Jan	95	0	87	17	19.54	486	258
Feb	173	0	158	34	21.52	804	293
Mar	277	0	258	41	14.91	1,858	599
Apr	18	0	17	0	14.91	121	65
May	0	0	0	0	--	--	--
Jun	0	0	0	0	--	--	--
Totals	2,166	10	1,916	583		9,215 ±	2,031

Number of pre-smolt hatchery fish released above the weir (25 July 1996): 30,880
Estimated # of redds above the weir in 1995 was: 2
Estimated # of female spring Chinook salmon above the weir in 1995 was: 2
Estimated # of male spring Chinook salmon above the weir in 1995 was: 1

[a] *Because the trap efficiency release was less than 25 fish for the month of April 1997, the release for April was combined with March to make one trap efficiency estimate that was used for each individual month after that.*

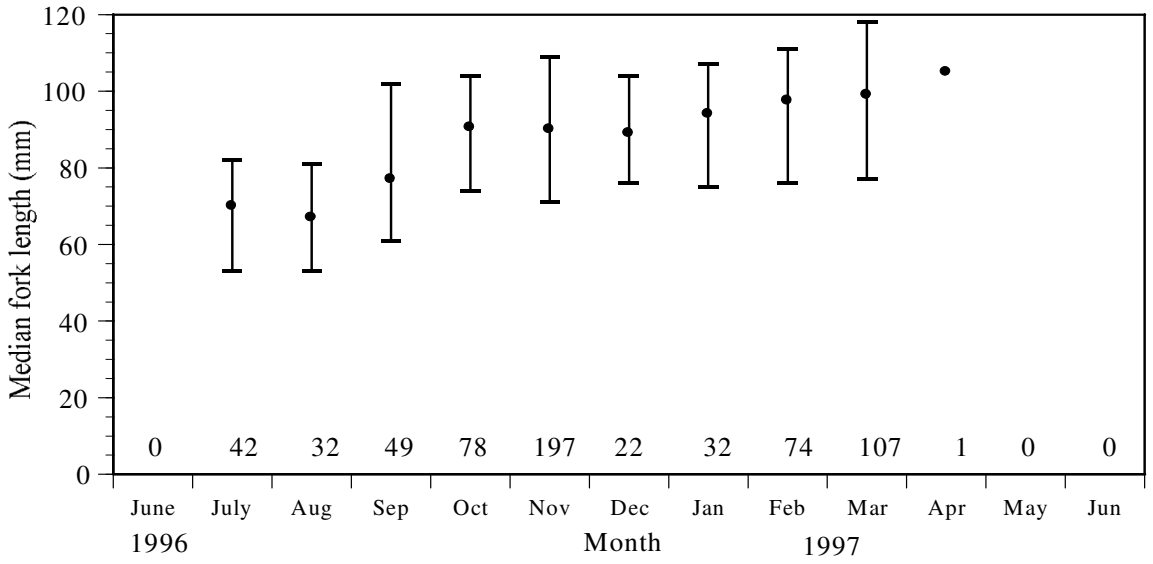

Figure 7. Monthly median and range of fork lengths from 1995 cohort juvenile spring Chinook salmon captured in the rotary screw trap on Lookingglass Creek in 1996 and 1997. Length information from fish trapped around the 20th (± 5 days) of each month was used. Sample size is shown above the month.

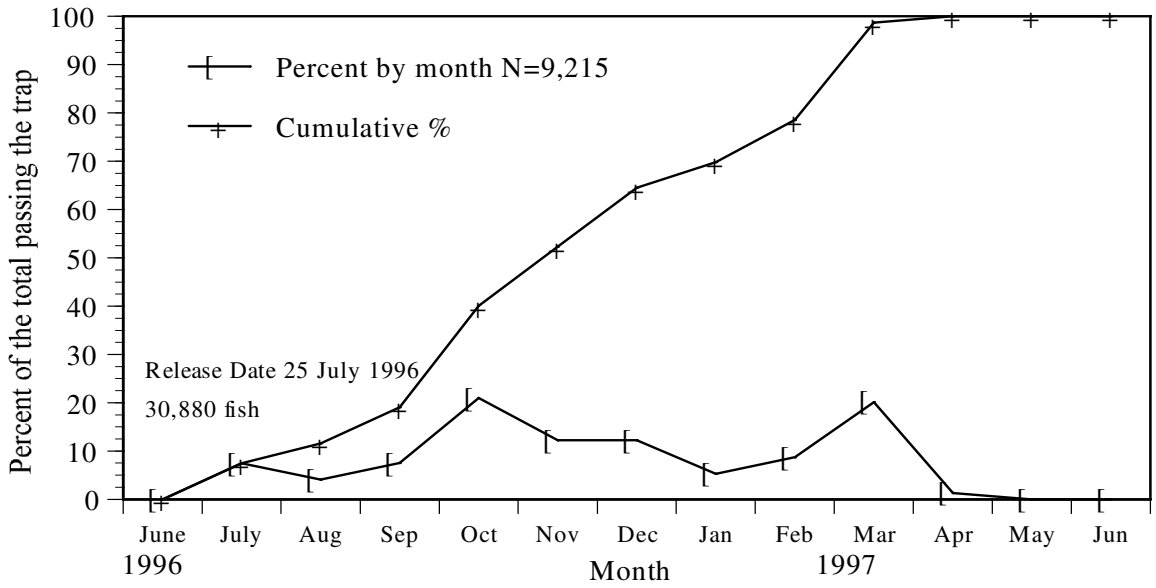

Figure 8. Percent of the total expanded numbers of 1995 cohort juvenile spring Chinook salmon passing the rotary screw trap site on Lookingglass Creek in 1996 and 1997. The total estimated population passing the trap (9,215) is an expanded number.

Table 5. PIT-tagging information for juvenile spring Chinook salmon from the 1995 cohort captured at the rotary screw trap on Lookingglass Creek in 1996 and 1997.

Group	Number PIT-tagged	Median date of PIT-tagging	Median arrival date at Lower Granite Dam	Number Detected	Expanded[a] Detections
Fall (trap)	193	10 September 1996	19 April 1997	14	17
Winter (trap)	1,014	25 October 1996	16 April 1997	104	122
Spring (trap)	470	2 March 1997	16 April 1997	100	120

[a] *Expansion factors may differ depending upon timing of individual fish.*

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

Juvenile Chinook salmon from the hatchery-reared 1995 cohort first arrived at Lower Granite Dam the week of 8 April, with the last fish arriving the week of 20 May (Figure 9). The arrival distributions of the three groups appeared similar with median dates of arrival being 16 April 1997 for the winter and spring groups and 19 April 1997 for the fall group (Table 5)(Figure 9). The PIT tag detectors at Lower Granite Dam became operational on 1 March 1997.

Minimum survival rates of PIT-tagged juvenile spring Chinook salmon from the hatchery-reared 1995 cohort for the fall, winter, and spring groups were 11.9, 22.2, and 40.4%, respectively. There was a significant difference in detection rates between the fall, winter and spring groups based on the 95% confidence interval overlap (Figure 10). Survival indices of the 1995 cohort captured at the trap by month for the months in which more than 50 tagged fish were released (September to March), ranged from 9.9 to 44.6% (Figure 10).

PIT-Tagging Effects on Survival and Migration Timing of the 1995 Cohort

We PIT-tagged 1,199, 1,190, and 1,223 fish in the small, medium, and large size categories respectively. The control group had 1,214, 1,197, and 1,227 fish in the small, medium, and large size categories, respectively.

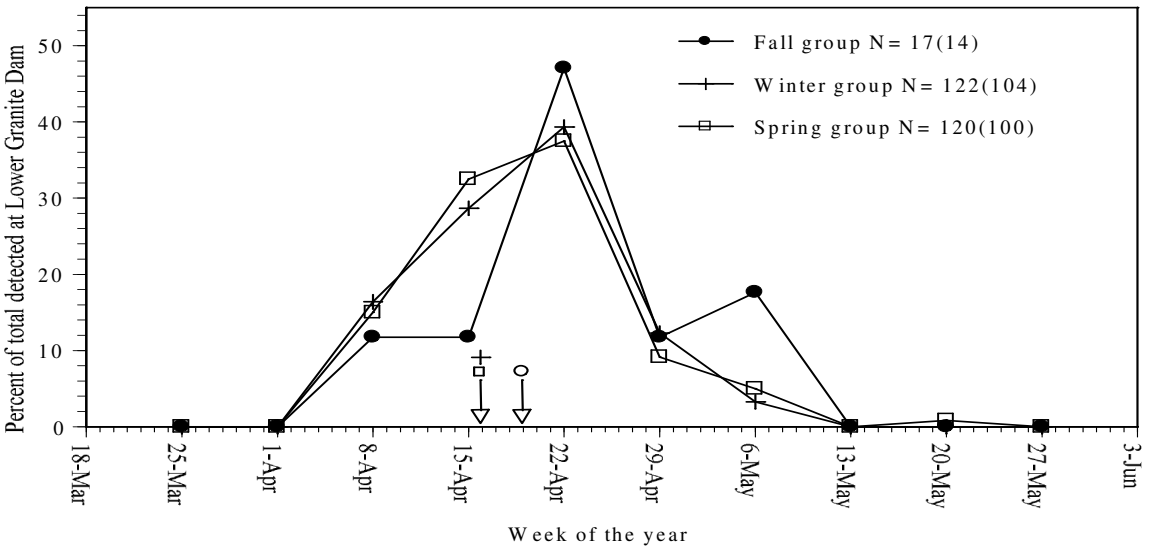

Figure 9. Arrival timing by week at Lower Granite Dam in 1997 of three groups of hatchery-reared 1995 cohort juvenile spring Chinook salmon PIT-tagged at the rotary screw trap on Lookingglass Creek. The arrows indicate the median arrival date of each group. Expanded detections (N) are graphed. Actual detections are in parentheses. Week of the year is represented by the last date in the week.

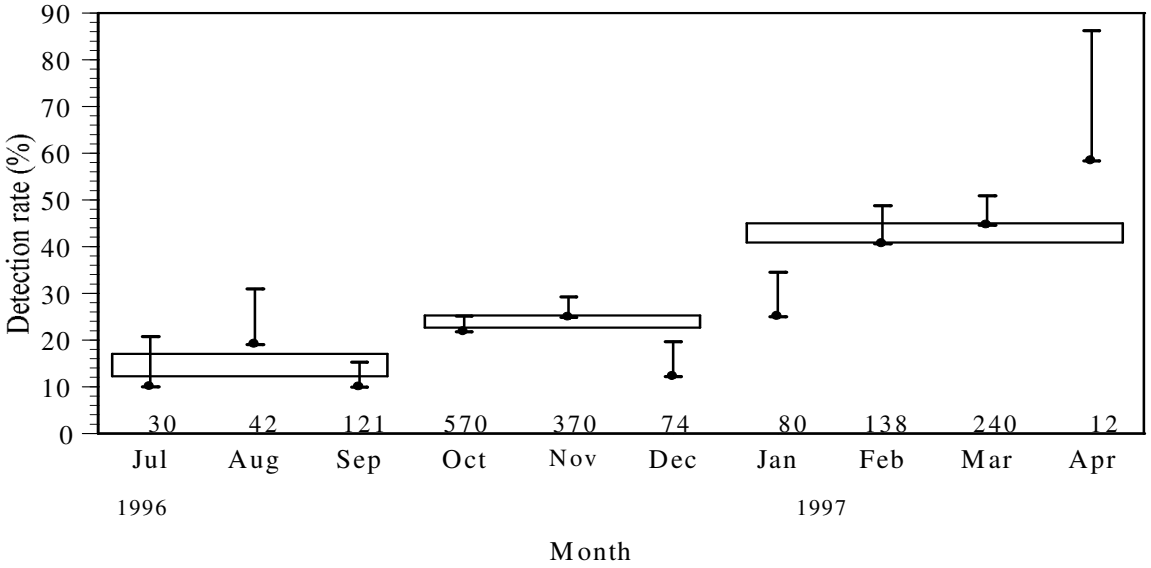

Figure 10. Total unique detection rates with upper ninety-five percent confidence intervals (bars) for 1995 cohort juvenile spring Chinook salmon tagged at the rotary screw trap in Lookingglass Creek and detected at Snake or Columbia River dams. The rectangles represent detection rates and upper ninety-five percent confidence intervals for fish from summer (Jul-Sep), fall (Oct-Dec), and spring (Jan-Apr) groups. Number tagged is above each month.

Monthly Arrival Timing and Survival to the Screw Trap for the 1995 Cohort

The Alcian Blue mark loss from the PIT-tagged group was used to create a mark loss expansion factor to expand the number of control fish trapped (Table 6). The mark loss was grouped into 5-month intervals then applied to the monthly catch (Table 6). The mark retention was high for the PIT-tagged fish during the first 5 months of trapping: 85% for the small group, 95% for the medium group, and 96% for the large group (Table 6). The mark retention decreased during the next 5 months of trapping, 37% for the small group, 80% for the medium group, and 84% for the large group (Table 6). We used estimated catch at the screw trap to account for differences in arrival timing between the groups and the different trap efficiencies that may occur at that time. We captured an estimated 304 PIT-tagged and 146 control fish from the small category (Table 7). We captured an estimated 285 PIT-tagged and 256 control fish from the medium group (Table 8). We captured an estimated 450 PIT-tagged and 411 control fish from the large group (Table 9). The control groups of small and medium fish tended to arrive earlier at the screw trap than the PIT-tagged fish from the same groups (Figure 11). For the large group, however, the PIT-tagged fish arrived earlier at the screw trap than the control group (Figure 11). For the medium and large groups of PIT-tagged fish, 82.8 and 77.6% of the fish had moved past the screw trap by January, while only 54.3% of the PIT-tagged small group had moved past (Figure 11). Movement patterns for the control fish were similar to PIT-tagged fish, with 63.3 and 70.1% of the medium and large fish moving past the trap by January and only 51.4% of the small group (Figure 11).

There was no significant difference in survival indices between the PIT-tagged and control fish within or among any of the small, medium, and large size groups (Figure 12).

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

Juvenile Chinook salmon from the 1995 cohort small, medium, and large PIT-tagged groups from Lookingglass Creek first arrived at Lower Granite Dam the week of 1 April (small group), with the last fish arriving the week of 13 May (all groups)(Figure 13). The median dates of arrival were 22, 15, and 16 April 1997 for the small, medium, and large groups respectively (Figure 13).

There were significant differences in the minimum survival rates to Lower Granite Dam between the small, medium, and large groups of PIT-tagged fish. The survival rate for the small group (7.8%) was significantly lower than both the medium (10.1%) and the large (11.9%) groups (Figure 14). There was no significant difference between the medium and large groups (Figure 14).

Table 6. Secondary mark loss from PIT-tagged juvenile spring Chinook salmon from the small, medium, and large size groups within the 1995 cohort captured in a rotary screw trap in 1996 and 1997.

	Small			Medium			Large		
Month	Total	Mark loss	Loss expansion[a]	Total	Mark loss	Loss expansion[a]	Total	Mark loss	Loss expansion[a]
Jul	0	0	0.85	3	0	0.95	8	0	0.96
Aug	4	0	0.85	1	0	0.95	1	0	0.96
Sep	6	1	0.85	1	0	0.95	4	0	0.96
Oct	21	3	0.85	37	1	0.95	33	1	0.96
Nov	10	2	0.85	14	2	0.95	34	2	0.96
Dec	3	1	0.37	6	1	0.80	7	0	0.84
Jan	3	3	0.37	3	1	0.80	1	0	0.84
Feb	8	5	0.37	3	0	0.80	9	2	0.84
Mar	12	8	0.37	2	1	0.80	5	2	0.84
Apr	1	0	0.37	1	0	0.80	3	0	0.84
May	0	0	--	0	0	--	0	0	--

[a] *The total captured and the mark loss for the months from July to November and December to April were combined because of the low sample size to create one mark loss expansion for each 5-month time period.*

Table 7. Actual and estimated numbers of juvenile spring Chinook salmon from the small size group (55-59 mm FL) of PIT-tagged and control fish within the 1995 cohort captured in a rotary screw trap in 1996 and 1997.

Month	PIT tag trapped	Control trapped	Control Mark loss expansion[a]	Population Estimate[b] PIT tag	±95%CI	Control	±95%CI
Jul	0	1	0.85	0	0	12	36
Aug	4	2	0.85	24	40	14	27
Sep	6	2	0.85	29	26	11	14
Oct	21	8	0.85	54	19	24	12
Nov	10	5	0.85	24	12	14	9
Dec	3	0	0.37	34	52	--	--
Jan	3	2	0.37	15	19	28	28
Feb	8	2	0.37	37	28	25	24
Mar	12	1	0.37	80	48	18	22
Apr	1	0	0.37	7	13	--	--
May	0	0	--	--	--	--	--
Totals	68	23		304	96	146	66

Number of PIT-tagged small fish released: 1,199
Number of Control small fish released: 1,214

[a] *The mark loss expansion is from Table 6. The months Jul to Nov and Dec to Apr were combined because of low sample sizes within months.*

[b] *The population estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates in Table 4. The number of control fish captured was first expanded by the mark loss expansion then the trapping efficiency was applied. The variances from the two expansions were added to estimate the 95%CI for each month and the total.*

Table 8. Actual and estimated numbers of juvenile spring Chinook salmon from the medium size group (62-66 mm FL) of PIT-tagged and control fish within the 1995 cohort captured in a rotary screw trap in 1996 and 1997.

Month	PIT tag trapped	Control trapped	Control Mark loss expansion[a]	Population Estimate[b] PIT tag	±95%CI	Control	±95%CI
Jul	3	3	0.95	30	73	32	77
Aug	1	5	0.95	6	15	32	51
Sep	1	3	0.95	5	9	15	17
Oct	37	5	0.95	95	26	13	9
Nov	14	11	0.95	33	13	28	13
Dec	6	3	0.80	67	95	42	65
Jan	3	2	0.80	15	19	13	18
Feb	3	4	0.80	14	16	23	21
Mar	2	6	0.80	13	18	50	38
Apr	1	1	0.80	7	13	8	14
May	0	0	--	--	--	--	--
Totals	71	43		285	129	256	125

Number of PIT-tagged medium fish released: 1,190
Number of Control medium fish released: 1,197

[a] *The mark loss expansion is from Table 6. The months Jul to Nov and Dec to Apr were combined because of low sample sizes within months.*

[b] *The population estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates in Table 4. The number of control fish captured was first expanded by the mark loss expansion then the trapping efficiency was applied. The variances from the two expansions were added to estimate the 95%CI for each month and the total.*

Table 9. Actual and estimated numbers of juvenile spring Chinook salmon from the large size group (69-73 mm FL) of PIT-tagged and control fish within the 1995 cohort captured in a rotary screw trap in 1996 and 1997.

Month	PIT tag trapped	Control trapped	Control Mark loss expansion[a]	Population Estimate[b] PIT tag	±95%CI	Control	±95%CI
Jul	8	3	0.96	80	142	31	76
Aug	1	4	0.96	6	15	25	36
Sep	4	6	0.96	19	21	30	28
Oct	33	20	0.96	84	25	53	20
Nov	34	23	0.96	81	23	57	19
Dec	7	7	0.84	79	128	94	126
Jan	1	3	0.84	5	9	18	22
Feb	9	7	0.84	42	28	39	28
Mar	5	8	0.84	34	30	64	44
Apr	3	0	0.84	20	23	--	--
May	0		--	--	--	--	--
Totals	105	81		450	202	411	166

Number of PIT-tagged large fish released: 1,223
Number of Control large fish released: 1,227

[a] *The mark loss expansion is from Table 6. The months Jul to Nov and Dec to Apr were combined because of low sample sizes within months.*

[b] *The population estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates in Table 4. The number of control fish captured was first expanded by the mark loss expansion then the trapping efficiency was applied. The variances from the two expansions were added to estimate the 95%CI for each month and the total.*

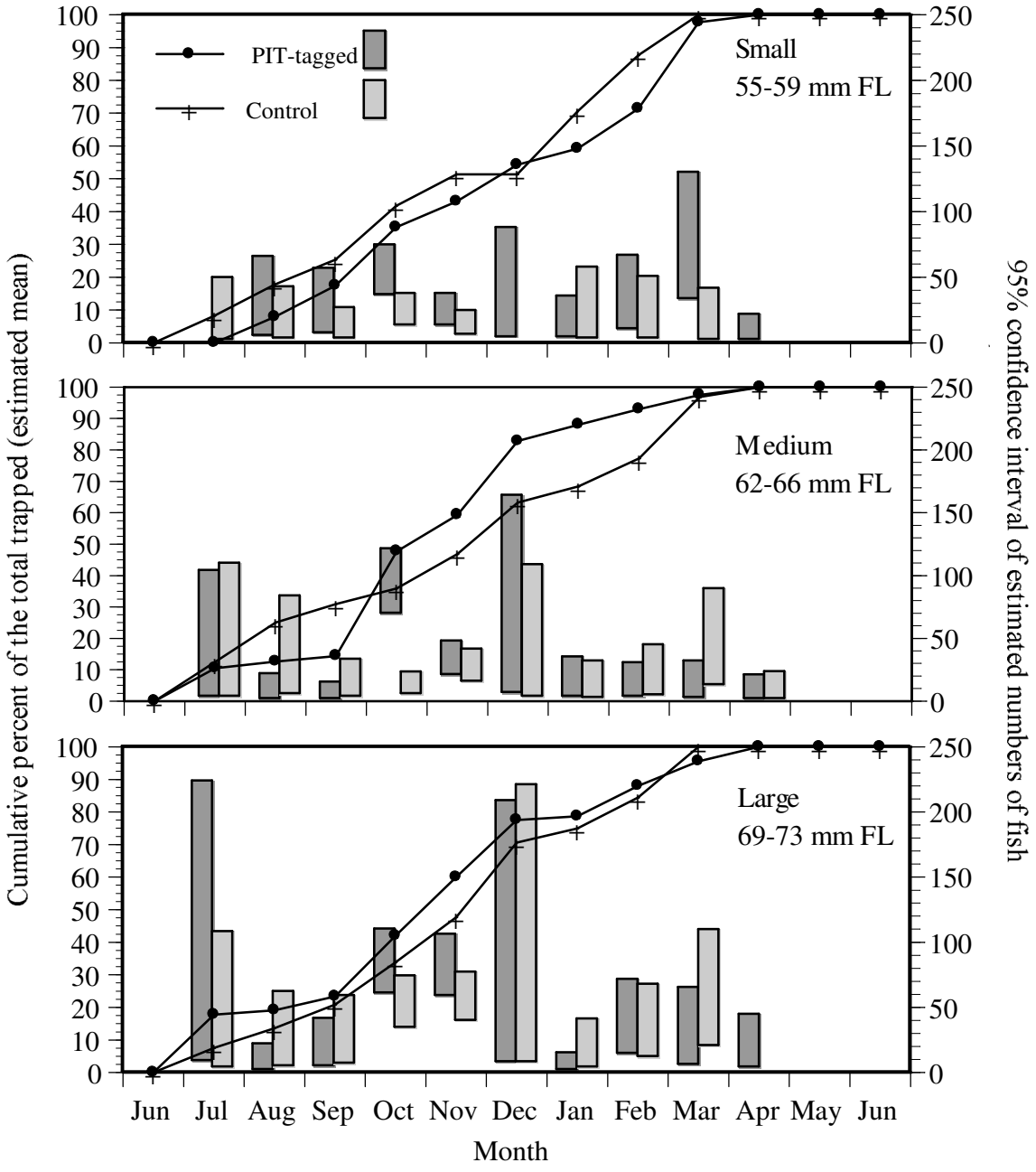

Figure 11. Monthly 95% confidence intervals (solid bars) and cumulative percent of the total population estimates for PIT-tagged and control fish from the 3 size groups of fish from the hatchery-reared 1995 cohort (captured in 1996 and 1997).

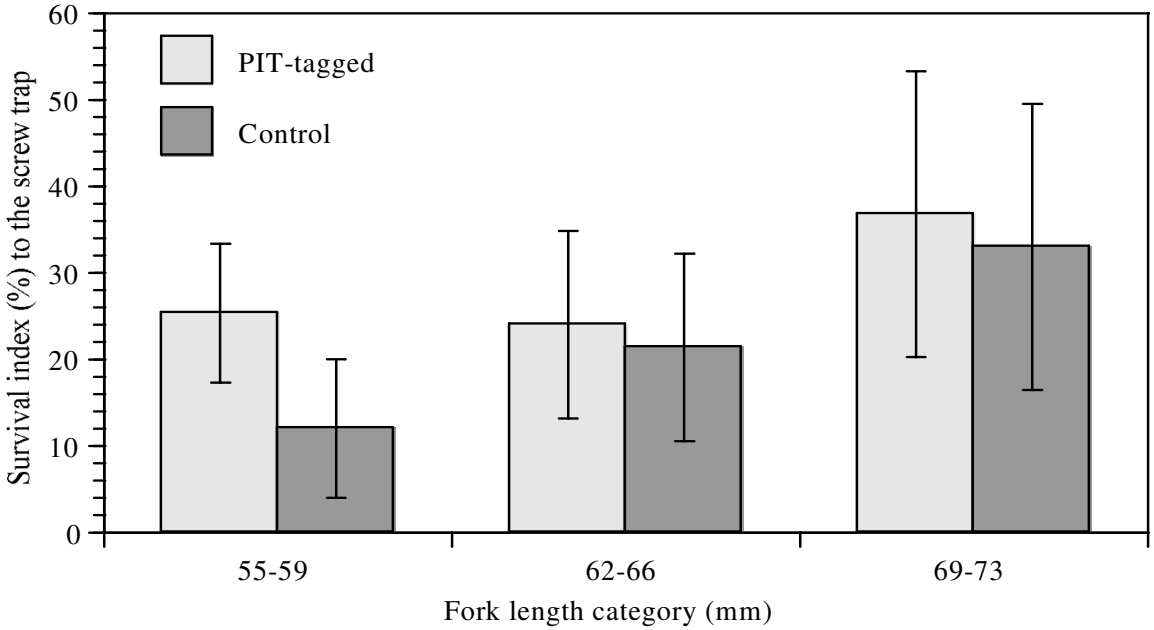

Figure 12. Survival indices to the screw trap for the PIT-tagged and control fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length groups from the hatchery-reared 1995 cohort released into Lookingglass Creek. The error bars represent the 95% confidence intervals.

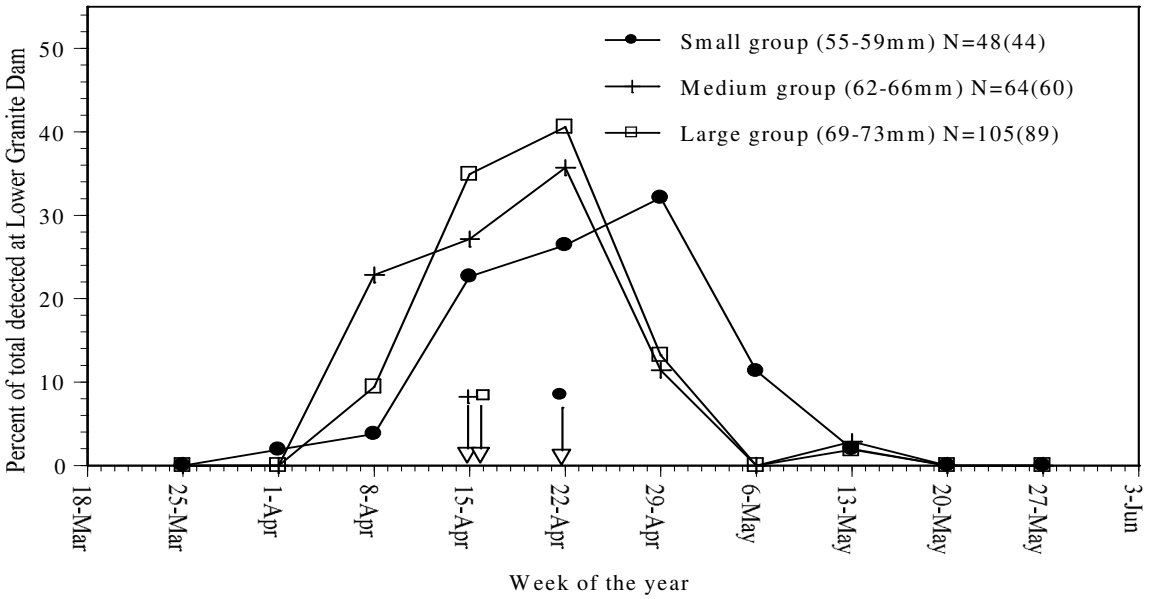

Figure 13. Arrival timing by week at Lower Granite Dam in 1997 of the PIT-tagged fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length groups from the hatchery-reared 1995 cohort released into Lookingglass Creek. Expanded detections (N) are graphed. Actual detections are in parentheses. Arrows indicate the median date of arrival for each group. Week of the year is represented by the last date in the week.

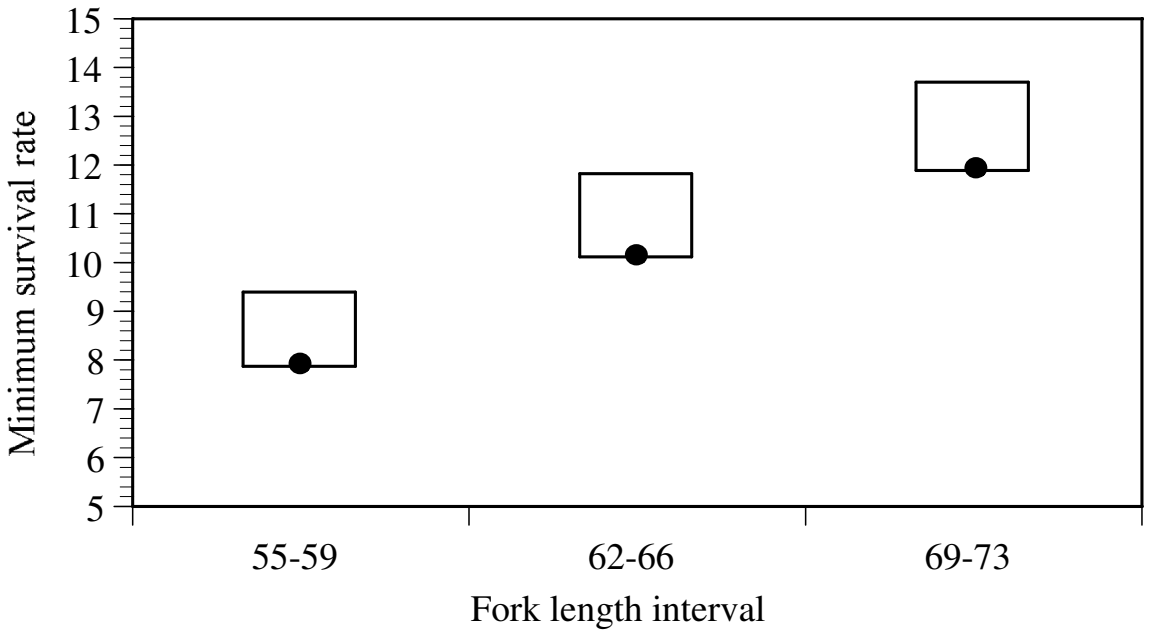

Figure 14. Total unique detection rates and upper ninety-five percent confidence intervals of the PIT-tagged fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length groups of hatchery-reared 1995 cohort released into Lookingglass Creek that were detected at Snake or Columbia River dams in 1997.

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SECTION II

Assistance Provided to LSRCP Cooperators and Other Projects

We provided assistance to LSRCP cooperator ODFW in 1997 for ongoing hatchery evaluation research. Project personnel completed extensive spawning ground surveys for spring Chinook salmon in the Grande Ronde and Imnaha river basins. We provided assistance in pre-release sampling of juvenile summer steelhead at Irrigon Hatchery and the Little Sheep and Big Canyon acclimation facilities and spring Chinook salmon at Lookingglass Hatchery and the Imnaha River Facility. In addition, project personnel provided assistance in sampling adult spring Chinook salmon at Oregon LSRCP facilities and helped with the release of juvenile spring Chinook salmon parr into Lookingglass Creek. Assistance was provided in data summarization and analysis for ODFW monthly and annual progress reports.

We assisted ODFW personnel who have been collecting data on bull trout (*Salvelinus confluentus*) in the Grande Ronde River basin. We have collected fork length and weight data from bull trout we have captured in Lookingglass Creek in our screw trap and those captured in the Lookingglass Hatchery adult bypass. In addition, we have implanted PIT tags in bull trout we have captured in our rotary screw trap.

Due to concerns about the location of the CTUIR work area in the Lookingglass Hatchery building, Lookingglass Hatchery constructed and plumbed an "annex building" near the intake building in 1997. We assisted by obtaining construction bids and overseeing some of the work. We were allowed to use this area as our worksite while checking the screw trap.

Acknowledgments

Our thanks to Dan Herrig and Ed Crateau (United States Fish and Wildlife Service) for administering this contract and coordinating communication between Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and other management and research entities. Gary James, Michelle Thompson, Julie Burke, and Celeste Reeves (CTUIR) provided technical and administrative support, particularly with contract modifications. Thanks go to members of the Research and Development Section of Oregon Department of Fish and Wildlife (ODFW) in La Grande: Rich Carmichael, Mike Flesher, Brian Jonasson, MaryLouise Keefe, Steve Parker, Paul Sankovich, Debra Eddy, and Tim Whitesel for their assistance in the field and the office. Thanks to Craig Contor and Steve Boe (CTUIR), Dan Herrig, Gary James and Rich Carmichael for reviewing drafts of this report. Warren Groberg, Sam Onjukka and Karen Waln of ODFW Fish Pathology, La Grande, sampled adult Chinook salmon for pathogens and provided results. We thank Jo Miller (United States Geologic Survey) for providing stream flow data. Thanks go to ODFW Lookingglass Hatchery personnel: Bob Lund, Ken Danison, Gary Huser, Don Falk, and numerous seasonal personnel for assisting in handling and tagging fish, allowing us the use of facilities at the hatchery, keeping an eye on the screw trap for us and especially for cheerfully offering assistance during emergency situations that helped us prevent or minimize damage to the trap during high water incidents. Thanks go to all CTUIR and ODFW personnel who assisted with the PIT-tagging and marking of over 7,000 fish at Lookingglass Hatchery. Special thanks to Greg Blanc who handled the horse used for packing the fish into the remote areas in upper Lookingglass Creek.

Special thanks to CTUIR technician Cynthia Danison and Barb Blanc for working under adverse conditions, often on weekends, collecting, handling and releasing fish, maintaining the screw trap, assisting in activities at the hatchery, and assisting in data analysis.

Appendices

Appendix Table A-1. Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
07/25/96	1.9	16.8	8.3			Installed fyke net trap at intake,				Released 30,880 juv. chs	
07/26/96	2.0	16.8	8.1								First trap check at 1710, 2310
07/27/96	2.0	15.1	8.5	42		18	a		3	Trap check 0120, first fish at 0440,0630,1750	
07/28/96	2.0	16.3	9.0	--							Trap door not opened
07/29/96	2.0	12.9	10.0	26		22	b	1	1	a1	Opened door last check
07/30/96	1.9	14.5	8.6	0							
07/31/96	1.9	16.4	8.5	1							
08/01/96	1.9	15.9	8.1	3		3	c		0		
08/02/96	1.9	12.4	8.4	3		3	d	1	0	a1	Installed trap in flume 1430
08/03/96	1.9	13.1	8.0	6		4	e		1		Removed fyke net at intake
08/04/96	1.8	12.5	7.8								
08/05/96	1.8	12.9	8.3	4				1		e1	
08/06/96	1.9	14.6	6.6			3	f		0		
08/07/96	1.8	15.4	7.0								
08/08/96	1.9	15.9	7.7	5							Release times were
08/09/96	1.9	16.0	7.9			5	g		3		Day(0800) night(1900).
08/10/96	1.9	16.1	7.9								JAT=Just above trap
08/11/96	1.9	16.3	8.4	2				3		g3	
08/12/96	1.8	15.2	7.5			1	h		0		JAT day
08/13/96	1.7	13.6	8.1								
08/14/96	1.7	15.0	8.8	2							
08/15/96	1.8	15.4	8.2			2	I		0		JAT night
08/16/96	1.8	14.6	7.5	3							
08/17/96	1.8	11.4	7.7								
08/18/96	1.8	13.4	6.9								
08/19/96	1.7	14.0	6.5	9							
08/20/96	1.8	12.8	7.7	0		8	j		2		JAT day
08/21/96	1.7	13.8	6.6								
08/22/96	1.7	14.0	6.7	5				2		j2	
08/23/96	1.8	14.3	6.8			3	k		1		JAT night
08/24/96	1.9	14.1	7.0								
08/25/96	2.0	14.1	7.5								
08/26/96	1.8	13.0	7.6	14							
08/27/96	1.9	10.5	8.6			11	m		0		JAT night
08/28/96	1.9	13.2	8.2								
08/29/96	1.8	14.1	7.6								
08/30/96	1.8	14.2	7.8	7							
08/31/96	1.7	13.4	7.2			5	n		1		JAT day

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
09/01/96	1.8	12.7	6.5								
09/02/96	1.7	12.8	6.2								
09/03/96	1.9	12.6	7.1	11	1	10	o	1	4	n1	JAT night
09/04/96	1.7	11.0	7.7								
09/05/96	1.6	10.6	7.3								
09/06/96	1.7	11.6	5.6								
09/07/96	1.7	12.6	7.2	17				4		o4	
09/08/96	1.7	12.8	6.6			14	p		1		JAT day
09/09/96	1.7	13.1	6.6								
09/10/96	2.0	13.1	7.0	9				1		p1	
09/11/96	1.7	13.3	7.5			6	q		0		JAT night
09/12/96	1.7	11.4	7.6								
09/13/96	1.7	12.3	7.7								
09/14/96	1.7	10.4	7.9	12							
09/15/96	1.7	10.2	7.5			12	r		4		JAT day
09/16/96	1.6	8.5	6.7	12		12	s	3	2	r3	JAT night
09/17/96	1.7	9.3	6.2								
09/18/96	1.7	9.4	5.8								
09/19/96	1.8	10.0	7.0								
09/20/96	1.7	9.4	6.1	20				3		s2 r1	
09/21/96	1.7	9.7	5.3			20	t		5		JAT day
09/22/96	1.6	8.8	5.9								
09/23/96	1.6	8.8	4.3	18				5		t5	
09/24/96	1.6	9.0	5.5			18	u		3		JAT night
09/25/96	1.6	9.1	4.2								
09/26/96	1.6	9.6	4.7	18	1			1		u1	
09/27/96	1.6	10.3	5.2								
09/28/96	1.6	10.7	5.6								
09/29/96	1.8	10.5	5.7	26				2		u2	
09/30/96	1.6	10.3	5.4								
10/01/96	1.6	9.7	5.3	21							
10/02/96	1.6	9.5	5.2	29	1						
10/03/96	1.6	10.1	5.7	19		84	v		31		JAT day(42) night (42)
10/04/96	1.7	9.9	5.9	39	1			31		v31	
10/05/96	1.7	9.5	7.0	9		50	w		14		JAT day(33) night (17)
10/06/96	1.7	9.6	5.7								
10/07/96	1.7	9.7	5.3	12				13		w13	Begin release at norm. site
10/08/96	1.7	10.0	5.9	3		23	x	1	6	w1	3 JAT night 18; day 2 night 3
10/09/96	1.7	10.0	5.9	7				1		x1	
10/10/96	1.7	10.1	6.6	2				5		x5	
10/11/96	1.8	9.5	5.8			9	y		2		Norm day(5) night(4)
10/12/96	1.7	9.1	5.8								
10/13/96	1.7	8.4	6.9	28				1		y1	
10/14/96	1.7	8.5	6.4								
10/15/96	1.8	8.2	6.0	35				1		y1	

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
10/16/96	1.7	7.3	4.7			55	z		12		Norm day(28) night(27)
10/17/96	1.7	6.2	3.4	19				1		k1	
10/18/96	1.8	6.9	5.5	30				13		z12 a1	
10/19/96	1.7	6.2	4.8			48	aa		16		Norm day(28) night(20)
10/20/96	1.6	6.5	4.1	78	1			16		aa16	
10/21/96	1.6	6.3	2.8	52							
10/22/96	1.8	5.5	4.1	41							
10/23/96	1.8	6.5	4.9			158	ab		56		Norm day(77) night (81)
10/24/96	2.7	7.1	5.2	228	1			57		ab56 b1	
10/25/96	2.4	6.5	4.5	67		180	ac		98		Norm day(90) night(90)
10/26/96	1.8	6.4	4.1	14				92		ac92	
10/27/96	1.7	6.2	3.6	12	1	70	ad	2	29	ac2	Norm day(35) night(35)
10/28/96	1.7	6.2	3.9								
10/29/96	1.7	6.6	5.4	10				27		ad27	
10/30/96	1.7	6.6	5.7			21	ae		9		Norm day(11) night(10)
10/31/96	1.7	6.5	4.1								
11/01/96	1.8	5.6	3.3	14		14	af	5	5	ae3 ac2	Norm day(8) night(6)
11/02/96	1.7	5.8	3.3								
11/03/96	1.7	6.3	3.6								
11/04/96	1.6	5.9	3.8	64	1			12		af5 ae5 ad2	
11/05/96	1.6	5.6	4.2	5		62	ag		21		Norm day(31) night(31)
11/06/96	1.8	5.3	3.7								
11/07/96	1.7	5.9	4.0								
11/08/96	1.7	6.6	4.3	32				21		ag21	
11/09/96	1.8	5.6	3.6			26	ah		3		Norm day(13) night(13)
11/10/96	1.7	5.3	3.4								
11/11/96	1.7	6.0	3.9								
11/12/96	1.6	5.7	3.6	26		23	ai	3	8	ah3	Norm day(12) night(11)
11/13/96	1.7	5.9	4.1	4				7		ai7	
11/14/96	1.9	6.0	4.6	3				1		ai1	
11/15/96	2.1	5.9	4.5	2		8	aj		3		Norm day(4) night(4)
11/16/96	1.8	5.3	4.3	2				3		aj3	
11/17/96	2.0	5.5	4.1	1							
11/18/96	2.4	4.6	1.5	3							
11/19/96	2.8	5.1	1.5	37	1	36	ak	1	11	ac1	Norm day(17) night(19)
11/20/96	2.8	4.1	2.6	198	1			13		ak11 ae1 ac1	
11/21/96	2.6	5.1	2.5	28							
11/22/96	2.6	5.4	3.7	6							
11/23/96	2.5	4.1	2.3	19		234	am		12		Norm day(113) night(121)
11/24/96	2.5	4.7	3.0	11				121		am121	
11/25/96	2.6	5.0	3.9	6							
11/26/96	2.5	4.7	4.1	0		15	an		3		Norm day(8) night(7)
11/27/96	2.5	4.7	3.9	1				2		an2	
11/28/96	2.8	4.9	3.4								
11/29/96	2.8	5.1	3.9	8				1		an1	
11/30/96	2.6	4.6	4.1	3		10	ao		3		Norm day(5) night(5)

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
12/01/96	2.7	4.9	3.2	1				1		ao1	
12/02/96	2.6	4.2	0.9	5				2		ao2	
12/03/96	2.5	4.0	1.4	6				1		am1	
12/04/96	2.4	1.8	-0.1	--		11	ap		0		d(5) n(6) Trap froze
12/05/96	2.6	3.8	-0.1	--							Started trap 1300
12/06/96	2.5	4.4	2.4	12							
12/07/96	2.5	3.4	2.7	4							
12/08/96	2.8	4.4	3.5	22							
12/09/96	3.3	3.9	3.0	21							
12/10/96	3.5	4.4	3.4	5		56	aq		7		Norm day(27) night(29)
12/11/96	3.4	4.1	3.0								
12/12/96	3.3	4.1	3.3	8							Trap box full of debris
12/13/96	3.0	4.1	2.1	2		8	ar		0		d(4) n(4) Moved trap
12/14/96	2.8	4.1	2.6	0							
12/15/96	2.7	4.1	2.2	0		2	as		0		Norm day(1) night(1)
12/16/96	2.7	3.9	1.9	1				5		aq5	
12/17/96	2.5	1.9	0.6	--				2		aq2	Trap froze
12/18/96	2.8	2.7	0.6	--							
12/19/96	2.7	3.1	1.2	--							Started trap
12/20/96	2.8	3.1	0.9			1	at		1		Norm day(1)
12/21/96	2.8	3.9	2.6	0							
12/22/96	2.8	3.3	1.8								
12/23/96	2.8	3.4	1.9								
12/24/96	2.8	3.4	2.7	2				1		at1	
12/25/96	3.2	3.3	2.8	0							
12/26/96	3.2	3.2	0.5	0							
12/27/96	3.2	4.0	2.9	0		2	au		0		Norm day(1) night(1)
12/28/96	3.2	3.3	1.7	0							
12/29/96	3.4	3.9	1.0								
12/30/96	4.5	3.8	2.9	4							
12/31/96	8.9	3.5	2.2	7		10	av		0		Norm day(5) night(5)
01/01/97	17.5	3.5	1.0	7							Trap was stopped by log
01/02/97	14.3	4.1	3.5			6	aw		0		Norm day(3) night(3)
01/03/97	11.8	3.9	3.4	19		18	ax		2		Norm day(9) night(9)
01/04/97	9.4	3.6	2.6	8		6	ay	2	1	ax2	Norm day(3) night(3)
01/05/97	8.5	3.2	1.8	8		8	az		2		Norm day(4) night(4)
01/06/97	7.4	2.8	1.5	6				3		az2 ay1	
01/07/97	6.5	3.8	2.7	2		6	ba		0		Norm day(4) night(2)
01/08/97	5.7	4.1	3.0								
01/09/97	5.4	4.8	3.4	3		2	bb		0		
01/10/97	4.8	4.7	3.7								
01/11/97	5.1	4.9	2.0	0							
01/12/97	4.6	1.7	0.0								
01/13/97	4.8	0.8	-0.4	--							Trap frozen, raised cone
01/14/97	4.9	0.3	-0.1	--							
01/15/97	4.7	0.0	0.0	--							

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
01/16/97	4.6	0.0	0.0	--							Started trap
01/17/97	4.8	0.0	0.0								
01/18/97	5.0	0.0	0.0	6		3	bc		2		Norm day(3)
01/19/97	4.3	0.0	0.0								
01/20/97	4.1	0.0	0.0	13		16	bd	2	5	bc2	Norm day(6) night(10)
01/21/97	4.1	0.0	0.0	1		1	be	2	0	bd2	Norm day(1)
01/22/97	4.2	0.0	0.0								
01/23/97	4.3	0.0	0.0	3		3	bf	2	0	bd2	Norm day(1) night(3)
01/24/97	3.9	0.0	0.0								
01/25/97	3.9	0.0	0.0	10		9	bg	1	2	bd1	Norm day(5) night(4)
01/26/97	4.1	0.0	0.0								
01/27/97	4.0	0.0	0.0	6		6	bh	1	2	bg1	d(3) n(3),Trap froze
01/28/97	4.0	0.0	0.0								
01/29/97	3.9	0.0	0.0	3		3	bi	2	1	bh2	Norm day(2) night(1)
01/30/97	4.2	0.0	0.0								
01/31/97	8.2	0.0	0.0								
02/01/97	10.8	0.0	0.0	36		34	bj	2	1	bi1 bg1	d(16) n(18),moved trap
02/02/97	9.6	0.0	0.0								
02/03/97	8.5	0.0	0.0	9		8	bk	1	1	bj1	Norm day(4) night(4)
02/04/97	7.8	0.0	0.0								
02/05/97	7.4	0.0	0.0								
02/06/97	6.7	0.0	0.0	10		9	bm		1		Norm day(4) night(5)
02/07/97	5.7	0.0	0.0								
02/08/97	4.7	0.0	0.0	6		6	bn	1	2	bm1	Norm day(3) night(3)
02/09/97	4.2	0.0	0.0								Otter sited near trap
02/10/97	4.2	0.0	0.0	8		7	bo	3	2	bn2 bk1	Norm day(3) night(4)
02/11/97	4.1	0.0	0.0								
02/12/97	2.9	0.0	0.0								
02/13/97	2.7	0.0	0.0	13				2		bo2	
02/14/97	3.9	0.0	0.0	0		13	bp		3		Norm day(13)
02/15/97	7.4	0.0	0.0								
02/16/97	8.9	0.0	0.0								
02/17/97	9.5	0.0	0.0	23		22	bq	3	6	bp3	Norm day(11) night(11)
02/18/97	9.4	0.0	0.0								
02/19/97	10.1	0.0	0.0	3		3	br	2	1	bq2	Norm day(2) night(1)
02/20/97	10.1	0.0	0.0								
02/21/97	9.1	0.0	0.0	17		15	bs	3	2	bq3	Norm day(7) night(8)
02/22/97	7.2	0.0	0.0								
02/23/97	6.1	0.0	0.0	6		6	bt	1	1	bs1	Norm day(3) night(3)
02/24/97	5.7	0.0	0.0								
02/25/97	5.6	0.0	0.0	25		9	bu	2	2	bt1 bs1	Norm day(9)
02/26/97	5.6	0.0	0.0			11	bv		5		Norm night(11)
02/27/97	5.5	0.0	0.0								
02/28/97	5.5	0.0	0.0	17		15	bw	7	7	bv4 bu2 br1	Norm day(8) night(7)

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
03/01/97	5.6	0.0	0.0								
03/02/97	5.9	0.0	0.0	23		23	bx	7	4	bw7	Norm day(11) night(12)
03/03/97	5.5	0.0	0.0								
03/04/97	5.5	0.0	0.0	14		14	by	5	2	bx4 bv1	Norm day(7) night(7)
03/05/97	5.4	0.0	0.0								
03/06/97	5.6	0.0	0.0	7		7	bz	2	1	by2	Norm day(4) night(3)
03/07/97	5.9	0.0	0.0								
03/08/97	6.1	0.0	0.0								
03/09/97	6.5	0.0	0.0	37		37	ca	2	8	bz1 bq1	Norm day(18) night(19)
03/10/97	8.7	0.0	0.0								
03/11/97	10.5	0.0	0.0	44				8		ca8	
03/12/97	10.1	0.0	0.0	14		40	cb		12		Norm day(20) night(20)
03/13/97	8.2	0.0	0.0	11		12	cc	5	2	cb5	Norm day(6) night(6)
03/14/97	7.3	0.0	0.0	5		9	cd	7	2	cc1 cb6	Norm day(4) night(5)
03/15/97	7.0	0.0	0.0	9		5	ce	4	1	cd2 cc1 cb1	Norm day(2) night(3)
03/16/97	7.7	0.0	0.0	11		9	cf	1	2	ce1	Norm day(4) night(5)
03/17/97	10.6	0.0	0.0	9		11	cg	2	2	cf2	Norm day(6) night(5)
03/18/97	11.6	0.0	0.0	24				2		cg2	
03/19/97	15.2	0.0	0.0	21							
03/20/97	21.5	0.0	0.0	9		30	ch		2		Norm night(30)
03/21/97	21.8	0.0	0.0	1		29	ci	1	2	ci1	Norm day(29)
03/22/97	19.5	0.0	0.0	8		8	cj	3	1	ci1 ch2	d(4) n(4),Trap not turning
03/23/97	18.6	0.0	0.0	4		3	ck	1	0	cj1	Norm day(2) night(1)
03/24/97	18.3	0.0	0.0	7		7	cm		0		Norm day(5) night(2)
03/25/97	18.4	0.0	0.0	4		4	cn		0		Norm day(2) night(2)
03/26/97	20.5	0.0	0.0								
03/27/97	22.7	0.0	0.0	5		2	co		0		Norm day(2)
03/28/97	20.7	0.0	0.0	4		5	cp		0		Norm night(5)
03/29/97	16.7	0.0	0.0								
03/30/97	15.6	0.0	0.0	5		3	cq		0		Norm day(2) night(1)
03/31/97	14.7	0.0	0.0	1							
04/01/97	13.0	5.7	2.8	0							
04/02/97	11.9	6.3	2.1	0							
04/03/97	11.6	6.5	2.8	0							
04/04/97	11.6	5.7	2.4	0							
04/05/97	11.0	5.9	2.3	0							
04/06/97	10.2	6.7	2.3	3		3	cr		0		Norm day(2) night(1)
04/07/97	9.9	5.7	2.7	2		2	cs		0		Norm day(1) night(1)
04/08/97	9.9	6.5	3.7	0							
04/09/97	9.3	7.0	3.6	3		3	ct		0		Norm day(1) night(2)
04/10/97	9.9	6.2	3.3	3		3	cu		0		Norm day(2) night(1)
04/11/97	9.4	6.6	2.7	0							
04/12/97	9.5	7.0	2.4								
04/13/97	9.9	5.6	3.5	1							
04/14/97	11.1	5.6	4.0	0		1	cv		0		Norm night(1)
04/15/97	12.5	7.5	4.1	3		3	cw		0		Norm day(1) night(2)

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
04/16/97	14.8	6.4	4.1	2		2	cx		0		Norm day(1) night(1)
04/17/97	16.8	6.8	3.5	0							Moved trap to side
04/18/97	17.4	5.7	3.5	0							
04/19/97	20.2	4.8	3.9	1							
04/20/97	32.8	5.0	3.1	--							Trap not turning
04/21/97	28.6	5.6	3.1	--							Removed due to high flow
04/22/97	23.2	5.6	3.8	--							
04/23/97	24.8	4.9	3.6	--							
04/24/97	22.1	5.1	3.7	--							
04/25/97	20.5	6.8	3.4	--							
04/26/97	18.7	7.7	3.7	0							
04/27/97	22.7	6.1	3.7	0							Trapped not turning, Log
04/28/97	19.7	5.0	3.5	0							
04/29/97	18.5	6.4	3.8	0							
04/30/97	17.7	4.9	3.4	0							
05/01/97	15.5	4.9	3.3	0							
05/02/97	13.7	6.5	2.8	0							
05/03/97	13.2	6.6	4.2	0							Trap not turning, Log
05/04/97	14.8	7.6	4.1	0							
05/05/97	15.4	7.5	4.0								
05/06/97	17.1	7.0	3.8	0							
05/07/97	17.9	7.4	3.4	0							
05/08/97	18.4	7.9	3.3	0							
05/09/97	20.0	7.6	3.6	0							
05/10/97	22.0	8.0	3.6	0							
05/11/97	24.4	7.7	3.7	0							Raised cone, 2100
05/12/97	25.0	8.2	3.8	--							
05/13/97	28.3	7.9	4.4	--							
05/14/97	25.6	7.6	4.0	--							
05/15/97	26.3	8.6	4.4	--							
05/16/97	25.9	8.8	4.6	--							Started trap 1600
05/17/97	24.1	8.6	4.8	0							Trap stopped , high flow
05/18/97	21.1	8.4	4.2	--							
05/19/97	18.3	9.2	4.2	--							Started trap
05/20/97	16.8	8.6	4.9	0							
05/21/97	14.8	9.1	4.2	0							
05/22/97	13.6	9.0	4.8	0							
05/23/97	12.7	8.1	5.9	0							
05/24/97	12.1	8.4	5.5	0							
05/25/97	11.6	6.7	5.7	0							
05/26/97	11.1	7.4	5.6	0							
05/27/97	10.8	8.1	5.1	0							
05/28/97	10.1	8.4	5.7	1							ADRV hatchery fish
05/29/97	10.2	9.2	6.6	1							ADRV hatchery fish
05/30/97	11.0	9.9	6.6	0							
05/31/97	11.8	10.7	7.1	0							

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
06/01/97	11.9	9.8	6.5	0							
06/02/97	11.0	10.7	5.7	0							
06/03/97	10.1	8.9	7.1	1							ADRV hatchery fish
06/04/97	10.3	8.3	7.2	0							Otter seen near trap
06/05/97	9.8	9.1	6.6	0							
06/06/97	8.7	10.3	6.2	0							
06/07/97	8.4	11.7	6.1	0							
06/08/97	8.0	11.7	6.7								
06/09/97	8.1	12.6	7.0	1							ADRV hatchery fish
06/10/97	7.9	10.8	8.1	3							ADRV hatchery fish
06/11/97	8.0	10.6	8.5	0							
06/12/97	8.1	9.5	8.0								
06/13/97	7.8	10.9	7.7	1							ADRV hatchery fish
06/14/97	7.2	10.8	8.2								
06/15/97	6.7	13.6	8.1	1							ADRV hatchery fish
06/16/97	6.5	13.3	9.2								
06/17/97	6.1	12.5	9.0	2							ADRV hatchery fish
06/18/97	5.9	13.0	8.7								
06/19/97	5.6	12.8	7.7	0							
06/20/97	5.0	12.6	7.8								
06/21/97	4.4	11.2	7.4	1							ADRV hatchery fish
06/22/97	4.2	12.2	7.0								
06/23/97	4.3	10.2	7.7								
06/24/97	3.9	13.3	7.0								
06/25/97	3.7	14.2	7.7	1							ADRV hatchery fish
06/26/97	3.7	14.1	8.6								
06/27/97	3.3	14.4	7.6								
06/28/97	3.3	14.4	7.7	0							
06/29/97	3.3	13.0	8.9								
06/30/97	3.3	11.8	8.5								
07/01/97	3.7	10.9	8.4	1							ADRV hatchery fish
07/02/97	3.2	14.0	7.6								
07/03/97	3.2	14.7	7.6								
07/04/97	3.2	15.7	8.3								
07/05/97	2.8	16.0	9.1								
07/06/97	2.8	15.4	9.5								
07/07/97	2.6	15.7	8.5								
07/08/97	2.5	15.2	8.8								
07/09/97	2.7	11.0	9.5								
07/10/97	2.8	12.6	8.6								
07/11/97	2.6	12.7	7.6								
07/12/97	2.4	14.8	7.2	0							
07/13/97	2.2	15.5	7.7								
07/14/97	2.2	14.7	8.9								
07/15/97	2.2	16.4	8.6								

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
07/16/97	2.2	16.1	8.4	0							
07/17/97	2.3	16.3	9.7								
07/18/97	2.0	13.8	9.4								
07/19/97	1.9	14.3	8.5	0							
07/20/97	1.8	16.3	8.8								
07/21/97	1.8	15.8	9.1								
07/22/97	1.8	16.2	8.6								
07/23/97	1.8	16.2	8.4								
07/24/97	1.8	16.0	8.1								
07/25/97	1.6	15.8	8.3								
07/26/97	1.6	15.7	7.7								
07/27/97	1.6	12.5	8.4								
07/28/97	1.5	15.4	8.2								
07/29/97	1.6	11.1	9.7	0							
07/30/97	1.6	15.9	9.2								
07/31/97	1.6	14.4	8.7	0							
08/01/97	1.5	14.6	8.5	0							
08/02/97	1.5	16.2	8.9								
08/03/97	1.6	16.6	8.9								
08/04/97	1.4	15.5	9.1	2							ADRV hatchery fish
08/05/97	1.4	17.0	9.4								expressing milt,dark
08/06/97	1.3	17.0	9.3								
08/07/97	1.3	16.6	9.9	0							
08/08/97	1.3	15.3	9.1								
08/09/97	1.3	15.1	7.7								
08/10/97	1.2	15.3	7.8								
08/11/97	1.2	15.0	7.8								
08/12/97	1.3	14.9	8.3	1							
08/13/97	1.1	15.1	8.3								
08/14/97	1.1	15.9	8.5								
08/15/97	1.2	15.4	9.1								
08/16/97	1.3	14.6	8.0								
08/17/97	1.2	15.2	8.2	1							
08/18/97	1.2	14.2	8.2								
08/19/97	1.2	15.3	8.1								
08/20/97	1.2	14.4	8.9								
08/21/97	1.2	15.2	8.2								
08/22/97	1.4	15.4	8.4								
08/23/97	1.3	15.3	8.7								
08/24/97	1.3	14.2	9.5	6							3 ADRV hatchery fish
08/25/97	1.4	11.7	8.3								
08/26/97	1.5	14.5	7.8								
08/27/97	1.5	13.4	8.0	4							2 ADRV hatchery fish
08/28/97	1.4	12.3	8.2								
08/29/97	1.3	13.5	7.7								
08/30/97	1.4	14.1	7.5								
08/31/97	1.5	13.2	8.1	0							

Appendix Table A-1 (cont.). Daily trapping records of the 1995 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Low	Daily numbers of fish trapped Hat.	Wild	Trap efficiency[a] No. Rel.	grp.	Re. on date	Re. from Rel. grp.	Rel. grp. on date	Comments
09/01/97	1.6	14.2	8.3								
09/02/97	1.5	10.4	8.9								
09/03/97	1.5	11.4	8.2	0							
09/04/97	1.5	13.5	7.7								
09/05/97	1.4	14.1	8.1								
09/06/97	1.5	13.0	8.3								
09/07/97	1.3	13.4	7.3	1							
09/08/97	1.3	13.1	7.0								
09/09/97	1.3	13.0	7.2								
09/10/97	1.4	12.9	8.9	1							
09/11/97	1.5	10.4	8.4								
09/12/97	1.6	10.7	7.5								
09/13/97	1.6	11.3	6.4								
09/14/97	1.6	12.2	7.1	3							ADRV hatchery fish
09/15/97	1.6	10.0	7.8								Last 95 cohort captured

[a] *PIT tags were used to mark all trap efficiency fish. The release groups in this table were identified by letter combinations each day of release. The trap efficiency recaptures were separated both by the total number of fish that were recaptured on a given date as well as the number of fish from each release group that were captured on that date. No. Rel. is the number of PIT-tagged fish released for trap efficiency. Grp is a release group code that day. Re.on date is the number of trap efficiency fish recaptured on that day. Re. from Rel. Grp. is the total number of trap efficiency fish recaptured from specific release group. Re. Grp. on date is the number of fish from the release group captured on that date.*

Appendix Table A-2. New redds observed during spawning ground surveys conducted in Lookingglass Creek in 1997.

Date of Survey	Unit	Live Fish On	Off	New Redds	Occ.	Unocc.	Comments
07/12	3U	0	26				Lower 1mile of unit
07/14	3U	0	13				Lower 1mile of unit
07/16	3U	0	13				Lower 1mile of unit
07/18	3U	0	12				Lower 1mile of unit
08/04	3U	2	5	3	2	1	
08/06	4	0	0				
08/06	2	0	0				
08/06	1	0	0				
08/11	3U	0	0	2	0	2	
08/15	3U	2	1	4	1	3	
08/20	3U	11	1	4	3	1	
08/21	2	0	0				
08/21	1	0	2				
08/25	3U	7	6	2	2	0	
08/27	3U	6	2				
08/28	2	0	0				
08/28	1	0	1	1	0	1	
08/29	3U	3	8				
09/02	3U	8	0	4	4	0	
09/04	4	0	0				
09/04	2	0	0				
09/04	1	0	1	1	0	1	
09/05	3U	5	0	2	0	2	
09/08	3U	2	3				Index survey (ODFW)
09/08	4	0	0				Index survey (ODFW)
09/08	2	0	0				Index survey (ODFW)
09/08	1	0	0	2	0	2	Index survey (ODFW)
09/09	3L	0	0	3	0	3	
09/15	3U	0	0				
09/15	2	0	0				
09/15	1	0	1				
10/10	1	0	0				

Appendix Table A-3. Results of analyses by ODFW Fish Pathology for pathogens of adult spring Chinook salmon from Lookingglass Creek in 1997.

Date of Samp.	ELISA OD	Rs antigen[a] (BKD)	Culture[b]	Sex	Unit and Disposition of recovery	
Unk	0.125	Low level Rs	M/C-L	M	3U	Dead
Unk	0.121	Low level Rs	APS-M	F	3U	Dead
Unk	0.105	Low level Rs	ERM-I (H)	F	3U	Dead
Unk	0.154	Low level Rs	APS-M	F	3U	Dead
7/8/97	0.118	Low level Rs	M/C-L	F	Hat.	Dead
7/10/97	0.114	Low level Rs	APS-M	F	3U	Dead
7/10/97	0.109	Low level Rs	APS-L	F	3U	Dead
7/10/97	0.105	Low level Rs	Gram + bacillus (M)	M	3U	Dead
7/10/97	0.116	Low level Rs	M/C-L	M	Hat.	Dead
7/12/97	0.122	Low level Rs	Gram + bacillus (M)	F	3U	Dead
7/12/97	0.104	Low level Rs	M/C-L	F	3U	Dead
7/12/97	0.109	Low level Rs	M/C-L	M	3U	Dead
7/14/97	2.488	Clinical level Rs	APS-L	M	3U	Dead
7/14/97	0.113	Low level Rs	APS-L	F	3U	Dead
7/16/97	0.112	Low level Rs	Negative	M	3U	Dead
7/18/97	0.108	Low level Rs	APS-L	F	3U	Dead
7/18/97	0.123	Low level Rs	APS-H	F	3U	Dead
7/18/97	0.112	Low level Rs	APS-M	M	3U	Dead
7/18/97	0.115	Low level Rs	FUR-L & APS-H	M	3U	Dead
7/18/97	0.107	Low level Rs	APS-H	M	3U	Dead
7/28/97	0.111	Low level Rs	APS-L	F	Intake	Dead
7/30/97	0.135	Low level Rs	APS-H	F	3U	Dead
7/30/97	0.291	Low/Moderate Rs	APS-M	M	3U	Dead
7/30/97	0.160	Low level Rs	APS-H	F	3U	Dead
7/30/97	0.137	Low level Rs	APS-H	F	3U	Dead
7/30/97	0.128	Low level Rs	APS-H	M	3U	Dead
7/30/97	0.137	Low level Rs	APS-H	F	3U	Dead
7/30/97	0.184	Low level Rs	FUR-L & APS-M	M	3U	Dead
7/30/97	0.183	Low level Rs	APS-M	F	3U	Dead
7/30/97	1.755	Clinical level Rs	APS-M	M	3U	Dead
8/4/97	0.177	Low level Rs	APS-M	F	3U	Dead
8/4/97	0.135	Low level Rs	APS-M	M	3U	Dead

Appendix Table A-3 (cont.). Results of analyses by ODFW Fish Pathology for pathogens of adult spring Chinook salmon from Lookingglass Creek in 1997.

Date of Samp.	ELISA OD	Rs antigen[a] (BKD)	Culture[b]	Sex	Unit and Disposition of recovery	
8/15/97	0.173	Low level Rs	M/C-H	F	3U	Dead
8/15/97	0.317	Low/Moderate Rs	FUR-M	F	3U	Live
8/15/97	0.140	Low level Rs	FUR-M	M	3U	Dead
8/20/97	0.144	Low level Rs	ERM-I (H)	F	3U	Live
8/20/97	0.145	Low level Rs	Negative	F	3U	Live
8/22/97	0.119	Low level Rs	FUR-L	F	3U	Dead
8/25/97	0.142	Low level Rs	FUR-M	F	3U	Live
8/25/97	0.148	Low level Rs	Negative	F	3U	Live
8/25/97	0.176	Low level Rs	FUR-M	M	3U	Dead
8/27/97	0.159	Low level Rs	M/C-H	M	3U	Dead
8/27/97	0.127	Low level Rs	FUR-L	M	3U	Dead
8/29/97	0.174	Low level Rs	M/C-H	M	3U	Dead
9/2/97	0.184	Low level Rs	M/C-L	F	3U	Dead
9/2/97	0.211	Low/Moderate Rs	FUR-M	F	3U	Dead
9/2/97	0.116	Low level Rs	Negative	M	3U	Dead
9/2/97	0.213	Low/Moderate Rs	Negative	F	3U	Dead
9/4/97	0.175	Low level Rs	Negative	F	3U	Live
9/5/97	0.126	Low level Rs	FUR-L	F	3U	Dead
9/5/97	0.125	Low level Rs	M/C-M	F	3U	Live
9/5/97	0.119	Low level Rs	Negative	M	3U	Dead
9/5/97	0.156	Low level Rs	Negative	M	3U	Dead
9/5/97	0.114	Low level Rs	Not done	F	3U	Live
9/5/97	0.376	Low/Moderate Rs	Not done	F	3U	Live
9/8/97	0.502	Moderate level Rs	FUR-M	F	3U	Dead
9/8/97	0.152	Low level Rs	Negative	F	3U	Dead
9/8/97	0.164	Low level Rs	Negative	M	3U	Dead
9/8/97	0.118	Low level Rs	Negative	F	3U	Dead
9/8/97	0.291	Low/Moderate Rs	Negative	F	3U	Dead

Appendix Table A-3 (cont.). Results of analyses by ODFW Fish Pathology for pathogens of adult spring Chinook salmon from Lookingglass Creek in 1997.

Date of Samp.	ELISA OD	Rs antigen[a] (BKD)	Culture[b]	Sex	Unit and Disposition of recovery	
9/15/97	0.241	Low level Rs	M/C-M	M	3U	Dead
9/15/97	0.432	Moderate level Rs	M/C-H	M	3U	Dead
9/15/97	0.297	Low/Moderate Rs	Negative	M	3U	Dead
9/15/97	0.151	Low level Rs	APS/Gram+ Bacillus	M	3U	Dead
9/15/97	0.211	Low/Moderate Rs	Negative	M	1	Dead
9/15/97	0.303	Low/Moderate Rs	Negative	M	3U	Dead

[a] *This column indicates the level of Rs antigen (BKD) - OD readings <0.19 (Low); 0 .200-0.399 (Low/Moderate); 0.400-0.799 (Moderate); 0.800-1.000 (High); and >1.0 are considered to be clinical.*

[b] *APS is aeromonad-pseudomonad bacteria, ERM-I is Enteric Redmouth Disease caused by Yersinia ruckeri, FUR is Furunculosis caused by Aeromonas salmonicida, M/C is mixed culture. (L =Low level, M=Moderate level and H=Heavy level).*