Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January to 31 December 1998

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 57 unmarked spring Chinook salmon adults at the Lookingglass Hatchery trap between 27 May and 9 September 1998. All of these fish were transported to the South Fork Walla Walla (SFWW) facility for hatchery production. We spawned 17 female and 12 male spring Chinook salmon for an estimated 68,000 eggs. Twenty-seven fish died before spawning and 1 fish was killed and not spawned. We did not release adult spring Chinook salmon above the hatchery weir in 1998. Only one spawning ground survey was conducted in Lookingglass Creek on 8 September 1998. We observed only one redd above the hatchery weir and 4 below the weir. We recovered no carcasses above or below the hatchery weir.

Progeny-per-parent ratios for the 1992, 1993, and 1994 cohorts from Lookingglass Creek were 0.58, 0.37, and 0.26 while ratios from other Grande Ronde River tributaries ranged from 0.23 to 0.89, 0.42 to 0.95, and 0.33 to 2.74.

Spring Chinook salmon smolts from unmarked parents spawned in 1996, that were being held in 2 raceways at Lookingglass Hatchery, were released in 1998. The size of the fish in one raceway was 42.1fish/lb while the other was 19.3 fish/lb. A portion of each raceway was PIT-tagged by ODFW for arrival timing and survival estimates. Fish from the two raceways had median arrival dates at Lower Granite Dam within one day of each other (1 and 2 May). The minimum survival rate to Lower Granite Dam for the 42.1 fish/lb group was 49.1% while that of the 19.3 fish/lb was 53.4% with no significant difference based on the overlap of the upper 95% confidence intervals.

Movement of juveniles from the naturally-produced 1996 cohort past the rotary screw trap in Lookingglass Creek peaked in October of 1997, and March of 1998, with an estimated total of 15,241 juveniles passing the trap. The range of median monthly fork lengths of fish captured in the trap was 36 mm in March 1997 to 95 mm in March 1998. Median fork lengths appeared similar between fish captured in the trap (rm 2.50) and those sampled from rm 7.25 on a monthly basis from March 1997 to June 1998.

We PIT-tagged four groups of fish from the naturally-produced 1996 cohort from Lookingglass Creek for survival and arrival timing to Lower Granite Dam. Three groups were tagged at the screw trap: June to September 1997 (fall), October to December 1997 (winter), January to June 1998 (spring), and one group which was seined from Lookingglass Creek in September 1997 (field). The median arrival date at Lower Granite Dam for the spring group was 29 April 1998 which was 12 to 13 days later than the other 3 groups. Groups tagged later at the trap had higher minimum survival rates: 23.5, 30.6, and 49.5%. The minimum survival rate for the field group was 22.6%. Minimum survival rates for months with at least 50 fish PIT-tagged (August 1997 through April 1998) ranged from 8.1 to 55.4%. The median date of arrival at Lower Granite Dam of larger fish in the field group was significantly earlier than that of the smaller fish, with the median arrival dates being 12 April and 21 April respectively. Minimum survival rates among fish of 6 different fork length ranges from the field group were not different ($\alpha \leq 0.05$) from average survival for the entire group. The arrival

timing at the screw trap of the 1996 cohort field group did not appear different from that of non-PIT-tagged fish. There were no significant differences in fork length, weight, or condition factor of the 1996 cohort field group between detected and non-detected fish at Lower Granite Dam. The median arrival date at Lower Granite Dam of the Lookingglass Creek field group from the1996 cohort (16 April 1998), was earlier than median arrival dates of natural populations from the Minam River and Catherine Creek (28 April and 12 May 1998), the only other Grande Ronde River basin populations tagged that year. The minimum survival rate to Lower Granite Dam of the field group from the 1996 cohort was generally similar to minimum survival rates for the Minam River and Catherine Creek field groups.

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 1996 cohort (3,600) was divided into three different fork length categories; small, 55-59 mm; medium, 62-66 mm; and large, 69-72 mm and PIT-tagged. PIT-tagged fish were marked with Alcian blue dye. A control group of 3,606 fish from the same size categories was marked with dye only. Both treatments were divided equally and released into two areas of Lookingglass Creek (~river mile 10.25 and 6.50) in 1997. The control fish from the small and large categories tended to arrive earlier at the screw trap than the PIT-tagged fish from the same categories. However, the medium category of PIT-tagged fish arrived earlier at the screw trap than the control fish from the same category. There was no significant difference in survival indices to the rotary screw trap between the PIT-tagged and control fish from the small, medium, and large size categories. The median arrival date at Lower Granite Dam of the PIT-tagged small and medium categories was 26 and 27 April 1998, while that of the PIT-tagged large category was 22 April. There was no significant difference in minimum survival rate to Lower Granite Dam among any of the size categories.

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 (Lower Snake River Compensation Plan (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 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 hatchery 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 blocked by a picket or floating weir located at the hatchery (Figure 1) and has been fairly effective at preventing upstream migration. However, 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 McLean 1995a; Lofy and McLean 1995b; and McLean and Lofy 1995). In the fall of 1994 an infectious hematopoietic necrosis (IHN) epizootic 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 above the hatchery weir with adult salmon increasing the pathogen prevalence 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 (McLean and Lofy 1998). Instead, CTUIR and co-managers retained the adults for artificial propagation and 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) (McLean and Lofy 1998, 1999).

With continued concern about increasing pathogen prevalence in the water supply for Lookingglass Hatchery, co-managers decided to release only 50 adults above the weir in 1996, fewer than the 100 to 300 fish released from 1992 to 1994 (McLean 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 (McLean 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) (McLean and Lofy 1999). In 1997 the strategy to release adults and the survey frequency was the same as in 1996 (McLean and Lofy 1999).

In 1998 it was decided again by co-managers to not intentionally release adult spring Chinook salmon above the Lookingglass Hatchery weir due to the potential increase in pathogen prevalence in the water supply. Returning spring Chinook salmon that were captured at the Lookingglass Hatchery trap were retained at the hatchery in 1998. These fish came from several sources, unmarked (most likely of natural parentage from Lookingglass Creek), adipose-only-clipped jacks (returns from our 1995 cohort release of progeny of unmarked adult spring Chinook salmon), and adipose-right ventral fin-clipped fish (returns from Lookingglass Hatchery releases that were not intercepted at Lower Granite Dam) (McLean and Lofy 1999 and 2000). All spring Chinook salmon captured at Lookingglass Hatchery were transported to the CTUIR South Fork Walla Walla Facility (SFWW) due to higher priority for holding space being given to programs for endemic broodstock that are held at Lookingglass Hatchery. The unmarked and adipose-only-clipped jacks were spawned at SFWW and the eggs were taken to Irrigon Hatchery for incubation. After hatching and marking, these fish will be scheduled for release into Lookingglass Creek in July of 1999. The gametes of the adipose-right ventral fin-clipped fish were taken at SFWW by the Nez Perce Tribe for the Rapid River stock program in Idaho.

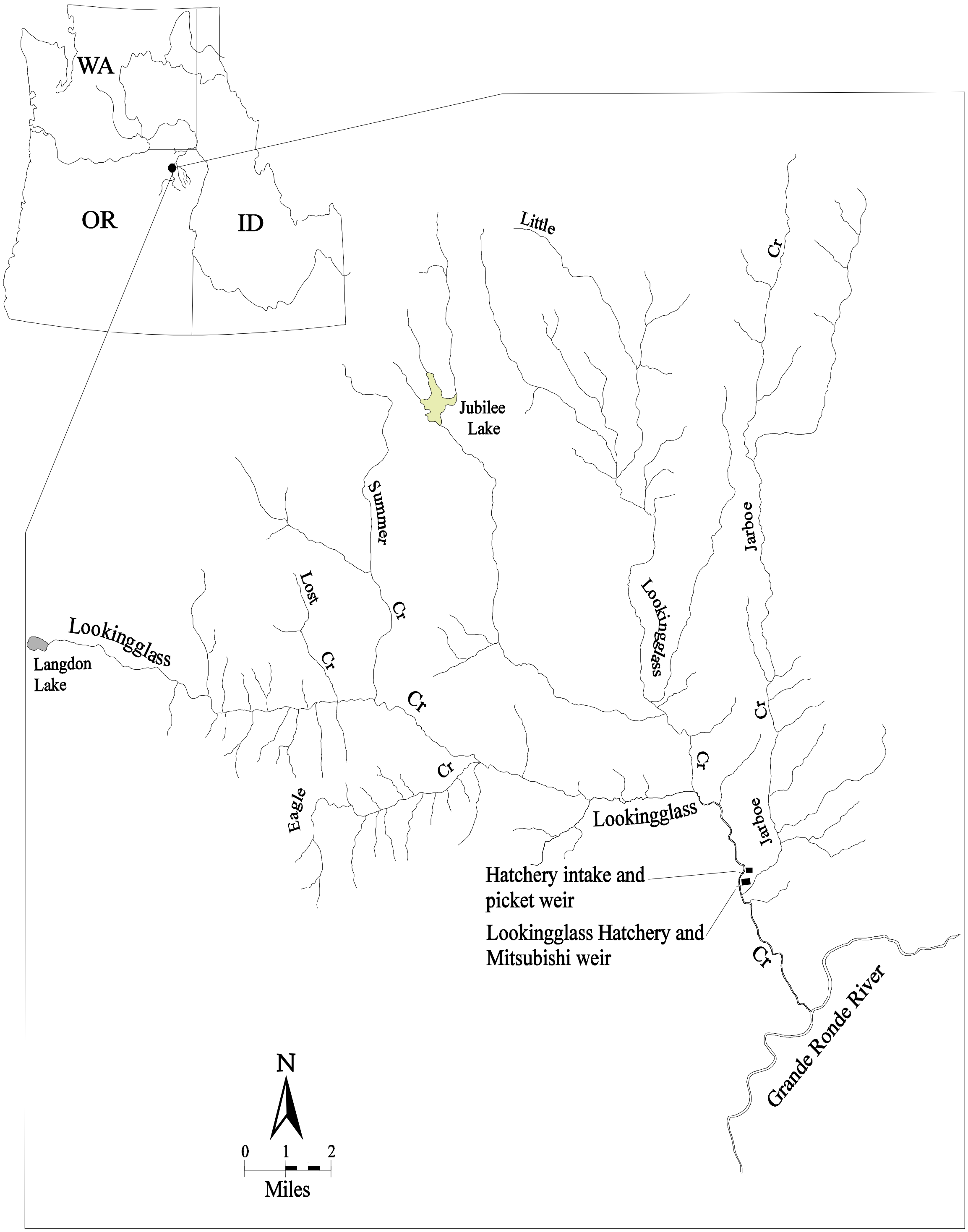

Figure 1. Map of the Lookingglass Creek basin showing the location of major tributaries and the Lookingglass Hatchery complex.

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 feet 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 feet 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. Lookingglass Hatchery is located at about rm 2.50 on Lookingglass Creek (Figure 2). 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). The lower portion of unit 3 is entirely privately owned. In 1998 we were not allowed any access by the landowner to his portion of Lookingglass Creek (Figure 2).

Methods

Stream Flow and Temperature

We obtained and summarized 1998 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 1998 were estimated from an electronic stream gauging station located just below the floating weir (Mitsubishi) (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 1998 were obtained from summaries completed by the United States Forest Service (USFS)(personal communication Scott Wallace, USFS, Umatilla National Forest, Pendleton, OR), 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 1998 were recorded by the USFS at the forest service boundary (at about rm 7.25), ODFW at the hatchery intake (at about rm 2.50) and by CTUIR at approximately rm 3.75 of Lookingglass Creek and about 10 m above the hatchery intake (at about rm 2.50) (Figure 3). There is about 250 ft of elevation change between rm 7.25 and the hatchery intake. We summarized all hourly stream temperature data as a weekly range (M^{c}Lean and Lofy 1995).

Adult Returns to Lookingglass Hatchery

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 the floating weir (Mitsubishi) (primary), which was installed on 1 April 1998, and the picket (secondary) weir, which was installed on 1 March 1998 (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 and injected with antibiotics. All spring Chinook salmon that returned to Lookingglass Hatchery in 1998 were trucked to SFWW each time the trap was checked. The fish were taken to SFWW for spawning due to higher importance being placed on the endemic broodstock to be held at Lookingglass Hatchery. The adult spring Chinook salmon returns to Lookingglass Creek consisted of progeny of natural fish which were not marked; progeny of unmarked parents hatched and partially reared (July presmolt release) in the hatchery which were adipose-clipped only; and progeny of marked fish hatched and reared in the hatchery for an April smolt release (Rapid River stock) which were adipose and right ventral clipped. No fish were intentionally released above the hatchery weir for natural production in 1998.

Progeny-Per-Parent Ratios

In order to evaluate the relative success of adult releases in 1992, 1993, and 1994 (Lofy and McLean 1995a, Lofy and McLean 1995b, and McLean 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 year.

The progeny-per-parent ratio was calculated using the number of unmarked progeny that were recovered in Lookingglass Creek at or above 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 McLean 1995b and McLean and Lofy 1995). Progeny-per-parent calculations assumed either no straying from Lookingglass Creek and 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.

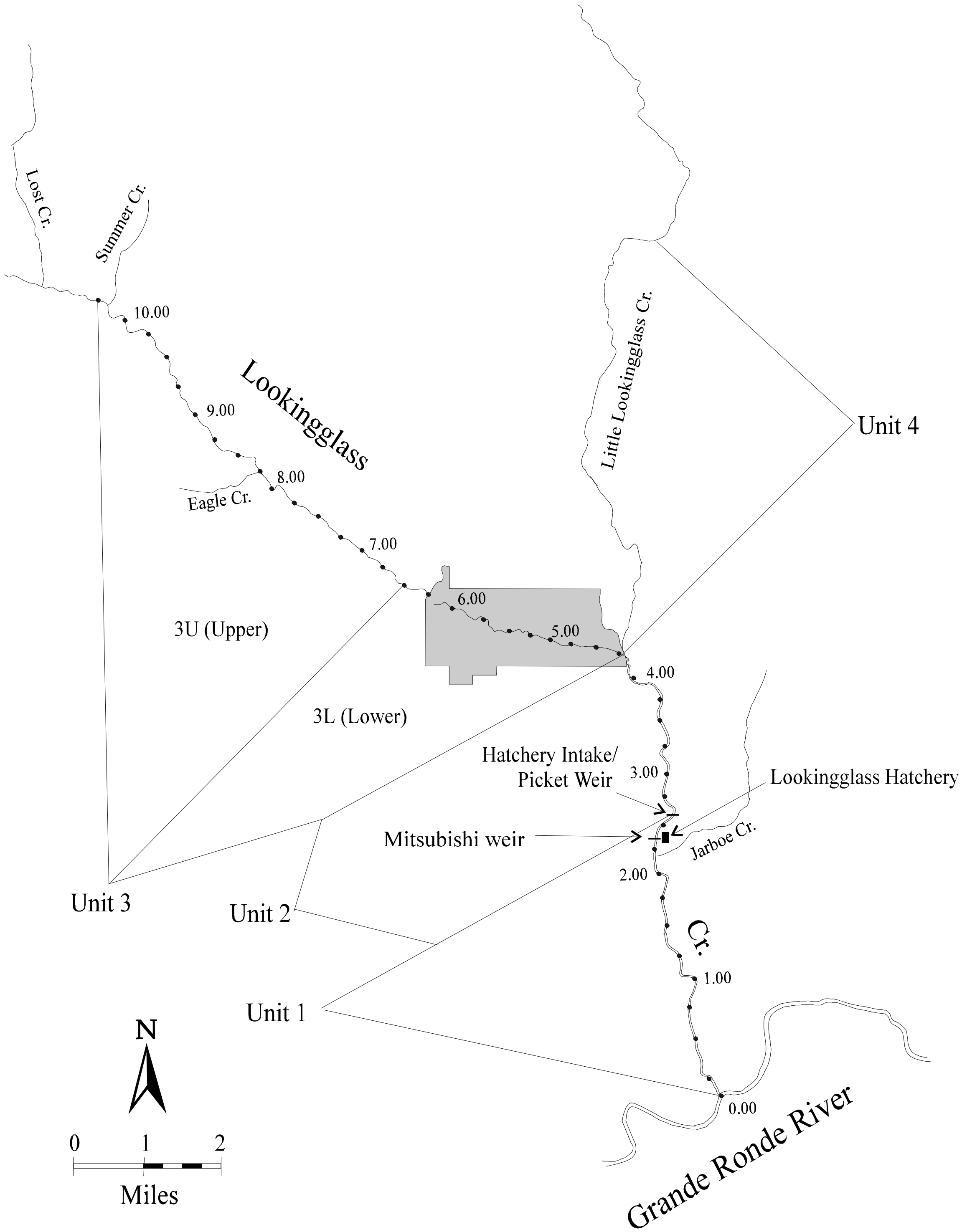

Figure 2. Unit Designations and 0.25-river mile sections of Lookingglass Creek. The shaded area is the private property where access by the landowner was not allowed in 1998.

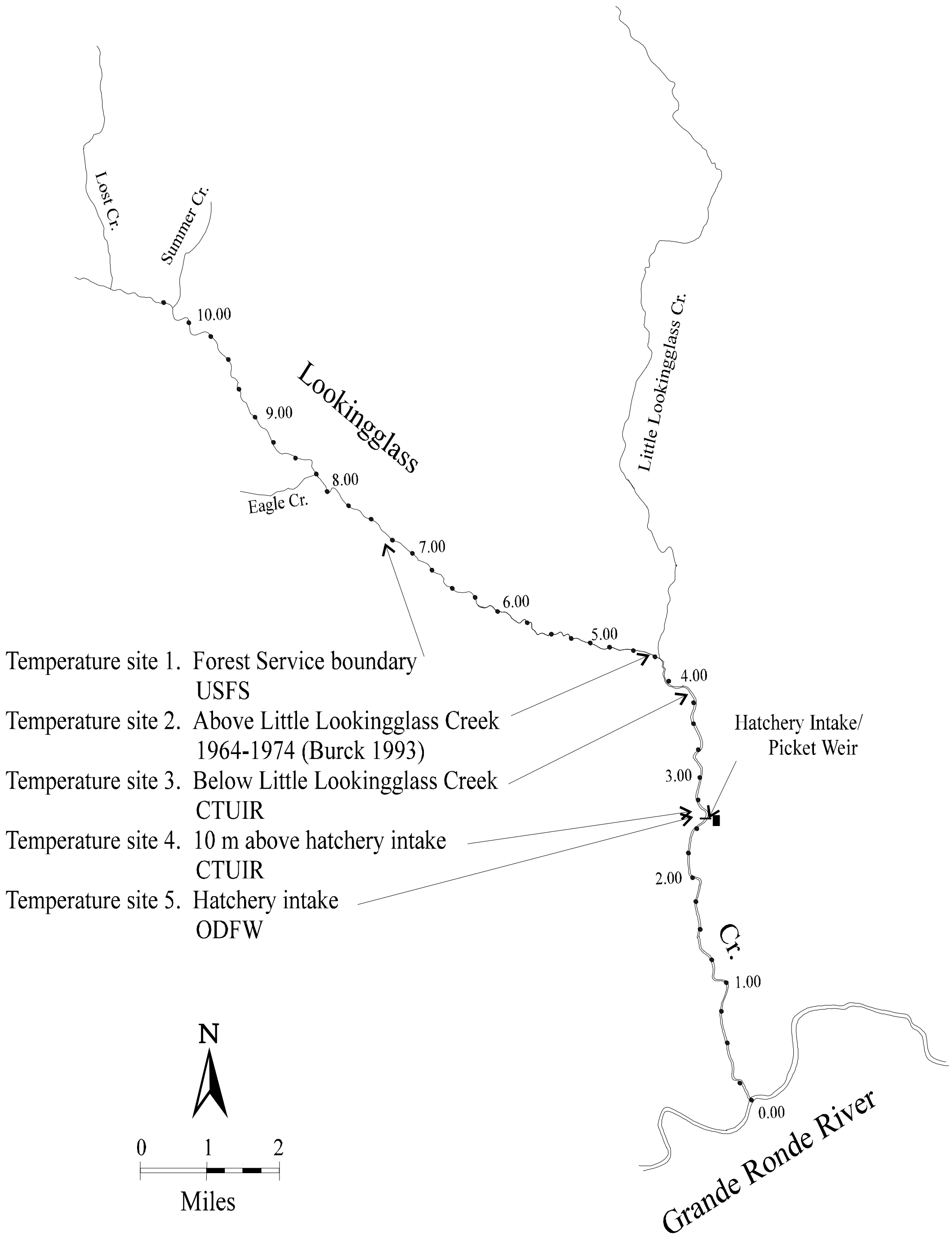

Figure 3. Location of temperature data recorders in Lookingglass Creek in 1998.

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 McLean 1995a, Lofy and McLean 1995b, and McLean and Lofy 1995) to obtain an estimate of adult escapement (Appendix Tables A-1 to A-5). Spawning ground surveys completed in the Grande Ronde River basin usually consisted of an index count (covering all sections) followed by two supplemental counts (covering an index area where most of the spawning occurs but not always every section of the stream) (Appendix Tables A-1 to A-5). The age structure was based on scales from spring Chinook salmon carcasses recovered on spawning grounds on a run year basis throughout the Grande Ronde River basin (Appendix Table A-6). Cohort proportions within a run year were applied to all natural populations to estimate the number of fish from each cohort for each return year (ODFW, unpublished data)(Appendix Table A-6).

The redd counts from 1993 to 1998 were expanded in order to account for times or places where multiple surveys were not completed. We expanded redds by section using the average (1986-1998) percentage of redds in each section of all redds counted on the last date that all sections were surveyed (Appendix Tables A-1 to A-5). These percentages for each section was then applied to sections where redd counts were not complete (not surveyed on the final survey of the year) (Appendix Tables A-1 to A-5). If the expanded number of redds in a section was less than the actual number of redds counted in that section the actual number was used in the total expanded redd estimation (Appendix Tables A-1 to A-5). This method assumes that the distribution of redds at the end of spawning is similar to that on the last date a comprehensive count was completed.

Release of Adult Spring Chinook Salmon Above the Weir

We did not intentionally release any adult spring Chinook salmon above the Lookingglass Hatchery weir for natural production in 1998. All unmarked adults, including adipose clipped only jacks from the 1995 cohort which were from unmarked parents, which were collected at Lookingglass Hatchery, were taken to SFWW for spawning.

Spawning Ground Surveys

We conducted only one spawning ground survey on 8 September in Lookingglass Creek for 1998. Only one survey was completed because we were confident that most of the fish attempting to migrate above the weir were stopped. 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. For females a flaccid abdomen and severe tail erosion were interpreted as evidence of completed spawning. Length of time the female had been observed on a redd was also taken into account. 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.

During the survey, only completed redds were counted (using methods described in McLean and Lofy 1995). This survey was done to complete the ODFW spring Chinook salmon spawning ground index count for Lookingglass Creek, recover any carcasses and document all spring Chinook salmon that returned to Lookingglass Creek.

Genetic Monitoring

As part of an ongoing genetic monitoring program, the NMFS requested that we collect tissue samples for genetic analysis (eye, heart, liver, and body tissues) from unmarked and marked adult spring Chinook salmon that returned to Lookingglass Hatchery or were trucked to SFWW from Lower Granite Dam. After the tissue samples were collected, they were immediately placed on ice and transported to La Grande for storage in a freezer at -80^{o}C within six hours. At the end of the spawning season the samples were mailed to the NMFS in Seattle, Washington.

Smolt Release of the 1996 Cohort 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, raceway 10) and the second at 42 fish/lb (52,594 fry, raceway 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 raceway 9 for a July 1997 release into Lookingglass Creek to evaluate size at PIT-tagging (see PIT-Tagging Effects on Survival and Migration Timing of the 1996 cohort). About 400 fish were removed in September 1997 from raceway 9 and were used by the co-manager's captive brood program. These 7,606 fish did not contribute to the final loading densities. About 500 fish in both raceways 9 and 10 were PIT-tagged as part of a survival study being conducted by ODFW. 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 raceway) 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 and differentiated them from progeny of unmarked fish.

Size at Release Effects on Survival and Arrival at Lower Granite Dam

In 1998 we summarized data collected on the hatchery-produced 1996 cohort released at 42.1 and 19.3 fish/lb in April 1998 from Lookingglass Hatchery. We used detections of PIT-tagged fish to describe weekly arrival timing and minimum survival rate to Lower Granite Dam for these two groups of fish released from Lookingglass Hatchery.

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. In order to determine if the size of the juvenile Chinook salmon at release affected arrival timing of fish that were detected at Lower Granite Dam a Kolmogorov-Smirnov two sample test (Wilkinson 1996) was used to compare arrival distributions of the two groups of fish (α 0.05).

To determine the minimum survival rates to Lower Granite Dam of the two groups from Lookingglass Hatchery, 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.

Population Estimates of the Naturally-produced 1996 Cohort Using a Screw Trap

To evaluate the survival of naturally-produced juvenile spring Chinook salmon from the 1996 cohort, we operated a screw trap from 1 January 1997 to 31 December 1998 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 1998 to December 1998, we also captured fish from the 1997 cohort. Differences in fork length ranges made it possible to differentiate the two cohorts.

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 more fish in the trap than was necessary for the minimum sample size (we subsampled this group). Occasionally, small fry that were dipped out of the trap box were presumed to have been eaten when they were not observed later in the bucket.

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 naturally-produced 1996 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 in fork length was tagged and released for trap efficiency estimation. For smaller fish (<60 mm) we used only a mark of Alcian blue dye applied with a battery operated tattoo pen. 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 tattoo pen on the caudal peduncle of the trap efficiency fish. 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 as well as the only mark on fish smaller than 60 mm. To calculate the variance around the estimate of total migration and the estimated numbers of fish trapped each month for the naturally-produced 1996 cohort, we used a bootstrap method described in M^c^Lean and Lofy (1998).

Monthly Fork Length Sampling of the Naturally-produced 1996 Cohort

We conducted monthly fork length sampling of naturally-produced spring Chinook salmon from the 1996 cohort to compare growth patterns of fish passing the screw trap site and fish still residing in the upper reaches of Lookingglass Creek. We attempted to measure fork lengths from about 50 juvenile spring Chinook salmon at rm 7.25 around the 20^{th} of the month (M^{c}Lean and Lofy 1998). We selected fish captured at the trap around the same dates as those sampled in the field (± 5 days) to calculate the range and median fork length for comparison.

PIT-tagging of the Naturally-produced 1996 Cohort

Four groups of juvenile spring Chinook salmon from the naturally-produced 1996 cohort were PIT-tagged to determine arrival timing at, and the minimum survival rate to Lower Granite Dam. Three of the four groups were categorized by initial arrival timing at the screw trap. The "fall group" was PIT-tagged from 29 July 1997 to 30 September 1997. The "winter group" was tagged from 1 October 1997 to 31 December 1997. The "spring group" was tagged from 1 January 1998 until the last non-precocial juvenile (defined in M^{c}Lean and Lofy 1998) from the naturally-produced 1996 cohort was captured in the screw trap. In 1998 this date was 26 June. The fourth group to be tagged (field group) was seined from and released back into the upper reaches of Lookingglass Creek on 23 and 24 September 1997. This group was tagged for comparison to other natural populations in the Grande Ronde River basin PIT-tagged during the same time period by ODFW. 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 four groups of PIT-tagged fish from the Lookingglass Creek as well as PIT-tagged fish from other natural populations in the Grande Ronde River basin from the 1996 cohort (Tagged by ODFW in 1997) to describe the outmigration timing and to determine if a trend in survival was evident over time. The arrival timing at Lower Granite Dam was calculated in the same manner described earlier (see **Smolt Release of the 1996 Cohort From Lookingglass Hatchery**, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*). 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.

In order to determine if the size of the juvenile Chinook salmon at the time of tagging affected arrival timing of fish that were detected at Lower Granite Dam, unexpanded detections at Lower Granite Dam from the Lookingglass Creek field group were divided into two size categories. Fish shorter than or equal to the median fork length at tagging were included in the "< median" group. Fish longer than the median fork length comprised the "≥median" group. A Kolmogorov-Smirnov two sample test (Wilkinson 1996) was then used to compare arrival distributions of the groups of small and large fish (α 0.05).

To determine the minimum survival rates and 95% confidence intervals to Lower Granite Dam of juvenile outmigrants from the four groups from Lookingglass Creek and the Grande Ronde River basin we used the same methods for migration timing described earlier (see **Smolt Release of the**

1996 Cohort From Lookingglass Hatchery, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*).

Chi-square goodness of fit analysis was used with the field group to determine if minimum survival rates to Lower Granite Dam differed among fish of different fork lengths at tagging (α 0.05). Fish from the field group were categorized into 5-mm intervals except at the extremes of the fork length distribution, where intervals were combined to increase the expected detections to at least five (Thorndike 1982). The overall cumulative detection rate was used to calculate the expected number of detections for each size interval. The intervals used for the naturally-produced 1996 cohort were 55-77, 78-82, 83-87, 88-92, 93-97, and 98-109 mm.

Effects of PIT-Tagging on Fish Movement Past the Rotary Screw Trap

In order to determine whether PIT-tagging influenced migration timing out of Lookingglass Creek, we described the migration timing past the trap of both tagged and non-tagged fish from the naturally-produced 1996 cohort after PIT-tagging commenced. We expanded PIT tag recaptures and non-PIT-tagged captures at the trap based on the trap efficiency estimates during the period the fish were captured (M^c^Lean and Lofy 1998) (see Population Estimates And Timing Past The Rotary Screw Trap For The 1996 Cohort). We described arrival timing for each group by graphing the expanded trap captures for each month as a percentage of the estimated total number of fish captured from that group after the first day of PIT-tagging. A Kruskal-Wallis one-way ANOVA (Wilkinson 1992) was then used to compare arrival distributions by trapping period for the field group and the untagged fish within each cohort (α 0.05).

Fork Length, Weight, and Condition Factor of Detected vs. Non-detected Fish

The field group from the 1996 naturally-produced cohort was used to determine if fish that were detected at Columbia and Snake River dams differed in size (fork length or weight) or condition factor at the time of tagging from those that were not detected. We used a Kolmogorov-Smirnov two-sample test within cohorts, to compare the fork length, weight, and condition factor of fish from the field group that were detected compared to the fish that were not detected (α 0.05).

Comparison of Arrival Timing and Survival Rates to Lower Granite Dam Between Lookingglass Creek and Other Grande Ronde River Tributaries

In order to compare arrival timing at and minimum survival rates to Lower Granite Dam, we made comparisons between the Lookingglass Creek 1996 cohort field group and the same cohort from natural populations of juvenile spring Chinook salmon in the Minam River and Catherine Creek. The natural populations from other Grande Ronde River tributaries were PIT-tagged by ODFW during the same general time, August to September, as the Lookingglass Creek field group. Parr from no other tributaries were PIT-tagged from the 1996 cohort.

The arrival timing at Lower Granite Dam was calculated in the same manner described earlier (see **Smolt Release of the 1996 Cohort From Lookingglass Hatchery**, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*). We illustrated arrival timing by week at Lower Granite Dam for each tributary for the 1996 cohort by graphing weekly detections as a percentage of the expanded total number of fish detected.

To determine the minimum survival rates and 95% confidence intervals to Lower Granite Dam of juvenile outmigrants for each tributary we used the same methods described earlier (see **Smolt Release of the 1996 Cohort From Lookingglass Hatchery**, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*).

PIT-Tagging of the Hatchery-produced 1996 Cohort

In 1998 we summarized data collected on the hatchery-produced 1996 cohort from three size categories of fish used in the evaluation of PIT-tagging effects on survival and migration timing (McLean and Lofy 2000). To determine if there were differences in weekly arrival timing at and survival to the screw trap and Lower Granite Dam between fish of three different size categories, we marked a portion of the 1996 cohort hatchery-produced 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 (McLean and Lofy 2000).

Monthly Arrival Timing and Survival to the Screw Trap

We used the three size categories of PIT-tagged and control 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 fish recaptures at the trap for the 1996 cohort based on the trap efficiency estimates during the period the fish were initially captured (McLean and Lofy 1998) (see Population Estimates And Timing Past The Rotary Screw Trap For The 1996 Cohort). Since experimental and control fish were the only fish in Lookingglass Creek that would have been adipose clipped, we could identify the origin of every fish. Since some of the control fish lost the mark that identified which size category they were in, we assigned a size category to these fish based on the Alcian Blue mark loss rate of PIT-tagged fish in each size category, and by the size of the control fish at recapture. The actual number of control fish trapped was expanded for trapping efficiency using a bootstrap method.

We described arrival timing for each size category 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 category 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 category. The variance around the population estimate was calculated using a bootstrap method. We determined differences between the PIT-tagged and control fish 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 categories (55-59 mm, small group; 62-66 mm, medium group; and 69-73 mm, large group) of PIT-tagged fish from Lookingglass Creek. The arrival timing at Lower Granite Dam was calculated in the same manner described earlier (see **Smolt Release of the 1996 Cohort From Lookingglass Hatchery**, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*). Arrival timing at Lower Granite Dam for each category was graphed using the expanded weekly detections as a percentage of the total expanded number of fish for that category.

To determine the minimum survival rates and 95% confidence intervals to Lower Granite Dam of juvenile outmigrants from the three size categories from Lookingglass Creek we used the same methods described earlier (see **Smolt Release of the 1996 Cohort From Lookingglass Hatchery**, *Size at Release Effects on Survival and Arrival at Lower Granite Dam*).

Results/Discussion

Stream Flow and Temperature

Increasing flows did not began in Lookingglass Creek until the week of 11 March in 1998 (Figure 4). Weekly maximum flows ranged from 1 to 16 m^3/s with two major peaks occurring the weeks of 25 March and 6 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 until mid November (Figure 4). There were higher flows the weeks of 25 March and 2 and 9 December than were seen historically from 1964 to 1971 (Figure 4). The peak flows in April and May of 1998 were well below what were seen historically from 1964 to 1971 (Figure 4).

Water temperature peaked at all four sites in Lookingglass Creek for 1998 during the week 23 July (13.9, 18.3, 20.6, and 18.3°C) (Figure 4). This was 1 week after the peak in maximum water temperature observed from 1964 to 1971 (17.8 °C) (Figure 4). Maximum temperatures at sites 1, 3, and 5 in 1998 (Figures 3 and 4) were mostly within the range of maximum temperatures observed among all years from site 2 from 1964 to 1971 (Figure 4). The minimum water temperatures for all sites in 1998 were very similar to one another, generally falling within the minimums observed from 1964 to 1971 (Figure 4). Maximum temperatures in 1998 at the hatchery intake (20.6°C) were somewhat higher than those from locations upstream in 1998 (Figure 4).

Adult Returns to Lookingglass Hatchery

Unmarked adult spring Chinook salmon that were trapped at Lookingglass Hatchery in 1998 included 32 four-year-old, and 25 five-year-olds (Table 1). No three-year-old fish were observed. We did not collect any adult spring Chinook salmon during spawning ground surveys conducted above or below the weir on Lookingglass Creek in 1997 (Table 1). There were 7 marked fish that swam into the Lookingglass Hatchery trap in 1998. These 7 fish were taken to the SFWW facility where the NPT utilized them for their hatchery programs in Idaho. The unmarked fish first arrived at the trap the week of 3 June with the peak arrival the week of 17 June (Figure 5).

We spawned 12 male and 17 female unmarked adult spring Chinook salmon at SFWW in 1998. Eighteen males and 9 females died and one male was killed while being held at the SFWW facility. The eggs were incubated at Irrigon Hatchery. They are expected to be transferred to Lookingglass Hatchery for final rearing in May of 1999.

Progeny-Per-Parent Ratios

The Lookingglass Creek progeny-to-parent ratio for the completed (3-5-year-olds) 1992 and 1993 cohorts was 0.58 and 0.37 (Table 2). The 1992 and 1993 cohorts in other Grande Ronde River tributaries ranged from 0.23 to 0.89 and 0.42 to 0.95 (Table 2). The ratio for the 1994 cohort, three and four-year-old fish, was 0.26 in Lookingglass Creek and ranged from 0.33 to 2.74 for the other Grande Ronde River tributaries (Table 2).

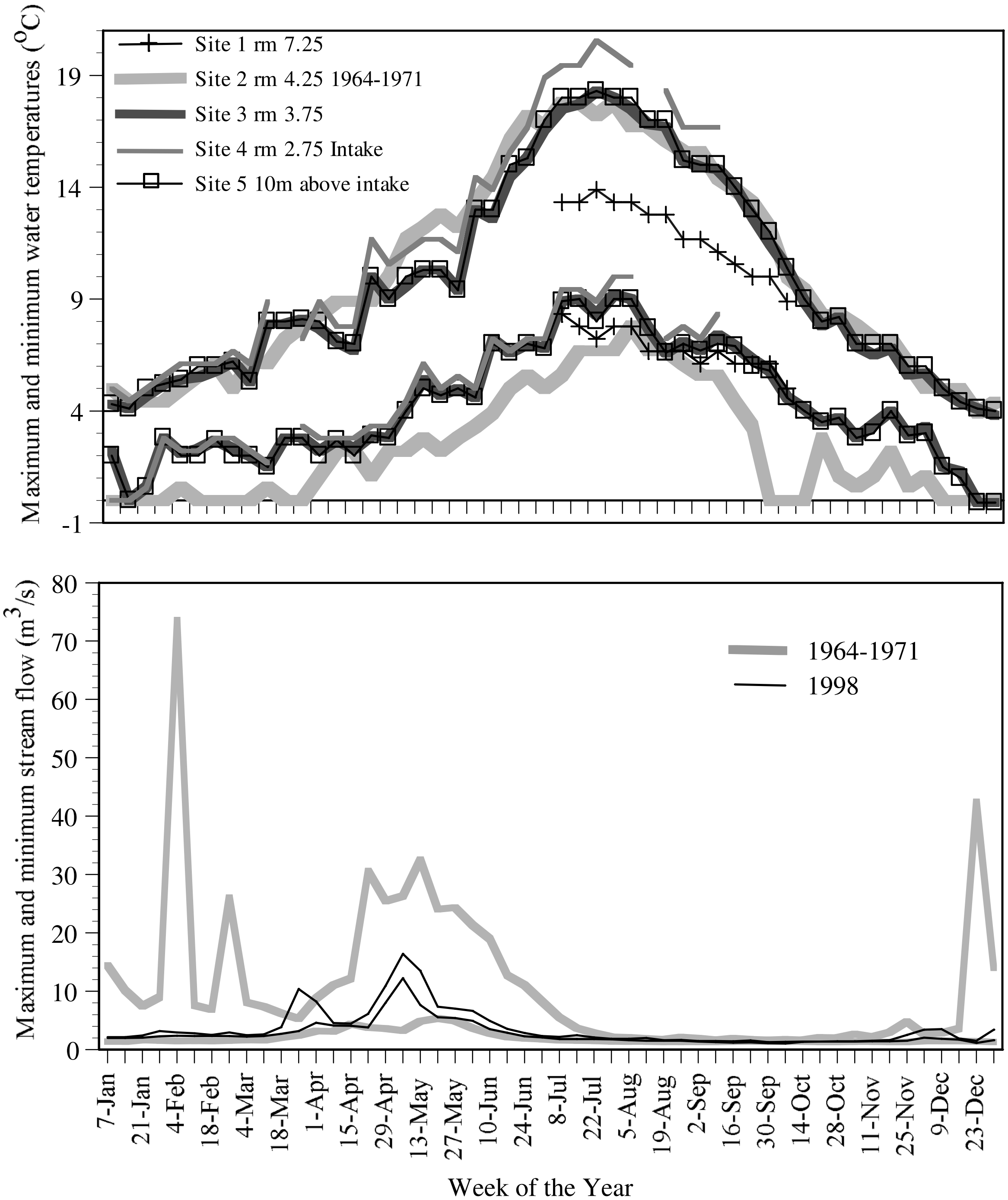

Figure 4. Historical (1964-1971) and 1998 ranges of weekly stream temperature and flow in Lookingglass Creek. Week of the year is represented by the last day of the week. Data for temperatures were provided by the USFS unpublished, Burck 1993, and ODFW HMIS unpublished. Data for flows were provided by USGS unpublished and Burck (1964-1974).

Table 1. Disposition, age, sex, and fork length data from spring Chinook salmon that were spawned at SFWW facility, recovered above the Lookingglass Hatchery weir but were not trapped at the hatchery, and unmarked spring Chinook salmon that died while being held at the SFWW facility in 1998.

		Males[a]			Females[a]		
			Fork length (mm)			Fork length (mm)	
Disposition[b]	Age[c]	N	Range	Median	N	Range	Median
Spawned	3	0	--	--	0	--	--
Spawned	4	6	740-825	778	12	690-790	742
Spawned	5	6	898-995	937	5	795-855	830
Mortality	3	0	--	--	0	--	--
Mortality	4	10[d]	675-890	760	4	674-860	766
Mortality	5	9	804-968	840	5	821-945	869
Recovered	3	0	--	--	0	--	--
Recovered	4	0	--	--	0	--	--
Recovered	5	0	--	--	0	--	--

[a] *The sex of the spawned, dead, and recovered fish was determined by internal inspection.*

[b] *Disposition of the fish, Spawned = gametes taken at the hatchery for artificial production, Mortality = died while at Lookingglass or SFWW facilities, Recovered = found during spawning ground surveys, not trapped at weir.*

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

[d] *This number includes 1 fish that was killed and not spawned.*

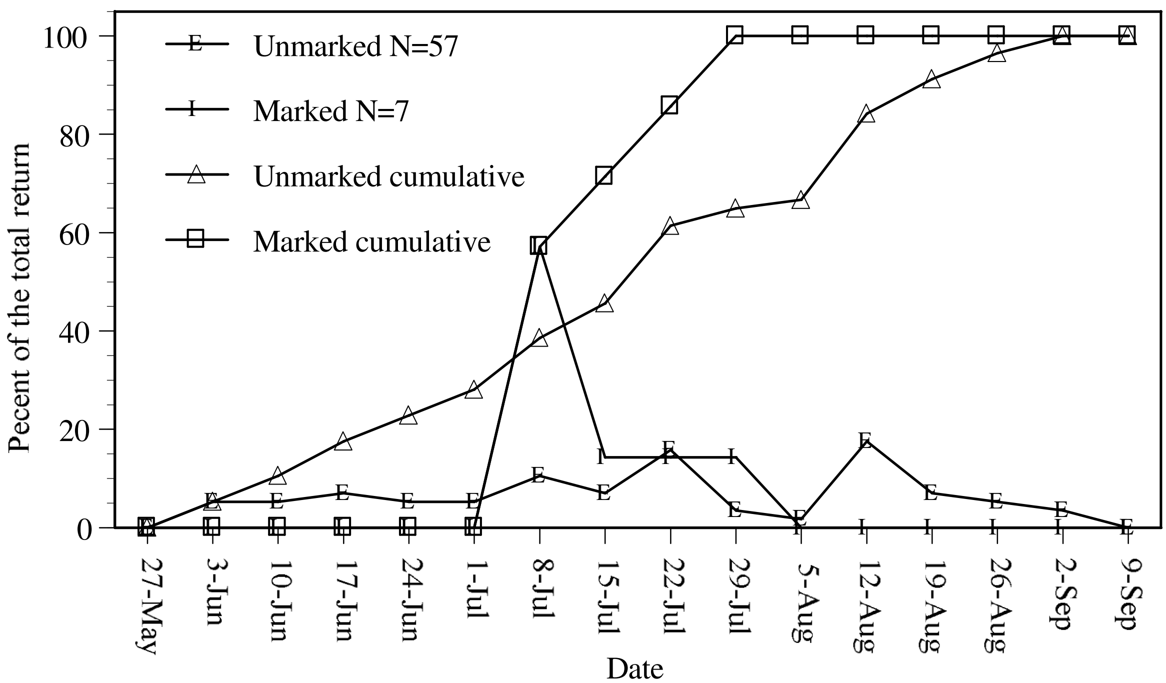

Figure 5. Arrival timing at the Lookingglass Hatchery adult trap of progeny of marked (ADRV) and unmarked (AD only and no clip) adult spring Chinook salmon in 1998. N= total number of each mark type captured at the hatchery. The trap was opened on 1 March, 1998 and was closed on 30 September, 1998.

In our calculation of progeny-per-parent ratios we used fish-per-redd estimates from our releases in Lookingglass Creek from 1992 to 1994. Since Sex ratio may influence production by affecting the number of eggs available for fertilization, and production of progeny. We generally tried to place an equal proportion of males and females above the weir in Lookingglass Creek each year. The high progeny-per-parent ratio seen for the Grande Ronde River for the 1994 cohort may be due to the low redd count. The addition of only a couple of returning progeny inflates the ratio greatly.

It is possible that any or all of 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 a source of unmarked adult spring Chinook salmon returning to the Lookingglass Creek basin. Since we marked (fin clip, PIT tag, CWT) very few of the fish leaving Lookingglass Creek, we have no way of being certain where most of the unmarked fish originated, some very well could be strays from other basins. If a large portion of the unmarked fish returning to Lookingglass Creek are strays from other basins, this would lower the estimate of success (parent-progeny ratio) of our adult outplants in Lookingglass Creek. If indeed these are strays, we may need to take another look at the genetic make-up of the unmarked adult population in Lookingglass Creek, because of the declining status of other Grande Ronde River tributary natural populations. If the unmarked fish returning to Lookingglass Creek are from production in Lookingglass Creek we need to document the success of outplanting hatchery adults in order to re-establish natural production so that others can see that this method can be successful.

Table 2. Progeny-per-parent ratios for the 1992, 1993 and 1994 cohort spring Chinook salmon returning in 1995, 1996, 1997, and 1998 to Lookingglass Creek or other Grande Ronde River tributaries.

Cohort, Location	Expanded redd count[a]	Parent Population[a]	Returning progeny by age[b]			Progeny-per-Parent
			3	4	5	
1992						
Lookingglass Cr.	49	220	9	101	17	0.58
Grande Ronde R.	130	424	3	77	19	0.23
Catherine Cr.	105	342	17	56	31	0.31
Lostine R.	42	137	5	83	33	0.89
Minam R.	269	877	16	371	47	0.50
Wenaha R.	195	634	10	407	48	0.73
1993						
Lookingglass Cr.	132	297	3	79	27	0.37
Grande Ronde R.	113	368	4	68	81	0.42
Catherine Cr.	138	451	3	112	75	0.42
Lostine R.	105	342	4	119	78	0.59
Minam R.	163	532	18	167	166	0.66
Wenaha R.	118	383	19	172	172	0.95
1994						
Lookingglass Cr.	40	121	0	32		0.26
Grande Ronde R.	5	15	4	37		2.74
Catherine Cr.	34	110	7	34		0.37
Lostine R.	18	60	7	35		0.71
Minam R.	80	261	10	75		0.33
Wenaha R.	66	215	10	78		0.41

[a] *Table is a summary of Appendix Tables A1-A5 (ODFW Research, La Grande, unpublished data).*

[b] *Age structure from Appendix Table A6 was used to calculate the returning progeny from each cohort (ODFW Research, La Grande, unpublished data).*

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. Pre-release sampling suggest the 1992, 1993, and 1994 cohorts, released from Lookingglass Hatchery, were about 100% marked with either an adipose (AD) or right pelvic (RV) fin clip or a combination of the two (ADRV) (Table 3)(ODFW Research, La Grande, unpublished data).

Table 3. Release and fin clip quality data for the Rapid River stock spring Chinook salmon released at Lookingglass Hatchery from the 1992, 1993, and 1994 cohorts. Source: ODFW Research, La Grande, unpublished data.

Cohort	Number released	Pre-release fin clip			
		ADRV	RV	AD	None
1992	849,273	830,968	18,305	0	0
1993	658,230	645,413	554	12,263	0
1994	139,112	114,219	503	24,390	0

Spawning Ground Surveys

We observed 1 completed redd on 8 September 1998 above the upper weir (Unit 3U), no redds in Unit 3L, and 4 completed redds below Lookingglass Hatchery in Unit 1 (Figure 2). There were no redds observed in units 4 or 2 on 8 September (Figure 2). No dead fish were recovered during the 8 September survey of Lookingglass and Little Lookingglass creeks.

Genetic Monitoring

We collected eye, heart, liver, and body tissue for genetic analysis by the NMFS. The tissue from 57 unmarked and 40 marked adult spring Chinook salmon captured at the Lookingglass Hatchery weir and trucked in from Lower Granite Dam in 1998 was collected during spawning of the fish at the SFWW facility. The samples were frozen in a -80°C freezer until the end of the spawning season (22 September), at that time the samples were packaged and sent to the NMFS in Seattle, Washington.

Smolt Release of the 1996 Cohort from Lookingglass Hatchery

Smolts from the 1996 cohort were released from Lookingglass Hatchery on 6 April 1998. There were 51,131 smolts released from raceway 9 at 42.1 fish/lb (1,214.5 pounds) and 17,893 from raceway 10 at 19.3 fish/lb (927.1 pounds). ODFW PIT-tagged 534 fish from raceway 9 and 538 fish from raceway 10 as part of their survival study.

Size at Release Effects on Survival and Arrival at Lower Granite Dam

Juvenile Chinook salmon from raceway 9 first arrived at Lower Granite Dam the week of 8 April, with the last fish arriving the week of 20 May (Figure 6). The PIT tag detectors at Lower Granite Dam became operational on 1 March 1998.

There was no difference in arrival timing between the fish from raceways 9 and 10 (P=0.17). The median date of arrival for the fish from raceway 9 was 2 May 1998 and for raceway 10 was 1 May 1998.

Minimum survival rates of PIT-tagged juvenile spring Chinook salmon from raceways 9 and 10 were 49.1 and 53.4%, respectively (Figure 7). There was no significant difference in detection rates between the two groups based on the 95% confidence interval overlap (Figure 7).

Population Estimates of the Naturally-produced 1996 Cohort Using a Screw Trap

We captured 15,241 naturally-produced juvenile spring Chinook salmon from the 1996 cohort in the rotary screw trap through June of 1998 (Table 4). We captured the first naturally-produced fry from 1996 cohort on 11 March 1997 and the last fish on 21 September 1998 (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.

Of the fish estimated to have passed the trap site, over half (61.4%) of the juveniles from the naturally-produced 1996 cohort migrated before January 1998 as sub-yearlings (Figure 8). Peak migration past the trap for the 1996 cohort occurred during the October and March trapping periods (Figure 8).

On 12 March 1998 we noticed a hole in the livebox of the screw trap that was large enough for fish to escape through. It is unknown how long the hole was there and how many fish escaped through it. The hole appeared to have affected the trap efficiency estimates (lowering) when the numbers of fish in the livebox were high (September 1997 to November 1997, and March 1998)(Table 4).

Monthly Fork Length Sampling of the Naturally-produced 1996 Cohort

We recorded fork length data from naturally-produced spring Chinook salmon captured at about rm 7.25 in June, August, September, and October 1997 and June 1998. Median monthly fork lengths of fish captured ranged from 56 mm in June to 133 mm one year later (Figure 9). Median monthly fork lengths of fish captured in the trap around the 20th of each month ranged from 36 mm for April 1997 to 95 mm one year later (Figure 9). The median fork length of field captured and trap captured fish, for months when both were captured, appeared very similar (Figure 9).

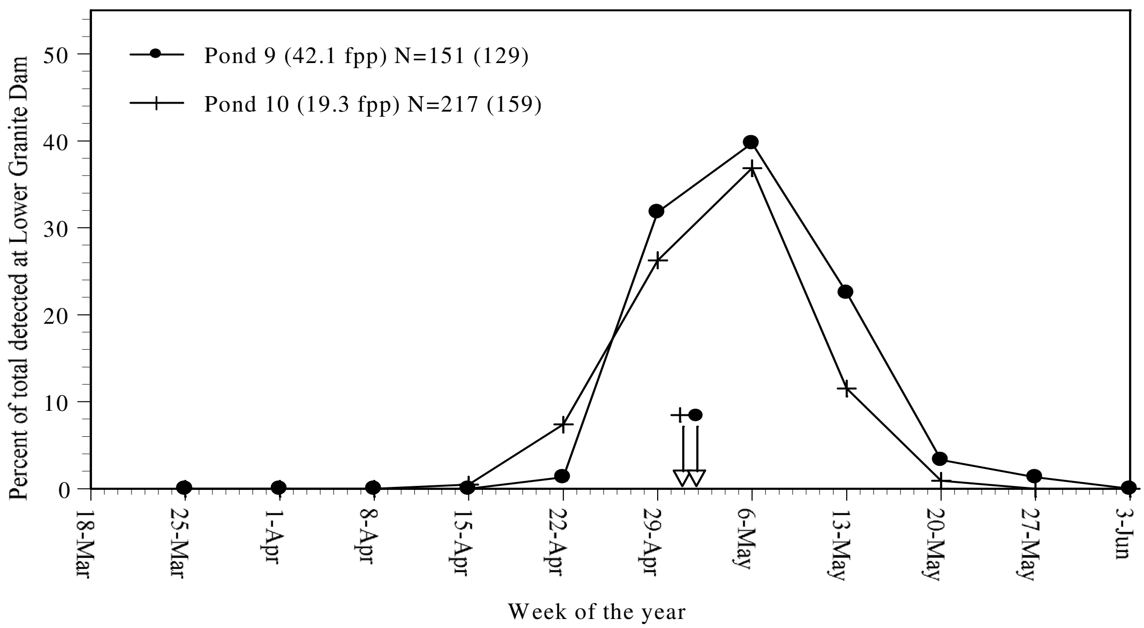

Figure 6. Arrival timing by week at Lower Granite Dam in 1998 of hatchery-produced 1996 cohort juvenile spring Chinook salmon from raceways 9 and 10 at Lookingglass Hatchery. The fish were released as smolts into Lookingglass Creek. The arrows indicate the median arrival date of each group. Expanded detections (N) are graphed. Actual detections are in parentheses. Week of the year is represented by the last date in the week.

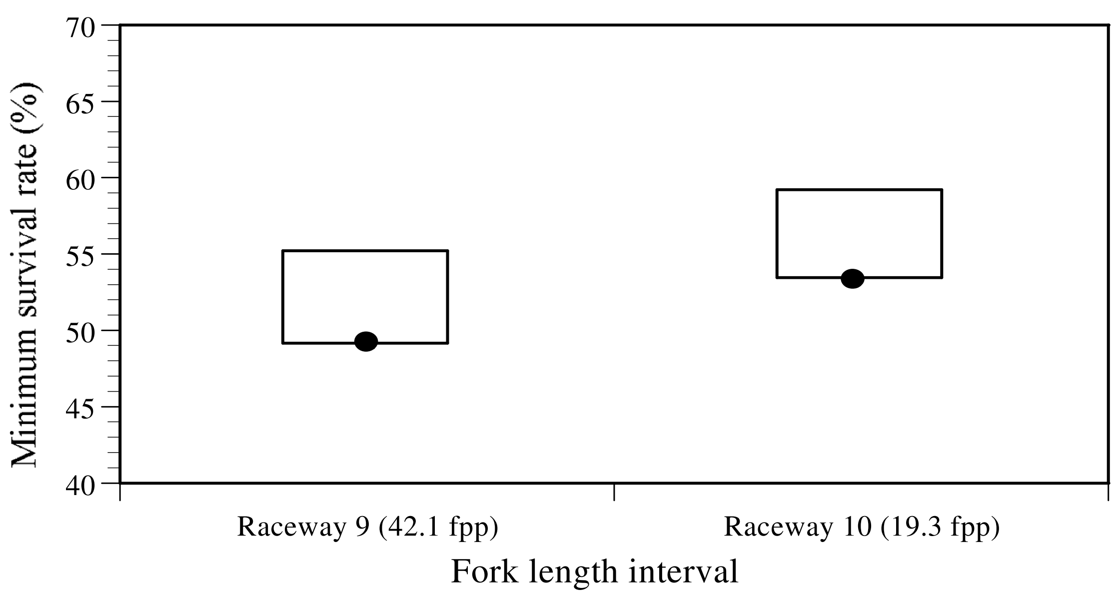

Figure 7. Total unique detection rates and upper ninety-five percent confidence intervals of hatchery-produced 1996 cohort juvenile spring Chinook salmon PIT-tagged from raceways 9 and 10 at Lookingglass Hatchery. The fish were released from the hatchery as smolts and detected at Snake or Columbia River dams in 1998.

Table 4. Juvenile spring Chinook salmon from the 1996 cohort captured in a rotary screw trap, releases and recaptures from trap efficiency tests, and the estimated number of migrants from Lookingglass Creek during 1997 and 1998. Estimates include only wild (unmarked) fish captured.

	Total	Trap efficiency		% Trap	Population	
Month	trapped	release	recapture	efficiency[a]	Estimate	±95%CI
Mar	4	0	0	4.55	88	211
Apr	12	6	1	4.55	264	550
May	8	6	0	4.55	176	389
Jun	1	1	0	4.55	22	77
Jul	3	8	0	4.55	66	159
Aug	68	67	3	4.55	1,495	2,561
Sep	229	232	27	11.64	1,967	901
Oct	136	145	5	3.45	3,942	6,365
Nov	217	243	43	17.70	1,226	396
Dec	40	37	13	35.14	114	67
Jan	37	39	9	23.08	160	144
Feb	88	101	20	19.80	444	214
Mar	258	281	17	6.05	4,264	2,845
Apr	84	86	8	8.79	956	1,203
May	2	2	0	8.79	23	44
Jun	3	3	0	8.79	34	58
Jul	0	0	0	--	--	--
Totals	1,190	1,257	146		15,241 ±	7,629

Estimated # of redds above the weir in 1996 was: 24
Estimated # of female spring Chinook salmon above the weir in 1996 was: 25
Estimated # of male spring Chinook salmon above the weir in 1996 was: 25

[a] *Because the trap efficiency release was less than 25 fish for the months of March 1997 to July 1997 and May 1998 to June 1998, the releases were combined with August 1997 and April 1998 to make one trap efficiency estimate that was used for each individual month before and after. Hatchery fish captured in the trap were also used in the release numbers used to calculate the trap efficiency to increase the sample size.*

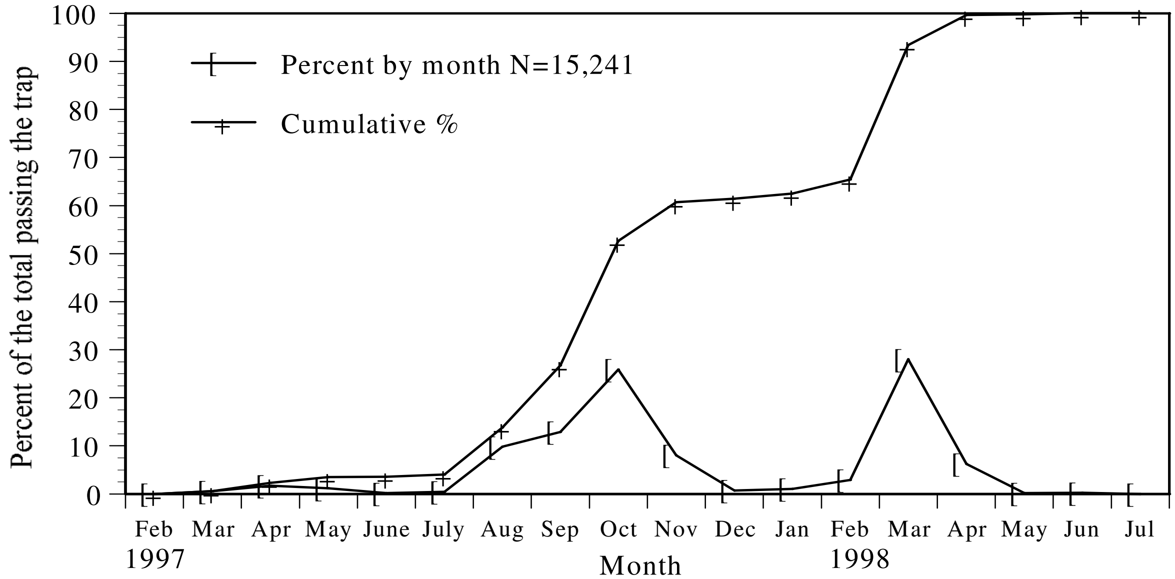

Figure 8. Percent of the total expanded numbers of unmarked 1996 cohort juvenile spring Chinook salmon passing the rotary screw trap site on Lookingglass Creek in 1997 and 1998. The total estimated population passing the trap (15,241) is an expanded number.

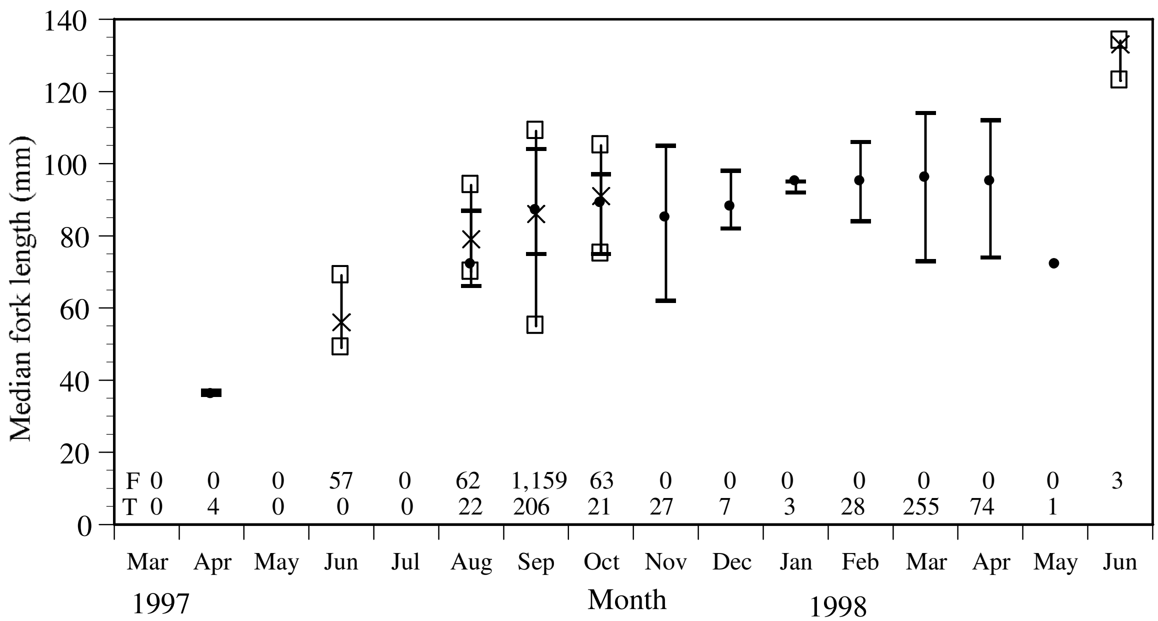

Figure 9. Monthly median and range of fork lengths from naturally-produced 1996 cohort juvenile spring Chinook salmon captured in the rotary screw trap (T) and in upper Lookingglass Creek (F) in 1997 and 1998. Length information from fish trapped and captured with a seine around the 20th of each month (± 5 days) was used. Sample size for each group is shown above the month. The X and open squares represent the field group while the dots and lines represent the trap group.

PIT-Tagging of the Naturally-Produced 1996 Cohort

We PIT-tagged a total of 272 juveniles from the fall group, 379 juveniles from the winter group, and 453 juveniles from the spring group for the naturally-produced 1996 cohort at the screw trap (Table 5). We PIT-tagged 995 naturally-produced juvenile spring Chinook salmon from the field group seined from the upper reaches of Lookingglass Creek.

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

Juvenile Chinook salmon from the naturally-produced 1996 cohort PIT-tagged at the screw trap and in the field first arrived at Lower Granite Dam the week of 1 April, with the last fish arriving the week of 8 July 1998 (Figure 10). The arrival distributions of the fall, winter, and field groups appeared similar with median dates of arrival being 16, 17 and 16 April 1998 for the fall, winter, and field groups respectively (Table 5)(Figure 10). The median arrival of the spring group was 29 April 1998. The later arrival for the spring group may be do in part to the fact that the median date of PIT-tagging for the spring group was 22 March 1998 (Table 5) and that 11.0% of the fish PIT-tagged from that group were captured at the trap and PIT-tagged after the median arrival date of the winter group at Lower Granite Dam.

The arrival timing of the "< median" group (< 88mm fork length) was significantly later than the arrival timing of the "≥ median" group (≥ 88mm fork length) for the 1996 cohort field group PIT-tagged in Lookingglass Creek (P=0.01) (Figure 11). The median date of arrival for the small group was 21 April while that of the large group was 12 April. The median length at tagging for all fish that were detected was 88 mm with sample sizes of 61 for the small group and 64 for the large group.

Minimum survival rates of PIT-tagged juvenile spring Chinook salmon from the naturally-produced 1996 cohort for the fall, winter, spring, and field groups were 23.5, 30.6, 49.5, and 22.6%, respectively. There was a significant difference in detection rates among the fall, winter and spring groups based on the 95% confidence interval overlap (Figure 12). The field group was significantly different from both the winter and spring groups (Figure 12). Survival indices of the 1996 cohort captured at the trap and in the field by month for the months in which more than 50 tagged fish were released (August to April), ranged from 8.1 to 55.4% (Figure 12).

Minimum survival rates among 6 different size categories of fish from the naturally-produced 1996 cohort field group in Lookingglass Creek were not significantly different (χ^2=2.59, P=0.41, df=5) (Figure 13).

Effects of PIT-Tagging on Fish Movement Past the Rotary Screw Trap

The field group of PIT-tagged fish for the 1996 cohort had two peaks in movement past the rotary screw trap in October and March (Figure 14). The non-PIT-tagged fish had similar peaks in movement past the screw trap after the first date of PIT-tagging of the field group (Figure 14).

Table 5. PIT-tagging information for naturally-produced juvenile spring Chinook salmon from the 1996 cohort captured at the rotary screw trap and in the field from Lookingglass Creek in 1997 and 1998.

Group	Number PIT-tagged	Median date of PIT-tagging	Median arrival date at Lower Granite Dam	Number Detected	Expanded[a] Detections
Fall (trap)	272	18 September 1997	16 April 1998	31	33
Winter (trap)	379	2 November 1997	17 April 1998	71	76
Spring (trap)	453	22 March 1998	29 April 1998	128	147
Field	995	23 September 1997	16 April 1998	125	142

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

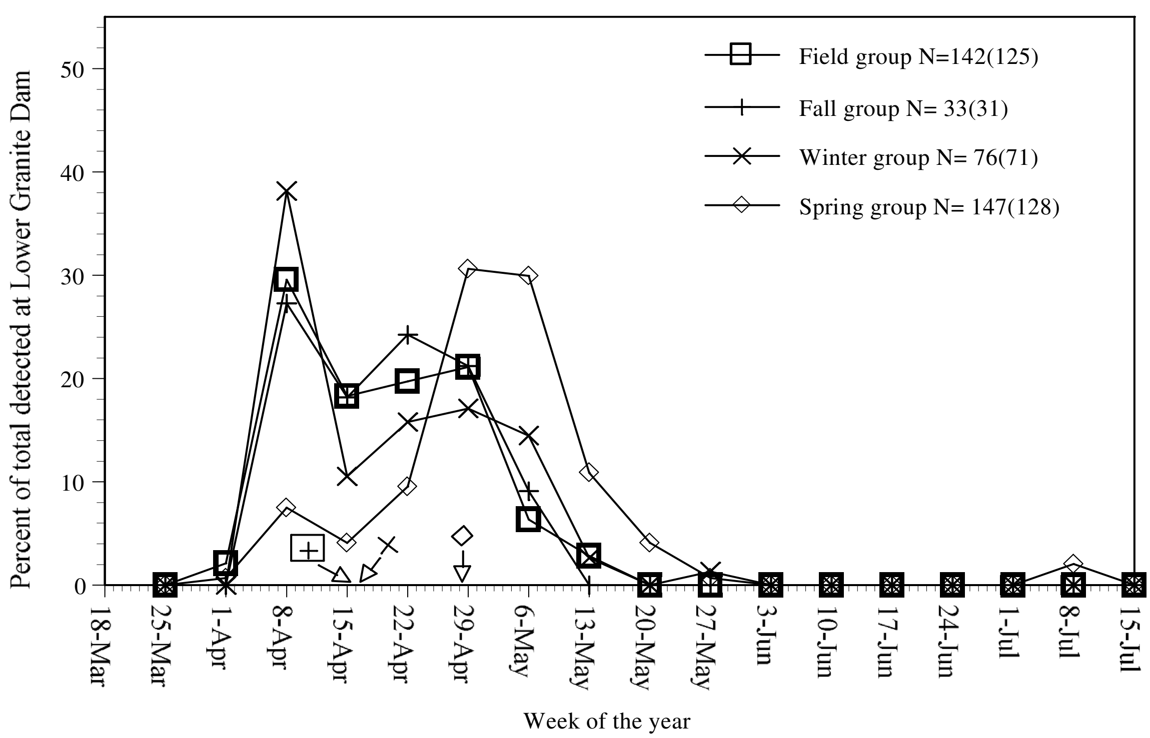

Figure 10. Arrival timing by week at Lower Granite Dam in 1998 of four groups of naturally-produced 1996 cohort juvenile spring Chinook salmon PIT-tagged at the rotary screw trap and in the upper reaches of Lookingglass Creek. The arrows indicate the median arrival date of each group. Expanded detections (N) are graphed. Actual detections are in parentheses. Week of the year is represented by the last date in the week.

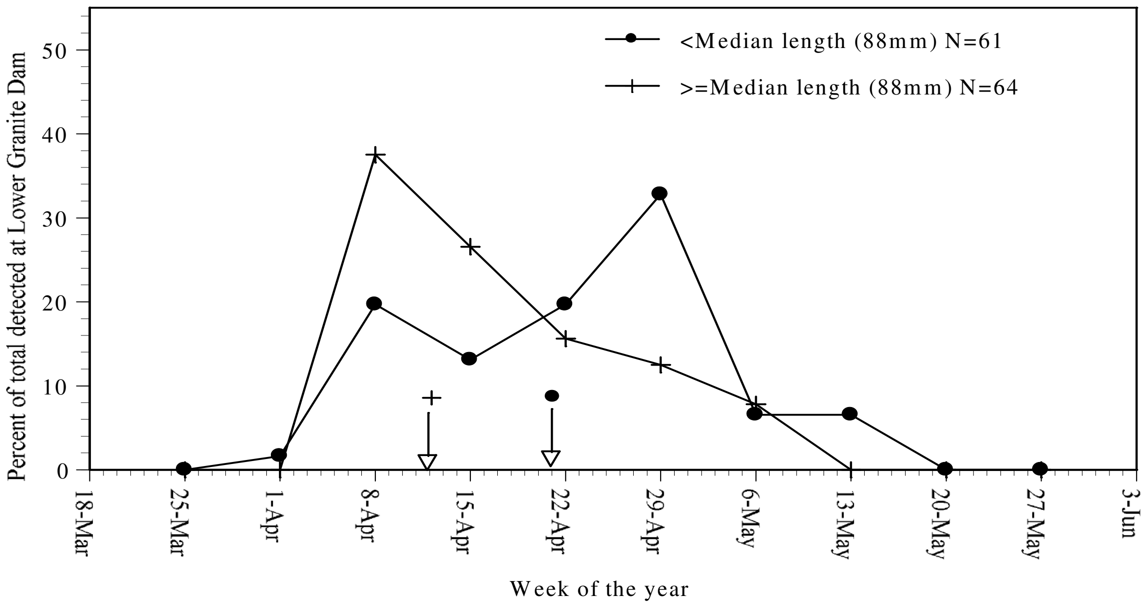

Figure 11. Arrival timing by week at Lower Granite Dam in 1998 for groups of smaller (fork length < 88 mm) and larger (fork length ≥ 88 mm) fish from the field group of naturally-produced 1996 cohort juvenile spring Chinook salmon in Lookingglass Creek. Actual detections (N) are graphed. Arrows indicate the median arrival date. Week of the year is represented by the last date in the week.

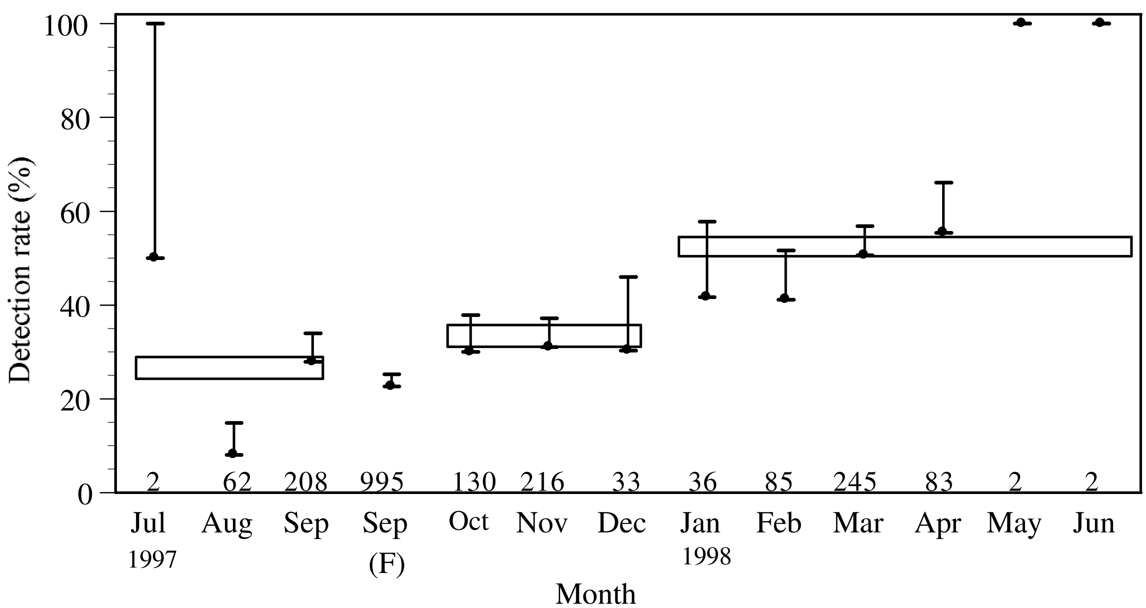

Figure 12. Total unique detection rates with upper ninety-five percent confidence intervals (bars) for 1996 cohort juvenile spring Chinook salmon tagged at the rotary screw trap in Lookingglass Creek and detected at Snake or Columbia River dams. The rectangles represent detection rates and upper ninety-five percent confidence intervals for fish from summer (Jul-Sep), fall (Oct-Dec), and spring (Jan-Apr) groups. Number tagged is above each month.

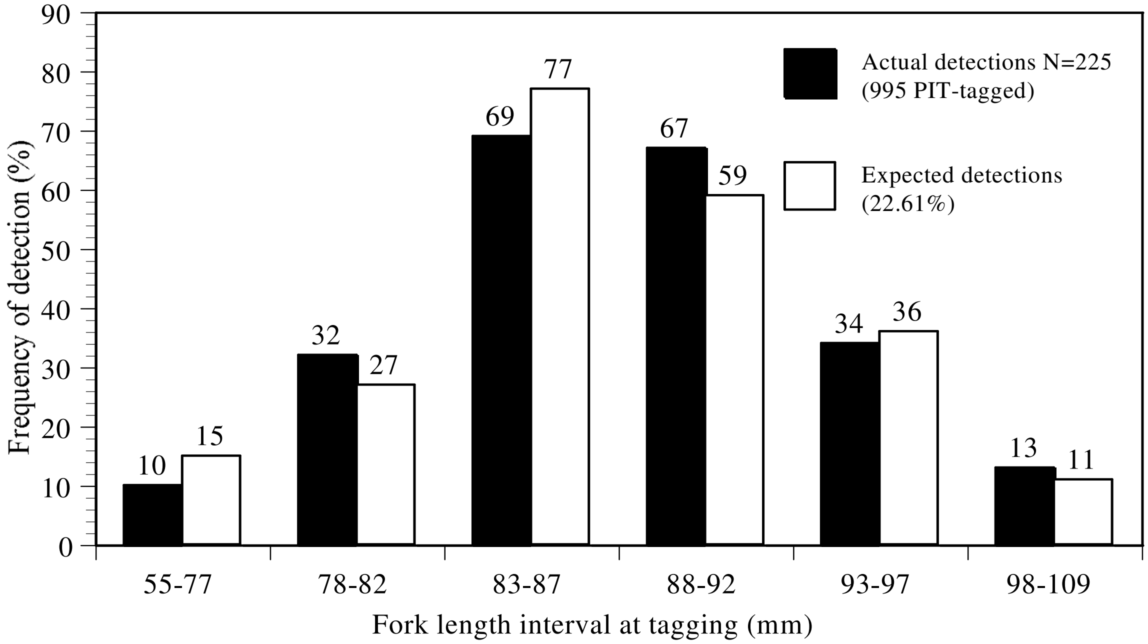

Figure 13. Comparison of actual and expected (overall survival of field group) unique PIT tag detections at Snake or Columbia River dams by fork length interval of 1996 cohort juvenile spring Chinook salmon seined from Lookingglass Creek (PIT-tagged in 1997). N values are shown above the bars.

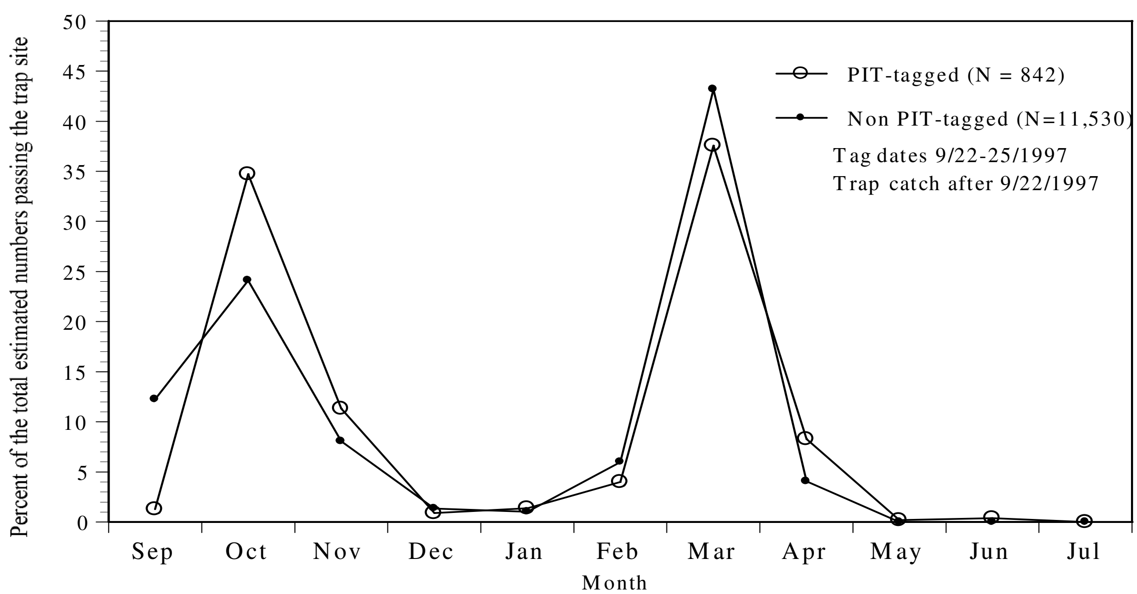

Figure 14. Arrival timing at the rotary screw trap in Lookingglass Creek of PIT-tagged and non-PIT-tagged juvenile spring Chinook salmon after commencing PIT-tagging of the 1996 cohort field group. N represents the total numbers of fish trapped (expanded for trap efficiency).

This similar movement pattern for PIT-tagged and non-PIT-tagged groups past the screw trap for the 1996 cohort was not similar to what was seen for the 1993 and 1994 cohorts (M^{c}Lean and Lofy 1999). For the 1993 and 1994 cohorts the PIT-tagged group peak movement past the trap was in September while the non-PIT-tagged group peaked in October (M^{c}Lean and Lofy 1999). The dates of PIT-tagging for the 1996 cohort were similar to that of both the 1993 and 1994 cohorts (M^{c}Lean and Lofy 1999).

Monthly Arrival Timing and Survival to the Screw Trap for the 1996 Cohort

There were no differences in fork length, weight, or condition factor between detected and non-detected juvenile spring Chinook salmon from Lookingglass Creek that were PIT-tagged in the field for the 1996 cohort (Table 6).

Table 6. Weight, fork length, and condition factor at PIT-tagging of juvenile spring Chinook salmon from the 1996 cohort Lookingglass Creek field group that were detected at Snake or Columbia River dams versus those that were not detected.

	Detected N= 224		Not Detected N= 770
Fork length (mm)			
Min	73		55
Max	104		109
Mean	87.5		87.0
P		0.767	
Weight (g)			
Min	4.0		1.9
Max	14.4		15.1
Mean	8.1		8.0
P		0.461	
Condition Factor			
Min	1.0		0.9
Max	1.4		1.4
Mean	1.2		1.2
P		0.800	

Comparison of Arrival Timing and Survival Rates to Lower Granite Dam Between Lookingglass Creek and Other Grande Ronde River Tributaries

The arrival timing of PIT-tagged juvenile spring Chinook salmon at Lower Granite Dam for the Grande Ronde River tributaries did not appear similar to that of Lookingglass Creek (Figure 15). The median arrival date for Lookingglass Creek was 16 April while that of the Minam River and Catherine Creek was 28 April and 12 May 1998 (Figure 15).

The survival of the field group from Lookingglass Creek was not significantly different from either the Minam River or Catherine Creek groups (Figure 16).

PIT-Tagging of the Hatchery-produced 1996 Cohort

We PIT-tagged 1,188, 1,217, and 1,195 fish in the small, medium, and large size categories respectively. The control group had 1,189, 1,220, and 1,197 fish in the small, medium, and large size categories, respectively.

Monthly Arrival Timing and Survival to the Screw Trap

We used estimated catch at the screw trap to account for differences in arrival timing between the categories and the different trap efficiencies that may occur at that time. We captured an estimated 134 PIT-tagged and 253 control fish from the small category (Table 7). We captured an estimated 213 PIT-tagged and 180 control fish from the medium category (Table 8). We captured an estimated 270 PIT-tagged and 158 control fish from the large category (Table 9). The control group of small and large fish tended to arrive earlier at the screw trap than the PIT-tagged fish from the same category (Figure 17). For the medium category, however, the PIT-tagged fish tended to arrive earlier at the screw trap than the control fish (Figure 17). For the small and large categories, only 58.9 and 48.5% of the PIT-tagged fish had moved past the screw trap by January, while 70.4 and 62.0% of the control fish had moved past (Figure 17). For the medium category, 53.5% of the PIT-tagged fish moved past the screw trap by January while only 48.3% of the control fish moved past (Figure 17).

There was no significant difference in survival indices between the PIT-tagged and control fish among any of the small, medium, and large size categories (Figure 18).

Weekly Arrival Timing and Minimum Survival to Lower Granite Dam

Juvenile Chinook salmon from the 1996 cohort of PIT-tagged fish from the small, medium, and large size categories first arrived at Lower Granite Dam the week of 8 April, with the last fish arriving the week of 10 June (small category)(Figure 19). The larger categories tended to arrive earliest at Lower Granite Dam (Figure 19). The median dates of arrival were 27, 26, and 22 April 1998 for the small, medium, and large categories respectively (Figure 19).

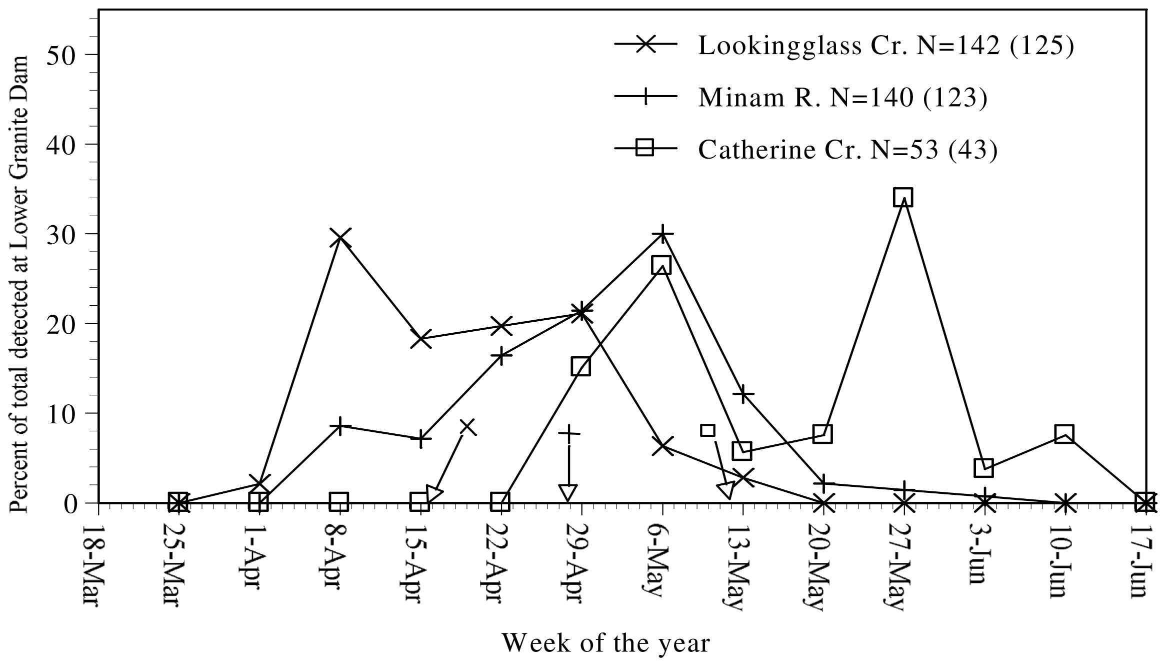

Figure 15. Arrival timing by week at Lower Granite Dam in 1998 of PIT-tagged fish from Lookingglass Creek, Minam River, and Catherine Creek. Expanded detections (N) are graphed. Actual detections are in parentheses. Arrows indicate the median date of arrival for each group. Week of the year is represented by the last date in the week.

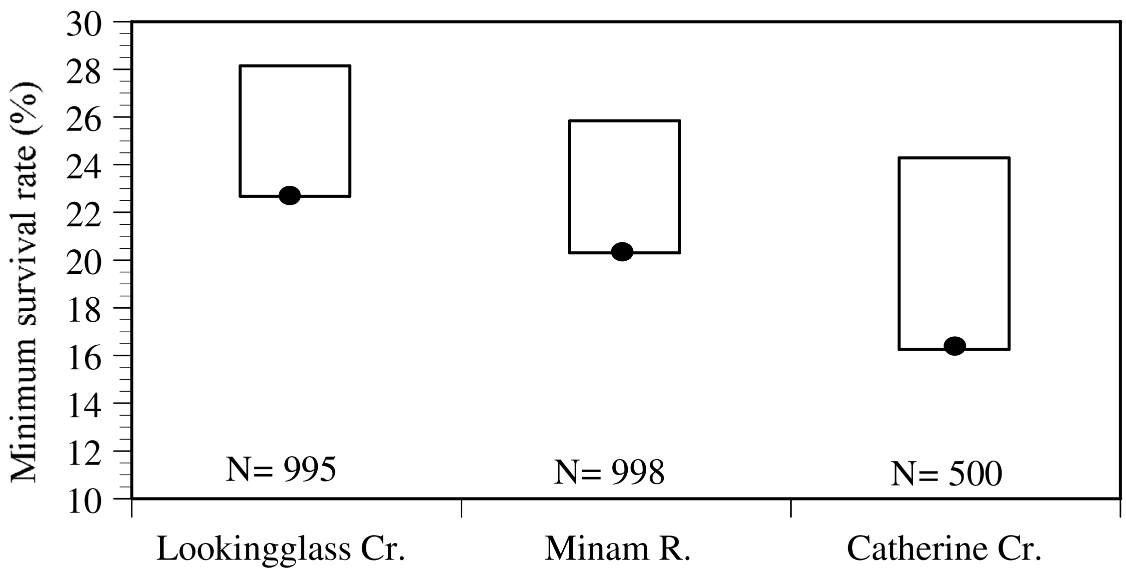

Figure 16. Total unique detection rates and upper ninety-five percent confidence intervals of 1996 cohort PIT-tagged fish from Lookingglass Creek, Minam River, and Catherine Creek that were detected at Snake or Columbia River dams in 1998.

Table 7. Actual and estimated numbers of juvenile spring Chinook salmon from the small size category (55-59 mm FL) of PIT-tagged and control fish within the 1996 cohort captured in a rotary screw trap on Lookingglass Creek in 1997 and 1998.

				Population Estimate			
Month	PIT tag trapped	Control trapped	Trap efficiency[a]	PIT tag	±95%CI	Control	±95%CI
Jul	1	0	4.55	22	77	0	--
Aug	0	1	4.55	0	--	22	77
Sep	2	0	11.64	17	24	0	--
Oct	1	5	3.45	29	89	145	302
Nov	2	2	17.70	11	15	11	15
Dec	0	0	35.14	0	--	0	--
Jan	0	1	23.08	0	--	4	9
Feb	1	1	19.80	5	10	5	10
Mar	3	4	6.05	50	65	66	78
Apr	0	0	--	--	--	--	--
May	0	0	--	--	--	--	--
Totals	10	14		134	138	253	321

Number of PIT-tagged small fish released: 1,188
Number of Control small fish released: 1,189

[a] *The trap efficiency estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates from Table 4.*

Table 8. Actual and estimated numbers of juvenile spring Chinook salmon from the medium size category (62-66 mm FL) of PIT-tagged and control fish within the 1996 cohort captured in a rotary screw trap on Lookingglass Creek in 1997 and 1998.

Month	PIT tag trapped	Control trapped	Trap efficiency[a]	Population Estimate: PIT tag	±95%CI	Control	±95%CI
Jul	3	0	4.55	66	159	0	--
Aug	1	0	4.55	22	77	0	--
Sep	1	0	11.64	9	18	0	--
Oct	0	3	3.45	0	--	87	222
Nov	3	0	17.70	17	18	0	--
Dec	0	0	35.14	0	--	0	--
Jan	0	0	23.08	0	--	0	--
Feb	1	2	19.80	5	10	10	14
Mar	5	5	6.05	83	91	83	91
Apr	1	0	8.79	11	28	0	--
May	0	0	--	--	--	--	--
Totals	15	10		213	202	180	241

Number of PIT-tagged medium fish released: 1,217
Number of Control medium fish released: 1,220

[a] *The trap efficiency estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates from Table 4.*

Table 9. Actual and estimated numbers of juvenile spring Chinook salmon from the large size category (69-73 mm FL) of PIT-tagged and control fish within the 1996 cohort captured in a rotary screw trap on Lookingglass Creek in 1997 and 1998.

				Population Estimate			
Month	PIT tag trapped	Control trapped	Trap efficiency[a]	PIT tag	±95%CI	Control	±95%CI
Jul	2	1	4.55	44	137	22	77
Aug	2	1	4.55	44	137	22	77
Sep	1	1	11.64	9	18	9	18
Oct	0	0	3.45	0	--	0	0
Nov	6	8	17.70	34	28	45	33
Dec	0	0	35.14	0	--	0	0
Jan	1	0	23.08	4	9	0	0
Feb	5	2	19.80	25	24	10	14
Mar	6	3	6.05	99	98	50	65
Apr	1	0	8.79	11	28	0	0
May	0	0	--	--	--	--	0
Totals	24	16		270	223	158	133

Number of PIT-tagged large fish released: 1,195
Number of Control large fish released: 1,197

[a] *The trap efficiency estimates for the PIT-tagged and control fish were calculated using the monthly trap efficiency estimates from Table 4.*

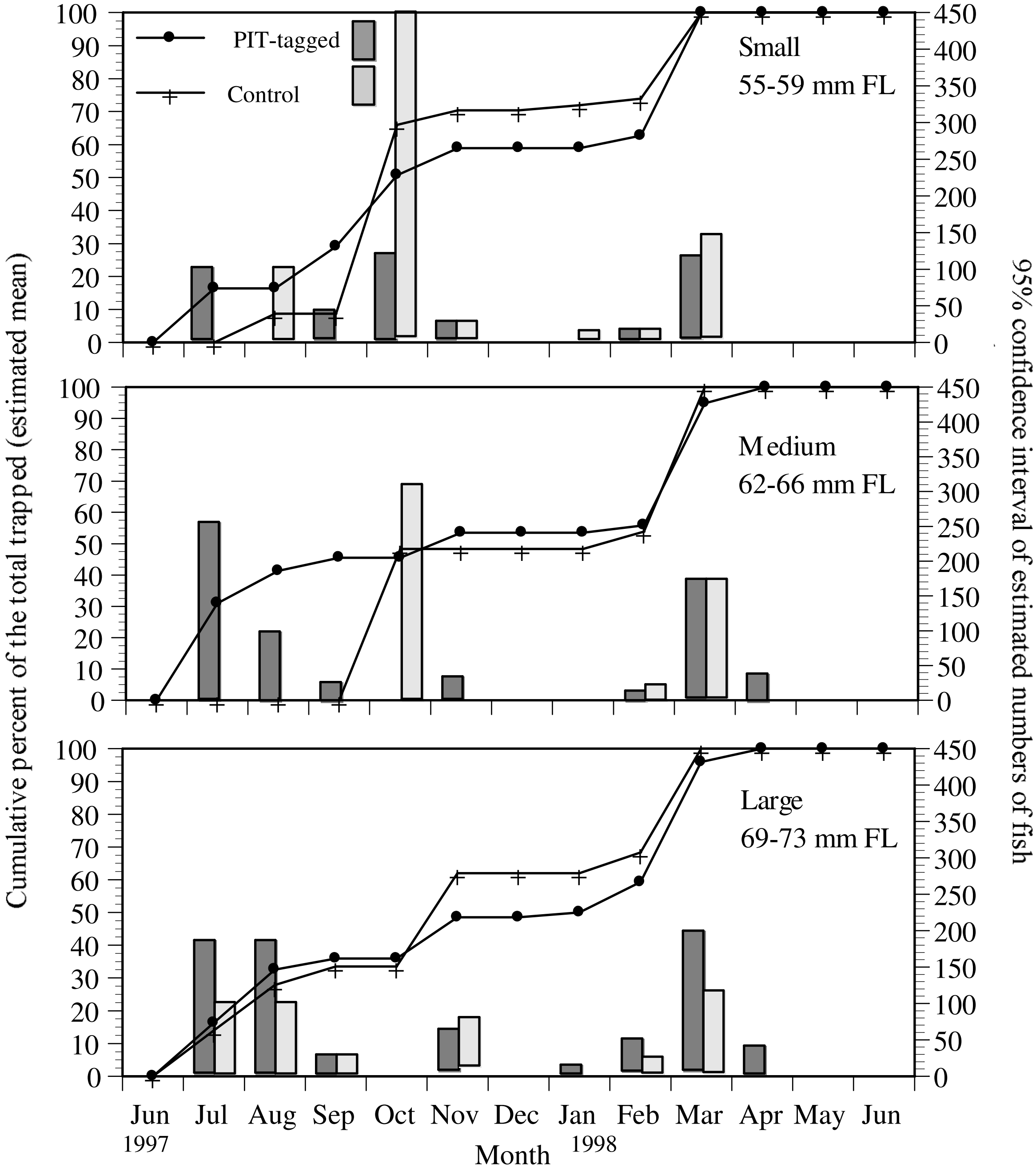

Figure 17. Monthly 95% confidence intervals (bars) and cumulative percent (lines) of the total population estimates for PIT-tagged and control fish from the 3 size categories of fish from the hatchery-produced 1996 cohort released into Lookingglass Creek (captured in 1997 and 1998).

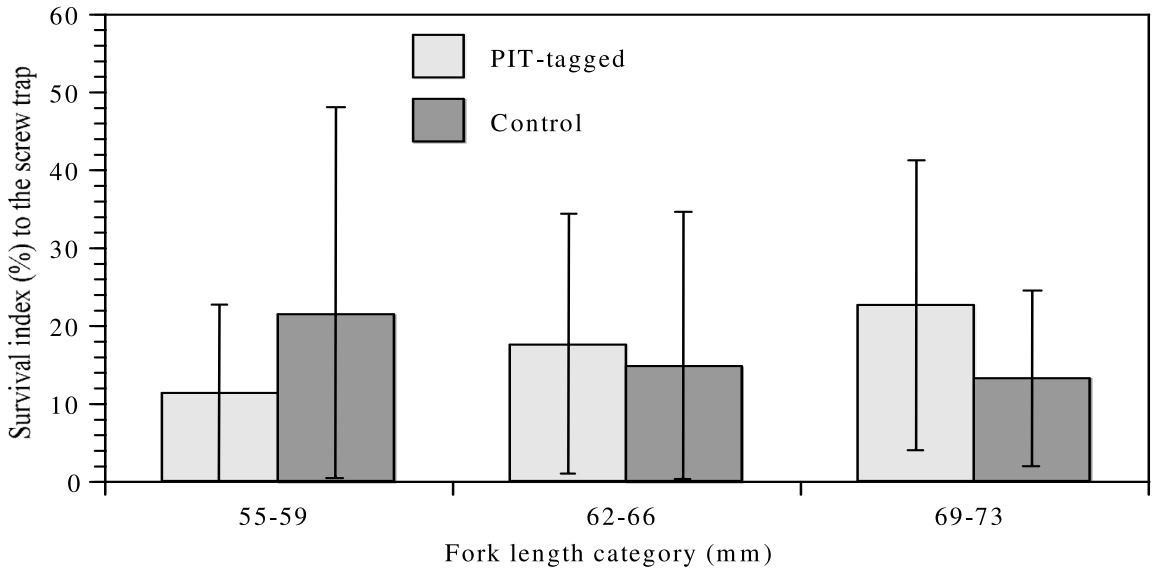

Figure 18. Survival indices to the screw trap for the PIT-tagged and control fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length categories from the hatchery-produced 1996 cohort released into Lookingglass Creek. The error bars represent the 95% confidence intervals.

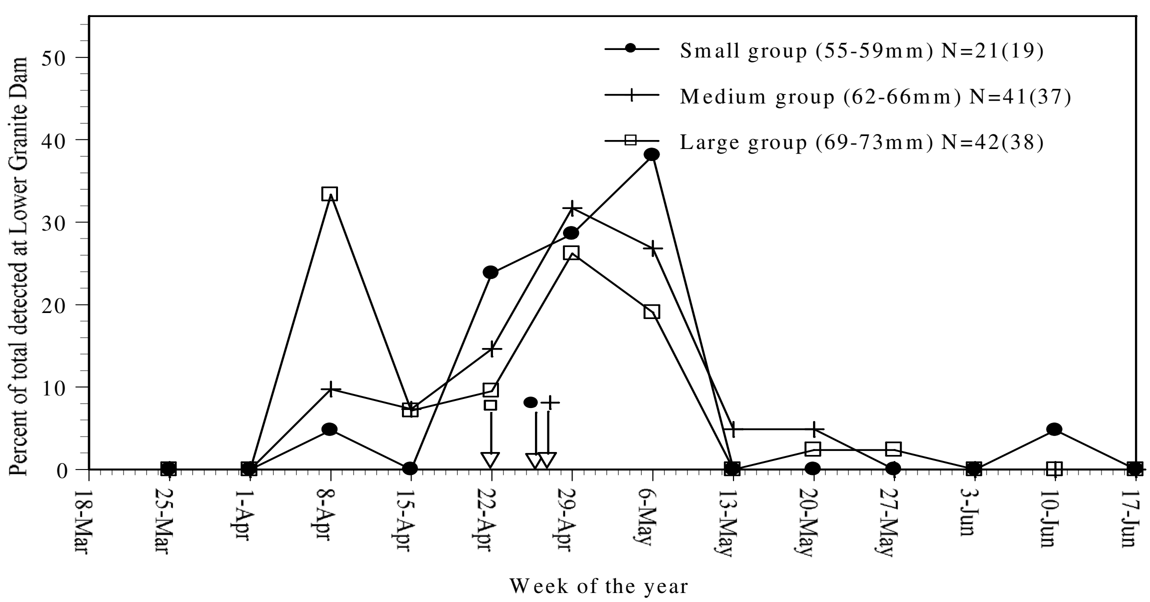

Figure 19. Arrival timing by week at Lower Granite Dam in 1998 of the PIT-tagged fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length categories from the hatchery-produced 1996 cohort released into Lookingglass Creek. Expanded detections (N) are graphed. Actual detections 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.

There were no significant differences in the minimum survival rates to Lower Granite Dam among the small, medium, and large categories of PIT-tagged fish (Figure 20). The survival rate for the small, medium, and large categories was 3.5, 6.3, and 5.2% respectively (Figure 20).

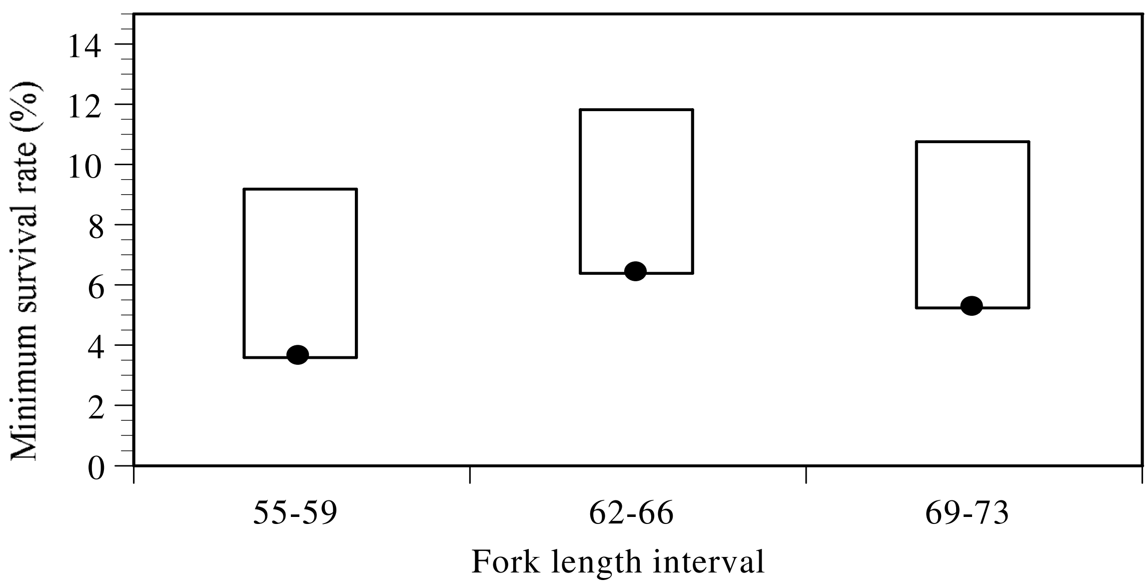

Figure 20. Total unique detection rates and upper ninety-five percent confidence intervals of the PIT-tagged fish from the small (55-59 mm), medium (62-66 mm), and large (69-73 mm) fork length categories of hatchery-produced 1996 cohort released into Lookingglass Creek that were detected at Snake or Columbia River dams in 1998.

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SECTION II

Assistance Provided to LSRCP Cooperators and Other Projects

We provided assistance to LSRCP cooperator ODFW in 1998 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 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 Bonneville Power Administration (BPA) projects with data collection in 1999. 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. We assisted the conventional adult spring Chinook salmon broodstock collection project in the Grande Ronde River and Catherine Creek in 1998 with weir building and trap checking. This is a BPA project in which CTUIR has the lead in these tributaries.

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, Dan Herrig, Gary James and Rich Carmichael for reviewing drafts of this report. We thank Jo Miller (United States Geologic Survey) and Scott Wallace 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 CTUIR technicians 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.

A special thanks to ODFW for the use of their PIT-tagging data from tributaries of the Grande Ronde River basin.

Appendices

Appendix Table A-1. Redd count and redd expansion data for the Grande Ronde River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
Index redds 1986-1994			290	166	64									
		Unit proportions	0.57	0.32	0.12									
1986	3-Sep	Index	18	19	11							48		
	Expansion		18	19	11								48	
	Redress		18	19	11								48	156
1987	20-Aug	Supp.		14										
	1-Sep	Index	65	41	42									
	10-Sep	Supp.		23								185		
	Expansion		136	78	30								244	
	Redress		136	78	42								256	835
1988	30-Aug	Index	77	22	5									
	6-Sep	Supp.		6										
	16-Sep	Supp.		6								116		
	Expansion		59	34	13								107	347
	Redress		77	34	13								124	405
1989	16-Aug		0	0	0							0		
	Expansion		0	0	0								0	
	Redress		0	0	0								0	0
1990	28-Aug	Index	3	1	0									
	4-Sep	Supp.		9										
	11-Sep	Supp.	18	1								32		
	Expansion		21	11	4								36	
	Redress		21	11	4								36	119
1991	4-Sep	Index	1	9	0									
	11-Sep	Supp.		4										
	18-Sep	Supp.		0								14		
	Expansion		23	13	5								41	
	Redress		23	13	5								41	133

Appendix Table A-1 (cont.). Redd count and redd expansion data for the Grande Ronde River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
1992	2-Sep	Index	76	21	2									
	9-Sep	Supp.	10	2										
	17-Sep	Supp.	2	3								116		
	Expansion		88	26	16								130	
	Redress		88	26	16								130	424
1993	3-Sep	Index	49	39	4									
	10-Sep	Supp.	6	4										
	16-Sep	Supp.	1	0								103		
	Expansion		56	43	14								113	
	Redress		56	43	14								113	368
1994	30-Aug	Index	1	0	0									
	7-Sep	Supp.	0											
	14-Sep	Supp.	1	2								4		
	Expansion		2	2	1								5	
	Redress		2	2	1								5	15
1995	28-Aug	Index	0		0									
	5-Sep	Supp.	0	5										
	12-Sep	Supp.	0	2								7		
	Expansion		0	7	1								8	
	Redress		0	7	1								8	26
1996	26-Aug	Index	2		0									
	3-Sep	Supp.	9											
	10-Sep	Supp.	0	11								22		
	Expansion		11	11	3								25	
	Redress		11	11	3								25	82
1997	25-Aug	Index	10											
	2-Sep	Supp.	1		1									
	8-Sep	Supp.	2		5									
	18-Sep	Supp.			0							19		
	Expansion		13	9	6								28	
	Redress		13	9	6								28	91

Appendix Table A-1 (cont.). Redd count and redd expansion data for the Grande Ronde River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
1998	24-Aug	Index	12		0									
	31-Aug	Supp.	8		1									
	8-Sep	Supp.	3		1							25		
	Expansion		23	12	2								37	
	Redress		23	12	2								37	120

[a] *Expansion is based on unit proportions. Only index surveys for years when all sections were surveyed were used to calculate the unit proportions. Unit proportions are the total number of redds counted in each unit during the index survey and any surveys prior to the index survey divided by the total redds for all sections. These proportions were used to estimate the total number of redds for sections when a survey was not done. Redress is used to update the unit expansions when the expanded number of redds is less than the actual number of redds counted.*

[b] *The estimated population is calculated by multiplying the total expanded redress redds by 3.26 fish-per-redd. The average 3.26 fish-per-redd was calculated from fish-per-redd estimates in Lookingglass Creek from 1992-1994 (Lofy and McLean 1995a; Lofy and McLean 1995b; McLean and Lofy 1995)*

Appendix Table A-2. Redd count and redd expansion data for Catherine Creek. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
Index redds 1986-1998			91	9	87	141	164	88	108			688		
Unit proportions			0.13	0.01	0.13	0.20	0.24	0.13	0.16					
1986	4-Sep	Index	8	0	21	47			11					
	10-Sep	Supp.					7					94		
Expansion			4	0	4	6	7	4	5				29	
Redress			8	0	21	47	7	4	11				98	320
1987	21-Aug	Supp.					15							
	2-Sep	Index	14	6	35	28	40	35	46					
	11-Sep	Supp.					6					225		
Expansion			34	3	32	52	61	33	40				256	
Redress			34	6	35	52	61	35	46				269	878
1988	2-Sep	Index	38	0	39	35	37	27	33					
	7-Sep	Supp.					3							
	15-Sep	Supp.					0					212		
Expansion			22	2	21	34	40	21	26				168	
Redress			38	2	39	35	40	27	33				214	698
1989	29-Aug	Index	6	0	1	17	8	6	4					
	7-Sep	Supp.					3							
	14-Sep	Supp.					4					49		
Expansion			8	1	8	13	15	8	10				63	
Redress			8	1	8	17	15	8	10				67	219
1990	29-Aug	Index	6	3	7	10	7	2	2					
	5-Sep	Supp.					2							
	12-Sep	Supp.					1					40		
Expansion			6	1	5	9	10	5	7				42	
Redress			6	3	7	10	10	5	7				48	156
1991	3-Sep	Index	3	0	1	4	9	2	0					
	10-Sep	Supp.					1							
	17-Sep	Supp.					0					20		
Expansion			6	1	5	9	10	5	7				42	
Redress			6	1	5	9	10	5	7				42	137

Appendix Table A-2 (cont.). Redd count and redd expansion data for Catherine Creek. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
1992	3-Sep	Index	5	0	0	14	18	4	1					
	10-Sep	Supp.					6							
	18-Sep	Supp.					1					49		
	Expansion		14	1	13	21	25	13	16				105	
	Redress		14	1	13	21	25	13	16				105	342
1993	2-Sep	Index	7	0	2	17	31	6	19					
	8-Sep	Supp.					2							
	15-Sep	Supp.					0					84		
	Expansion		18	2	18	28	33	18	22				138	
	Redress		18	2	18	28	33	18	22				138	451
1994	29-Aug	Index	0	0	0	4	0	0	0					
	6-Sep	Supp.					3							
	12-Sep	Supp.				7	1					15		
	Expansion		4	0	4	11	4	4	5				34	
	Redress		4	0	4	11	4	4	5				34	110
1995	29-Aug	Index	0	0	0	2	5	0	0					
	6-Sep	Supp.				6	3							
	12-Sep	Supp.				2	2					20		
	Expansion		6	1	6	10	10	6	7				45	
	Redress		6	1	6	10	10	6	7				45	147
1996	27-Aug	Index	1	0	0	1	5	2	1					
	4-Sep	Supp.				0	0							
	11-Sep	Supp.				0	2					12		
	Expansion		2	0	2	1	7	2	3				18	
	Redress		2	0	2	1	7	2	3				18	59
1997	26-Aug	Index	7	0	2	6	4	2	2					
	3-Sep	Supp.	1	0	0	2	2	3	5					
	10-Sep	Supp.	0	0	0	2	3	2	3			46		
	Expansion		8	0	2	10	9	7	10				46	
	Redress		8	0	2	10	9	7	10				46	150

Appendix Table A-2 (cont.). Redd count and redd expansion data for Catherine Creek. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
1998	25-Aug	Index	4	0	0	3	0	2	0					
	1-Sep	Supp.	2	0	0	4	4	4	2					
	11-Sep	Supp.	1	0	0	1	2	4	1			34		
Expansion			7	0	0	8	6	10	3				34	
Redress			7	0	0	8	6	10	3				34	111

[a] *Expansion is based on unit proportions. Only index surveys for years when all sections were surveyed were used to calculate the unit proportions. Unit proportions are the total number of redds counted in each unit during the index survey and any surveys prior to the index survey divided by the total redds for all sections. These proportions were used to estimate the total number of redds for sections when a survey was not done. Redress is used to update the unit expansions when the expanded number of redds is less than the actual number of redds counted.*

[b] *The estimated population is calculated by multiplying the total expanded redress redds by 3.26 fish-per-redd. The average 3.26 fish-per-redd was calculated from fish-per-redd estimates in Lookingglass Creek from 1992-1994 (Lofy and McLean 1995a; Lofy and McLean 1995b; McLean and Lofy 1995)*

Appendix Table A-3. Redd count and redd expansion data for the Lostine River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
Index redds 1986-1998				27	1	148	16	8	0	3		203		
	Unit proportions			0.13	0.00	0.73	0.08	0.04	0.00	0.01				
1986	27-Aug	Index	0	0	6	48	5		2			61		
	Expansion		0	0	6	48	5	3	2	1			64	
	Redress		0	0	6	48	5	3	2	1			64	210
1987	27-Aug	Index			2	49	4			6				
	9-Sep	Supp.				7								
	17-Aug	Supp.				27						95		
	Expansion			15	1	83	9	4	0	2			114	
	Redress			15	2	83	9	4	0	6			120	390
1988	24-Aug	Index		4	18	107	30		0	5				
	3-Sep	Supp.				16								
	13-Sep	Supp.				2						182		
	Expansion			23	1	125	14	7	0	3			171	
	Redress			23	18	125	30	7	0	5			208	677
1989	23-Aug	Index		4	1	20	0	1	0	0				
	31-Aug	Supp.				21								
	12-Sep	Supp.				6						53		
	Expansion			9	0	47	5	3	0	1			64	
	Redress			9	1	47	5	3	0	1			65	212
1990	23-Aug	Index		2	0	16	0		1	0				
	30-Aug	Supp				5								
	7-Sep	Supp				2						26		
	Expansion			4	0	23	2	1	0	0			32	
	Redress			4	0	23	2	1	1	0			33	106
1991	27-Aug	Index		2	2	11	5		0	0				
	5-Sep	Supp.				6								
	12-Sep	Supp.				2						28		
	Expansion			3	0	19	2	1	0	0			26	
	Redress			3	2	19	5	1	0	0			31	101

Appendix Table A-3 (cont.). Redd count and redd expansion data for the Lostine River. Source: ODFW Research, La Grande, unpublished data[a].

Survey Year	Date	Survey type	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Redds Total	Redds Exp.	Est. Pop.[b]
1992	26-Aug	Index		2	1	14	3		1	1				
	2-Sep	Supp.				14								
	11-Sep	Supp.				1						37		
	Expansion			5	0	29	3	2	0	1			40	
	Redress			5	1	29	3	2	1	1			42	137
1993	26-Aug	Index		11	0	66	10	6	0	2				
	4-Sep	Supp.				7								
	13-Sep	Supp.				0						102		
	Expansion			13	0	73	8	4	0	1			100	
	Redress			13	0	73	10	6	0	2			105	342
1994	25-Aug	Index		4	0	7	0	0	0	0				
	1-Sep	Supp.				2								
	8-Sep	Supp.				3						16		
	Expansion			2	0	12	1	1	0	0			16	
	Redress			4	0	12	1	1	0	0			18	60
1995	23-Aug	Index		0	0	6	1	0	0	0				
	30-Aug	Supp.				2								
	6-Sep	Supp.				2						11		
	Expansion			2	0	10	1	1	0	0			14	
	Redress			2	0	10	1	1	0	0			14	45
1996	21-Aug	Index		0	0	13	3	1	0	0				
	28-Aug	Supp.		0	0	4	1	3	0	0				
	5-Sep	Supp.		0	0	0	0	2	0	0		27		
	Expansion			0	0	17	4	6	0	0			27	
	Redress			0	0	17	4	6	0	0			27	88
1997	21-Aug	Index		5	0	27	2	0	0	1				
	28-Aug	Supp.		0	0	8	1	0	0	1				
	4-Sep	Supp.		0	0	2	0	1	1	0		49		
	Expansion			5	0	37	3	1	1	2			49	
	Redress			5	0	37	3	1	1	2			49	160

Appendix Table A-3 (cont.). Redd count and redd expansion data for the Lostine River. Source: ODFW Research, La Grande, unpublished data[a].

Year	Date	Survey type	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Redds Total	Redds Exp.	Est. Pop.[b]
1998	20-Aug	Index		3	0	9	0	0	0	0				
	27-Aug	Supp.	0	2	0	8	0	0	0	0				
	30-Aug	Supp.		0	1	5	0	0	0	0				
	17-Sep	Supp.								7				
	23-Sep	Supp.								0				
	1-Oct	Supp.								0		35		
	Expansion			5	1	22	0	0	0	7			35	
	Redress			5	1	22	0	0	0	7			35	114

[a] *Expansion is based on unit proportions. Only index surveys for years when all sections were surveyed were used to calculate the unit proportions. Unit proportions are the total number of redds counted in each unit during the index survey and any surveys prior to the index survey divided by the total redds for all sections. These proportions were used to estimate the total number of redds for sections when a survey was not done. Redress is used to update the unit expansions when the expanded number of redds is less than the actual number of redds counted.*

[b] *The estimated population is calculated by multiplying the total expanded redress redds by 3.26 fish-per-redd. The average 3.26 fish-per-redd was calculated from fish-per-redd estimates in Lookingglass Creek from 1992-1994 (Lofy and McLean 1995a; Lofy and McLean 1995b; McLean and Lofy 1995)*

Appendix Table A-4. Redd count and redd expansion data for the Minam River. Source: ODFW Research, La Grande, unpublished data[a].

Year	Date	Survey type	1	2	3	4	5	6	7	8	9	Redds Total	Redds Exp.	Est. Pop.[b]
Index redds 1986-1998			23	11	24	20	26	20	94	17	66	301		
			0.08	0.04	0.08	0.07	0.09	0.07	0.31	0.06	0.22			
1986	29-Aug	Index	0	1	15	6	5	21	14			62		
	Expansion		0	1	15	6	5	21	14	5	19		86	
	Redress		0	1	15	6	5	21	14	5	19		86	279
1987	25-Aug	Index	1		8	12	5	8	56					
	26-Sep	Supp.							56			146		
	Expansion		27	13	29	24	31	24	112	20	79		359	
	Redress		27	13	29	24	31	24	112	20	79		359	1169
1988	10-Sep	Supp.							17					
	25-Aug	Index	12	4	9	6	6	9	41			104		
	Expansion		14	7	15	12	16	12	58	10	41		186	
	Redress		14	7	15	12	16	12	58	10	41		186	605
1989	14-Sep	Supp.							5					
	29-Aug	Index	3	1	3	0	3	4	19			38		
	Expansion		6	3	6	5	7	5	24	4	17		77	
	Redress		6	3	6	5	7	5	24	4	17		77	251
1990	28-Aug	Index	2	8	2	3	2	0	36					
	11-Sep	Supp.							5			58		
	Expansion		10	5	10	9	11	9	41	7	29		131	
	Redress		10	8	10	9	11	9	41	7	29		134	438
1991	27-Aug	Index	5	6	0	4	5	4	13					
	9-Sep	Supp.							13			50		
	Expansion		6	3	7	6	7	6	26	5	18		83	
	Redress		6	6	7	6	7	6	26	5	18		86	281
1992	27-Aug	Index	2	2	2	4	4	1	1	3	13			
	4-Sep	Supp.							77					
	16-Sep	Supp.							6			115		
	Expansion		21	10	21	18	23	18	84	15	59		269	
	Redress		21	10	21	18	23	18	84	15	59		269	877

Appendix Table A-4 (cont.). Redd count and redd expansion data for the Minam River. Source: ODFW Research, La Grande, unpublished data[a].

Year	Date	Survey type	1	2	3	4	5	6	7	8	9	Redds Total	Redds Exp.	Est. Pop.[b]
1993	26-Aug	Index	10	4	6	8	6	3	26	6	16			
	3-Sep	Supp.							21					
	13-Sep	Supp.							4			110		
	Expansion		12	6	13	11	14	11	51	9	36		163	
	Redress		12	6	13	11	14	11	51	9	36		163	532
1994	23-Aug	Index	1	0	2	1	0	1	0	0	2			
	2-Sep	Supp.							14					
	12-Sep	Supp.							11			32		
	Expansion		6	3	6	5	7	5	25	5	18		80	
	Redress		6	3	6	5	7	5	25	5	18		80	261
1995	31-Aug	Index	1	0	0	0	0	0	9	3	2			
	7-Sep	Supp.							5					
	14-Sep	Supp.							0			20		
	Expansion		3	2	4	3	4	3	14	3	10		45	
	Redress		3	2	4	3	4	3	14	3	10		45	148
1996	17-Aug	Supp.	1		1									
	30-Aug	Index	0	1	1	4	4	10	35	5	14			
	3-Sep	Supp.	2	0		1	2	8	8					
	10-Sep	Supp.			1	0	0	1	4			103		
	Expansion		9	4	3	5	6	19	47	6	25		124	
	Redress		9	4	3	5	6	19	47	6	25		124	403
1997	28-Aug	Index	1	2	6	3	7	3	14	0	10			
	2-Sep	Supp.	0	0	0	2	3	0	3					
	9-Sep	Supp.				0	0	1	1			56		
	Expansion		5	3	6	5	10	4	18	4	16		70	
	Redress		5	3	6	5	10	4	18	4	16		71	230

Appendix Table A-4 (cont.). Redd count and redd expansion data for the Minam River. Source: ODFW Research, La Grande, unpublished data[a].

Year	Date	Survey type	1	2	3	4	5	6	7	8	9	Redds Total	Redds Exp.	Est. Pop.[b]
1998	27-Aug	Index	7	2	6	0	5	2	9	0	9			
	1-Sep	Supp.	0	0	0	5	1	2	9					
	8-Sep	Supp.				0	0	1	6			64		
Expansion			6	3	6	5	6	5	24	4	17		75	
Redress			7	3	6	5	6	5	24	4	17		77	249

[a] *Expansion is based on unit proportions. Only index surveys for years when all sections were surveyed were used to calculate the unit proportions. Unit proportions are the total number of redds counted in each unit during the index survey and any surveys prior to the index survey divided by the total redds for all sections. These proportions were used to estimate the total number of redds for sections when a survey was not done. Redress is used to update the unit expansions when the expanded number of redds is less than the actual number of redds counted.*

[b] *The estimated population is calculated by multiplying the total expanded redress redds by 3.26 fish-per-redd. The average 3.26 fish-per-redd was calculated from fish-per-redd estimates in Lookingglass Creek from 1992-1994 (Lofy and McLean 1995a; Lofy and McLean 1995b; McLean and Lofy 1995)*

Appendix Table A-5. Redd count and redd expansion data for the Wenaha River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
Index redds 1986-1998			14	3	274	119	54	105	10			579		
Unit proportions			0.02	0.01	0.47	0.21	0.09	0.18	0.02					
1986	3-Sep	Index			68							68		
	Expansion		3	1	68	30	13	26	2				144	
	Redress		3	1	68	30	13	26	2				144	468
1987	7-Sep	Index	3	2	62	26	25	32	2			152		
	Expansion		3	2	62	26	25	32	2				152	
	Redress		3	2	62	26	25	32	2				152	496
1988	6-Sep	Index	2	1	98	21	11	32	3			168		
	Expansion		2	1	98	21	11	32	3				168	
	Redress		2	1	98	21	11	32	3				168	548
1989	5-Sep	Index	0	0	9	5	0	4	0			18		
	Expansion		0	0	9	5	0	4	0				18	
	Redress		0	0	9	5	0	4	0				18	59
1990	3-Sep	Index	3	0	31	23	8	16	2			83		
	Expansion		3	0	31	23	8	16	2				83	
	Redress		3	0	31	23	8	16	2				83	271
1991	2-Sep	Index	2	0	28	15	5	7	1					
	13-Sep	Supp.					7					65		
	Expansion		1	0	25	11	5	10	1				54	
	Redress		2	0	28	15	12	10	1				68	222
1992	9-Sep	Index	10		58	47	14	49	5					
	14-Sep	Supp.			7	2						192		
	Expansion		4	1	65	49	16	30	3				168	
	Redress		10	1	65	49	16	49	5				195	634
1993	9-Sep	Index	4	0	46	29	5	14	2					
	16-Sep	Supp.			2	2						104		
	Expansion		3	1	48	31	11	21	2				116	
	Redress		4	1	48	31	11	21	2				118	383

Appendix Table A-5 (cont.). Redd count and redd expansion data for the Wenaha River. Source: ODFW Research, La Grande, unpublished data[a].

Survey			Unit number									Redds		Est.
Year	Date	type	1	2	3	4	5	6	7	8	9	Total	Exp.	Pop.[b]
1994	8-Sep	Index			12	16	9	5						
	15-Sep	Supp.			3	11	1	6	1			64		
	Expansion		2	0	15	27	10	11	1				66	
	Redress		2	0	15	27	10	11	1				66	215
1995	6-Sep	Index			3	11	1	6	1					
	13-Sep	Supp.	0	0	2	1						25		
	Expansion		0	0	5	12	2	4	0				24	
	Redress		0	0	5	12	2	6	1				26	86
1996	4-Sep	Index			28	30	18	21	5					
	12-Sep	Supp.			10	3	4	10				129		
	Expansion		3	1	38	33	22	31	5				133	
	Redress		3	1	38	33	22	31	5				133	433
1997	4-Sep	Index		0	26	9	8	16	4					
	11-Sep	Supp.		0	0	4	1	1				69		
	Expansion		2	0	26	13	9	17	1				68	
	Redress		2	0	26	13	9	17	4				71	230
1998	3-Sep	Index		0	24	9	17	12	3					
	10-Sep	Supp.		0	2	4	1	4				76		
	Expansion		2	0	26	13	18	16	1				76	
	Redress		2	0	26	13	18	16	3				78	254

[a] *Expansion is based on unit proportions. Only index surveys for years when all sections were surveyed were used to calculate the unit proportions. Unit proportions are the total number of redds counted in each unit during the index survey and any surveys prior to the index survey divided by the total redds for all sections. These proportions were used to estimate the total number of redds for sections when a survey was not done. Redress is used to update the unit expansions when the expanded number of redds is less than the actual number of redds counted.*

[b] *The estimated population is calculated by multiplying the total expanded redress redds by 3.26 fish-per-redd. The average 3.26 fish-per-redd was calculated from fish-per-redd estimates in Lookingglass Creek from 1992-1994 (Lofy and McLean 1995a; Lofy and McLean 1995b; McLean and Lofy 1995)*

Appendix Table A-6. Carcass recoveries and age structure for Grande Ronde River basin tributaries. Source: ODFW Research, La Grande, unpublished data.

Run Year	Tributary	Scale age 3	Scale age 4	Scale age 5	Total	Basin age structure 3	Basin age structure 4	Basin age structure 5
1987	Grande Ronde R.	0	46	1	47			
	Catherine Cr.	1	59	3	63			
	Lostine R.	0	21	14	35			
	Minam R.	1	2	3	6			
	Wenaha R.	0	38	6	44			
	Totals	**2**	**166**	**27**	**195**	**0.01**	**0.85**	**0.14**
1988	Grande Ronde R.	3	20	27	50			
	Catherine Cr.	1	27	18	46			
	Lostine R.	0	16	56	72			
	Minam R.	1	12	20	33			
	Wenaha R.	0	17	37	54			
	Totals	**5**	**92**	**158**	**255**	**0.02**	**0.36**	**0.62**
1989	Grande Ronde R.	0	2	0	2			
	Catherine Cr.	0	9	1	10			
	Lostine R.	1	15	6	22			
	Minam R.	0	8	2	10			
	Wenaha R.	1	0	3	4			
	Totals	**2**	**34**	**12**	**48**	**0.04**	**0.71**	**0.25**
1990	Grande Ronde R.	0	10	7	17			
	Catherine Cr.	0	6	2	8			
	Lostine R.	0	9	6	15			
	Minam R.	0	15	4	19			
	Wenaha R.	0	12	0	12			
	Totals	**0**	**52**	**19**	**71**	**0.00**	**0.73**	**0.27**
1991	Grande Ronde R.	1	7	1	9			
	Catherine Cr.	1	13	2	16			
	Lostine R.	0	7	18	25			
	Minam R.	0	5	8	13			
	Wenaha R.	0	10	8	18			
	Totals	**2**	**42**	**37**	**81**	**0.02**	**0.52**	**0.46**

Appendix Table A-6 (cont.). Carcass recoveries and age structure for Grande Ronde River basin tributaries. Source: ODFW Research, La Grande, unpublished data.

Run Year	Tributary	Scale age 3	4	5	Total	Basin age structure 3	4	5
1992	Grande Ronde R.	0	76	7	83			
	Catherine Cr.	0	9	0	9			
	Lostine R.	0	22	8	30			
	Minam R.	0	37	9	46			
	Wenaha R.	2	43	10	55			
	Totals	**2**	**187**	**34**	**223**	**0.01**	**0.84**	**0.15**
1993	Grande Ronde R.	0	3	42	45			
	Catherine Cr.	2	2	24	28			
	Lostine R.	0	16	58	74			
	Minam R.	0	18	26	44			
	Wenaha R.	0	8	21	29			
	Totals	**2**	**47**	**171**	**220**	**0.01**	**0.21**	**0.78**
1994	Grande Ronde R.	0	0	0	0			
	Catherine Cr.	0	2	3	5			
	Lostine R.	0	2	15	17			
	Minam R.	0	7	5	12			
	Wenaha R.	0	3	3	6			
	Totals	**0**	**14**	**26**	**40**	**0.00**	**0.35**	**0.65**
1995	Grande Ronde R.	0	1	0	1			
	Catherine Cr.	1	5	0	6			
	Lostine R.	0	3	0	3			
	Minam R.	0	4	0	4			
	Wenaha R.	1	2	0	3			
	Totals	**2**	**15**	**0**	**17**	**0.12**	**0.88**	**0.00**
1996	Grande Ronde R.	0	1	0	1			
	Catherine Cr.	0	5	0	5			
	Lostine R.	1	21	1	23			
	Minam R.	2	57	0	59			
	Wenaha R.	3	42	1	46			
	Totals	**6**	**126**	**2**	**134**	**0.04**	**0.94**	**0.01**

Appendix Table A-6 (cont.). Carcass recoveries and age structure for Grande Ronde River basin tributaries. Source: ODFW Research, La Grande, unpublished data.

Run		Scale age				Basin age structure		
Year	Tributary	3	4	5	Total	3	4	5
1997	Grande Ronde R.	0	7	3	10			
	Catherine Cr.	4	28	2	34			
	Lostine R.	4	46	23	73			
	Minam R.	1	49	4	54			
	Wenaha R.	1	41	16	58			
	Totals	**10**	**171**	**48**	**229**	**0.04**	**0.75**	**0.21**
1998	Grande Ronde R.	0	6	23	29			
	Catherine Cr.	1	4	14	19			
	Lostine R.	1	5	25	31			
	Minam R.	0	7	22	29			
	Wenaha R.	0	25	20	45			
	Totals	**2**	**47**	**104**	**153**	**0.01**	**0.31**	**0.68**

Appendix Table A-7. Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Water temp. hourly °C Low	Fish trapped[a] Nat.	Hatchery Exp.	Hatchery Con.	Trap efficiency[b] No. Rel.	grp.	Re. on date	Re. From Rel. grp.	Rel. grp. on date	Comments
03/01/97	5.6	--	--									
03/02/97	5.9	--	--	0	0	0						
03/03/97	5.5	--	--									
03/04/97	5.5	--	--	0	0	0						
03/05/97	5.4	--	--									
03/06/97	5.6	--	--	0	0	0						
03/07/97	5.9	--	--									
03/08/97	6.1	--	--									
03/09/97	6.5	--	--	0	0	0						
03/10/97	8.7	--	--									
03/11/97	10.5	--	--	2	0	0						First 96 cohort captured
03/12/97	10.1	--	--	0	0	0						
03/13/97	8.2	--	--	0	0	0						
03/14/97	7.3	--	--	0	0	0						
03/15/97	7.0	--	--	0	0	0						
03/16/97	7.7	--	--	0	0	0						
03/17/97	10.6	--	--	0	0	0						
03/18/97	11.6	--	--	0	0	0						
03/19/97	15.2	--	--	0	0	0						Trap was not turning
03/20/97	21.5	--	--	0	0	0						
03/21/97	21.8	--	--	0	0	0						
03/22/97	19.5	--	--	0	0	0						Trap was not turning
03/23/97	18.6	--	--	0	0	0						
03/24/97	18.3	--	--	0	0	0						
03/25/97	18.4	--	--	0	0	0						
03/26/97	20.5	--	--									
03/27/97	22.7	--	--	0	0	0						
03/28/97	20.7	--	--	1	0	0						
03/29/97	16.7	--	--									
03/30/97	15.6	--	--	1	0	0						
03/31/97	14.7	--	--	0	0	0						
04/01/97	13.0	5.7	2.8	0	0	0						
04/02/97	11.9	6.3	2.1	0	0	0						
04/03/97	11.6	6.5	2.8	0	0	0						
04/04/97	11.6	5.7	2.4									
04/05/97	11.0	5.9	2.3	0	0	0						
04/06/97	10.2	6.7	2.3	1	0	0						
04/07/97	9.9	5.7	2.7	0	0	0						
04/08/97	9.9	6.5	3.7	1	0	0						
04/09/97	9.3	7.0	3.6	1	0	0						
04/10/97	9.9	6.2	3.3	2	0	0						
04/11/97	9.4	6.6	2.7	0	0	0						
04/12/97	9.5	7.0	2.4									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp. hourly °C		Fish trapped[a]			Trap efficiency[b]					
	Flow				Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m³/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
04/13/97	9.9	5.6	3.5	3	0	0						
04/14/97	11.1	5.6	4.0	0	0	0	3	a	0			
04/15/97	12.5	7.5	4.1	3	0	0						
04/16/97	14.8	6.4	4.1	0	0	0	3	a	1			
04/17/97	16.8	6.8	3.5	0	0	0						Moved trap to bank
04/18/97	17.4	5.7	3.5	0	0	0						Still turning
04/19/97	20.2	4.8	3.9	0	0	0				1	a1	
04/20/97	32.8	5.0	3.1	0	0	0						Trap not turning
04/21/97	28.6	5.6	3.1	--	--	--						
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	--	--	--						Started trap
04/26/97	18.7	7.7	3.7	1	0	0						
04/27/97	22.7	6.1	3.7	0	0	0						Trap not turning
04/28/97	19.7	5.0	3.5	0	0	0						
04/29/97	18.5	6.4	3.8	0	0	0						
04/30/97	17.7	4.9	3.4	0	0	0						
05/01/97	15.5	4.9	3.3	1	0	0						
05/02/97	13.7	6.5	2.8	4	0	0	1	a	0			
05/03/97	13.2	6.6	4.2	0	0	0	4	a	0			Trap not turning
05/04/97	14.8	7.6	4.1	0	0	0						
05/05/97	15.4	7.5	4.0	0	0	0						
05/06/97	17.1	7.0	3.8	1	0	0						
05/07/97	17.9	7.4	3.4	0	0	0	1	a	0			
05/08/97	18.4	7.9	3.3	0	0	0						
05/09/97	20.0	7.6	3.6	1	0	0						
05/10/97	22.0	8.0	3.6	0	0	0						
05/11/97	24.4	7.7	3.7	1	0	0						Raised trap cone
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
05/17/97	24.1	8.6	4.8	0	0	0						Raised trap cone
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	0	0						
05/21/97	14.8	9.1	4.2	0	0	0						
05/22/97	13.6	9.0	4.8	0	0	0						
05/23/97	12.7	8.1	5.9	0	0	0						
05/24/97	12.1	8.4	5.5	0	0	0						
05/25/97	11.6	6.7	5.7	0	0	0						
05/26/97	11.1	7.4	5.6	0	0	0						

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp.		Fish trapped[a]			Trap efficiency[b]					
	Flow	hourly °C			Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m^3/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
05/27/97	10.8	8.1	5.1	0	0	0						
05/28/97	10.1	8.4	5.7	0	0	0						
05/29/97	10.2	9.2	6.6	0	0	0						
05/30/97	11.0	9.9	6.6	0	0	0						
05/31/97	11.8	10.7	7.1	0	0	0						
06/01/97	11.9	9.8	6.5	0	0	0						
06/02/97	11.0	10.7	5.7	0	0	0						
06/03/97	10.1	8.9	7.1	0	0	0						
06/04/97	10.3	8.3	7.2	0	0	0						Moved trap out
06/05/97	9.8	9.1	6.6	0	0	0						
06/06/97	8.7	10.3	6.2	0	0	0						
06/07/97	8.4	11.7	6.1	0	0	0						
06/08/97	8.0	11.7	6.7									
06/09/97	8.1	12.6	7.0	0	0	0						
06/10/97	7.9	10.8	8.1	0	0	0						
06/11/97	8.0	10.6	8.5	0	0	0						
06/12/97	8.1	9.5	8.0									
06/13/97	7.8	10.9	7.7	1	0	0	1	a	0			
06/14/97	7.2	10.8	8.2									
06/15/97	6.7	13.6	8.1	0	0	0						
06/16/97	6.5	13.3	9.2									
06/17/97	6.1	12.5	9.0	0	0	0						
06/18/97	5.9	13.0	8.7									
06/19/97	5.6	12.8	7.7	0	0	0						
06/20/97	5.0	12.6	7.8									
06/21/97	4.4	11.2	7.4	0	0	0						
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	0	0	0						
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	0	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	0	0						
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									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Water temp. hourly °C Low	Fish trapped[a] Nat.	Fish trapped[a] Hatchery Exp.	Fish trapped[a] Hatchery Con.	Trap efficiency[b] No. Rel.	Trap efficiency[b] grp.	Trap efficiency[b] Re. on date	Trap efficiency[b] Re. From Rel. grp.	Trap efficiency[b] Rel. grp. on date	Comments
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	0	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									
07/16/97	2.2	16.1	8.4	0	0	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	0	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	1	0	0	1	b	0			
07/30/97	1.6	15.9	9.2									Release of hatchery fish
07/31/97	1.6	14.4	8.7	1	6	1	1	c	0			
08/01/97	1.5	14.6	8.5	4	0	2	4	d	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	6	0	0	5	e	0			
08/05/97	1.4	17.0	9.4									
08/06/97	1.3	17.0	9.3									
08/07/97	1.3	16.6	9.9	3	0	0	2	f	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	2	0	0	2	g	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	7	0	0	7	h	0			
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									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Water temp. hourly °C Low	Fish trapped[a] Nat.	Fish trapped[a] Hatchery Exp.	Fish trapped[a] Hatchery Con.	Trap efficiency[b] No. Rel.	Trap efficiency[b] grp.	Trap efficiency[b] Re. on date	Trap efficiency[b] Re. From Rel. grp.	Trap efficiency[b] Rel. grp. on date	Comments
08/23/97	1.3	15.3	8.7									
08/24/97	1.3	14.2	9.5	15	1	0	12	j	1			
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	12	1	0	11	k	0			
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	19	1	0	19	m	0			
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	3	0	0	3	n	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	8	1	0	8	o	0			
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	2	0	0	2	p	0			
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	5	0	0	5	q	1			
09/15/97	1.6	10.0	7.8									
09/16/97	1.7	10.3	7.6									
09/17/97	1.7	9.0	7.2	44	0	1	44	r	5	2	q1 g1	
09/18/97	1.9	9.6	6.4	25	0	0	25	s	3	6	r5 j1	
09/19/97	1.6	11.3	6.2	23	0	0	23	t	2	2	s2	
09/20/97	1.5	11.2	5.8	36	2	0	36	u	5	2	t1 s1	
09/21/97	1.5	11.3	6.0	21	0	0	21	v	3	4	u4	
09/22/97	1.5	11.3	6.1	6	0	0				3	v2 u1	
09/23/97	1.7	11.4	6.1									
09/24/97	1.6	11.9	6.6	27	1	0	31	w	2	1	v1	
09/25/97	1.6	11.2	6.8	6	0	0	6	x	1			
09/26/97	1.5	10.4	7.7									
09/27/97	1.6	10.1	6.8	11	0	0	11	y	4	1	t1	
09/28/97	1.6	10.4	5.6									
09/29/97	1.5	10.9	5.9	12	0	0	12	z	1	5	y3 x1 w1	
09/30/97	1.6	10.3	6.3									
10/01/97	1.6	9.8	7.3									
10/02/97	1.6	9.2	7.1									
10/03/97	1.7	8.9	6.2									
10/04/97	1.7	9.7	7.0	12	0	1	12	aa	1			
10/05/97	1.7	8.7	5.7									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp. hourly °C		Fish trapped[a]			Trap efficiency[b]					
	Flow				Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m³/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
10/06/97	1.6	7.9	4.9									
10/07/97	1.6	8.0	5.0									
10/08/97	1.6	7.3	3.9	23	0	4	23	ab	1	1	aa1	
10/09/97	1.6	8.2	5.7	16	0	0	16	ac	0	1	ab1	
10/10/97	1.5	7.7	5.3	4	0	2						Trap not turning
10/11/97	1.6	6.8	4.9				4	ad	0			
10/12/97	1.7	7.7	5.0	3	0	0	3	ae	0			
10/13/97	1.6	8.4	5.4									
10/14/97	1.5	8.4	4.7	13	0	1	13	af	0			
10/15/97	1.5	8.2	4.6									
10/16/97	1.5	8.4	4.6									
10/17/97	1.5	8.3	4.7	4	0	0	4	ag	0			
10/18/97	1.4	8.3	5.6									
10/19/97	1.4	7.9	4.9									
10/20/97	1.5	7.5	4.1									
10/21/97	1.4	7.1	4.0	13	0	0	13	ah	0			
10/22/97	1.5	7.6	4.6									
10/23/97	1.6	6.8	5.0									
10/24/97	1.6	6.5	3.8									
10/25/97	1.6	5.8	3.2	4	0	0	4	aj	0			
10/26/97	1.5	6.4	3.3									
10/27/97	1.5	6.9	4.6									
10/28/97	1.6	6.6	4.1	8	1	0	8	ak	1			
10/29/97	2.2	6.6	5.8									
10/30/97	3.3	6.9	5.9	36	0	0	36	am	2	1	ak1	Trap not turning
10/31/97	3.3	7.3	5.5	--	--	--						Started trap
11/01/97	2.3	6.8	4.5	59	0	4	59	an	7	3	am2 z1	
11/02/97	2.1	6.2	4.0	27	3	4	27	ao	7	4	an4	
11/03/97	2.0	6.6	4.1	35	1	1	35	ap	11	8	ao6 an2	
11/04/97	1.9	7.1	4.9									
11/05/97	1.8	6.7	4.5	20	0	2	20	aq	1	12	ap11 an1	
11/06/97	1.8	7.0	4.4									
11/07/97	2.3	7.0	6.1	19	0	1	19	ar	2	2	aq1 ao1	
11/08/97	2.7	7.4	6.0									
11/09/97	2.9	7.0	5.1	15	1	1	15	as	8	2	ar2	
11/10/97	2.9	5.8	4.2									
11/11/97	2.5	4.8	3.6									
11/12/97	1.8	4.6	3.2									
11/13/97	1.8	3.9	2.6	21	3	2				8	as8	
11/14/97	1.9	3.6	2.3				21	at	4			
11/15/97	1.9	3.7	2.3									
11/16/97	1.9	4.6	2.1	10	2	0	10	au	1	4	at4	
11/17/97	2.0	5.6	4.1									
11/18/97	2.0	4.9	3.9									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

Date	Flow m^3/s	Water temp. hourly °C High	Water temp. hourly °C Low	Fish trapped[a] Nat.	Fish trapped[a] Hatchery Exp.	Fish trapped[a] Hatchery Con.	Trap efficiency[b] No. Rel.	Trap efficiency[b] grp.	Trap efficiency[b] Re. on date	Trap efficiency[b] Re. From Rel. grp.	Trap efficiency[b] Rel. grp. on date	Comments
11/19/97	2.2	5.7	4.1	9	1	0	9	av	0	1	au1	
11/20/97	2.5	4.9	3.3									
11/21/97	2.7	5.2	3.4									
11/22/97	2.4	4.1	2.8									
11/23/97	2.4	5.7	4.1	2	0	0	2	aw	0			
11/24/97	2.5	5.6	4.7									
11/25/97	2.6	5.0	3.4									
11/26/97	2.5	4.4	3.0									
11/27/97	2.3	5.0	3.9									
11/28/97	2.2	4.4	3.4	0	0	0						
11/29/97	2.2	4.7	3.4									
11/30/97	2.2	5.1	3.2									
12/01/97	2.1	3.6	2.7									
12/02/97	2.1	3.7	2.1									
12/03/97	2.1	3.6	1.4	1	0	0	1	ax	0			
12/04/97	2.0	3.6	1.6									
12/05/97	1.9	2.9	1.3									
12/06/97	1.8	3.0	1.9									
12/07/97	1.9	4.2	2.7	0	0	0						
12/08/97	1.9	4.0	3.2									
12/09/97	1.8	4.4	2.9									
12/10/97	1.9	3.9	2.4	0	0	0						
12/11/97	1.9	4.7	3.1									
12/12/97	1.9	3.8	2.1									
12/13/97	1.9	3.4	1.5									
12/14/97	1.9	4.1	2.8	0	0	0						
12/15/97	1.9	3.9	3.3									
12/16/97	2.4	4.1	3.2									
12/17/97	2.5	4.2	3.6									
12/18/97	2.2	4.1	2.1	0	0	0						
12/19/97	2.1	3.0	1.6									
12/20/97	2.2	3.4	2.7									
12/21/97	2.2	4.1	1.8	7	0	0	7	ay	0			
12/22/97	2.0	2.1	0.8									
12/23/97	2.0	3.1	2.2									
12/24/97	1.9	2.9	1.4									
12/25/97	1.9	3.3	1.1									
12/26/97	1.9	3.0	2.1	25	0	0	23	az	13			
12/27/97	1.9	4.1	1.7	5	0	0	4		0	13	az13	
12/28/97	1.9	3.8	2.5	2	0	0	2		0			
12/29/97	2.0	4.4	3.2									
12/30/97	2.0	3.0	2.0									
12/31/97	2.0	3.5	2.0									
01/01/98	2.0	4.3	2.4	0	0	0						

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp. hourly °C		Fish trapped[a]			Trap efficiency[b]					
	Flow				Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m³/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
01/02/98	2.1	4.2	3.0	13	1	0	13	ba	7			
01/03/98	2.1	4.3	3.3	0	0	0						
01/04/98	2.1	4.2	3.2	6	0	0	6	bb	2	5	bc5	
01/05/98	2.0	4.0	2.8	4	0	0	4	bc	0	4	bd2 bc2	
01/06/98	2.0	4.0	3.1	0	0	0						
01/07/98	2.0	4.1	2.2	0	0	0						
01/08/98	2.0	3.7	1.8									
01/09/98	2.0	2.4	0.4	3	0	0	3	bd	0			
01/10/98	2.0	3.2	1.5									
01/11/98	2.1	2.4	0.0	0	0	0						Trap not turning
01/12/98	2.1	2.4	0.7	0	0	0						
01/13/98	2.1	4.1	1.8									
01/14/98	2.1	3.7	3.0									
01/15/98	2.1	4.2	2.4	0	0	0						
01/16/98	2.0	4.0	0.6									
01/17/98	2.3	4.6	1.5	0	0	0						
01/18/98	2.3	4.3	3.1									
01/19/98	2.4	4.4	3.4	0	0	0						
01/20/98	2.4	4.7	3.3									
01/21/98	2.3	4.3	2.6									
01/22/98	2.3	4.9	2.8	3	0	0	3	be	0			
01/23/98	2.3	5.2	3.9	0	0	1						
01/24/98	2.5	5.0	3.6									
01/25/98	2.5	4.6	3.3									
01/26/98	2.6	5.2	3.9	7	0	0	7	bf	0			
01/27/98	3.2	4.9	3.7									
01/28/98	3.2	4.7	3.5	0	0	0						
01/29/98	3.0	4.6	3.4									
01/30/98	2.9	4.6	2.9	1	0	0	1	bg	0			
01/31/98	2.7	4.0	2.1									
02/01/98	2.6	4.1	2.1	4	1	1	4	bh	0			
02/02/98	2.5	5.1	3.7	0	0	0						
02/03/98	2.5	5.2	3.9									
02/04/98	2.4	5.4	3.8	2	0	0	2	bj	2			
02/05/98	2.4	5.3	3.1									
02/06/98	2.4	4.3	3.4	27	0	0	27	bk	11	1	bm1	
02/07/98	2.4	5.5	3.7									
02/08/98	2.7	5.4	3.8	8	0	0	8	bm	2	10	bm10	
02/09/98	2.8	5.3	3.0	14	1	0	14	bn	0	3	bn2 bm1	
02/10/98	2.6	4.2	2.3									
02/11/98	2.7	5.2	3.6	1	0	1	1	bo	0			
02/12/98	2.5	4.1	3.5									
02/13/98	2.5	5.8	3.4	7	0	0	7	bp	0	1	y1	
02/14/98	2.5	3.5	2.9									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

Date	Flow m³/s	Water temp. hourly °C High	Water temp. hourly °C Low	Fish trapped[a] Nat.	Fish trapped[a] Hatchery Exp.	Fish trapped[a] Hatchery Con.	Trap efficiency[b] No. Rel.	Trap efficiency[b] grp.	Trap efficiency[b] Re. on date	Trap efficiency[b] Re. From Rel. grp.	Trap efficiency[b] Rel. grp. on date	Comments
02/15/98	2.5	5.3	3.4	0	0	0						
02/16/98	2.4	4.8	2.8									
02/17/98	2.5	5.4	2.9	18	3	2	18	bq	1			
02/18/98	2.5	5.3	2.7	2	1	2	2	br	0	2	br1 w1	
02/19/98	2.3	6.2	3.5	0	0	0						
02/20/98	2.4	6.1	4.0	5	1	0	6	bs		1	bm1	
02/21/98	2.9	5.5	3.8									
02/22/98	2.9	5.0	3.4	0	0	0						
02/23/98	2.7	5.7	3.0	0	0	0						
02/24/98	2.7	5.4	2.8	0	0	0						
02/25/98	2.7	4.5	2.3									
02/26/98	2.5	5.0	2.8	0	0	0						
02/27/98	2.3	5.0	2.3									
02/28/98	2.3	3.7	2.0									
03/01/98	2.3	5.2	3.4									
03/02/98	2.4	5.3	3.5	4	0	0	4	bt	0			
03/03/98	2.4	5.1	2.9	0	0	0						
03/04/98	2.5	5.1	3.1	0	0	0						
03/05/98	2.4	5.1	2.1									
03/06/98	2.5	5.4	1.5									
03/07/98	2.4	5.4	1.7									
03/08/98	2.5	5.0	3.1									
03/09/98	2.4	6.5	3.4	0	0	0						
03/10/98	2.5	6.3	3.7									
03/11/98	2.6	7.9	4.1	0	0	0						
03/12/98	2.7	7.9	3.3									Noticed that fish
03/13/98	2.9	7.7	3.4	1	0	0	1	bu	0			escaped from livebox
03/14/98	3.5	7.7	3.4									
03/15/98	3.8	6.1	4.0	14	0	0	14	bv	2	1	bx1	
03/16/98	3.9	6.5	3.4									
03/17/98	3.6	5.5	3.4	63	3	4	64	bw	1	2	bw2	Repaired hole livebox
03/18/98	3.4	6.2	2.8									
03/19/98	3.2	7.1	2.8	2	0	0	2	bx	0			
03/20/98	3.2	8.1	3.3									
03/21/98	3.5	6.9	3.8	11	0	0	11	by	4			
03/22/98	5.3	6.0	4.2	33	2	0	33	bz	7	4	bz4	
03/23/98	8.6	4.8	3.2	102	6	8	98	ca	3	7	ca7	
03/24/98	10.4	6.0	3.0	5	1	0	5	cb	0	3	cb3	
03/25/98	9.4	6.1	3.4	13	0	0	13	cc	0			
03/26/98	8.3	5.4	3.7	9	2	0	9	cd	0			
03/27/98	7.1	5.0	2.9									
03/28/98	6.4	4.8	2.2	1	0	0	1	ce	0			
03/29/98	5.7	6.1	2.3									
03/30/98	5.1	6.4	2.2	0	0	0						

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp.		Fish trapped[a]			Trap efficiency[b]					
	Flow	hourly °C			Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m^3/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
03/31/98	4.9	6.4	3.1									
04/01/98	4.6	7.7	3.6	0	0	0						
04/02/98	4.6	5.9	4.0	0	0	0						
04/03/98	4.4	5.8	3.8									
04/04/98	4.4	6.5	4.1									
04/05/98	4.3	6.8	3.7	5	0	0	5	cf	0			
04/06/98	4.4	6.7	3.4									
04/07/98	4.2	7.1	4.0	1	0	0						
04/08/98	4.1	5.8	2.7									
04/09/98	4.1	6.6	3.8									
04/10/98	4.4	6.5	4.2	6	0	0	7	cg	2			
04/11/98	4.5	6.7	4.0									
04/12/98	4.4	6.6	3.3	2	1	0	2	ch	0			
04/13/98	4.3	5.9	2.7									
04/14/98	4.3	6.6	2.3									
04/15/98	4.1	5.7	3.7									
04/16/98	3.9	7.9	3.1	26	0	0	26	cj	1	2	ch2	
04/17/98	3.8	7.2	3.5									
04/18/98	3.9	7.1	2.9	7	0	0	7	ck	1	1	ck1	
04/19/98	3.9	9.1	4.5									
04/20/98	4.0	9.5	3.4									
04/21/98	4.9	10.0	4.0									
04/22/98	6.1	8.6	4.2	24	1	0	24	cm	2	1	cm1	
04/23/98	8.5	7.7	4.3	4	0	0	4	cn	1	2	cn2	
04/24/98	9.8	6.2	3.9	5	0	0	5	co	0	1	co1	
04/25/98	8.6	6.4	3.6									
04/26/98	8.0	7.9	2.8	2	0	0	2	cp	0			
04/27/98	9.0	8.6	3.4									
04/28/98	9.2	9.0	3.7									
04/29/98	10.9	8.9	3.7	2	0	0	2	cq	0			
04/30/98	12.2	8.9	4.1	0	0	0						Trap not turning
05/01/98	13.6	9.0	4.1	0	0	0						
05/02/98	14.8	8.7	4.3	0	0	0						
05/03/98	16.4	8.9	4.4	0	0	0						Raised cone 8p
05/04/98	16.1	9.3	4.6	--	--	--						Started trap 1p
05/05/98	15.3	9.6	5.4	0	0	0						
05/06/98	14.4	9.3	5.2	0	0	0						
05/07/98	13.5	10.3	5.6	0	0	0						Raised cone 8p
05/08/98	11.9	9.0	5.4	--	--	--						
05/09/98	11.8	6.8	5.4	--	--	--						Started trap 10a
05/10/98	9.9	9.8	5.5	1	0	0	1	cr	0			
05/11/98	8.7	8.6	6.2									
05/12/98	8.1	9.3	6.0	0	0	0						
05/13/98	7.6	7.3	6.4									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp.		Fish trapped[a]			Trap efficiency[b]					
	Flow	hourly °C			Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m^3/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
05/14/98	7.4	6.6	5.6									
05/15/98	6.9	7.5	4.7									
05/16/98	6.4	6.2	5.0									
05/17/98	6.3	6.3	5.4	0	0	0						
05/18/98	6.2	8.5	4.9									
05/19/98	5.9	10.3	5.2									
05/20/98	5.6	9.7	6.3	0	0	0						
05/21/98	5.4	7.3	6.3									
05/22/98	6.6	7.3	6.0	0	0	0						
05/23/98	5.8	8.1	6.2	1	0	0	1	cs	0			
05/24/98	5.5	9.4	6.3									
05/25/98	7.0	7.9	6.4									
05/26/98	6.9	6.3	5.4	0	0	0						
05/27/98	6.5	8.2	5.0									
05/28/98	6.6	10.4	4.6	0	0	0						
05/29/98	6.3	9.1	6.8	0	0	0						
05/30/98	5.7	9.6	5.8									
05/31/98	5.6	11.8	6.2									
06/01/98	5.2	13.0	7.0									
06/02/98	4.9	11.7	7.1	1	0	0	1	ct	0			
06/03/98	5.0	11.2	7.7									
06/04/98	4.9	12.6	7.2									
06/05/98	4.7	10.6	8.2	0	0	0						
06/06/98	4.4	11.1	7.2									
06/07/98	4.4	9.3	7.4									
06/08/98	4.2	11.0	7.6	0	0	0						
06/09/98	3.7	12.2	7.4									
06/10/98	3.5	12.3	7.8	0	0	0						
06/11/98	3.6	12.5	8.6									
06/12/98	3.4	13.9	8.7	0	0	0						
06/13/98	3.2	14.0	9.1									
06/14/98	2.9	14.5	8.2	1	0	0	1	cu	0			
06/15/98	3.0	14.1	9.1									
06/16/98	3.3	9.6	7.7									
06/17/98	3.0	13.4	6.6	0	0	0						
06/18/98	2.9	14.6	7.9									
06/19/98	2.7	11.8	8.3	0	0	0						
06/20/98	2.6	14.1	7.0									
06/21/98	2.4	14.4	8.0									
06/22/98	2.4	12.9	8.4	0	0	0						
06/23/98	2.3	15.3	8.1									
06/24/98	2.3	10.8	8.8	0	0	0						
06/25/98	2.3	12.0	8.4									
06/26/98	2.3	11.6	8.1	1	0	0	1	cv	0			

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp.		Fish trapped[a]			Trap efficiency[b]					
	Flow	hourly °C			Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m^3/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
06/27/98	2.3	14.0	6.8									
06/28/98	2.1	15.5	7.6	0	0	0						
06/29/98	2.1	15.9	8.1	0	0	0						
06/30/98	2.1	16.5	9.2									
07/01/98	2.1	16.6	9.2	0	0	0						
07/02/98	2.2	16.7	9.2									
07/03/98	2.2	15.3	9.6	0	0	0						
07/04/98	2.0	16.2	9.7									
07/05/98	2.0	16.5	9.0									
07/06/98	1.9	17.3	8.9	0	0	0						
07/07/98	1.9	17.5	9.1									
07/08/98	1.8	17.5	9.8	0	0	0						
07/09/98	2.5	17.7	9.5									
07/10/98	2.1	15.3	10.2									
07/11/98	2.0	16.7	9.9									
07/12/98	1.8	16.5	9.1									
07/13/98	1.8	16.5	9.0	0	0	0						
07/14/98	2.0	17.0	9.0									
07/15/98	2.0	17.2	9.2	0	0	0						
07/16/98	1.9	17.8	9.4									
07/17/98	1.9	18.3	9.7									
07/18/98	2.1	17.8	9.5									
07/19/98	1.9	17.5	9.2									
07/20/98	1.8	17.1	8.3	0	0	0						Trap not turning
07/21/98	1.9	17.3	8.5									
07/22/98	1.8	17.5	9.0	0	0	0						
07/23/98	1.8	13.1	9.2									
07/24/98	1.8	17.2	9.6	0	0	0						
07/25/98	1.8	17.7	9.4									
07/26/98	1.8	17.8	9.6									
07/27/98	1.8	17.7	9.5									
07/28/98	1.9	18.0	9.8	0	0	0						
07/29/98	1.8	15.2	9.5									
07/30/98	1.8	16.0	10.0	0	0	0						
07/31/98	1.7	16.1	10.1	0	0	0						
08/01/98	1.9	14.3	9.7									
08/02/98	1.6	17.2	9.0									
08/03/98	1.7	17.4	9.2	0	0	0						
08/04/98	1.7	17.5	9.1									
08/05/98	1.6	17.1	9.2	0	0	0						
08/06/98	1.7	16.8	9.0									
08/07/98	1.6	15.9	8.5	0	0	0						
08/08/98	1.6	16.0	7.7									
08/09/98	1.6	16.4	8.1									

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp. hourly °C		Fish trapped[a]			Trap efficiency[b]					
	Flow				Hatchery		No.		Re. on	Re. From	Rel. grp.	
Date	m³/s	High	Low	Nat.	Exp.	Con.	Rel.	grp.	date	Rel. grp.	on date	Comments
08/10/98	1.5	16.5	8.7	0	0	0						
08/11/98	1.7	16.6	8.5									
08/12/98	2.0	16.5	8.5									
08/13/98	1.6	16.7	8.8									
08/14/98	1.5	16.7	8.6	1	0	0						
08/15/98	1.6	16.2	8.7									
08/16/98	1.6	14.5	8.1									
08/17/98	1.6	14.4	7.2	1	0	0						
08/18/98	1.6	14.4	6.6									
08/19/98	1.6	14.7	6.7	1	0	0						
08/20/98	1.6	15.1	8.0									
08/21/98	1.6	15.2	8.2	4	0	0						
08/22/98	1.6	14.8	7.8									
08/23/98	1.6	13.8	9.0									
08/24/98	1.7	14.3	7.1	15	1	0						
08/25/98	1.6	14.8	7.3									
08/26/98	1.6	14.3	7.3	9	0	0						
08/27/98	1.5	14.3	6.7									
08/28/98	1.5	14.9	7.3	13	0	0						
08/29/98	1.4	14.9	7.6									
08/30/98	1.5	14.7	7.2									
08/31/98	1.4	14.8	7.6	5	0	0						
09/01/98	1.4	14.9	7.7									
09/02/98	1.5	14.7	7.7	4	0	0						
09/03/98	1.4	14.7	7.4									
09/04/98	1.5	14.8	7.8	6	0	0						
09/05/98	1.3	14.4	7.9									
09/06/98	1.3	14.5	7.5									
09/07/98	1.4	11.6	8.3									
09/08/98	1.3	14.0	8.4									
09/09/98	1.3	11.5	8.9	3	0	0						
09/10/98	1.4	11.9	8.5									
09/11/98	1.3	13.6	7.3	3	0	0						
09/12/98	1.3	13.4	7.1									
09/13/98	1.3	13.4	6.9									
09/14/98	1.2	13.5	6.9	2	0	0						
09/15/98	1.3	13.8	7.2									
09/16/98	1.4	14.0	8.9									
09/17/98	1.3	12.7	7.9									
09/18/98	1.2	9.8	7.5	7	0	0						
09/19/98	1.4	10.1	8.2									
09/20/98	1.2	10.7	7.7									
09/21/98	1.3	11.8	6.3	2	0	0						Last 96 cohort captured

Appendix Table A-7 (cont.). Daily trapping records of the 1996 cohort from a screw trap in Lookingglass Creek.

		Water temp. hourly °C		Fish trapped[a]			Trap efficiency[b]					
					Hatchery							
Date	Flow m^3/s	High	Low	Nat.	Exp.	Con.	No. Rel.	grp.	Re. on date	Re. From Rel. grp.	Rel. grp. on date	Comments

[a] *Fish trapped included both Wild fish (naturally-produced) and Hatchery fish. The hatchery group had two components, an experimental EXP.(PIT-tagged) and a control Con. (non-PIT-tagged).*

[b] *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.*