Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2004 to 31 December 2004

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Evaluation of Reestablishing Natural Production of Spring Chinook Salmon in Lookingglass Creek, Oregon, Using an Endemic Stock (Catherine Creek)

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1 SECTION I. EVALUATION OF REESTABLISHING NATURAL PRODUCTION OF SPRING CHINOOK SALMON IN LOOKINGGLASS CREEK, OREGON, USING AN ENDEMIC STOCK (CATHERINE CREEK)

1.1 Abstract

. Lower than normal snow pack in the upper reaches of the watershed resulted in lower than normal flows. Peak Lookingglass Creek stream flow was 626 CFS on 4 May 2004Maximum water temperatures ≥ 18°C were observed on four dates in July 2004. We collected 72 unclipped (Rapid River stock) spring Chinook salmon adults (39 males, 35 females, 1 unknown sex) from 26 May 2004-14 September 2004 and 52 ad-clipped adults (34 males, 18 females) from 2 June 2004-14 September 2004. A total of 226 ad-clipped adults collected from Catherine Creek were outplanted below the Lookingglass Hatchery trap and 204 adults caught from Catherine Creek were transported and held at Lookingglass Hatchery for use as conventional broodstock. One-hundred and three ad-clipped returns to Lookingglass Creek or Catherine Creek were outplanted above the Lookingglass Hatchery trap on 20 July 2004 to spawn naturally. Spawning ground surveys from 23 July 2004-22 September 2004 produced 49 redds above the barrier weir and 49 below the Lookingglass Hatchery trap. We recovered 40 ad-clipped carcasses above the Lookingglass Hatchery trap and 47 ad-clipped and 23 unclipped carcasses below. The tribal harvest estimate was 171. Total returns to Lookingglass Creek were estimated at 52 ad-clipped and 112 unclipped. Age composition for ad-clipped fish was age 3(21.6%), age 4(72.5%), and age 5(5.9%). Age composition for unclipped fish was age 3 (2.7%) and age 4(97.3%). Brood year 2002 natural-origin outmigrants from September 2003-March 2004 totaled 2,295 (SE 423). PIT-tagged outmigrants totaled 212, with 133 in the fall 2003 group and 79 in the combined winter 2003/spring 2004 group. Mean FL (mm) were 90.2 (fall 2003) and 91.4 winter 2003/spring 2004). Survival rates to Lower Granite Dam were 0.1729 (fall 2003) and 0.3038 (winter 2003/spring 2004). Median arrival dates at Lower Granite Dam were 14 April 2004 (fall 2003) and 7 April 2004 (winter 2003/spring 2004). A total of 53,195 hatchery-reared, ad-clipped/coded wire tagged juveniles (Catherine Creek captive brood progeny) were released from Lookingglass Hatchery on 8 April 2004, including 5,193 PIT-tagged. Mean FL was 120.0 mm, survival to Lower Granite Dam was 0.5633 and median arrival date at Lower Granite Dam was 29 April 2004. Management of spring Chinook salmon in Lookingglass Creek is in transition, as the Rapid River stock is being replaced with Catherine Creek stock. Juvenile survival and first-year adult returns of the first two hatchery releases of Catherine Creek stock suggest these fish will contribute little to adult returns. The number of hatchery-reared Catherine Creek stock juveniles released to date has been only a small fraction of the number of Rapid River releases.

1.2 Introduction

The native Lookingglass Creek stock of spring Chinook salmon was functionally extirpated within a few years of the establishment of Lookinglass Hatchery (LH) in 1982. Lookingglass Creek is within the "usual and accustomed" areas of gathering for the

Confederated Tribes of the Umatilla Indians (CTUIR). CTUIR, along with the Oregon Department of Fish and Wildlife (ODFW) as comanagers, in the 1990's began efforts to reestablish natural production of spring Chinook salmon in Lookingglass Creek. The ultimate goal is to reestablish a self-sustaining population of spring Chinook salmon, restore balance to the ecosystem, and restore harvest opportunities for tribal members. Fertilized eggs from Rapid River (Idaho) stock fish were hatchery-reared and released into Lookingglass Creek. After sufficient adults returned, they were used as broodstock. Except for a small number in 1989, no Rapid River stock adults were intentionally released above the Lookingglass Hatchery trap to spawn naturally until 1992, due to concerns about pathogens in the hatchery water supply. Adults were released above the hatchery trap from 1992-1994 and 1996-1997, but none from 1998-2003. The last Rapid River stock juvenile release occurred in 2000. Reintroduction was continued using a Grande Ronde Basin endemic stock (Catherine Creek) starting in 2001. Potential hatchery-origin adult returns in 2004 could be from the last Rapid River stock release in 2000, or Catherine Creek stock releases into Lookingglass Creek in 2001 and 2002 (Table 1). Zimmerman and Patterson (2002) described current stock management practices for the Grande Ronde Basin.

Table 1. BY 1999-2001 hatchery-produced spring Chinook salmon released into Lookingglass Creek.

BY	Release Date	Number	Mean weight (g)	Marks*
1999	9 June 2000	23,819	6.5	Ad clip/CWT
2000	24 September 2001	51,864	17.8	Ad clip/CWT/PIT
2001	28 May 2002	17,539	7.0	Ad clip/CWT

* *Ad = adipose, CWT = coded wire tag, PIT=PIT tag*

CTUIR has evaluated the reintroduction of spring Chinook salmon into Lookingglass Creek since 1992. We seek to describe production (e.g. adult returns, redds, outmigrant abundance) and life history (e.g. adult and juvenile run timing, survival) metrics and compare performance of the endemic and reintroduced (Catherine Creek) stocks, as well as year-to-year comparisons of the reintroduced stock. Annual reports describing the historical efforts at reestablishing natural production of spring Chinook salmon in Lookingglass Creek are available at http://www.fws.gov/lsnakecomplan/Publications.html.

1.3 Study Area

The Lookingglass Creek watershed is in the Blue Mountains of northeast Oregon, the headwaters at the outlet of Langdon Lake 4,870 ft above sea level. Lookingglass Creek flows to the southeast for 15.5 river miles (rm) through the Umatilla National Forest (UNF) then through private land before entering the Grande Ronde River at rm 85, at an elevation of 2,355 feet above sea level (Figure 1). Little Lookingglass Creek is the only major tributary. Minor tributaries are Lost Creek, Summer Creek, Eagle Creek, and Jarboe Creek. Spring Chinook salmon spawning and rearing occurs in Lookingglass

Creek and Little Lookingglass Creek. Lookingglass Hatchery is located at rm 2.3 on Lookingglass Creek.

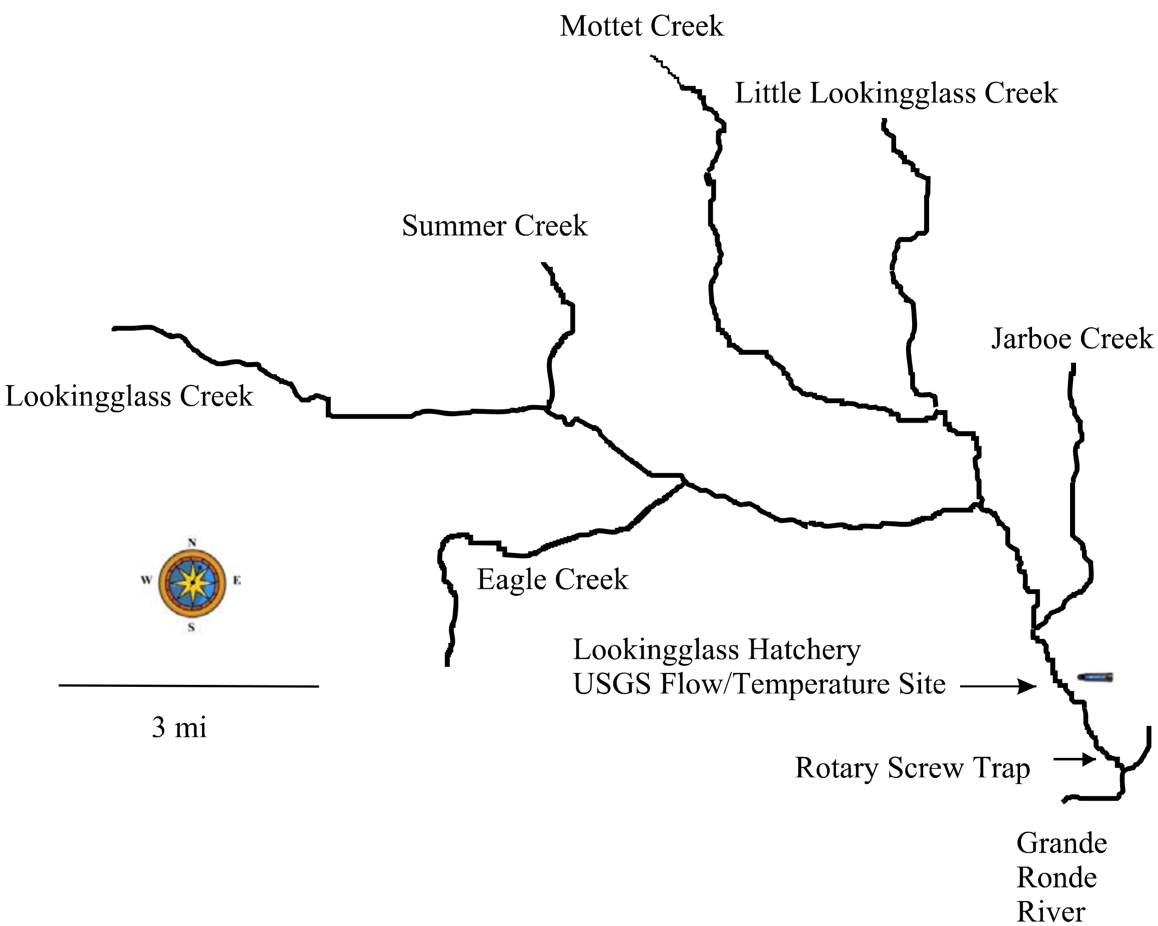

Figure 1. Map of the Lookingglass Creek basin showing tributaries, temperature and flow recorders, screw trap and Lookingglass Hatchery.

1.4 Methods

1.4.1 Stream Flow and Temperature

We obtained and summarized Lookingglass Creek stream flow and water temperature data collected in 2004 by the United States Geological Survey (USGS) with electronic recorders at rm 2.3 near Lookingglass Hatchery. Data for the site USGS13324300 Lookingglass Creek near Looking Glass, OR are available online at http://waterdata.usgs.gov/or/nwis/uv/?site_no=13324300&PARAmeter_cd=00065,00060

1.4.2 Adult Spring Chinook Salmon

Adult spring Chinook salmon returning to Lookingglass Creek were diverted with a picket weir into a trap near the Lookingglass Hatchery water intake. ODFW staff installed the trap and operated it from 2 March 2004-2 October 2004, checking it three times a week or more.

All spring Chinook salmon were enumerated, examined and scanned for fin clips, opercle punches and other marks and tags, measured (mm FL), and sex and maturity status determined. Week of capture was designated by the first day of the week (e.g. week of 1 January included 1-7 January). Sex was based on external characteristics, however, examination of spawned fish has shown that determinations made at the trap are not 100% accurate. Unmarked adults (presumed to be Rapid River origin) were euthanized. About 10 scales from unmarked adults were removed from 2-3 rows above the lateral line on a line from the posterior end of the dorsal fin to the anterior end of the anal fin, and hot-pressed into cellulose acetate to make permanent impressions. We later read impressions using criteria for annuli described by Mosher (1969). We estimated age composition using age-length-keys (Ricker 1975).

Some adults trapped at Catherine Creek were transported to Lookingglass Creek and released 1 mi below the LH trap to provide opportunities for tribal harvest. Recaptures of these at the LH trap were recognized by a left opercle punch (LOP). Returns of hatchery-origin fish liberated into Lookingglass Creek as juveniles (with ad clips and coded wire tags) received a right opercle punch (ROP) and were placed in a holding pond at LH. These were later released above the LH trap to spawn naturally. Ad-clipped adults identified from other streams or stocks (strays) caught in the Lookingglass Hatchery trap were placed in holding ponds for broodstock use or outplanted to the stream of origin.

Conventional broodstock are collected from streams as returning adults, spawned at LH, and their progeny reared at LH. Adults spawned at LH as conventional broodstock were sexed, measured, weighed, examined and scanned for marks and tags and snouts collected at time of spawning. Fecundity was estimated at the eyed stage using an electronic egg counter, and groups of 20 eyed eggs per female were each weighed to the nearest 0.01 g with an electronic balance.

CTUIR planned to release 50 pairs of spring Chinook salmon above the Lookingglass Hatchery in 2004 to spawn naturally. These fish would be either ad-clipped swim-ins to the Lookingglass Hatchery trap (returns from the brood year 2000 and 2001 releases) or Catherine Creek captive broodstock progeny captured at the Catherine Creek trap. A barrier weir was installed about 0.4 mi above the Lookingglass Hatchery trap on 20 July 2004 to prevent carcasses from drifting downstream and creating a pathogen problem for the LH water supply.

Spawning ground surveys (Parker et al. 1995) to count redds and sample carcasses were conducted during August-September 2004. Weekly surveys were conducted in the various stream units after the outplanting (Figure 2). Only completed redds (Lofy and McLean 1995) were counted and flagged to eliminate double counting. Carcasses were enumerated and FL, sex, marks/tags, and percent spawned recorded. Tails were cut off to prevent double sampling. Snouts were taken from any ad-clipped carcasses for CWT recovery. We counted and interviewed tribal fishers on an irregular basis to estimate harvest of ad-clipped fish below the trap.

We used the tribal harvest estimate, redds below the trap, and fish per redd to estimate the total returns to Lookingglass Creek that were not sampled at the trap. Fish per redd estimates vary, but most studies report values of 2-3.5. We used a conservative estimate of 2.5 fish per redd.

We combined tribal harvest data with the length and fin clip composition of adults caught in the Lookingglass Hatchery trap or on spawning ground surveys and age-length keys developed from unclipped fish (scales) or ad-clipped fish (CWT) data to estimate total returns.

Stock of origin for ad-clipped fish was determined by CWT group. Snouts for CWT recovery were collected from all ad-clipped fish euthanized at the trap, spawned at Lookingglass Hatchery, or carcasses from spawning ground surveys. Snouts were dissected and CWT data obtained by the ODFW CWT laboratory in Clackamas, OR. We later obtained data from the Regional Mark Processing Center database maintained by the Pacific States Marine Fisheries Commission (http://www.rmpc.org/).

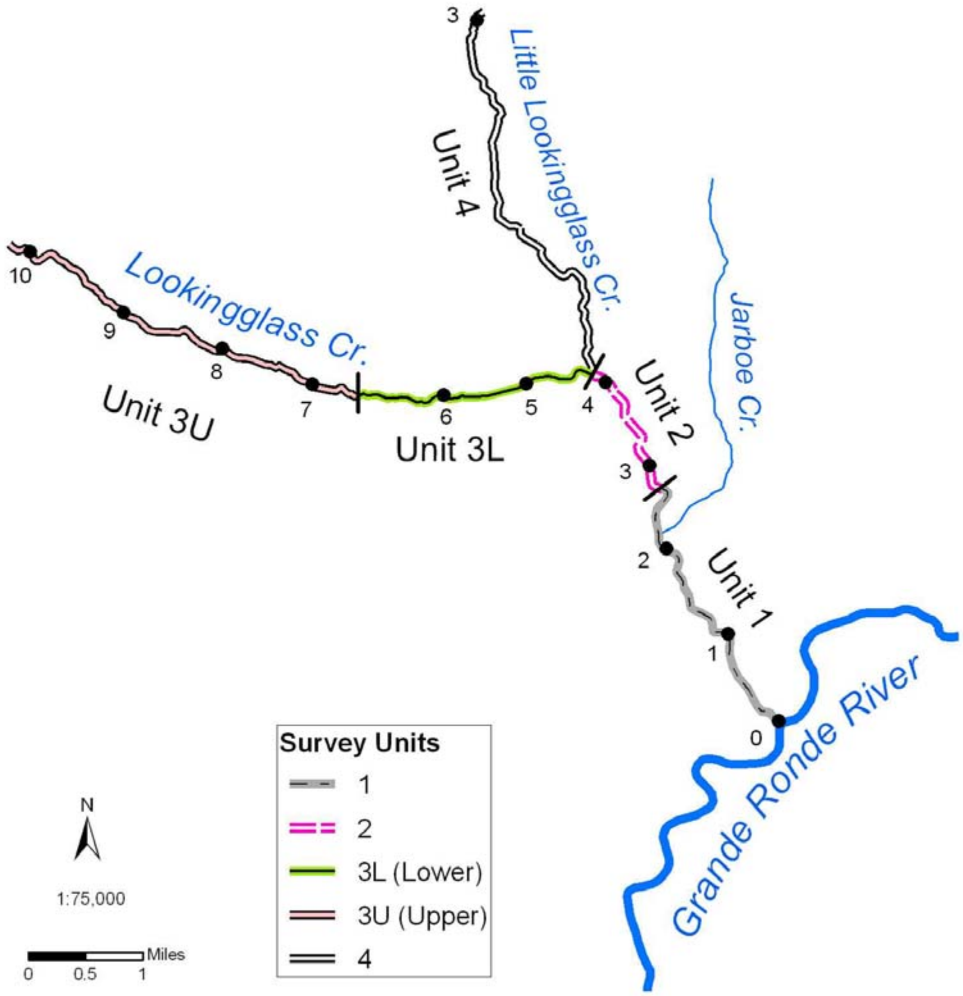

Figure 2. Spawning ground survey unit designations and river miles for Lookingglass Creek (modified from Burck 1993).

1.4.3 Juvenile Spring Chinook Salmon

We operated a 1.52 m diameter rotary screw trap (Roper and Scarnecchia 1996) at rm 0.1 on Lookingglass Creek to collect outmigrating brood year (BY) 2002 naturally-produced juvenile spring Chinook salmon. The screw trap was operated continuously during 2003 and 2004 except for brief periods during the spring freshet and when iced up in winter. The trap was usually checked 3 times/week or more frequently if catches or flows were high. All fish were identified, enumerated, examined for external marks, scanned with a PIT tag reader, measured (mm FL), and weighed (0.1) g. Those not already PIT-tagged were tagged using standard methods (PIT Tag Steering Committee 1999). All newly PIT-tagged fish were released about 100 ft above the screw trap; recaptures were released 50 ft below the screw trap. No secondary mark was used for migration year 2004 fish since no field group was tagged and released in 2003.

We used DARR 2.0 (Bjorkstedt 2005) to estimate the numbers of BY 2002 naturally-produced spring Chinook salmon outmigrants. DARR 2.0 uses temporally stratified mark-recapture data and pools adjacent strata if capture probabilities are similar. We used the “one trap” and “no prior pooling of strata” options.

An outmigrating brood year of juvenile spring Chinook salmon from Lookingglass Creek has the following pattern: an unknown (but probably small) number leave as fry (30-45 mm FL) in March-June during high water. Most juveniles outmigrate as presmolts from August-November at lengths of 50-90 mm FL. A much smaller number outmigrate as 70-100 mm smolts during February-June, about 18 months after spawning.

Naturally-produced juvenile spring Chinook collected by the screw trap in 2004 could be distinguished into two groups based on size. During January-May of 2004, naturally-produced (unmarked) BY 2003 juveniles were distinguished from BY 2002 naturally-produced juveniles by their much smaller size (30-45 mm FL) and lower abundance. BY 2003 naturally-produced juveniles were not marked or used in estimates of trap efficiency. Production and performance of BY 2002 natural-origin spring Chinook salmon will be described in the 2006 annual report

PIT-tagged natural-origin BY 2002 juvenile spring Chinook were grouped by season (fall 2003, winter 2003/spring 2004 combined) to compare arrival timing, travel time, survival and capture probability to Lower Granite Dam. Seasonal groups were categorized by initial arrival timing at the screw trap (Burck 1993). The fall 2003 group was PIT-tagged from 1 August 2003-30 September 2003, the winter 2003/spring 2004 group from 12 October 2003-3 March 2004. No separate spring 2004 group was used because of the small number of fish caught. Performance of the 8 April 2004 hatchery release group was assessed as one group.

Survival, capture probabilities, and travel time to Lower Granite Dam were calculated using by querying the PIT tag database maintained by the Pacific States Marine Fisheries

Commission at http://www.ptagis.org/ and using PitPro software (Westhagen and Skalski 2006). We used the standard configuration, and excluded the *.rcp file. Observation sites, in downstream order, were Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, McNary Dam, John Day Dam, Bonneville Dam, and the Estuary Towed Array (Juvenile

Daily PIT tag detections at Lower Granite Dam were expanded for spill using flow data from the U. S. Army Corps of Engineers, Portland District website (http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?k=id:LWG), and calculating a daily expansion factor [(Powerhouse Outflow+ Spill) /Powerhouse Outflow]. Median arrival timing at Lower Granite Dam for each group was the date that 50% of the expanded detections had occurred.

1.5 Results

1.5.1 Stream Flow and Temperature

A brief spike in Lookingglass Creek stream flow occurred from 26 January 2004-7 February 2004 (Figure 3). Stream flows began rising rapidly the second week of March. Mean flows were >300 CFS for over 2 months, with a peak flow of 626 CFS on 4 May 2004.

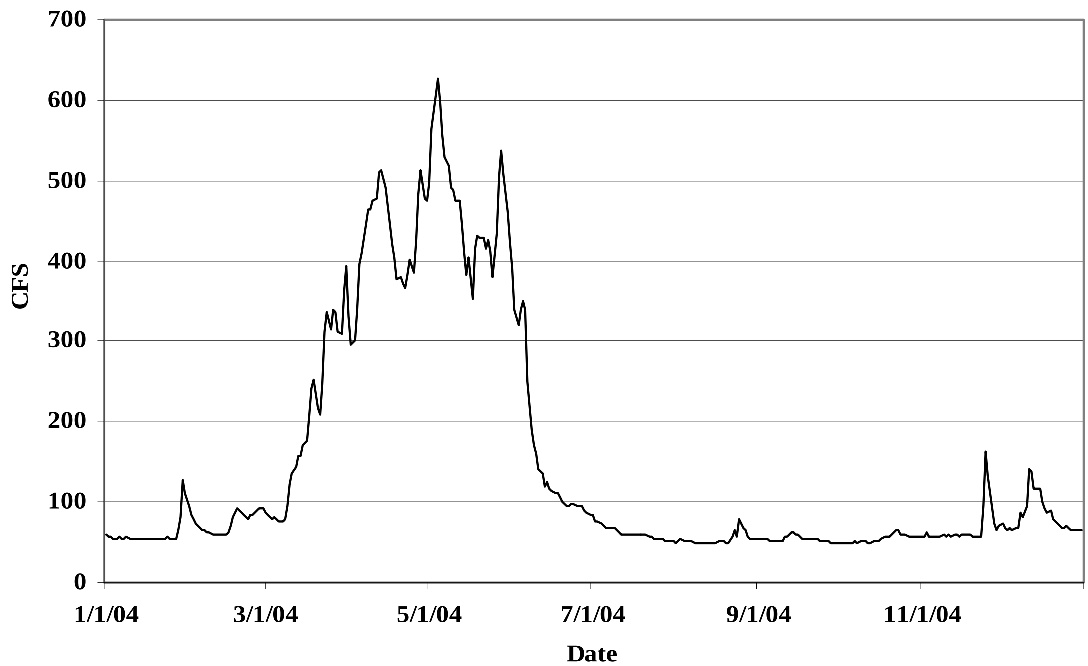

Figure 3. Mean daily stream flows (CFS, cubic feet per second) for Lookingglass Creek at the USGS gauging station near Lookinglass Hatchery, 2004.

Water temperatures began rising rapidly in June and were highest in July and August (Figure 4). Maximum temperatures of 18°C were recorded on 15-16 July 2004 and 24-25 July 2004. Daily maxima ≥16°C were recorded for 39 days during June (1 d), July (27 d), and August (11 d).

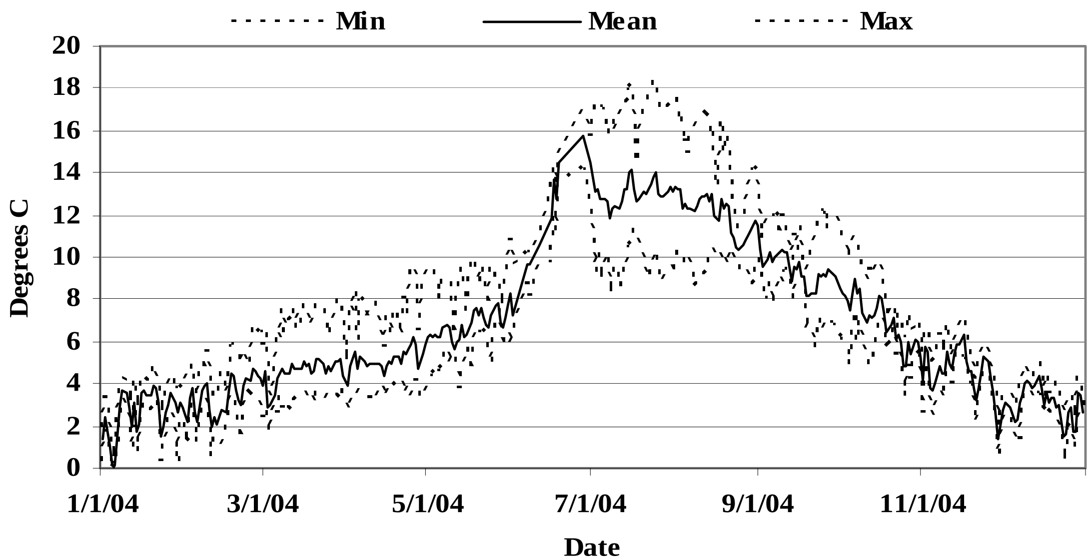

Figure 4. Water temperatures in Lookingglass Creek at the USGS gauging station near Lookingglass Hatchery, 2004.

1.5.2 Adult Spring Chinook Salmon

Adult spring Chinook salmon captured in the Lookingglass Hatchery trap in 2004 consisted of returning unmarked progeny of marked and unmarked fish spawning naturally in Lookingglass Creek (these likely included some unmarked strays from other streams) and those hatchery-reared as juveniles. Adult catches also included outplants of captive broodstock progeny collected at the Catherine Creek trap, transported to Lookingglass Creek, and released below the hatchery for harvest.

1.5.2.1 Catherine Creek stock outplants

A total of 226 ad-clipped adult spring Chinook salmon (108 females, 118 males) from 42-100 cm FL (Figure 5) collected at the Catherine Creek trap were transported to Lookingglass Creek and released about 1 mi below the LH trap. Capture dates at the Catherine Creek trap ranged from 18 May 2004-11 August 2004. All were captive broodstock progeny (ad clip/CWT) except for 5 conventional broodstock progeny (ad clip/CWT/visual elastomer implant tag).

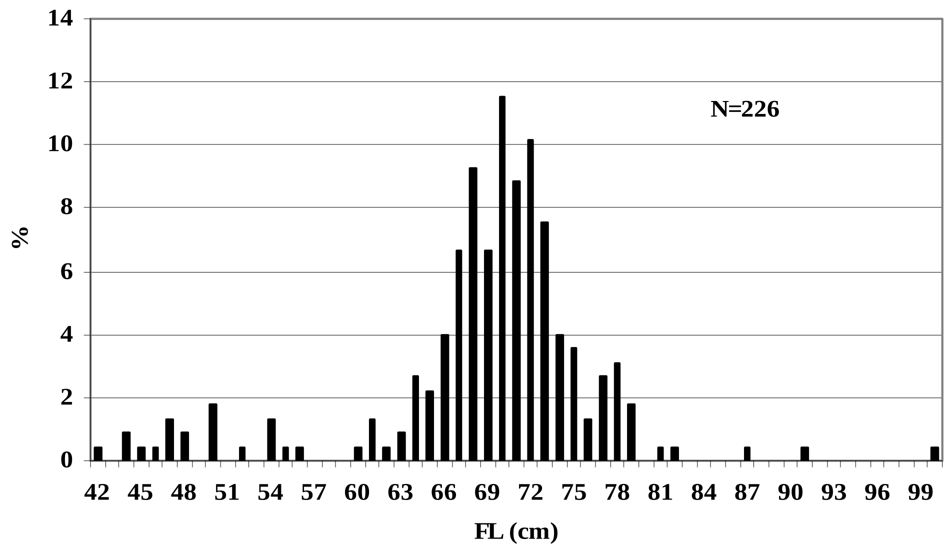

Figure 5. FL frequency of ad-clipped Catherine Creek stock spring Chinook salmon outplanted below the Lookingglass Hatchery trap, 2004.

1.5.2.2 Unclipped (Rapid River stock) adults

Unclipped adults (34 females, 37 males, 1 unknown sex) were caught from 26 May 2004-14 September 2004, but most were caught during June (Figure 6). Fish ranged from 51-83 cm FL but those in the 63-78 cm FL categories dominated (Figure 7). Adults ≤ 60 cm were probably males while those > 60 cm were about equally distributed between males and females.

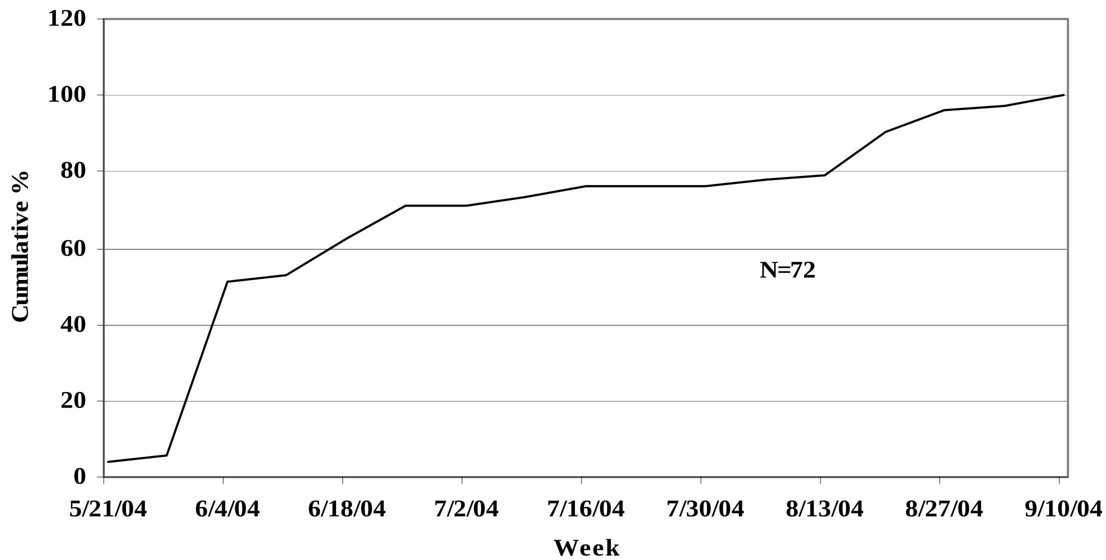

Figure 6. Cumulative % of total catch by week for unclipped (Rapid River stock) spring Chinook salmon caught in the Lookingglass Hatchery trap, 2004.

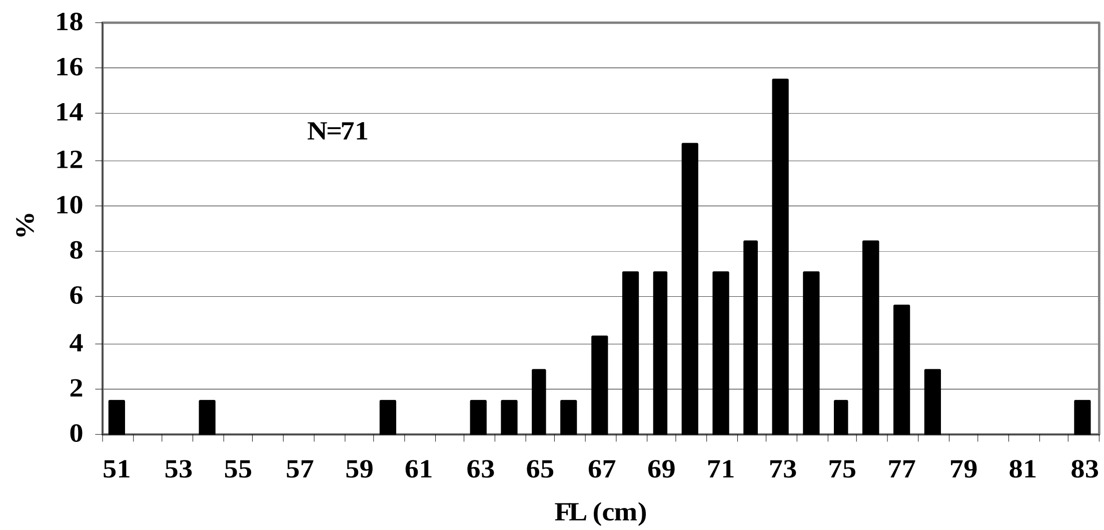

Figure 7. FL frequency for unclipped (Rapid River stock) spring Chinook salmon caught in the Lookingglass Hatchery trap, 2004 (1 not measured).

1.5.2.3 Ad-clipped returns

Ad-clipped returns (34 males, 18 females) without opercle punches were caught from 2 June 2004-14 September 2004 in relatively steady numbers during the weeks from 11

June 2004-6 August 2004 (Figure 8).

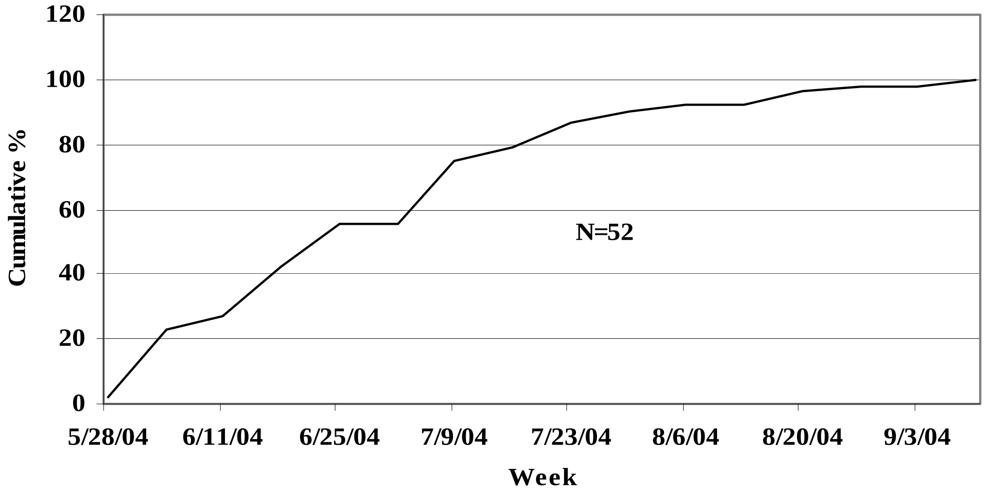

Figure 8. Cumulative % of total catch by week for ad-clipped (Catherine Creek stock) caught in the Lookingglass Hatchery trap, 2004.

Returns ranged from 44-86 cm FL (Figure 9). Four males 47-51 cm were euthanized and four adults caught in late August and September were outplanted below the LH trap. The remainder were outplanted above the LH trap to spawn naturally or spawned as conventional broodstock at LH.

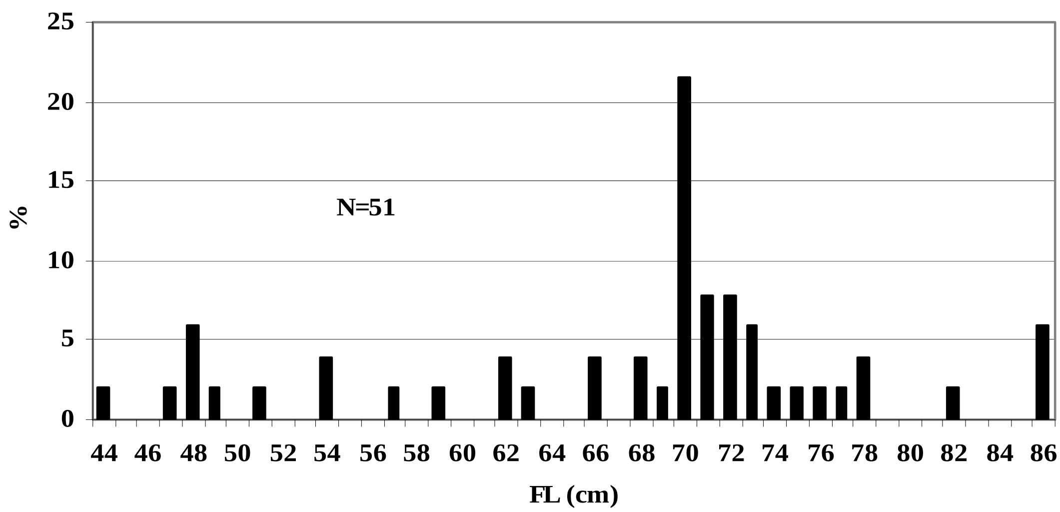

Figure 9. FL frequency for ad-clipped spring Chinook salmon caught in the Lookingglass Hatchery trap, 2004 (1 not measured).

1.5.2.4 Tribal Harvest

Interviews of tribal fishers below the LH trap were conducted on 18 occasions from 2 June 2004-11 July 2004. Nine parties were interviewed that harvested a total of 11 spring Chinook salmon. Harvest per hour was 0.401 and the estimated harvest for the season was 171.

1.5.2.5 Outplants above the Lookingglass Hatchery weir

A total of 101 (approximately equal numbers of each sex) ad-clipped spring Chinook salmon were outplanted above the Lookingglass Hatchery trap at rm 6.6 on 20 July 2004 to spawn naturally. Outplants caught at the Catherine Creek trap totaled 77 and swim-ins to the Lookingglass Hatchery trap totaled 24.

1.5.2.6 Conventional Broodstock Spawning

Lookingglass Creek conventional broodstock were primarily ad-clipped returns caught at the Catherine Creek adult trap, transported to Lookingglass Hatchery, and held in a pond (Figure 10). Similar to the fish outplanted above Lookingglass Hatchery, a few were ad-clipped returns caught at the Catherine Creek adult trap, transported to Lookingglass Creek and released below the weir, and later caught in the Lookingglass Creek adult trap, and a few were ad-clipped swim-ins to the Lookingglass Creek adult trap that had not been previously caught.

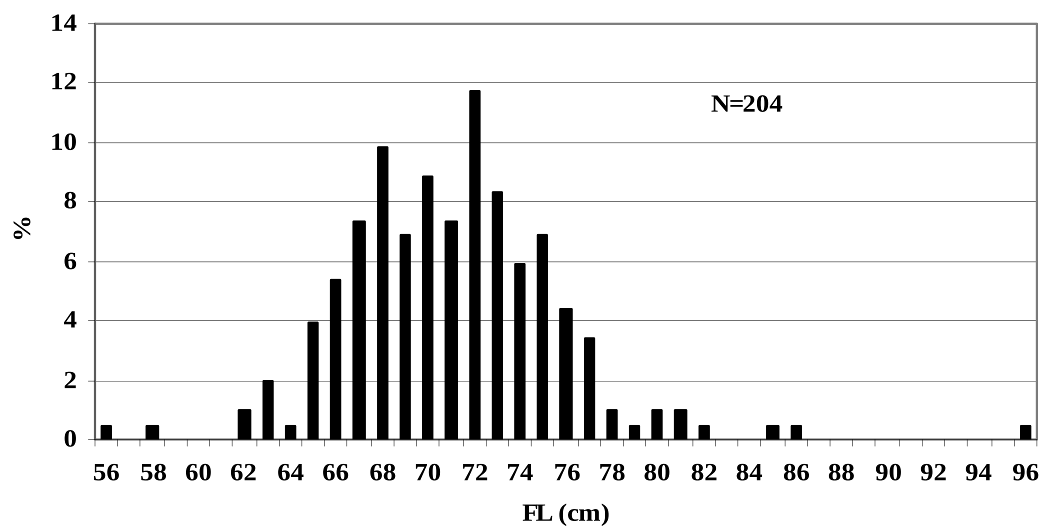

Figure 10. FL frequency distribution for ad-clipped spring Chinook salmon returns at the Catherine Creek trap, transported to Lookingglass Hatchery, and held for use as conventional broodstock for Lookingglass Creek, 2004.

Females were spawned (number in parentheses) on 26 August 2004 (2), 2 September 2004 (16), 9 September 2004 (20), and 13 September 2004 (15). A 720 mm FL female died while in the holding pond, and a 755 mm FL female had bad eggs that were not fertilized. Mean FL of the 53 spawned females was 714.7 mm and mean weight was 3.8 kg. All but 2 of 53 females were 64-78 cm FL (Figure 11). Mean FL of 48 spawned males was 713.7 mm. All but 9 males were from 65-77 cm.

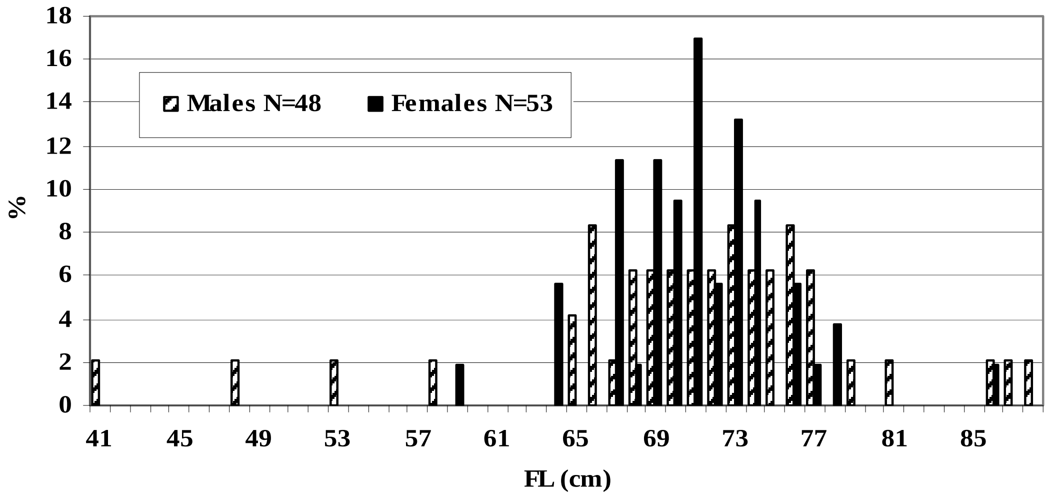

Figure 11. FL frequency distribution for spring Chinook used as Lookingglass Creek conventional broodstock at Lookingglass Hatchery, 2004.

Groups of 20 eyed eggs from each of 36 females were weighed. Mean weights of the 36 groups ranged from 0.18-0.30 g (median 0.24). Mean fecundity for 53 females was 3,254 eggs/fish.

1.5.2.7 Spawning Ground Surveys

The area where the outplanting took place was surveyed on 23 July 2004 but no mortalities were found. Surveys from 20 August 2004-22 September 2004 yielded 98 new redds, with equal numbers above and below the trap (Figure 12). Most new redds appeared during the first ten days in September. Adults per redd were 2.06 (101/49).

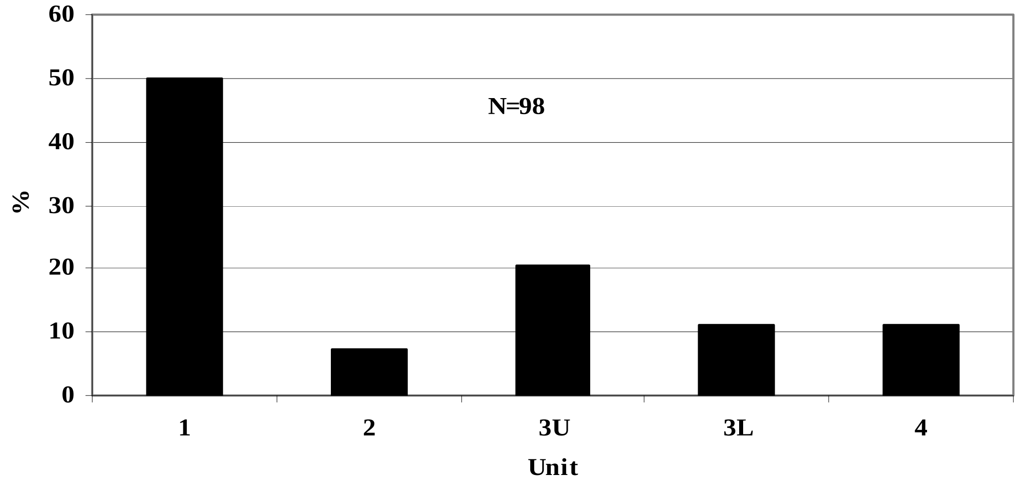

Figure 12. Spring Chinook salmon redds by unit, Lookingglass Creek, 2004.

Carcass recoveries above the trap totaled 40 (16 females, 24 males) ad-clipped, opercle-punched fish. No carcasses were recovered without an opercle punch. FL ranged from 59-96 cm (Figure 13). All 15 carcasses recovered on the barrier weir were males. Fifteen of sixteen females were 100% spawned out.

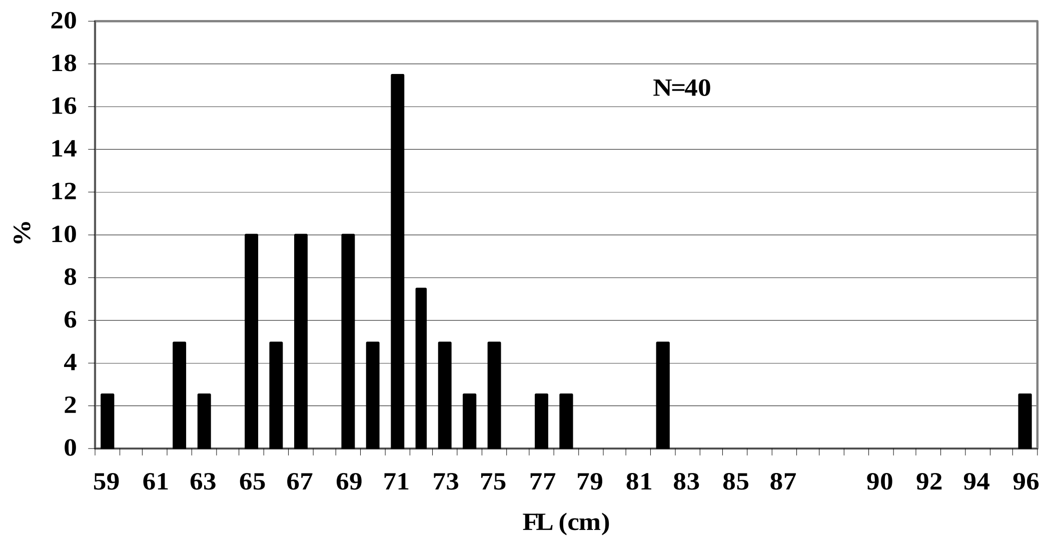

Figure 13. FL frequency for ad-clipped spring Chinook salmon carcasses recovered above the Lookingglass Hatchery trap on spawning ground surveys, 2004.

Carcass recoveries below the Lookingglass Hatchery trap totaled 47 (32 females, 15 males) ranging from 51-80 cm (Figure 14). Most (24) females were estimated to be 100% spawned out, 2 were 25-50% spawned out and 4 were prespawn mortalities (0% spawned out) . Percent spawned was not recorded for 2 females.

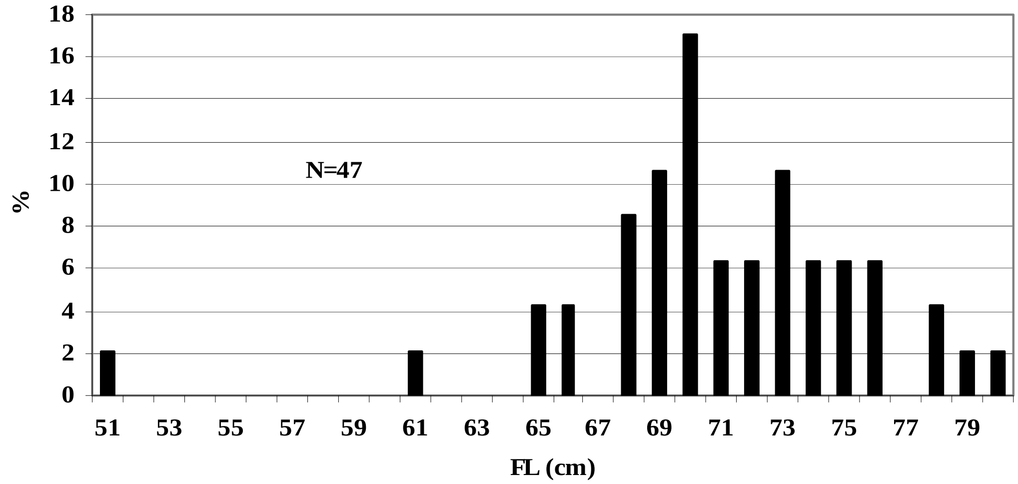

Figure 14. FL frequency for ad-clipped spring Chinook salmon carcasses recovered below the Lookingglass Hatchery trap on spawning ground surveys, 2004

Ad-clipped carcasses with a LOP (left opercle punch) comprised 25 of the 47 recoveries and those with an ROP (right opercle punch) 22. An LOP meant the fish was caught at the Catherine Creek trap, then either outplanted directly into Lookingglass Creek or held for a time at Lookingglass Hatchery before outplanting. An ROP meant that it was captured in the Lookingglass Creek trap and held before release below the trap.

Unclipped carcasses recovered below the hatchery weir included 23 (10 females, 13 males), ranging from 62-83 cm FL (Figure 15). Six of the ten females were 100% spawned out, two were prespawn mortalities (0% spawned out), and percent spawned was not recorded for two.

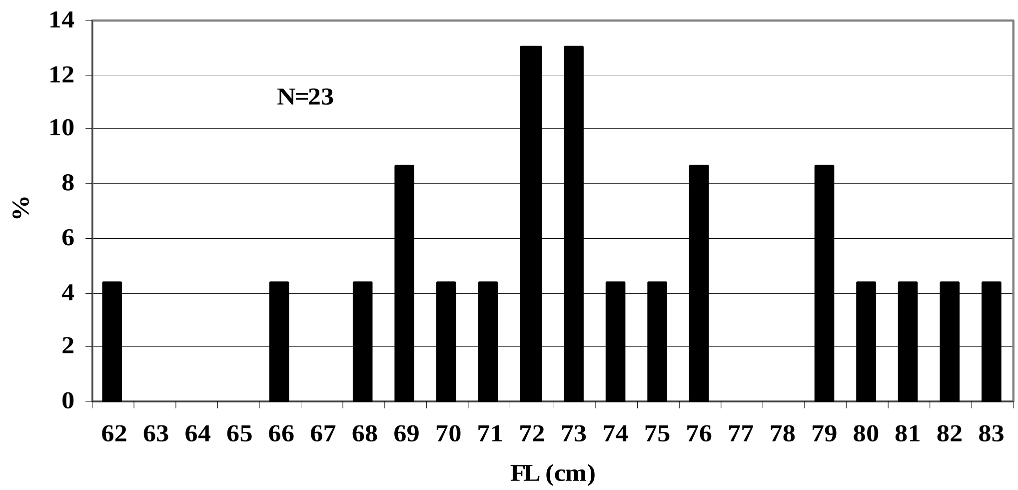

Figure 15. FL frequency for unclipped spring Chinook salmon carcasses recovered below the Lookingglass Hatchery trap on spawning ground surveys, 2004

Ad-clipped carcass recoveries above the Lookingglass Hatcher trap were dominated by BY 2000 Catherine Creek fish released from the Catherine Creek acclimation facility in 2002 (Table 2). Next most abundant were Catherine Creek stock released from Lookingglass Hatchery in September 2001. Only tag status "1" codes (tag read and OK) were used in Table 2. Three snouts were tag status "2" (no tag) and one was tag status "8" (head not processed).

Table 2. Ad-clipped adult spring Chinook salmon carcass recoveries by stock above the Lookingglass Hatchery trap, 2004, using coded wire tag data.

BY	Stock	Recoveries	%
2000	upper Grande Ronde River	2	5.7
2000	Catherine Creek	25	71.4
2000	Catherine Creek*	6	17.1
2001	Catherine Creek	1	2.9
2001	upper Grande Ronde River	1	2.9

* *Catherine Creek stock released into Lookingglass Creek*

A similar pattern existed for ad-clipped carcasses recovered below the trap (Table 3). Only tag status "1" codes (tag read and OK) were used in Table 3. Three snouts were tag status "2" (no tag) and two were tag status "3" (lost before read). There was no data for one snout submitted, resulting in the difference between the snouts collected (47) and data available (46).

Table 3. Ad-clipped adult spring Chinook salmon carcass recoveries by stock below the Lookingglass Hatchery trap, 2004.

BY	Stock	Recoveries	%
2000	upper Grande Ronde River	1	2.4
2000	Lostine River	1	2.4
2000	Catherine Creek	34	82.9
2000	Catherine Creek*	4	9.8
2001	Catherine Creek	1	2.4

* *Catherine Creek stock released into Lookingglass Creek*

Length at age data for all CWT recoveries from either Catherine Creek or Lookingglass Creek in 2004 were used to summarize growth for ad-clipped adults (Table 4). Mean FL of age 3 unclipped males was greater than ad-clipped and mean FL of age 4 unclipped females was greater than ad-clipped. Mean FL of age 4 males differed by only 0.9 mm between ad-clipped and unclipped groups.

Table 4. Length at age for unclipped (Rapid River) and ad-clipped (Catherine Creek stock) spring Chinook salmon, 2004.

Mark	Sex	Age	$\bar{X}$ FL	Range	SE	n
Unclipped	M	3	515.8	493-540	9.6	4
Ad-clip	M	3	495.1	413-630	8.8	33
Unclipped	M	4	732.5	603-838	8.1	40
Ad-clip	M	4	731.6	548-880	5.5	96
Unclipped	M	5				0
Ad-clip	M	5	873			1
Unclipped	F	4	717.5	633-783	4.8	41
Ad-clip	F	4	703.0	595-863	3.5	121
Unclipped	F	5				0
Ad-clip	F	5	773.5	767-780	9.2	2

1.5.2.8 Total Returns to the Stream

Adult spring Chinook salmon returning to Lookingglass Creek included both ad-clipped and unclipped fish but were dominated by Rapid River (unclipped) stock (Table 5). Age 3 returns made up a substantial number of the ad-clipped, but few of the unclipped. There were no recoveries of ad-clipped carcasses without an opercle punch (either ROP or LOP).

Table 5. Estimated mark and age composition of adult spring Chinook salmon returning to Lookingglass Creek, 2004.

Mark	Age	Number	%
Ad-clip	3	11	21.6
Ad-clip	4	38	72.5
Ad-clip	5	3	5.9
Unclipped	3	3	2.7
Unclipped	4	109	97.3
Unclipped	5	0	0.0

1.5.3 Juvenile Spring Chinook Salmon

1.5.3.1 Brood Year 2002

Screw trap operation was effective from 1 July 2003-31 December 2003 with only a few (2-3) days lost to freeze-up in November, and little trouble from mink. Most trap mortalities in 2003 resulted from heavy rain with debris on 7 September 2003. High flows and debris loads caused ineffective weir operation for a good part of March 2004. The trap was removed from operation during 30 July 2004-17 August 2004. Trap catches immediately preceding and after this period were very low, similar to other years.

We collected 6 BY 2002 parr ranging from 36-58 mm FL on 16 July 2004. We collected 413 natural-origin, outmigrating juvenile spring Chinook salmon from 22 August 2003-30 March 2004, including 214 first-time captures that were PIT-tagged prior to release, 155 mortalities, and 44 fish that were measured before release below the trap. There were 34 PIT tag recaptures, including 1 that had been eaten by a bull trout. Two precocials 147-159 mm FL caught and PIT-tagged on 22 August 2003 and 3 October 2003 were excluded from the mark-recapture estimation. Mortalities in 2003 were mostly from a rain event on 7 September 2003 that produced a lot of trap debris at the same time a large number of fish were outmigrating. Remaining mortalities were due to tagging (2), predation (5) or undetermined (3).

Three periods were used in the initial DARR 2.0 dataset; early September 2003 (September 1-15), late September 2003 (September 16)-late October 2003 (October 16-31), and November 2003-March 2004. Total outmigrants were 2,295 (SE 513). About 65% left Lookingglass Creek during late September-late October 2003. Outmigrants per redd for the 2002 brood year were 127.5 (2,295/18).

Table 6. Naturally-produced BY 2002 juvenile spring Chinook salmon captured in the Lookingglass Creek rotary screw trap, releases and recaptures from trap efficiency tests, estimated number of outmigrants and SE, for migration year 2004.

Period	u	m	r	C_p	N	SE
early September 2003	270	107	22	0.388	695	582
late September-late October 2003	99	91	6	0.066	1,502	591
November 2003-March 2004	42	14	6	0.429	98	29
Totals	411	212	34		2,295	513

u=newly caught, unmarked fish (includes fish not marked and released above the trap)
m=newly marked and released above the trap (includes a few fish inadvertently released below the trap)
r=recaptures summed across all time periods
C_p=capture probability (trap efficiency)
N=outmigration estimate
SE=variance$^{0.5}$

Fourteen hatchery-origin juvenile spring Chinook salmon were captured in the screw trap from 1 July 2003-11 March 2004 (the beginning of volitional release for brood year 2002 fish from Lookingglass Hatchery). These probably escaped from the various Lookingglass Hatchery raceways. A total of 53,195 ad-clipped and coded wire-tagged (including 5,193 PIT-tagged) BY 2002 progeny of Catherine Creek captive broodstock were released from Lookingglass Hatchery into Lookingglass Creek on 8 April 2004.

About 70% of the PIT-tagged and released natural-origin outmigrants were 80-99 mm FL and an additional 25% were 70-79 mm or 100-109 mm. Mean FL differed by only 2 mm between the fall 2003 and winter 2003/spring 2004 groups (Table 7). Mean weight was lower for the fall 2003 group but mean K was higher. FL and weight of hatchery-reared juveniles were much greater than for natural-origin fish.

Table 7. FL, weight, and K factor summary by group for natural-origin BY 2002 spring Chinook salmon caught in the Lookingglass Creek screw trap, PIT-tagged and released, or released from Lookingglass Hatchery, migration year 2004.

	Group		
Statistic	Fall 2003	Winter 2003/Spring2004	Hatchery
Mean FL (mm)	90.2	92.2	120.0
SE	0.7	1.4	0.6
Min-Max	74-118	74-154	75-184
N	133	80	840
Mean Weight (g)	8.5	9.2	17.9
SE	0.2	0.6	1.1
Min-Max	4.6-15.0	4.7-45.3	8-43
N	132	78	65
Mean K	1.14	1.11	1.02
SE	0.01	0.01	0.01
Min-Max	0.86-1.41	0.92-1.77	0.69-1.26
N	132	78	65

Median arrival dates at Lower Granite Dam varied by 7 d between the fall and winter groups (Table 8). Harmonic mean travel times varied by about 35 d between the fall and winter groups. Survival of the winter group was almost double the fall group. Survival of the hatchery-reared group was much higher than either of the naturally-reared groups.

Table 8. Survival, capture probability, travel time, and arrival timing to Lower Granite Dam by group BY 2002 spring Chinook salmon caught in the Lookingglass Creek screw trap, PIT-tagged and released, or released from Lookingglass Hatchery, migration year 2004.

	Group		
Statistic	Fall 2003	Winter 2003/Spring 2004	Hatchery
Survival	0.1729	0.3000	0.5633
SE	0.0328	0.0512	0.0097
N	134	80	5,193
Capture Probability	0.4348	0.2917	0.5093
SE	0.1034	0.0928	0.0111
N	10	7	1,491
Travel Time (d)	212.998	177.532	35.411
SE	2.541	5.177	0.415
N	10	7	1,491
Median Arrival Date	14 April 2004	7 April 2004	29 April 2004
10%	8 April 2004	2 April 2004	14 April 2004
90%	27 April 2004	3 May 2004	5 May /2004
N	10	9	1,491
N (expanded)	16	9	2,338

1.6 Discussion

Stream flow conditions in Lookingglass Creek during 2004 followed the typical pattern of a spring freshet resulting from snowmelt at higher elevations in the watershed, followed by a rapid return to base flows. Occasional spikes in base flows resulted from rainfall events during the summer and fall, and rainfall or warm weather during the winter. Stream flow (mean annual CFS) for Lookingglass Creek during water year 2004 (145) was similar to the long-term mean of 139 for water years 1983-2004 (Herrett et al. 2005). Mean stream flows in 2004 for the four months with the highest historical flows (March-June) ranged from 166-472 CFS, compared with the long-term means of 163-374 for the same months.

Maximum temperatures above 16^{o}C were frequently observed during July and August 2004 near Lookingglass Hatchery. These exceed the recommended level for salmon/trout juvenile rearing and may impair smoltification and increase disease risk (U. S. Environmental Protection Agency 2003). A large portion of the spawning and nursery area for spring Chinook salmon is above the hatchery, and temperatures there were probably cooler. Passage and survival conditions in the Snake River-Columbia River migration corridor in 2004 were poorer than several recent years due to lower than normal runoff (Columbia Basin Fish and Wildlife Authority 2005), that probably affected survival and migration timing of both outmigrating juveniles and returning adults.

Adult returns and juvenile production in 2004 continued to reflect the transition from non-endemic Rapid River stock to endemic Catherine Creek stock. Adult returns of Catherine Creek stock thus far have been low, due to the low numbers of fish released and the timing of some releases. The first liberation of Catherine Creek juveniles was of BY 2000 presmolts in September 2001, rather than the typical spring release that probably would have had better survival. The May 2002 release of presmolt BY 2001 fish was almost a year early and thus far has failed to produce any coded wire tag recoveries. No juveniles were released in 2003. Releases of Rapid River stock smolts or presmolts ranged from about 137,000-749,000 (median 301,000) for brood years 1986-1999. Releases of Catherine Creek stock smolts or presmolts ranged from about 17,000-51,000 for brood years 2000-2002. This year was the first that included both a juvenile release and natural spawning above the LH trap of Catherine Creek stock fish.

Estimating the number of adult returns to Lookingglass Creek accurately will remain difficult as long as substantial spawning occurs below the trap. Fish not caught at the trap will have to be estimated indirectly. The inability to handle fish spawning below the trap also means that there will likely be returns from other stocks reared as juveniles at Lookingglass Hatchery (e.g. upper Grande Ronde River) included as spawners.

Juvenile production (outmigrants per redd) has fluctuated considerably over the years, for both Rapid River and the endemic stocks. The range for 5 brood years (1965-1969) of the endemic Lookingglass Creek stock was 230-493 (median 341), using data from Burck (1993). For 10 brood years of Rapid River stock, the range was 68-4,608 (median 415).

Outmigrants resulting from outplanting Catherine Creek stock adults above the trap will be available beginning in early 2005. The screw trap will be moved to a location near the flume hole in 2005 to estimate production from above the Lookingglass Hatchery trap. Life history attributes of both adults and juveniles of the endemic, Rapid River, and Catherine Creek stocks have shown some variations suggestive of stock differences. An assessment of productivity (progeny-per-parent) for the Catherine Creek stock awaits accounting of adult progeny from the first substantial release of hatchery-reared smolts.

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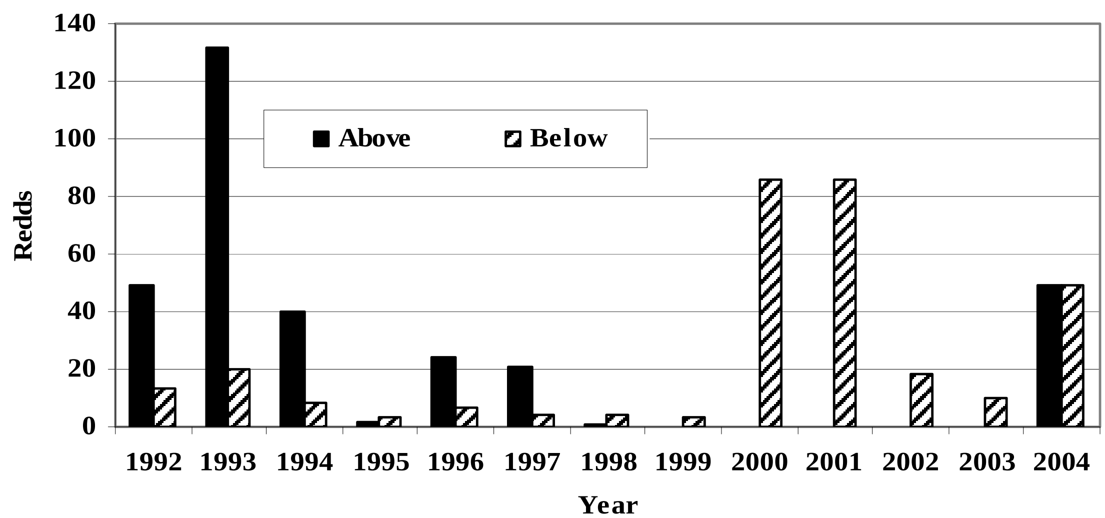
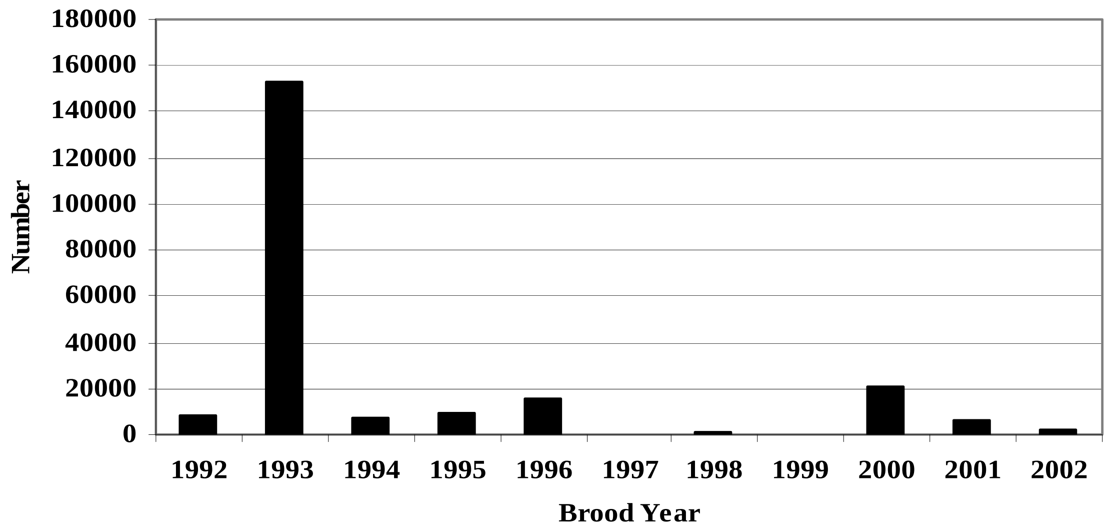
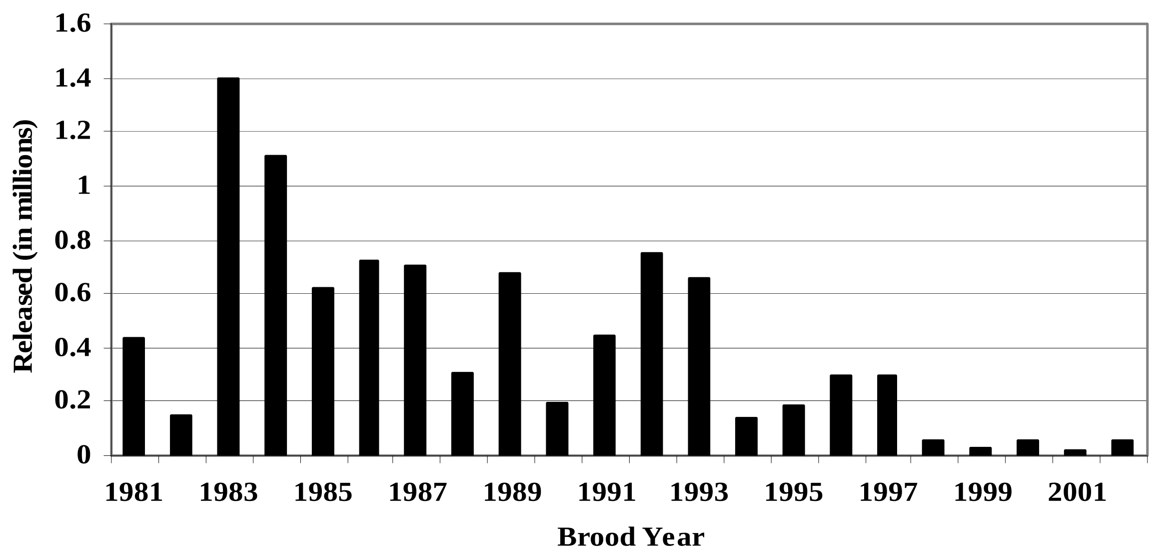
1.8 Appendix Figures



Appendix Figure 1. Spring Chinook salmon redds above and below the Lookingglass Hatchery trap, 1992-2004.



Appendix Figure 2. Lookingglass Creek spring Chinook salmon outmigrant production by brood year, 1992-2002.



Appendix Figure 3. Hatchery-releases of juvenile spring Chinook salmon into Lookingglass Creek by brood year, 1981-2002.

2 SECTION II. *O. MYKISS* INVESTIGATIONS IN LOOKINGGLASS CREEK AND OTHER GRANDE RONDE RIVER TRIBUTARIES

2.1 Abstract

We collected 132 wild (unclipped)) and 2 hatchery-origin (ad-clipped) adult summer steelhead (72 females, 60 males) at the Lookingglass Hatchery trap from 11 March 2004-27 May 2004. Age composition was estimated at 68.6% 1-salt and 31.4% 2-salt. An estimated 57,414 (SE 9,451) juvenile *O. mykiss* outmigrants left Lookingglass Creek during 2004. A substantial number (47.1%) outmigrated during the late September-December 2004 period. Screw trap capture probabilities ranged from 0.02-0.267. Mean FL for 906 fish PIT-tagged and released from 13 June 2003-4 December 2003 was 140.8 mm, median arrival date at Lower Granite Dam was 11 May 2004, and survival to Lower Granite Dam was 0.2100. Mean FL for 526 fish PIT-tagged and released from 28 January 2004-9 June 2004 was 141.7 mm, median arrival date at Lower Granite Dam was 8 May 2004, and survival to Lower Granite Dam was 0.3685. A total of 100 pools across 9 pool types were snorkeled in Lookingglass Creek and Little Lookingglass Creek from 22 July 2004-18 August 2004. Mean densities (fish/100m^2) of unidentified salmonids < 70 mm FL were highest in eddy and alcove pools. Mean densities (fish/100m^2) of *O. mykiss* 70-100 mm FL were also highest in eddy and alcove pools, but larger O. *mykiss* were more evenly distributed among pool types. Mean densities were often highly variable. Counts of *O. mykiss* > 70 mm FL obtained by electrofishing corresponded poorly with snorkel counts. The number of adult summer steelhead caught from 2001-2004 was higher than during 1969-1974. The numbers of outmigrating juveniles during 2001-2004 have also been higher than during the late 1960's. Arrival timing of adults at the Lookingglass Hatchery trap appears to be earlier than previously observed. Sex ratio, age composition, and mean length of smolts appears to be within the ranges published for summer steelhead.

2.2 Introduction

The Grande Ronde River Basin once supported large populations of fall and spring Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon and summer steelhead (*O. mykiss*) (U. S. Army Engineer District 1975, Nehlsen et al. 1991). Anadromous salmonid stocks throughout the Snake River Basin have experienced severe declines in abundance, principally due to construction and operation of hydroelectric facilities, overfishing, and the loss or degradation of critical spawning and rearing habitat (Nehlsen et al. 1991).

The sport fishery for summer steelhead in the Grande Ronde River Basin was closed in 1974 (Flesher et al. 2004). Hatcheries were built in Oregon, Washington and Idaho under the Lower Snake River Compensation Plan administered by the U. S. Fish and Wildlife Service (http://www.fws.gov/lsnakecomplan/index.html) to compensate for losses of anadromous fish due to the construction and operation of the four most downstream Snake River dams. The continued decline in wild summer steelhead populations led to the listing of Snake River populations as threatened under the federal Endangered Species Act of 1973 on 18 August 1997 (Federal Register Volume 62, Number 159).

Harvest augmentation in the Grande Ronde River Basin using non-endemic Wallowa Hatchery stock began in the early 1980s and consumptive recreational harvest was reopened in 1986 (Flesher et al. 2004). High stray rates of Wallowa Hatchery stock have occurred, particularly in the Deschutes River. A Biological Opinion directed the phasing out of Wallowa Hatchery stock releases in the Grande Ronde Basin (National Marine Fisheries Service 1999).

High spring flows make effective trapping difficult, so adult return numbers, genetic structure and other life history aspects of wild adult summer steelhead returning to tributaries of the Grande Ronde River are largely unknown. Burck (unpublished data, summarized by McLean et al. 2001) recorded the number of summer steelhead adults returning to Lookingglass Creek from 1965-1974. Counts at the LH adult trap have also been compiled since 1997, although trap installation dates have varied. The Lookingglass Creek summer steelhead population appears to be doing well in relatively undisturbed habitat with little influence from hatchery fish.

CTUIR has collected life history data for juvenile stages of summer steelhead since 1992. CTUIR has shared operation of the Lookingglass Hatchery adult trap with ODFW since 1997. Data from these and other activities are being used to develop a long-term database for summer steelhead in the Grande Ronde Basin and aid in recovery planning for the Snake River Basin.

2.3 Methods

2.3.1 Adults

2.3.1.1 Trapping

A picket weir at the LH water intake diverted returning fish into a trap at rm 2.3. All adult summer steelhead captured were enumerated, anesthetized in MS222, checked for fin clips and other marks or tags, measured (mm FL), and sexed. A paper punch was used to remove opercle tissues that were preserved in either 70% isopropanol or 95% ethanol. Scales were removed from 2-3 rows above the lateral line on a line from the posterior end of the dorsal fin to the anterior end of the anal fin, and later hot-pressed into cellulose acetate to make permanent impressions. Criteria for annuli were described by Mosher (1969). An age-length key (Ricker 1975) was used to estimate age composition. Week of capture was designated by the first day of the week (e.g. week of 1 January included 1-7 January). Ad-clipped fish were euthanized and removed from the stream. Unclipped (wild) fish were transported about 0.4 mi upstream and released.

2.3.1.2 Spawning Ground Surveys

Known or suspected spawning areas in Lookingglass Creek and tributaries were surveyed by walking downstream during March-June 2004 and recording observations of redds, live fish, and carcasses. Survey section, date, time, flow conditions, water temperature, water clarity, and redd visibility were also recorded. New redds were marked with orange flagging attached to nearby vegetation.

2.3.2 Juveniles

2.3.2.1 Screw trap

We operated a 1.52 m diameter rotary screw trap (Roper and Scarnecchia 1996) at rm 0.1 on Lookingglass Creek to collect outmigrating juvenile *O. mykiss*. The screw trap was operated continuously during 2004 except for brief periods during the spring freshet. The trap was usually checked 3 times a week or more frequently if catches or flows were high. All *O. mykiss* were enumerated, examined for external marks, scanned with a PIT tag reader, measured (mm FL), and weighed (0.1 g). First-time captures of fish >50 mm FL, in good condition (no injuries or obvious disease) were PIT-tagged using standard methods (PIT Tag Steering Committee 1999), or received a partial fin clip (lower caudal). All newly-tagged or clipped fish were released about 100 ft above the screw trap; recaptures were released 50 ft below the screw trap.

We used DARR 2.0 (Bjorkstedt 2005) to estimate the number of outmigrants. DARR 2.0 uses temporally stratified mark-recapture data and pools adjacent strata with similar capture probabilities. We used the "one trap" and "no prior pooling of strata" options.

Most steelhead spend 2 years in freshwater before migrating to the ocean (Busby et al. 1996). FL of most wild steelhead smolts is generally around 160 mm (Burgner et al. 1992). *O. mykiss* juveniles outmigrate from Lookingglass Creek during the entire year, with the largest peak during the spring (usually March-May) and a smaller one in the fall (usually September and October). Fall outmigrants move downstream in the Grande Ronde River or Snake River to continue rearing, but are not detected at Lower Granite Dam until the following spring. Spring outmigrants move directly downstream, but depending on size, may remain in freshwater to continue rearing. Outmigrants that were PIT-tagged were placed into two groups (fall 2003, spring 2004) for comparisons of FL, weight, K factor, arrival timing, travel time, and survival,. The date of PIT-tagging (in 2003) for the last detection in the hydrosystem in 2003 was used as the separation date for the fall 2003 group. All fish PIT-tagged after that date were placed in the fall 2003 group. Similarly, the date of PIT-tagging in 2004 for the last detection in the hydrosystem in 2004 was used as the separation date for the spring 2004 group. These two groups essentially represented migration year 2004.

FL and weight at PIT-tagging, travel time, survival and capture probability to Lower Granite Dam data were obtained by querying the PIT tag database (PTAGIS) maintained by the Pacific States Marine Fisheries Commission at http://www.ptagis.org/. Survival, capture probabilities, and travel time to Lower Granite Dam were calculated using PitPro software (Westhagen and Skalski 2006). We used the standard configuration, and excluded the *.rcp file and included the mortality file. Observation sites, in downstream order, were Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, Ice Harbor Dam, McNary Dam, John Day Dam, Bonneville Dam, and the Estuary Towed Array (Juvenile).

Daily PIT tag detections for Lower Granite Dam were also obtained from PTAGIS and used to estimate arrival timing to Lower Granite Dam. Daily PIT tag detections were expanded for spill using flow data from the U. S. Army Corps of Engineers, Portland District website (http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?k=id:LWG), and calculating a daily expansion factor [(Powerhouse Outflow+ Spill) /Powerhouse Outflow]. Median arrival date at Lower Granite Dam for each group was obtained using the date of 50% expanded daily detections as a percentage of the total expanded daily detections for that group.

2.3.2.2 Snorkeling

Underwater observation techniques (Thurow 1994) were used in pool habitats during July and August 2004 to make counts of *O. mykiss* in Lookingglass Creek and tributaries. Starting points for sampling areas were designated using the EMAP protocol (Stevens and Olsen 2004). Sample sites were restricted to the mainstem Lookingglass Creek, Little Lookingglass Creek, and Mottet Creek deep enough to effectively snorkel.

We used a handheld global positioning unit to locate the starting point for a section. The first five pools upstream of the starting point were observed using snorkel techniques counting all salmonids. As we approached a pool, the general size of the pool was discussed to determine sampling boundaries. One person snorkeled and another recorded data. The snorkeler entered the stream downstream of the pool and slowly moved upstream counting salmonids within the predetermined pool boundaries. Fish observed were recorded in five size categories: Unidentified salmonids < 70mm (most likely age-1 or age-0 *O. mykiss*), *O. mykiss* 70-100 mm, *O. mykiss* 100-150 mm, *O. mykiss* 150-200 mm and *O. mykiss* >200 mm. Spring Chinook salmon, bull trout (*Salvelinus confluentus*) and mountain whitefish (*Prosopium williamsonii*) were recorded without size. Pool type (Armantrout 1998), width (W, nearest 0.1 m), length (L, nearest 0.1 m), and depth (D, nearest 0.1 m) were recorded upon completion of snorkeling each pool. Snorkelers underwent familiarization with sizes and species of fish encountered prior to the start of sampling. Actual fish counts per pool (N) were expanded to the density of fish/100m^2 [N/(L*W)*100].

2.3.2.3 Electrofishing

We randomly sampled several pools by electrofishing in 2004 to calibrate the effectiveness of our snorkel counts. We electrofished selected pools the day after snorkeling, using block nets at the upstream and downstream ends. We used a Smith-Root Model 12-B battery powered backpack electrofisher, with pulsed direct current (DC) generating the lowest effective electric field to collect fish (range: 300-800 volts, 40-60 Hertz, 0.5-4µs). We reduced the settings if any fish appeared to be injured. Multiple passes were made to establish a depletion pattern (4 maximum). We identified salmonids captured to genus and species and measured FL (mm), and released non-salmonids outside the sample area.

We used MicroFish 3.0 (http://www.microfish.org) removal-depletion software developed by the U. S. Forest Service (Van Deventer and Platts 1989) to estimate total salmonid abundance of salmonids and least squares regression to evaluate the relationship between raw counts from electrofishing and snorkeling.

2.4 Results

2.4.1 Adults

2.4.1.1 Trapping

Trapping began on 2 March 2004 and the first female was captured on 11 March 2004; the first male was caught one day later. The last male and female were caught on 27 May 2004. Peak catch was during the week of 9 April 2004 (Figure 1). We captured 132 unclipped upstream-migrating prespawn adults and 2 ad-clipped. The ad-clipped fish (587 mm male, 673 mm female) were collected on 15 March 2004. A 650 mm postspawn female was caught on 2 July 2004. Weekly catches of males and females fluctuated similarly except for 19 March 2004 (Figure 2). Females made up 62% of the total catch. Males in the 58-59 cm groups and females in the 57, 60 and 61 cm FL groups were most abundant (Figure 3). Small numbers of fish < 50 cm of both sexes were collected. One-salt females were slightly longer than 1-males, but the reverse occurred for 2-salt fish (Table 1). Years spent in freshwater for 125 fish aged were 2 (85.6%) or 3 (14.4%). Saltwater age composition of the total catch from an age-length key was 68.6 1-salt and 31.4% 2-salt (Figure 4).

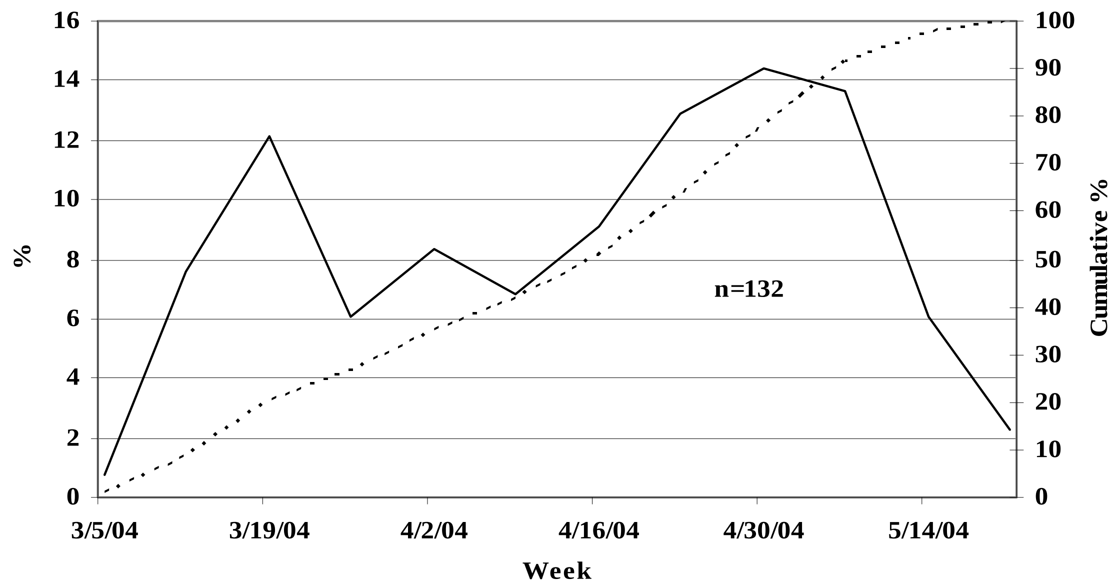


Figure 1. Percent (solid line) and cumulative % (dashed line) of total catch by week for adult summer steelhead caught in the Lookingglass Hatchery trap, 2004.

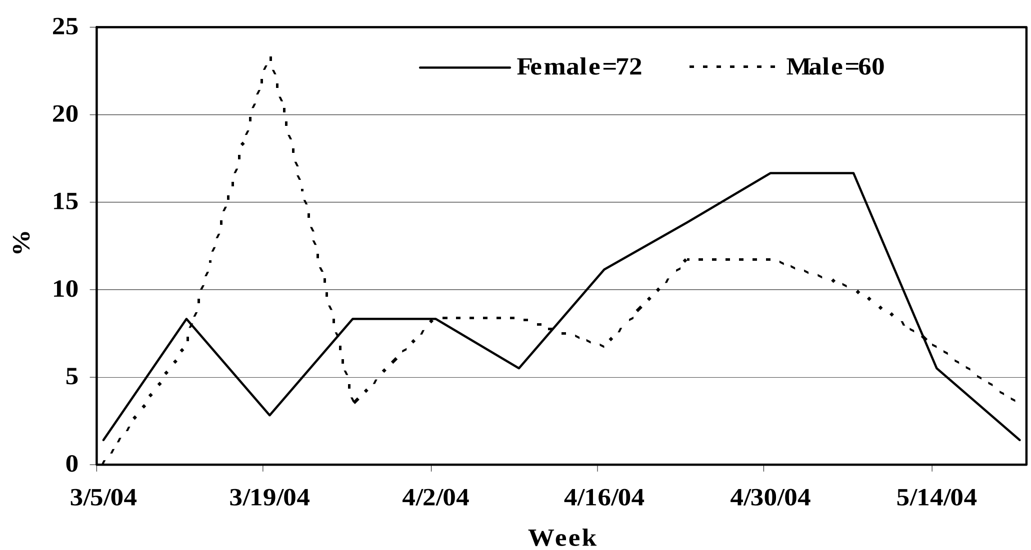


Figure 2. Percentages of total catch by week and sex for adult summer steelhead caught in the Lookingglass Hatchery trap, 2004.

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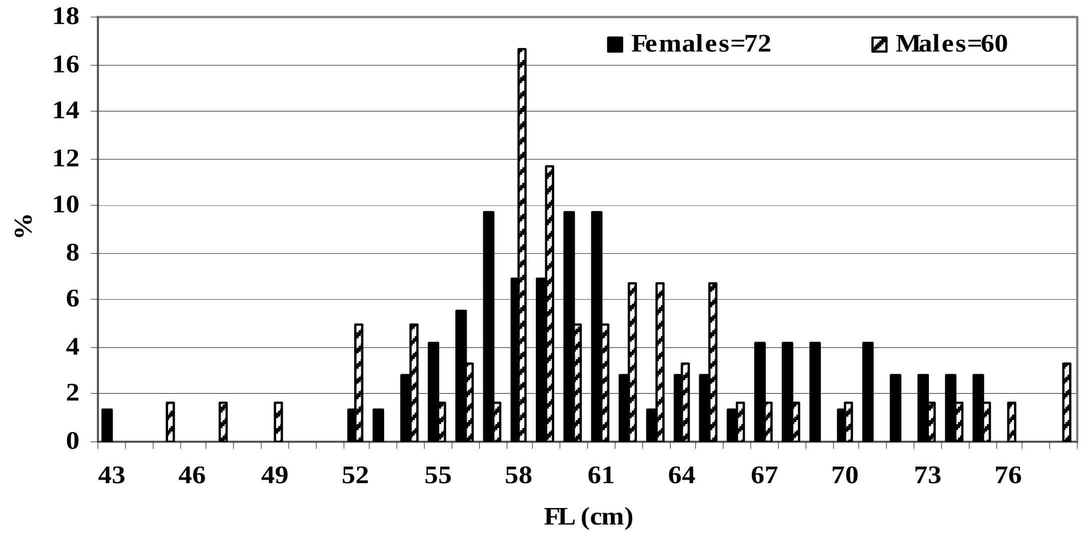

Figure 3. FL frequency of adult summer steelhead caught in the Lookingglass Hatchery trap, 2004

Table 1. FL (mm) summary by sex and age for adult summer steelhead caught in the Lookingglass Creek trap and aged using scales, 2004.

Sex	Age	$\bar{X}$ FL	SE	Min-Max	N
Male					
	1-salt	591.5	7.0	452-683	43
	2-salt	705.8	17.5	622-785	12
Female					
	1-salt	588.0	4.5	529-673	42
	2-salt	687.0	9.0	565-755	28

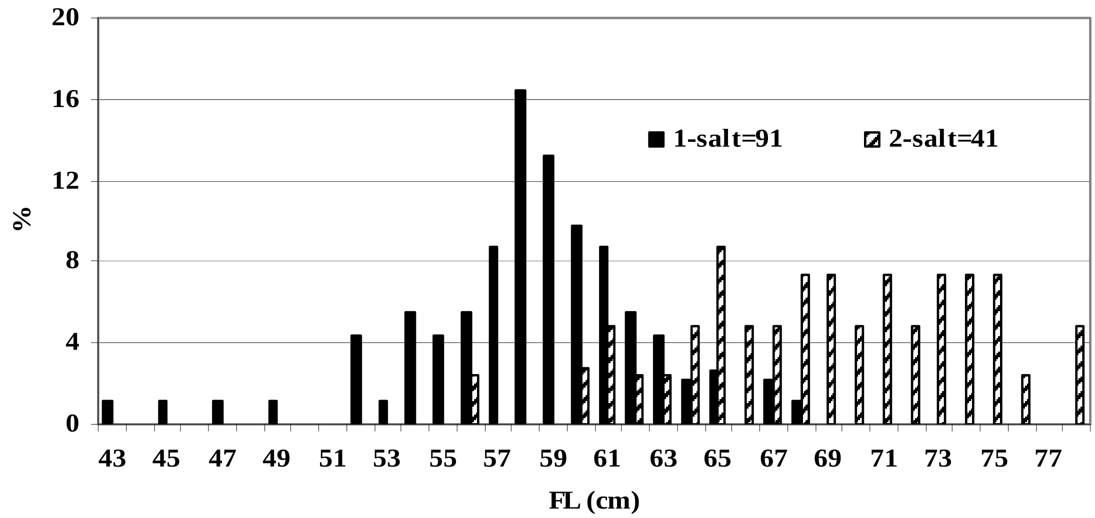

Figure 4. FL frequency by salt-water age for adult summer steelhead caught in the Lookingglass Hatchery trap, 2004.

2.4.1.2 Spawning Ground Surveys

We conducted 13 surveys of sections of Lookingglass Creek, Little Lookingglass Creek, and Mottet Creek that ranged from 1-4.8 mi from 13 March 2004-25 June 2004 and observed 13 new redds. Stream flows ranged from 250-626 CFS during 13 March 2004-7 June 2004, limiting visibility and reducing opportunities for surveys.

2.4.2 Juveniles

2.4.2.1 Screw trap

We operated the trap from 8 January-29 December 2004. We had over 100 mortalities from mink, and two mink were killed in leghold traps within the live box. High flows and debris loads caused ineffective weir operation for a good part of March and occasionally into May. The trap was removed from operation during 30 July 2004-17 August 2004. Trap catches immediately preceding and after this period were very low, similar to past years.

We had 1,662 first-time captures of *O. mykiss* during 2004, including 1,133 that were PIT-tagged and released above the trap, 329 that received a lower caudal fin clip and were released above the trap, 65 that were measured only and released below the trap, 30 (parr < 70 mm FL) that were counted only and released below the trap, and 105 mortalities (mostly due to mink predation). There were 37 PIT tag recaptures and 12 fin clip recaptures. One fin-clip recapture was PIT-tagged and released above the trap, making the total 1,134. One PIT-tag recapture was a trap mortality.

The ranges of FL (cm) for outmigrants sampled in the January-May and September-December periods were similar (Figure 5). There were higher proportions of 7-9 cm FL outmigrants caught during January-May, and higher proportions of 11-13 cm outmigrants caught during September-October. Proportions of outmigrants ≥ 14 cm were similar for the two periods. The FL (cm) distribution for May-August was dominated by the 7-10 cm categories (Figure 6).

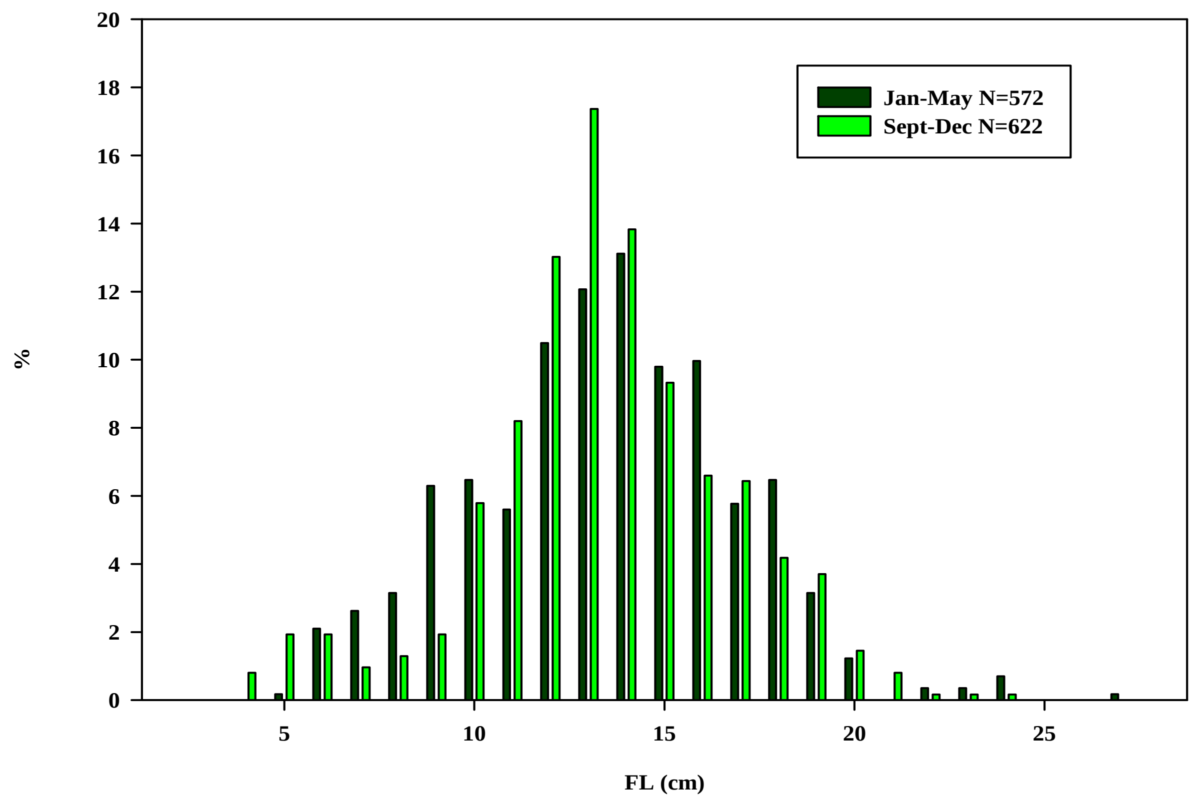

Figure 5. FL frequency for *O. mykiss* caught in the Lookingglass Creek screw trap, January-May and September-December, 2004.

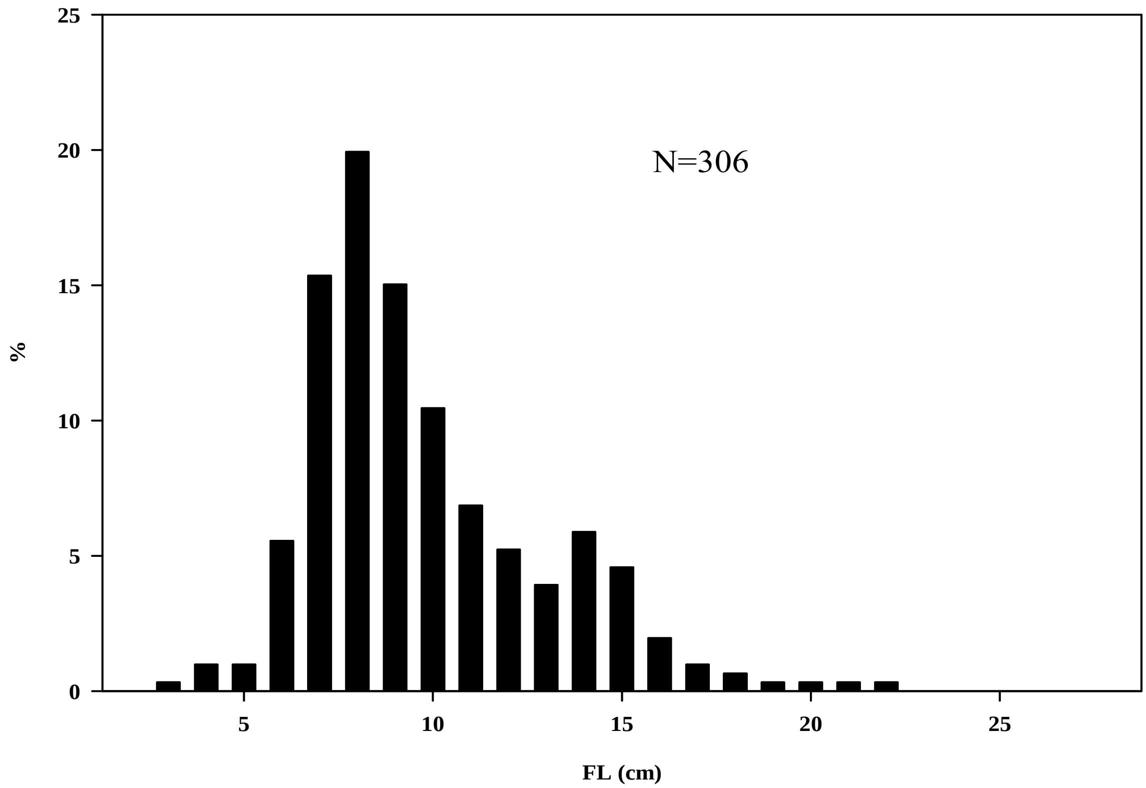

Figure 6. FL frequency for *O. mykiss* caught in the Lookingglass Creek screw trap, June-August 2004.

Mean FL (mm) of outmigrants during March and April and September-October were similar, ranging from 141.2-149.4 (Table 2). The smallest mean FL occurred in June and July. Mean weights followed a similar pattern as mean FL. Mean K factors varied from 1.01-1.18. Mean K values were 1.10-1.12 during May-June, but dropped to 1.02 in August and fluctuated from 1.03-1-09 during September-December. The highest mean K was observed in February but the sample size was small (N=3).

Table 2. FL (mm), weight (g), and K factor summary by month for *O. mykiss* caught in the Lookingglass Creek screw trap, 2004.

	Month											
Statistic	January	February	March	April	May	June	July	August	September	October	November	December
FL												
Mean	189.7	185.3	146.2	149.4	105.8	88.4	98.9	126.9	141.2	146.0	92.2	128.0
SE	33.0	48.7	1.6	2.5	2.5	1.3	3.6	3.6	1.4	3.2	5.1	11.9
Min	130	88	69	71	59	54	72	31	40	48	40	63
Max	244	238	247	270	175	157	150	229	242	220	199	189
n	3	3	282	166	119	175	28	103	475	99	38	10
Weight												
Mean	82.7	96.8	35.3	38.3	17.2	8.6	10.5	26.4	32.6	37.2	11.7	16.8
SE	34.6	43.8	1.3	1.7	1.2	0.5	0.9	2.0	0.9	2.3	2.3	5.7
Min	24.9	9.2	3.1	3.5	3.1	2.3	4.6	0.8	0.6	1.4	1.8	2.9
Max	144.5	142.3	151.2	166.8	56.3	38.4	26.5	123.1	115.2	117.6	83.0	38.6
n	3	3	263	165	105	175	28	101	470	98	37	6
K												
Mean	1.06	1.18	1.01	1.04	1.12	1.11	1.10	1.02	1.04	1.05	1.09	1.03
SE	0.04	0.09	0.01	0.01	0.01	0.01	0.06	0.01	0.004	0.01	0.03	0.03
Min	0.99	1.06	0.80	0.78	0.76	0.67	0.70	0.83	0.84	0.80	0.66	0.98
Max	1.13	1.35	1.24	1.40	1.34	1.65	1.92	1.48	1.50	1.37	1.46	1.16
n	3	3	261	165	105	175	28	101	469	98	37	6

The length-weight regression (Figure 7) produced an excellent fit (adjusted R^2 = 0.986964). As FL (mm) increased K factor decreased (Figure 8). The adjusted R^2 was 0.070661, and the regression P value was <0.0001.

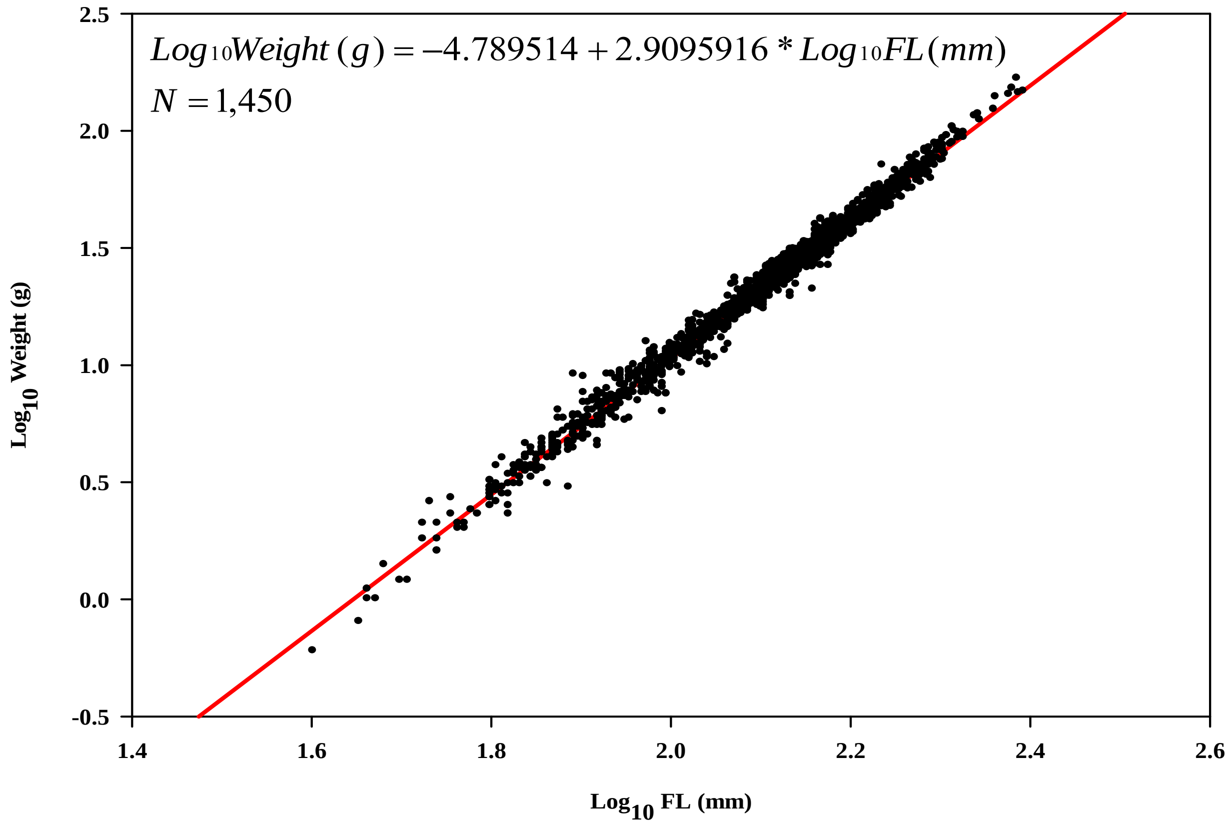

Figure 7. Log_{10} length-weight regression for *O. mykiss* caught in the Lookingglass Creek screw trap, 2004.

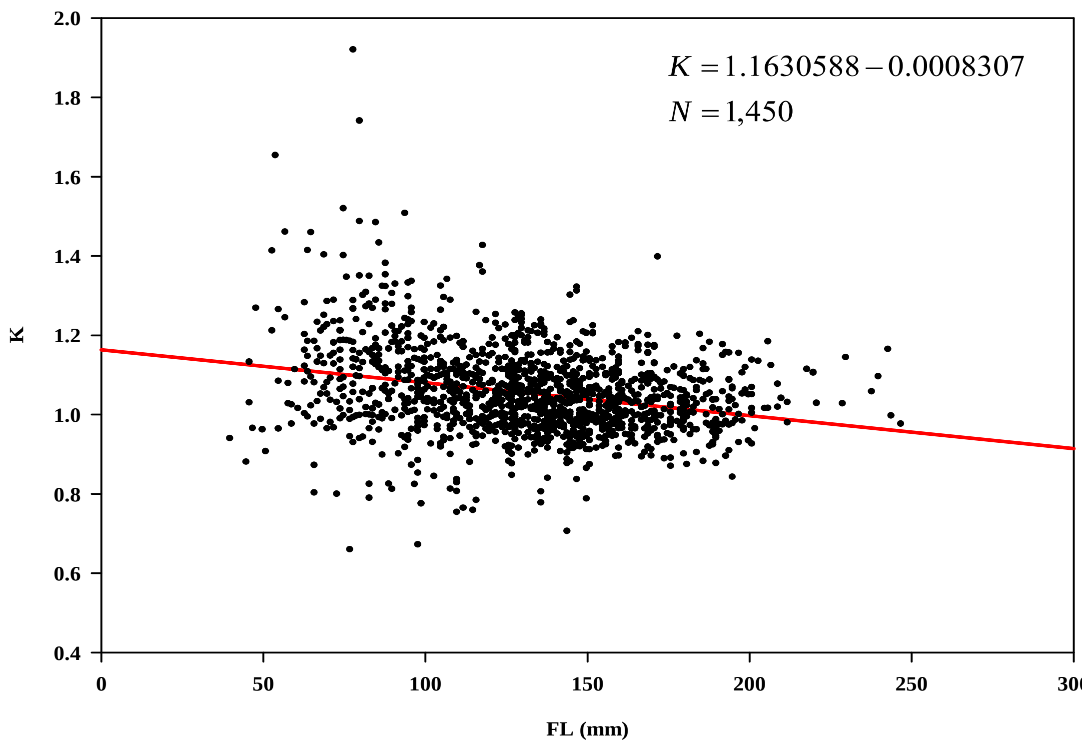

Figure 8. K-FL (mm) regression for *O. mykiss* caught in the Lookingglass Creek screw trap, 2004.

We initially tabulated the numbers of outmigrants caught, marked and released, and recaptured into 8 periods (January-March 15, March 16-31, April, May, June, July-August, September 1-15, and September 16-December) to use in DARR 2.0. DARR 2.0 combined the January-March 15 and March 16-31 periods into one, reducing the total periods to 7. The outmigrant estimate using all sizes was 57,414 (SE 9,451). The outmigrant estimate using only those ≥ 80 mm FL was 51,423 (SE 8,694). Outmigrants were caught during all 12 months, with the highest numbers in September and the lowest in January, February, March 1-15, July, and December (Table 3). Of the 37 PIT tag recaptures, 34 were caught 1-2 days after release with the maximum observed of 5 d. PIT tag recaptures ranged from 89-189 mm FL at tagging (mean 140.2, SE 4.1). The 12 fin clip recaptures ranged from 78-167 mm FL (mean 120.6, SE 8.1).

Approximately 24% of the PIT-tagged outmigrants were from 7-11 cm, 71% from 12-18 cm, and 6% from 19-24 cm (Table 4). PIT-tagged outmigrants ranged from 72-247 mm FL. Mean FL was 141.0 mm (SE 0.9). The proportions of outmigrants PIT-tagged and released were generally similar to the FL at PIT-tagging of the recaptures, with the exception of the 13 cm category (Figure 9).

Table 3. *O. mykiss* caught in the Lookingglass Creek screw trap, releases and recaptures from trap efficiency tests, outmigrant estimates and standard errors, 2004.

	All						≥ 80 mm FL					
Dates	u	m	r	C_p	N	SE	u	m	r	C_p	N	SE
January-March	296	268	10	0.037	7,933	2,460	288	267	10	0.037	7,690	2,384
April	166	147	3	0.02	8,134	4,647	163	145	3	0.021	7,878	4,500
May	120	81	3	0.037	3,240	1,835	96	80	3	0.038	2,560	1,449
June	180	153	5	0.033	5,508	2,422	118	109	3	0.028	4,287	2,440
July-August	132	120	3	0.025	5,280	3,009	119	111	3	0.027	4,403	2,507
September 1-15	77	69	9	0.267	288	392	69	63	9	0.317	218	337
September 16-30-December	692	625	16	0.026	27,031	6,669	646	604	16	0.026	24,387	6,013
Totals	1,663	1,463	49		57,414	9,451	1,499	1,379	47		51,423	8,694

u=newly caught, unmarked fish
m=newly marked and released above the trap
C_p=capture probability (trap efficiency)
N=outmigrant estimate
SE=standard error (variance0.5)

Table 4. *O. mykiss* caught in the Lookingglass Creek screw trap, PIT-tagged and released, by FL (cm) and month, 2004.

	Month											
FL (cm)	February	March	April	May	June	July	August	September	October	November	December	Totals
7				1	3	1	1					6
8		1		4	26	6	2	2		1		42
9		3	2	15	23	9	2	2		4		60
10		7	5	22	18	5	6	15	4	3	2	87
11		12	6	7	6	2	7	27	6	2		75
12		29	11	11	2		13	43	15	1		125
13		45	13	6	2	1	8	70	12	1	1	159
14		42	26	3	3	1	13	58	12		2	160
15		29	22	4	1	1	12	41	9		2	121
16		35	15	5			5	30	6			96
17		17	14	2			2	32	7			74
18		15	21				2	18	7		1	64
19		13	3				1	14	7	1		39
20		3	4				1	5	2			15
21								2				2
22		1	1				1		1			4
23	2											2
24		2	1									3
Totals	2	254	144	80	84	26	76	359	88	13	8	1,134*

* *FL estimated from length-weight regression for 2 fish in June and 1 in September*

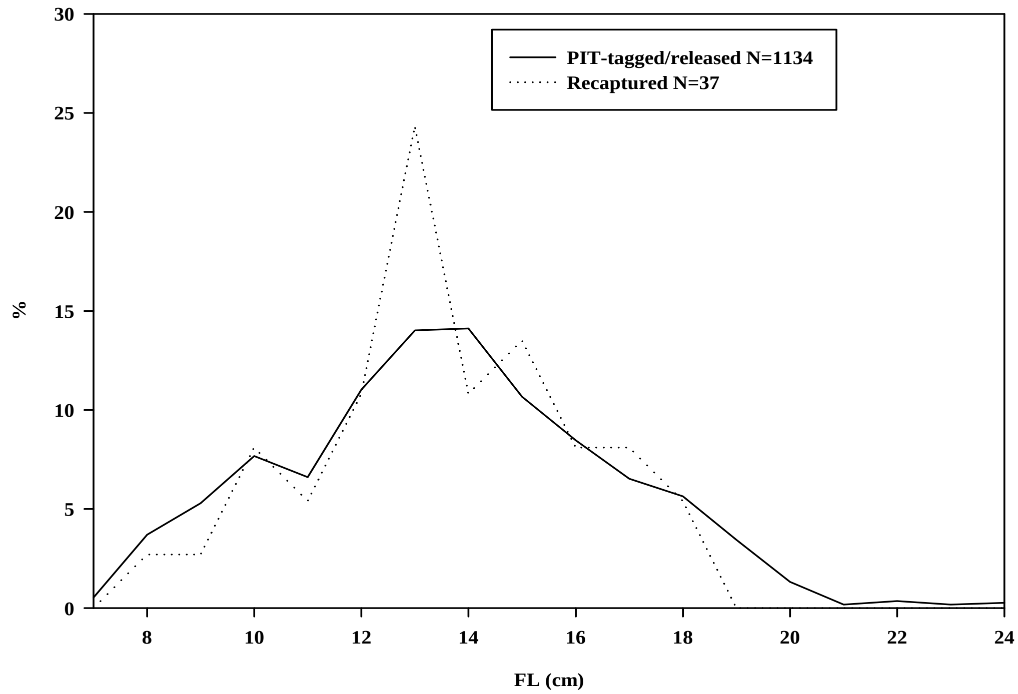

Figure 9. FL comparison of *O. mykiss* caught, PIT-tagged and released and recaptured in the Lookingglass Creek screw trap, 2004.

Approximately 67% of the fin-clipped outmigrants were from 4-11 cm, 28% from 12-17 cm, and 5% from 19-24 cm (Table 5). Fin-clipped outmigrants ranged from 46-242 mm FL. Mean FL was 102.9 mm (SE 2.5). The proportions of outmigrants fin-clipped and released were generally similar to the FL of the recaptures, with the exception of the 13 cm category, which had a much higher proportion in the recaptures (Figure 10).

Table 5. *O. mykiss* caught in the Lookingglass Creek screw trap, fin-clipped and released, by FL (cm) and month, 2004.

	Month												
FL (cm)	January	February	March	April	May	June	July	August	September	October	November	December	Totals
4								1	1	1			3
5						2		1	8		3		14
6						10		3	3	1	4	1	22
7			1	2		29	1	1		1	4		39
8		1	2			20		3	2	1	1	1	31
9			5	1		7	1	2	4	1			21
10								1	7	1			9
11								3	11				14
12						1			21				22
13	1		1						20				22
14									11				11
15									3				3
16					1				4				5
17									1				1
18													
19			1						2				3
20									1	1			2
21								1	3				4
22													
23									1				1
24									1				1
Totals	1	1	10	3	1	69	2	16	104*	7	12	2	228

* *29 were measured and clipped on 16 September 2004; an additional 101 were clipped but not measured.*

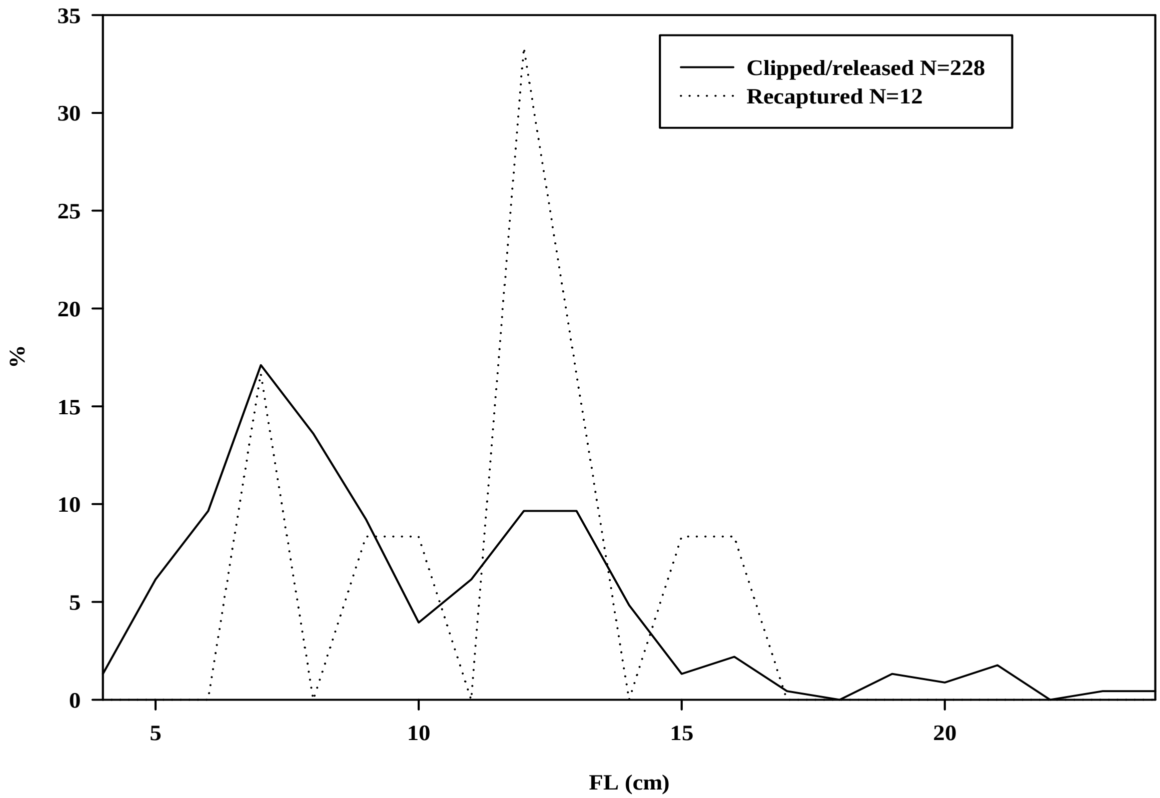

Figure 10. FL comparison of *O. mykiss* caught, fin-clipped and released and recaptured in the Lookingglass Creek screw trap, 2004.

The fall 2003 group was PIT-tagged from 13 June 2003-4 December 2003, and the spring 2004 group from 28 January 2004-9 June 2004. Mean FL, weight, and K factor were similar between the two groups (Table 6). Median arrival date for the fall 2003 group was 3 d earlier than the spring 2004 group (Table 7). Survival of the spring 2004 group was substantially higher than the fall 2003 group. FL (cm) at PIT-tagging frequencies of outmigrants released and detected in the hydropower system for both groups showed recaptures were lower than released for the smaller size groups (up to 10 cm for the fall 2003 group and 13 cm for the spring 2004 group). were generally similar for both groups (Figures 11-12). From those values to about 20 cm, the proportions recaptured were higher than those PIT-tagged and released.

Table 6. FL, weight, and K factor summary by group for *O. mykiss* caught in the Lookingglass Creek screw trap, PIT-tagged and released, 2003-2004.

	Group	
Statistic	Fall 2003	Spring 2004
Mean FL (mm)	140.8	141.7
SE	1.1	1.4
Min-Max	66-250	72-247
N	906	526
Mean Weight (g)	33.6	33.6
SE	0.8	1.0
Min-Max	4.0-158.3	4.8-166.8
N	872	519
Mean K	1.02	1.05
SE	0.003	0.004
Min-Max	0.77-1.37	0.76-1.40
N	872	517

Table 7. Survival, capture probability, travel time, and arrival timing to Lower Granite Dam by group for *O. mykiss* outmigrants caught in the Lookingglass Creek screw trap, PIT-tagged and released, 2003-2004.

	Group	
Statistic	Fall 2003	Spring 2004
Survival	0.2100	0.3685
SE	0.0139	0.0221
N	912	528
Capture Probability	0.8039	0.8068
SE	0.0315	0.0320
N	155	167
Travel Time (d)	215.966	26.055
SE	2.826	1.682
N	155	167
Median Arrival Date	11 May 2004	8 May 2004
10%	2 May 2004	13 April 2004
90%	27 May 2004	27 May 2004
N	155	167
N (expanded)	167	178

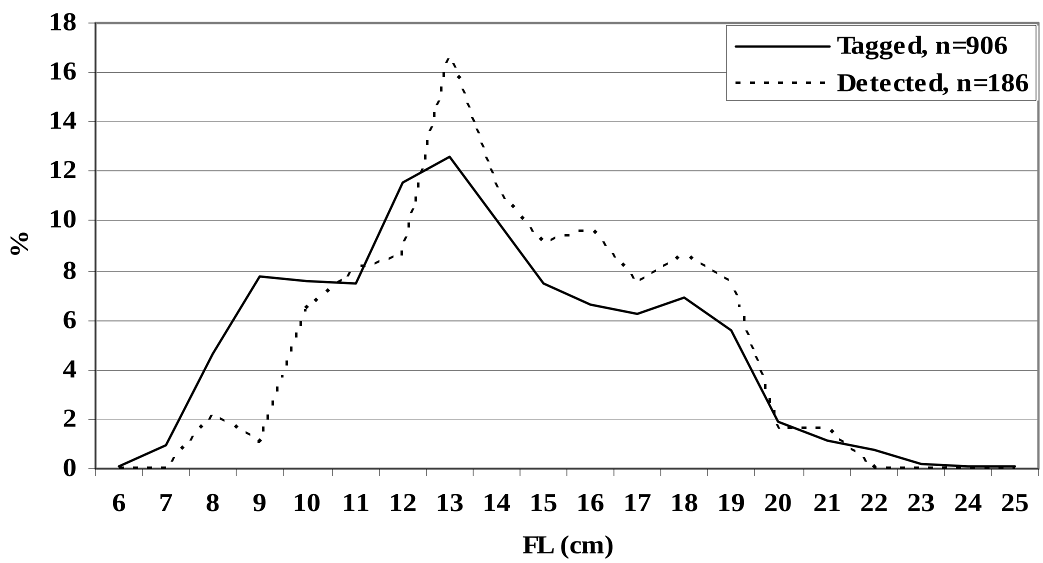

Figure 11. Percentages of *O. mykiss* PIT-tagged and released in Lookingglass Creek, fall 2003 group, and unique detections by FL group in the Columbia River hydrosystem during 2004.

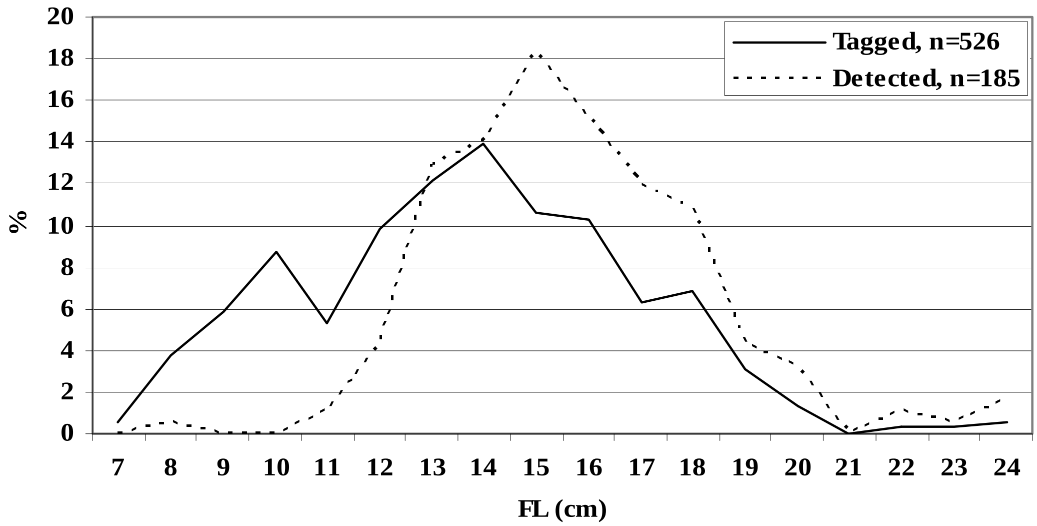

Figure 12. Percentages of *O. mykiss* PIT-tagged and released in Lookingglass Creek, spring 2004 group, and unique detections by FL group in the Columbia River hydrosystem during 2004.

2.4.2.2 Snorkeling

We completed snorkel surveys from 22 July 2004-18 August 2004. We sampled 100 pools across 9 pool types in two streams, Lookingglass Creek and Little Lookingglass Creek (Table 8). Scours were the most common pool type sampled, followed by approximately even numbers of pocket water, cascade/plunge, lateral scour and plunge pools, ranging from 11-15. Most of the pools sampled were in Lookingglass Creek below the Lookingglass Hatchery trap and above the mouth of Little Lookingglass, and in Little Lookingglass Creek. Ten pools were sampled above LH. We counted 2,245 *O. mykiss*, 449 spring Chinook salmon, 58 bull trout, and 243 mountain whitefish. Water temperatures ranged from 8.0-16.5°C and streamflows varied from 49-57 CFS during snorkeling. Visibility was generally excellent.

Table 8. Numbers of pools snorkeled by type in Lookingglass Creek and Little Lookingglass Creek, 2004 (pool types from Armantrout (1998))..

Pool Type	n	Resulting from
Scour (SC)	30	Flow deflection against obstruction
Pocket Water (PW)	11	Scour or eddy behind large boulder
Cascade/Plunge (CASCPL)	13	Water falling over an obstruction and scouring
Debris (DEB)	9	Channel obstruction, usually woody debris
Lateral Scour (LSC)	14	Current directed laterally to one side of stream
Eddy (EDDY)	2	Strong eddy currents on margin or off main channel
Alcove (ALC)	5	Deeper area along shoreline
Plunge (PL)	15	Water dropping steeply into streambed below.
Dammed/Beaver (DAM)	1	Impounded water from beaver dam or other blockage

Unidentified salmonids <70 mm (upstream of Lookingglass Hatchery, these were assumed to be mostly *O. mykiss*) had highest densities in alcove and eddy pools (Table 9). *O. mykiss* 70-100 mm and 100-150 mm showed a similar pattern, but became more equitably distributed among the pool types as size increased. were also most abundant in least abundant in debris pools. Densities of 150-200 mm *O. mykiss* were highest in alcove and debris pools, respectively, and *O. mykiss* > 200 mm most dense in debris pools.

Table 9. Mean densities (fish/100m^2) +/- SE by FL size group and pool type of age 0 (< 70 mm) salmonids and *O. mykiss* (70-100 to > 200 mm) observed by snorkeling in Lookingglass Creek and Little Lookingglass Creek, 2004.

	FL Size Group									
	< 70 mm		70-100 mm		100-150 mm		150-200 mm		> 200 mm	
Pool Type	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
SCO	7	2	14	3	15	3	14	2	6	1
ALC	41	4	44	2	40	1	23	1	5	<1
DAM			3		2		5		3	
CASC	3	1	5	1	16	2	15	3	6	2
LSC	6	2	8	2	18	4	20	4	6	2
DEB	15	7	19	5	19	4	13	3	10	3
EDDY	57	57	35	22	21	8	3	3		
PL	8	5	20	6	13	5	9	3	3	2
PW	12	5	10	4	17	8	16	9	4	3

Highest densities of bull trout were found in debris pools (Table 10). Juvenile spring Chinook salmon were only found below the hatchery weir, and were most abundant in alcove and debris pools. Mountain whitefish densities ranged from 0-5 per 100m^2 and rarely seen above the Lookingglass Hatchery trap.

Table 10. Mean densities (fish/100m^2) +/- SE by species and pool type of bull trout and age 0 spring Chinook salmon observed by snorkeling in Lookingglass Creek and Little Lookingglass Creek, 2004.

	Species			
	BUT		Juvenile CHS	
Pool Type	Mean	SE	Mean	SE
SCO	3	1	2	1
ALC			19	1
DAM				
CASC	1	1	8	4
LSC	1	1	5	3
DEB	5	3	10	7
EDDY	3	3		
PL	1	1	<1	<1
PW	<1	<1	3	5

2.4.2.3 Electrofishing

Correspondence between counts of *O. mykiss* made by electrofishing and snorkeling was generally poor. Adjusted R^2 values for 70-100 mm, 100-150 mm, 150-200 mm, and > 200 mm, size groups ranged from -0.075 to -0.220. The adjusted R^2 value for all fish combined was 0.297 and improved to 0.798 if site 11 was excluded. Electrofisher counts were usually lower than snorkel counts for the smaller size groups but the reverse occurred for fish in the 150-200 mm and > 200 mm groups. For all fish, electrofisher counts were less than snorkel counts half the time and greater than snorkel counts half the time.

2.5 Discussion

The catch of adults in 2004 was higher than those recorded in the 1970's and 1999-2001 (McLean et al. 2001, McLean et al. 2002). The start date of trapping has varied and for some years is unknown, so catches in some years prior to 2002 may have been higher. Only 1.5% of the adult catch in 2004 consisted of hatchery fish.

Most Grande Ronde River summer steelhead usually enter freshwater during August through October, with some entering the following spring. Movement into the smaller tributaries near the spawning areas occurs in the spring (Howell et al. 1985). Unpublished data collected by Burck from 1964-1974 showed peak arrivals of summer steelhead during May or June (Howell et al. 1985). Lookingglass Creek data for 2004 suggested an earlier arrival period, with peaks in mid-March and the end of April.

One-salt adult summer steelhead dominated the 2004 catch from Lookingglass Creek in 2004, similar to the general pattern for Snake River summer steelhead (Busby et al. 1996). The Lookingglass Creek sex ratio favored females, but Withler (1966) assumed equal numbers for each sex in steelhead populations. Sheppard (1972 cited in Burgner et al. 1992) found no trend in sex ratios for summer steelhead from north to south across North America.

The number of outmigrating *O. mykiss* from Lookingglass Creek since 2001 has varied. The 2004 estimate was 30% higher than the 2001 estimate (McLean et al. 2002). All 4 years (2001-2004) produced considerably higher numbers than the range of 6,907-11,863 from 1965-1969 by Mullarkey (1971). Outmigrant estimates ranged from 4,167-22,310 for Catherine Creek, the upper Grande Ronde River, and the Lostine River during migration years 1997-1990 (Van Dyke et al. 2001). Outmigrants from the Tucannon River ranged from 15,384-35,061 for brood years 1995-2003 (Bumgarner et al. 2006. Variability in the numbers of outmigrants is due to multiple factors, including adult fecundity and spawning success, survival at egg, parr, and smolt stages, and environmental conditions within the stream.

Mean FL of outmigrants during March-April and September-October ranged from about 141-149 mm. This was slightly less than the frequently reported average of 160 mm (Burgner et al. 1992). The smaller average for Lookingglass Creek included small numbers of outmigrants that were not smolts moving to the ocean, but rather moving further downstream to spend more time rearing in freshwater.

The high variability in observations and low sample size limited the utility of both the snorkeling and electrofishing data. However, juvenile *O. mykiss* appeared to be more common in pools with quieter water (eddy, alcove) and were more equitably distributed as they grew larger.

Observations thus far of summer steelhead life history in Lookingglass Creek are generally within the ranges previously published for the species (Burgner et al. 1992, Busby et al. 1996). Future data collection and analysis may reveal the significance of the apparent changes in migration timing of adults and outmigrant production.

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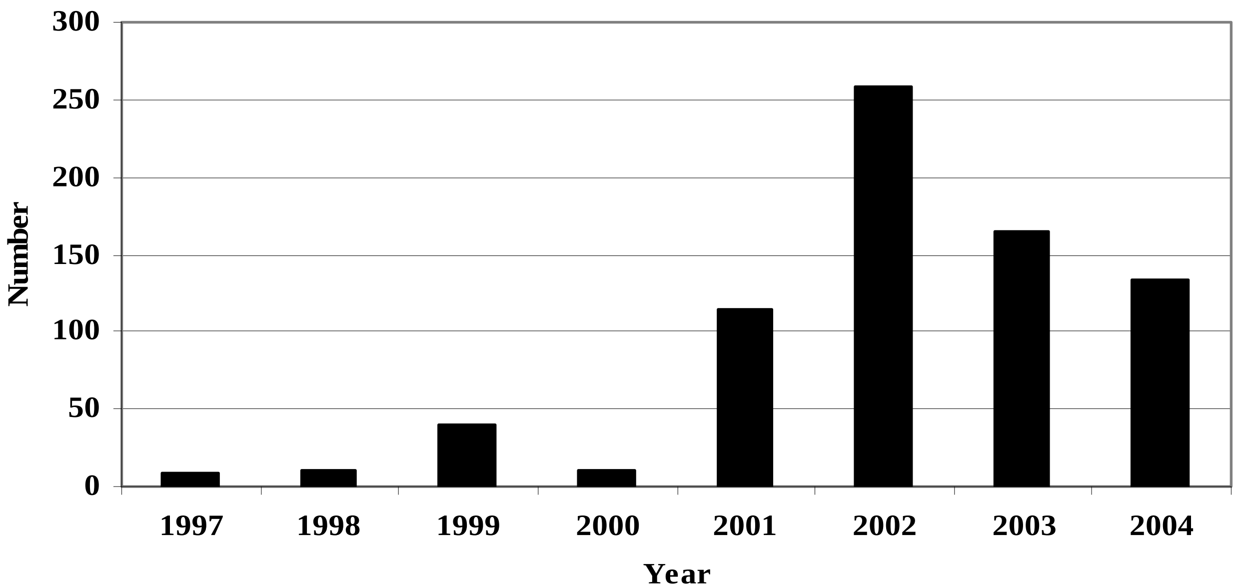
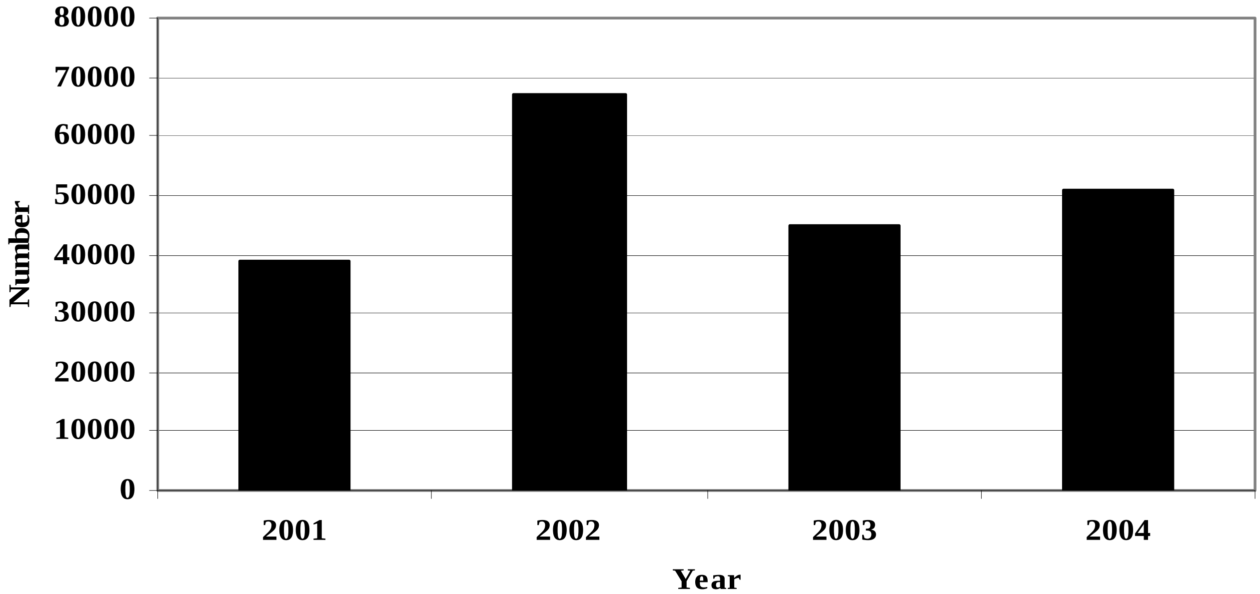
2.7 Appendix Figures



Appendix Figure 1. Total catch of unclipped (wild) summer steelhead at the Lookingglass Hatchery trap, 1997-2004.



Appendix Figure 2. Lookingglass Creek juvenile *O. mykiss* outmigrant production, 2001-2004.

3 SECTION III ASSISTANCE PROVIDED TO LSRCP COOPERATORS AND OTHER PROJECTS

We provided assistance to LSRCP cooperator ODFW in 2004 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 spring Chinook salmon at LH. 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 other Bonneville Power Administration (BPA) projects with data collection in 2004. We assisted ODFW personnel who have been collecting data on bull trout 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 LH adult bypass. In addition, we have implanted PIT tags in bull trout we have captured in our rotary screw trap. We assisted the BPA-funded adult spring Chinook salmon broodstock collection project in the Grande Ronde River and Catherine Creek in 2004 with weir building and trap checking.

4 ACKNOWLEDGMENTS

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