Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2006 to 31 December 2006

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

Section II
O. mykiss Investigations in Lookingglass Creek and Other Grande Ronde River Tributaries

Section III
Assistance Provided to LSRCP Cooperators and Other Projects

Stephen J. Boe, Carrie A. Crump, and Rey L. Weldert
Confederated Tribes of the Umatilla Indian Reservation
Department of Natural Resources, Fisheries Program
203 Badgley Hall, Eastern Oregon University
La Grande, Oregon 97850
(541)962-3043

Administered by the United States Fish and Wildlife Service
and funded under the Lower Snake River Compensation Plan
CTUIR Project No. 421, Contract No. 1411-06-J015

December 2009

Table of Contents

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

Maximum flow in Lookingglass Creek during 2006 was 693 CFS on 20 May. Maximum daily water temperatures were 19.3^{o}C on 27 June 2006 at the Lookingglass Hatchery site and 11.8^{o}C near Eagle Creek on 9 dates from 14-27 July 2006. Spring Chinook salmon adults captured at the Lookingglass Hatchery trap from 12 June-28 August 2006 totaled 94 (32 females, 62 males); 66 adipose fin-clipped and 28 unclipped. Unclipped returns included 16 naturalized Rapid River stock and 12 hatchery-origin conventional broodstock progeny from the upper Grande Ronde River. Ad-clipped returns (Catherine Creek captive broodstock progeny) were euthanized at the trap (n=16), released upstream of Lookingglass Hatchery on or after 3 August 2006 to spawn naturally (n=47), or used as Catherine Creek broodstock (n=3). Spawning ground surveys from 10 August-18 September 2006 yielded 28 redds and 15 carcasses above the trap and 28 redds and 19 carcasses below. Estimated total returns to the stream were 28 unmarked (naturalized Rapid River stock) and 136 hatchery-origin (115 Catherine Creek stock and 21 upper Grande Ronde River stock). Smolt to adult ratio for unmarked BY 2001 returns was 2.06%. There were no recoveries of BY 2001 hatchery-origin presmolts released in Lookingglass Cree in 2002.

Natural-origin brood year 2004 outmigrants totaled 11,927 and outmigrants per redd were 243. Outmigrants PIT- tagged and released were 360 (fall 2005), 262 (winter 2005), and 104 (spring 2006). Mean FL of fall 2005, winter 2005, and spring 2006 groups ranged from 84.7-94.6 mm. Survival probabilities to Lower Granite Dam ranged from 0.2220-0.5728 and median arrival dates ranged from 22 April-8 May 2006. A total of 140,675 brood year 2004 hatchery-reared progeny of Catherine Creek stock captive broodstock were released from Lookingglass Hatchery during September-November 2005 and January-March 2006. Mean FL of the January-March 2006 release group was 96.7 mm, survival probability to Lower Granite Dam was 0.6079 and median arrival timing at Lower Granite Dam was 2 May 2006. Survival probability to Lower Granite Dam was 0.1227 and median arrival timing to Lower Granite Dam was 28 April 2006 for 481 parr collected, PIT-tagged, and released in the primary rearing area upstream of Lookingglass Hatchery in August 2005.

Management of spring Chinook salmon to restore a self-sustaining population in Lookingglass Creek is in transition as Rapid River stock is replaced with Catherine Creek stock. Hatchery releases thus far have failed to yield either adequate numbers of adult returns to spawn in nature or natural-origin smolt production. Low numbers of hatchery-origin smolts are available due to both low numbers of adults and inadequate rearing space.

1.2 Introduction

Lookingglass Creek is within the "usual and accustomed" areas of hunting, fishing, and gathering for the Confederated Tribes of the Umatilla Indians (CTUIR). The native stock of spring Chinook salmon was functionally extirpated within a few years of the establishment of Lookingglass Hatchery (LH) in 1982. Spring Chinook salmon production from LH is to compensate for anadromous fish production lost due to construction and operation of the four most downstream hydroelectric dams on the Snake River. The Oregon Department of Fish and Wildlife (ODFW) began efforts in the 1980's to reestablish natural production of spring Chinook salmon in Lookingglass Creek. CTUIR joined this effort as comanagers in the early 1990's. Several stocks, including remnants of the endemic stock, Imnaha River, Wind River (Washington), Carson Hatchery (Washington), and Rapid River (Idaho) were used before the Rapid River was settled on. Presmolts and smolts were released into Lookingglass Creek and returning adults were used as broodstock. The last Rapid River stock juveniles were liberated in 2000. Reintroduction was continued using a Grande Ronde Basin stock (Catherine Creek) starting in 2001. Adult spring Chinook salmon captured in the Lookingglass Hatchery trap in 2006 were from Lookingglass Creek natural production (probably dominated by descendants of Rapid River stock), natural production strays from other streams, hatchery-reared Catherine Creek stock captive broodstock progeny, and hatchery-reared fish from other Grande Ronde Basin stocks. Some of the hatchery-origin adults from other stocks had visual implant elastomer (VIE) tags or coded wire tags (CWT), but no ad-clips. Most adults in 2006 were expected to come from releases of hatchery-reared juveniles into Lookingglass Creek during 2002-2005 (Table 1). The 2001 release had accelerated growth after being reared at Irrigon Hatchery and was released after only 1 year of rearing. No coded wire tags from this group have been recovered.

Table 1. Hatchery-produced spring Chinook salmon released into Lookingglass Creek, brood years (BY) 2001-2003.

BY	Release Date	No. Released	Mean weight (g)	Marks*
2001	28 May 2002[a]	17,539	6.9	Ad clip/CWT
2002	8 April 2004[b]	52,545	21.2	Ad clip/CWT/PIT
2003	29 March 2005[bc]	62,122	19.7	Ad clip/CWT/PIT
2003	29 March 2005[bc]	31,445	19.7	Ad clip

[*] *PIT=PIT (passive integrated transponder) tag*
[a] *presmolt release*
[b] *smolt releases*
[e] *forceout date, volitional release started 18 March 2005*

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 performance of the reintroduced stock. Annual reports describing past efforts by CTUIR and comanagers to reestablish natural production of spring Chinook salmon in Lookingglass Creek are available at http://www.fws.gov/lsnakecomplan/Publications.html.
Our goals are to reestablish a self-sustaining population of spring Chinook salmon and restore harvest opportunities for tribal members in Lookingglass Creek. These goals are consistent with the overall mission statement of the CTUIR Department of Natural Resources:

"To protect, restore, and enhance the First Foods water, salmon, deer, cous, and huckleberry - for the perpetual cultural, economic, and sovereign benefit of the CTUIR. We will accomplish this utilizing traditional ecological and cultural knowledge and science to inform: 1) population and habitat management goals and actions; and 2) natural resource policies and regulatory mechanisms.**"**

Similarly, the CTUIR DNR Fisheries Program mission statement is:

"To provide sustainable harvest opportunities for aquatic species of the first food order by protecting, conserving and restoring native aquatic populations and their habitats.**"**

1.3 Study Area

Lookingglass Creek begins at the outlet of Langdon Lake in the Blue Mountains of northeast Oregon at an elevation of 4,870 feet above sea level. Flow is southeast for 15.5 river miles (rm) through the Umatilla National Forest, then privately-owned land before entering the Grande Ronde River at rm 85, at an elevation of 2,355 feet above sea level (Figure 1). The five major tributaries are Lost Creek, Summer Creek, Eagle Creek, Little Lookingglass Creek, and Jarboe Creek. Lookingglass Creek below rm 10 and Little Lookingglass Creek (the largest tributary) below rm 3 are the only areas where spring Chinook salmon spawning occurs consistently. LH is at rm 2.25.

1.4 Methods

1.4.1 Stream Flow and Temperature

We summarized Lookingglass Creek stream flow data collected in 2006 by the United States Geological Survey (USGS) near LH. Data for site "USGS13324300 Lookingglass Creek near Looking Glass, OR" are available at http://waterdata.usgs.gov/or/nwis/uv/?site_no=13324300&PARAmeter_cd=00065,00060
Water temperature data were obtained from electronic data loggers operated by the USGS near LH and Umatilla National Forest (UNF) below the mouth of Eagle Creek.

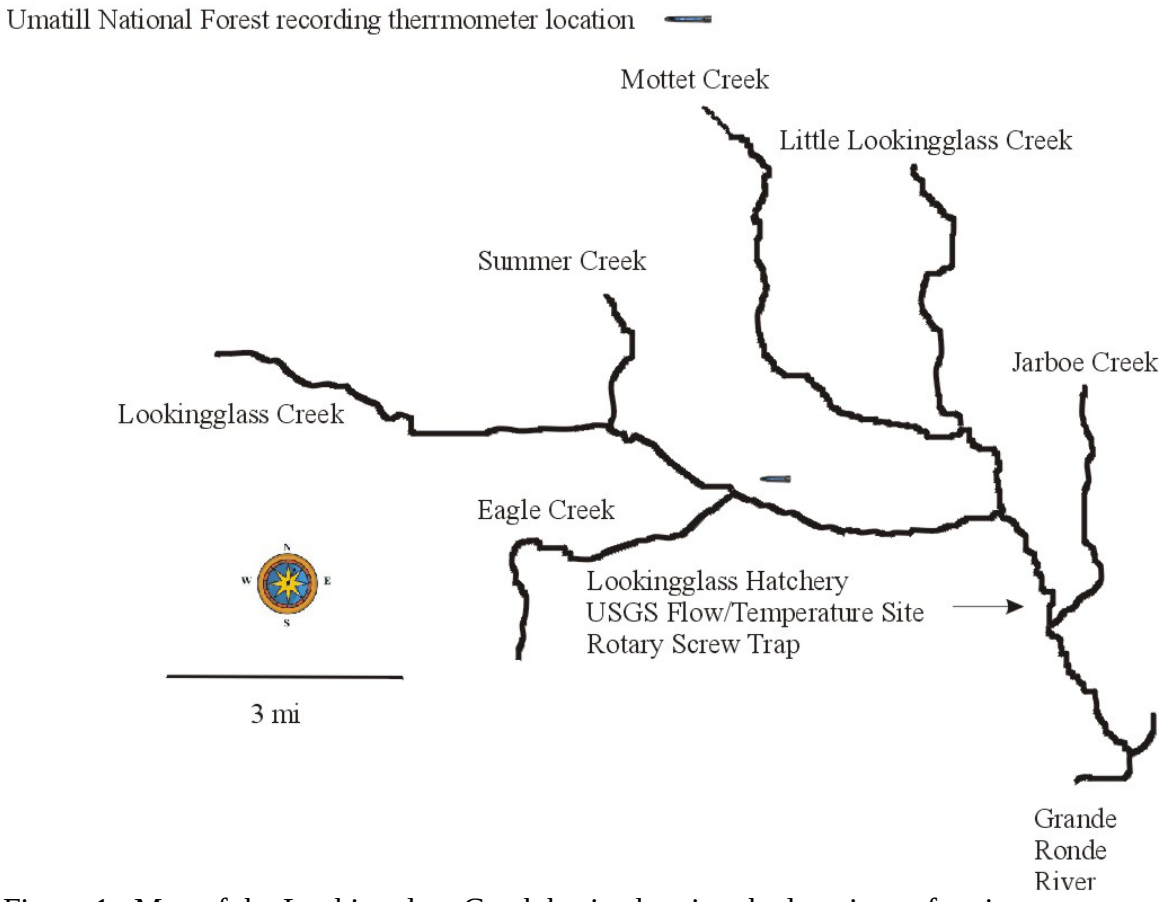


Figure 1. Map of the Lookingglass Creek basin showing the locations of major tributaries, temperature and flow recorders, screw trap and the Lookingglass Hatchery complex.

1.4.2 Adult Spring Chinook Salmon

Adult spring Chinook salmon returning to Lookingglass Creek were diverted into the LH trap using a picket weir near the LH water intake. ODFW LH staff usually complete installation by the first week in March and operate through late September annually. ODFW LH staff check the trap at least 3 times a week (Monday, Wednesday, Friday). All spring Chinook salmon captured were anesthetized, enumerated, examined and scanned for fin clips, opercle punches and other marks and tags, measured (mm FL), and sex and maturity status determined. Scales were removed from all unclipped returns without CWT. Up to 10 scales were removed from both sides of the fish 2-3 rows above the lateral line and on a diagonal from the posterior of the dorsal fin to the anterior of the anal fin. Permanent scale impressions were made using heat and pressure on cellulose acetate and examined under magnification with a microfiche reader using criteria for annuli from Mosher (1969). Week of capture was designated by the first day of the week (e.g. week of 1 January included 1-7 January).

Ad-clipped returns with CWT present were assumed to be returns of Catherine Creek captive broodstock progeny either released into Lookingglass Creek or from the Catherine Creek acclimation facility. These received an opercle punch (to be a visual mark and provide genetics tissues) and were placed in a holding pond at LH for later outplanting above the adult trap to spawn naturally. Goals for hatchery broodstock and in-stream spawners are set on a sliding scale (Appendix A). Unmarked returns (no ad-clip, CWT or VIE tags) were assumed to be naturalized Rapid River stock or strays from other streams and were euthanized. Unclipped adults with CWT and/or VIE tags were upper Grande Ronde River, Catherine Creek, or Lostine River stock returns; they were placed in the appropriate holding ponds at Lookingglass Hatchery and later spawned.

Spawning ground surveys (Parker et al. 1995) were conducted weekly during August and September 2006 after outplants were released above the Lookingglass Hatchery trap. The spawning area was divided into 5 units (Figure 2). Only completed redds (Lofy and McLean 1995) were counted and flagged to eliminate double counting. Carcasses were enumerated and fork length, sex, marks, and percent spawned recorded. Tails were cut off to prevent double sampling and snouts were taken from any ad-clipped and some unclipped carcasses for CWT recovery.

Total returns to Lookingglass Creek were estimated from the total number of fish released above the weir, those euthanized or spawned as broodstock at LH, redds counted below the trap multiplied by 2.5 fish/redd (Park 1990), and adjusted by the fractions of clip, age, and various coded wire tag groups observed in carcass recoveries or seen at the trap. Ages were assigned based on age-FL (cm) keys developed for hatchery-origin (634 ages 3-5 based on CWT data) and natural-origin (228 ages 3-5) returns to Lookingglass Creek from 2002-2008. Hatchery-origin returns <61 cm FL were assigned age 3, from 61-85 cm FL age 4, and >85 cm FL age 5. Natural-origin returns <60 cm FL were assigned age 3, 60-79 cm FL age 4, and >79 cm FL age 5. Smolt-to-adult (SAR) ratio was estimated for a brood year by summing the returns at ages 3-4-5 and dividing by the number of outmigrants surviving to Lower Granite Dam.

Snouts and biological data were collected from carcasses and sent to the ODFW CWT laboratory in Clackamas, OR for recovery of tags and posting of data on the Regional Mark Processing Center database maintained by the Pacific States Marine Fisheries Commission (http://www.rmpc.org/). CWT data were used to aid in run reconstruction.

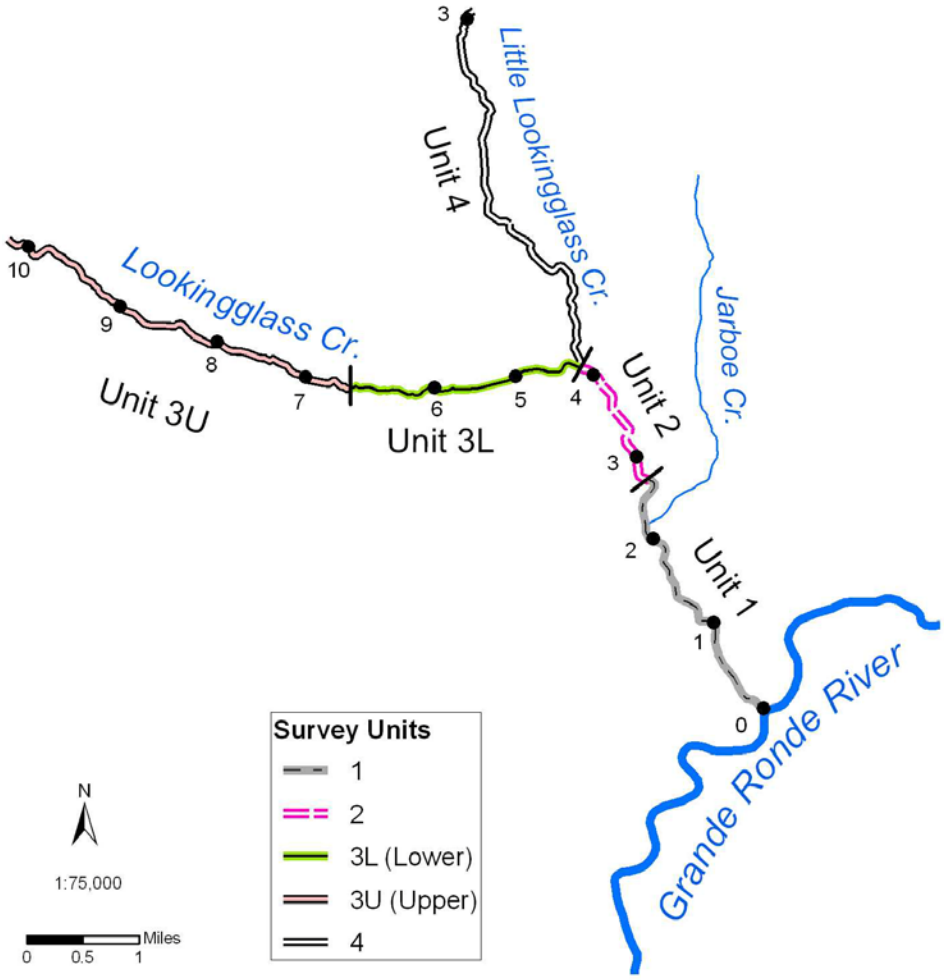


Figure 2. Spawning ground survey unit designations and river miles for Lookingglass Creek (modified from Burck 1993).

1.4.3 Juvenile Spring Chinook Salmon

Parr (designated as the "field group") were collected by snorkeling/seining in primary spawning and nursery areas above LH in Lookingglass Creek (approximately rm 3-10) during August 2006. Parr were measured (mm FL), weighed (0.1 g), PIT-tagged according to standard procedures (PIT Tag Steering Committee 1999) and released where collected. Life history for the field group was compared to groups of parr collected during similar periods with similar methods and PIT-tagged by ODFW in the Minam and Lostine Rivers and Catherine Creek (Jonasson et al. 2006).

We operated a 1.52 m diameter rotary screw trap (Roper and Scarnecchia 1996) at rm 2.4 on Lookingglass Creek to collect outmigrating naturally-produced juvenile spring Chinook salmon. The screw trap is located about 300 ft downstream from the LH adult trap and 800 ft upstream of the release point for the LH ponds We moved the trap from rm 0.1 near the mouth of Lookingglass Creek to the present location on 13 July 2005. The screw trap was operated continuously during 2005 and 2006 except for brief periods during high flows or in midwinter or midsummer when few fish were outmigrating. Branches and sticks occasionally became lodged in the trap and caused the cone to stop turning. The trap was usually checked 3 times per week or more frequently if catches or flows were high.

All spring Chinook salmon collected in the screw trap were counted, examined for external marks, scanned with a PIT tag reader, measured (mm FL), and weighed (0.1 g). Untagged outmigrants were either PIT-tagged according to standard procedures (PIT Tag Steering Committee 1999) or marked with a lower caudal fin clip and released about 100 m above the trap to estimate trap efficiency. Recaptures of field group parr PIT-tagged and released in August 2005 were marked with a lower caudal fin clip to avoid multiple recaptures.

Naturally-produced (unclipped) outmigrating juvenile spring Chinook salmon collected in the screw trap could be placed into groups based on size or date of capture. Naturally-produced BY 2004 fish caught prior to 24 August 2005 were uncommon and too small to PIT tag or use for trap efficiency estimates. The fall group of natural-origin BY 2004 fish was caught, PIT-tagged and released from 24 August 2005-30 September-2005, the winter group from 1 October 2005-31 December 2005, and the spring group from 1 January 2006-26 May 2006. BY 2004 fish caught during these periods were usually 60-100 mm FL. We used DARR 2.0 (Bjorkstedt 2005) to estimate the numbers of outmigrating BY 2004 natural-origin spring Chinook juveniles. 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 available in DARR 2.0. BY 2005 naturally-produced juveniles caught prior to 26 May 2006 were uncommon, and much smaller than those from BY 2004. Production and performance of BY 2005 natural-origin spring Chinook salmon will be described in the 2007 annual report.

A total of 140,675 BY 2004 hatchery-reared (ad-clipped and with CWT) juveniles were released from two ponds at Lookingglass Hatchery. Fish from one pond totaled 71,983; approximately 19,038 were volitionally-released as part of an experiment from 21 September-6 November 2005. An unknown number of PIT-tagged fish left during the fall volitional release period. Two-hundred and seventy-three seined from the stream below the hatchery, PIT-tagged and released (Fred Monzyk, personal communication). Remaining fish from this pond were released from 17 March-5 April 2006. The total number of fish PIT-tagged from this pond was 967 (694 in October 2005 plus 273 seined from the stream). The 17 March-5 April 2006 (volitional release followed by forceout of remaining fish) release from the other pond totaled 68,692; 492 were PIT-tagged in October 2005.

Survival and capture probabilities, travel time, and arrival timing to Lower Granite Dam for the four PIT-tagged groups of BY 2004 natural-origin and the 17 March 2006-5 April 2006 release group of hatchery-origin juvenile spring Chinook salmon were estimated using tagging and observation data from the PIT tag database maintained by the Pacific States Marine Fisheries Commission at http://www.ptagis.org/ and PitPro software (Westhagen and Skalski 2006). We used the standard configuration, and excluded the *.rcp file in PitPro. 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). We estimated arrival timing at Lower Granite Dam using daily PIT tag detections 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.

We monitored seasonal growth of natural-origin juvenile spring Chinook by measuring FL (mm) of 50 fish collected by snorkeling/seining at several locations (rm 0.25, 2.5, 5.5, and 7.0) above and below the Lookingglass Hatchery trap during June-September 2006. Collections were made on the 20th of each month +/- 5 d. Burck (1993) collected data for the endemic stock using similar methods during 1965-1969.

1.5 Results

1.5.1 Stream Flow and Temperature

Mean daily flows of 63-99 CFS during January-March 2006 alternated with spikes of 100-204 CFS lasting for 4-19 d resulting from warm weather or precipitation (Figure 3). The spring freshet occurred from about 24 March through 25 June and resulted in flows of 117-693 cubic feet per second (CFS). Maximum flow occurred on 20 May and flows returned to base levels near 50-60 CFS during August-October.

Water temperatures at the USGS site began rapidly increasing in May (Figure 4). Daily maximum temperatures of 18-19°C occurred on 25-27 June and 20-28 July and the highest daily maximum temperature of 19.3°C was recorded on 27 June. Daily maximum temperatures exceeded 16 °C on 26 days from 19 July-20 August. Data were not available for 28 June-18 July due to recorder malfunction. Daily maximum temperatures at the Eagle Creek site peaked at 11.8°C on 9 dates from 14 July-24 July (Figure 5).

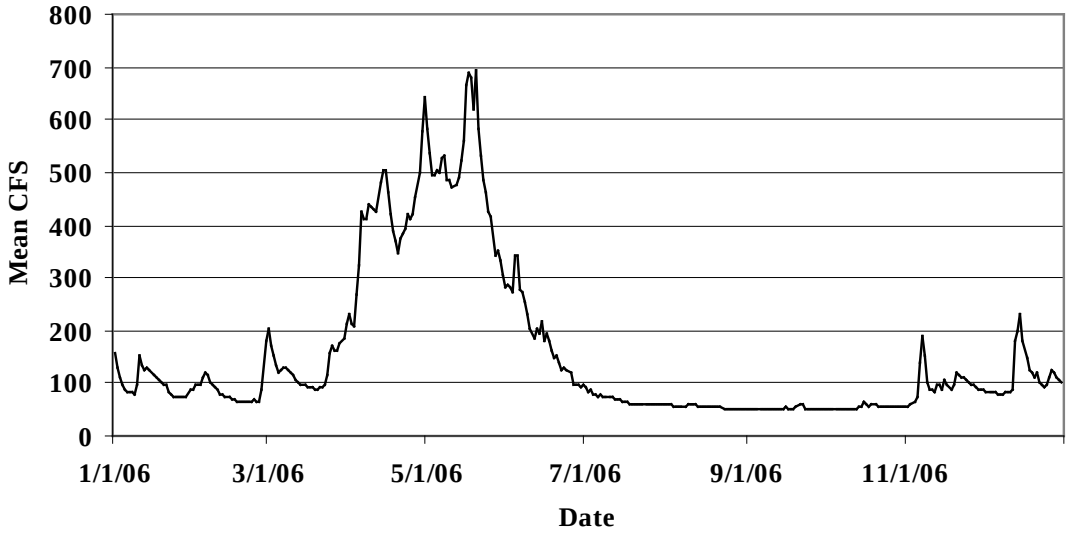


Figure 3. Mean daily streamflows for Lookingglass Creek at the USGS gauging station near Lookingglass Hatchery, 2006.

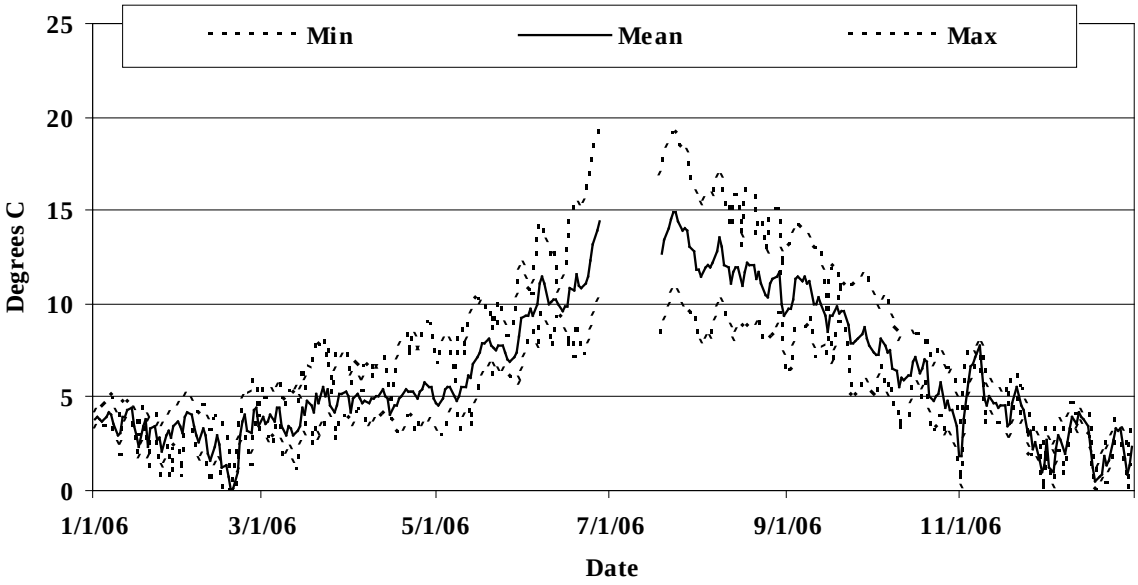


Figure 4. Water temperatures in Lookingglass Creek at the USGS gauging station, 2006.

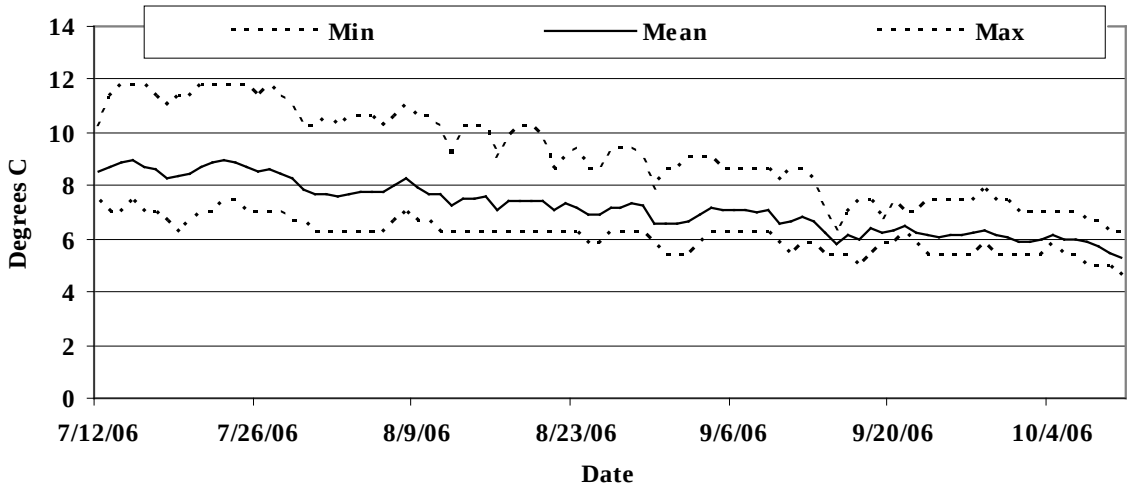


Figure 5. Water temperatures in Lookingglass Creek at the Umatilla National Forest site near the mouth of Eagle Creek, 2006.

1.5.2 Adult Spring Chinook Salmon

The Lookingglass Hatchery adult trap operated continuously during 2006 from 8 March-22 September, except for brief periods of 1-2 d during the spring freshet in April and May. A barrier weir installed at a ford about 0.4 rm upstream of the intake trap in late July prevented carcasses from drifting downstream and collecting near the hatchery water supply intake.

A total of 94 adults (32 females, 62 males) was collected (Figure 6). Most were caught in June and early July, with a few in August as spawning activity began. FL ranged from 39-94 cm, with most in the 61-75 cm groups (Figure 7). The first ad-clipped adult was collected on 12 June and the first unclipped on 14 June. The last ad-clipped and unclipped adults were collected on 28 August.

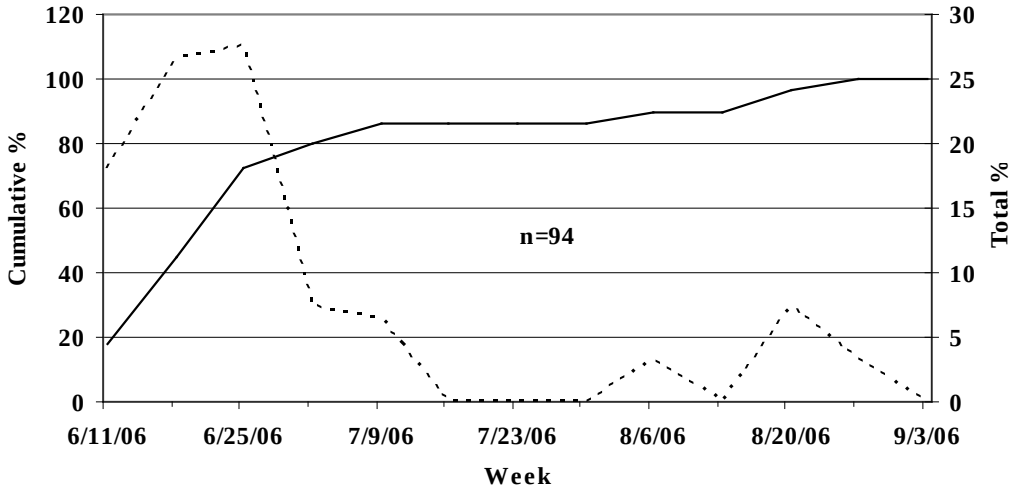


Figure 6. Total % (dashed line) and cumulative % (solid line) of catch by week for spring Chinook salmon in the Lookingglass Hatchery trap, 2006.

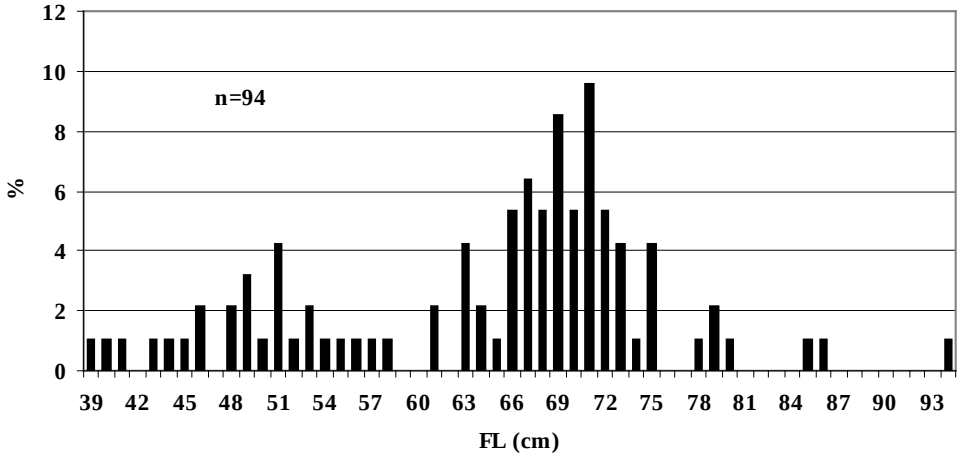


Figure 7. FL frequency for spring Chinook salmon caught in the Lookingglass Hatchery trap, 2006.

1.5.2.1 Unclipped

Unclipped returns totaled 28. Sixteen unmarked returns (no ad clips, CWT or VIE tags) assumed to be naturalized Rapid River stock were caught from 14 June-7 August (Figure 8). Two (63, 69 cm FL) were females and the rest males (Figure 9). Twelve unclipped with CWT (upper Grande Ronde River conventional broodstock progeny; 8 males, 4 females) from 65-79 cm FL were collected from 23 June-28 August, held in ponds at Lookingglass Hatchery and later spawned

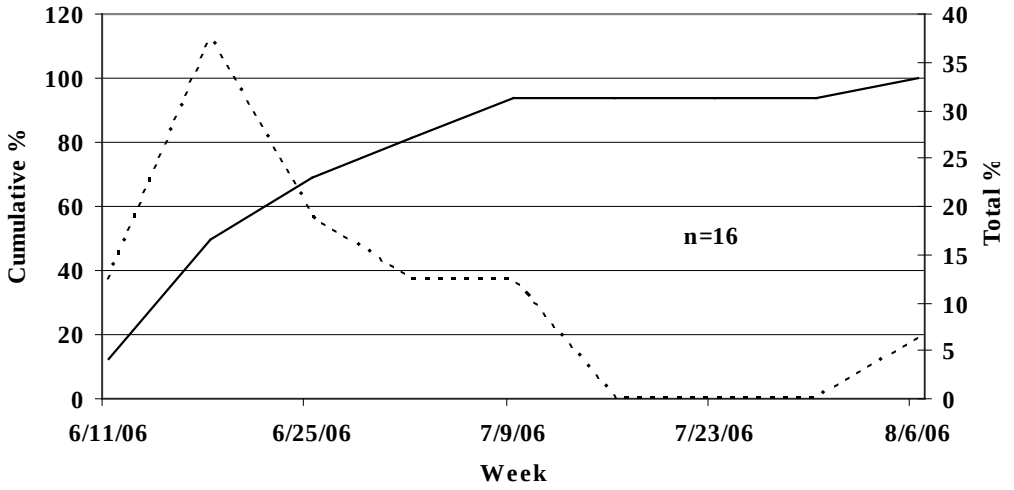


Figure 8. Total % (dashed line) and cumulative % (solid line) of total catch by week for unclipped (Rapid River stock) spring Chinook salmon caught in the Lookingglass Hatchery trap, 2006.

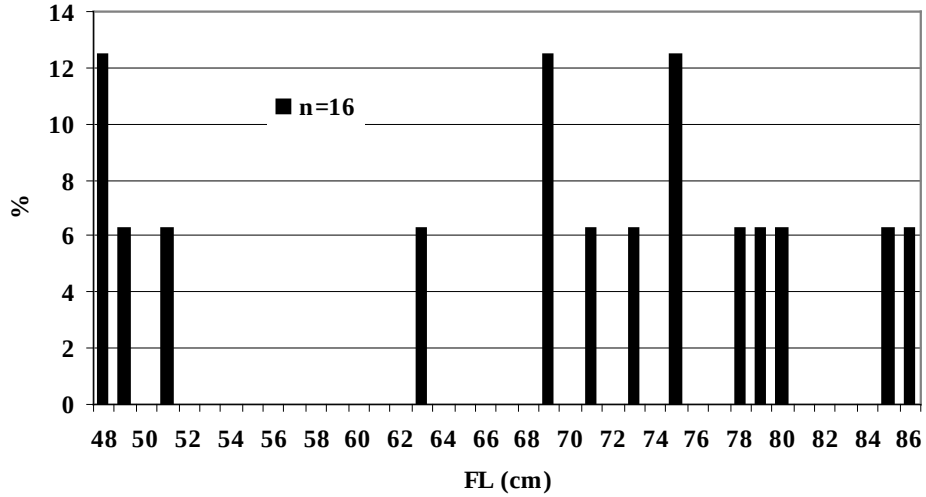


Figure 9. FL frequency for unclipped (Rapid River stock) male spring Chinook salmon caught in the Lookingglass Hatchery trap, 2006.

1.5.2.2 Ad-clipped

A total of 66 ad-clipped adults (26 females, 40 males) were collected from 12 June-28 August (Figure 10). The length frequency ranged from 40-94 cm and was dominated by the 61-75 cm groups (Figure 11). Catherine Creek captive broodstock progeny to be outplanted above the trap to spawn naturally totaled 47; 16 from 39-61 cm FL and presumed to be males were euthanized to stay within the management goal of ≤ 10

percent age 3 on the spawning grounds. Three returns were ad-clipped with CWT and a VIE tag and kept for use as Catherine Creek broodstock. Most of the ad-clipped adults outplanted above the trap were also in the 61-75 cm FL groups (Figure 12).

Adults to be outplanted that were collected before 23 June 2006 were held in a pond at Lookingglass Hatchery, and released at rm 7 in Lookingglass Creek on 3 August 2006. Any Catherine Creek captive broodstock progeny caught after 23 June 2006 were immediately passed above the barrier weir at the ford (0.4 rm above the trap) or taken to the Umatilla National Forest 62 bridge (1.3 rm above the trap) and released.

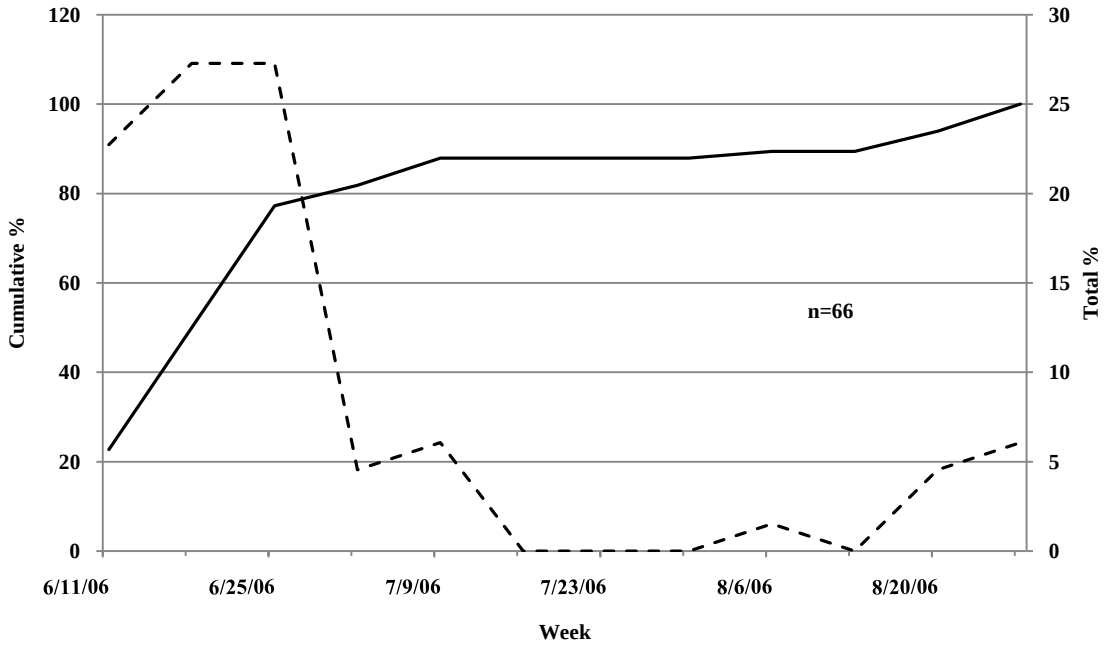


Figure 10. Total % (dashed line) and cumulative % (solid line) of total catch by week for ad-clipped Catherine creek stock spring Chinook salmon caught in the Lookingglass Hatchery trap, 2006.

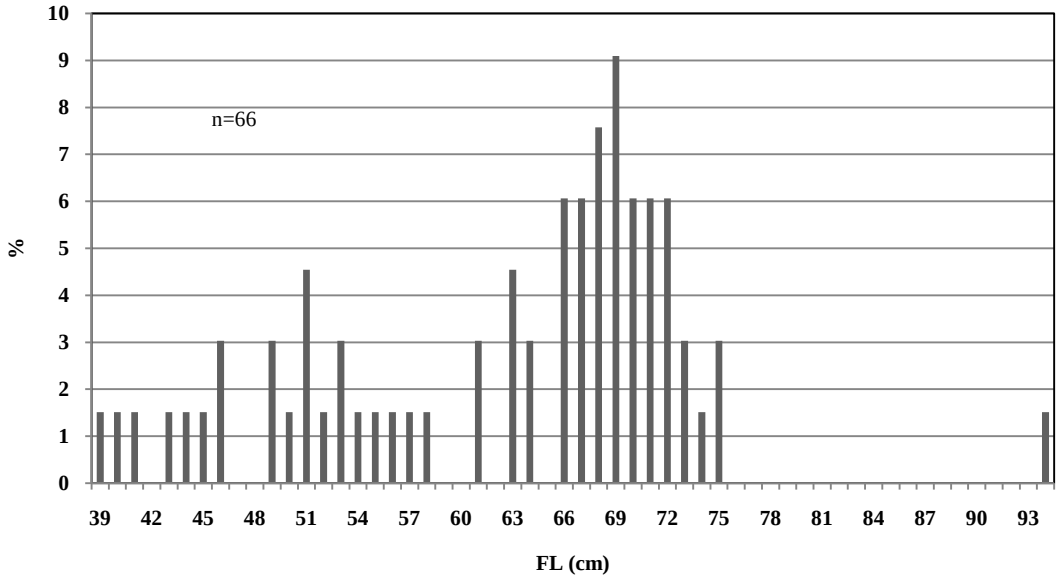


Figure 11. FL frequency for ad-clipped Catherine Creek stock spring Chinook salmon caught in the Lookingglass Hatchery trap, 2006.

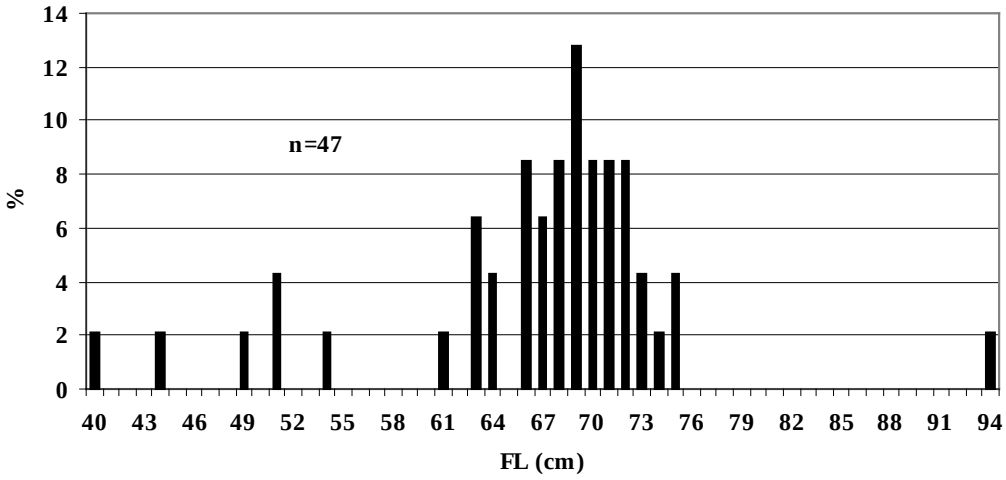


Figure 12. FL frequency for ad-clipped Catherine Creek stock spring Chinook salmon outplanted above the Lookingglass Hatchery trap, 2006.

1.5.2.3 Spawning Ground Surveys

Spawning ground surveys were completed on the various units from 3-7 times during 10 August-18 September. Equal numbers of redds (28) were observed above and below the Lookingglass Hatchery trap (Figure 13). The first redds were observed on 17 August and

the last on 13 September. The largest number of new redds (20, above trap and below trap combined) was observed during the 7-8 September survey. The surveys yielding the highest number of new redds below the trap occurred on 7-9 September (12) and above the trap on 31 August-1 September (11). Weather and visibility conditions were generally excellent during the survey period. Fish per redd above the Lookingglass Hatchery trap was 1.68.

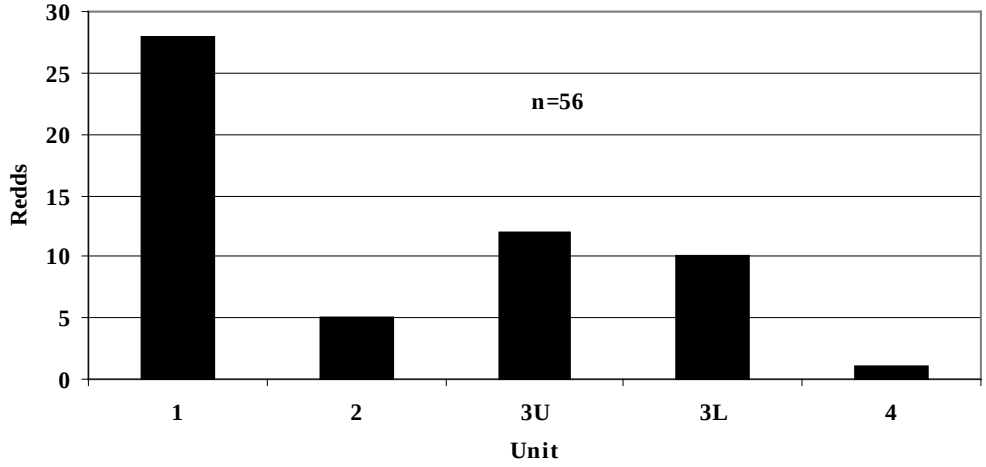


Figure 13. Spring Chinook salmon redds by unit, Lookingglass Creek, 2006.

1.5.2.4 Carcass Recoveries

Carcass recoveries on spawning ground surveys totaled 33, including 15 above the hatchery weir and 18 below (Table 2). Two carcasses recovered in Unit 1 were badly decomposed and no FL, sex, or mark data could be collected. Five additional carcasses (three from the rotary screw trap below the weir and two from the adult trap) were included in Table 2.

FL (cm) of carcasses ranged from 50-91 cm FL (Figure 14). Hatchery females ranged from 62-74 cm FL and natural (unclipped) females from 66-87 cm FL. Hatchery males ranged from 59-91 cm FL and natural (unclipped) males from 50-90 cm FL. Carcasses of hatchery females were 95-100% spawned (n=10), 0% (n=1 prespawn mortality), or unknown (n=2). The ad-clipped female prespawning mortality was recovered on the barrier weir on 10 July. Natural females were all 100% spawned out (n=7). Remaining ad-clipped female carcasses were recovered on 6-7 September (n=4), 13-14 September (n=6), and 18, 22 September (n=2). Unclipped female carcasses were recovered on 5 and 7-8 September (n=6) and 13 September (n=1). Snouts were taken from 29 carcasses.

Table 2. Carcass recovery summary* for spring Chinook salmon, Lookingglass Creek, 2006.

	Unit				
	1	2	3L	3U	Totals
Females	10	3	2	5	20
Ad-clip/OP punch	2	3	1	3	9
Ad-clip/no OP punch	2			2	4
No ad-clip/OP punch					
No ad-clip/no OP punch	6		1		7
Males	9	4		1	14
Ad-clip/OP punch	5*	3		1	9
Ad-clip/no OP punch		1			1
No ad-clip/OP punch	1				1
No ad-clip/no OP punch	3				3

**excludes 2 badly decomposed carcasses recovered in Unit 1 without FL, sex, or mark data*
[a] includes 2 caught in the Lookingglass Hatchery adult trap and euthanized
[b] includes 3 caught in the Lookingglass Creek screw trap and euthanized

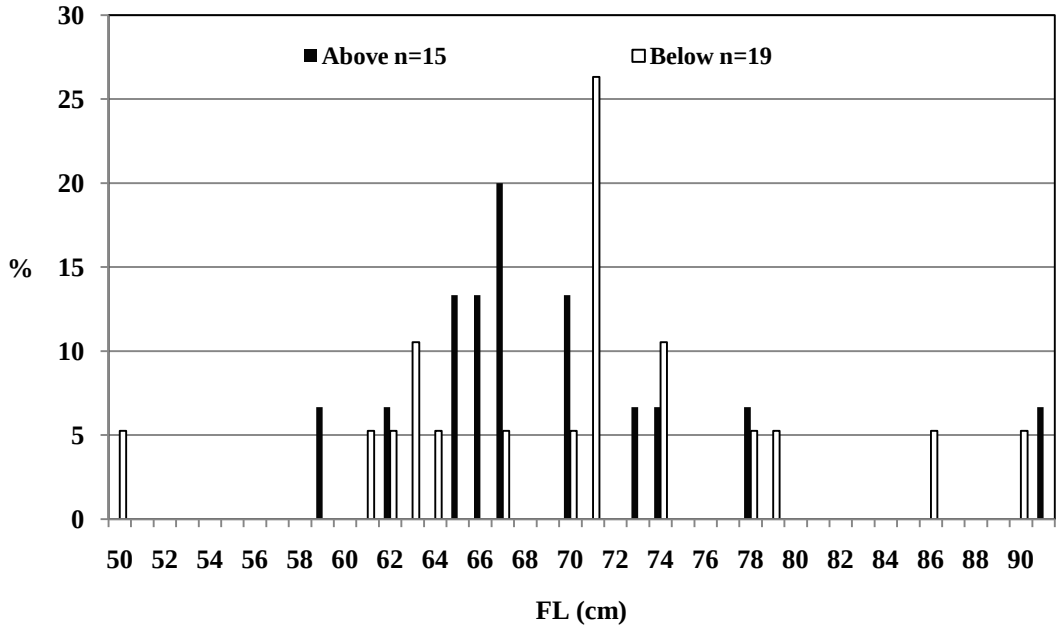


Figure 14. FL frequency for spring Chinook salmon carcasses recovered above and below the Lookingglass Hatchery trap on spawning ground surveys, 2006.

The presence of spawners above the weir without opercle punches and below the weir with opercle punches meant that there was some degree of movement between the two areas and that the hatchery and barrier weirs were not 100% effective. Alternatively, some, but probably not all, carcasses may have been misidentified by surveyors. Carcasses recovered above the hatchery and barrier weirs probably spawned in Units 2, 3U and 3L, but carcasses recovered in Unit 1 may have drifted over the weir after spawning in units upstream.

The 29 snouts were collected from above (n=14) and below (n=15) the hatchery weir. Nine codes were represented in the raw coded wire tag recoveries and two BY 2002 codes released in Lookingglass Creek in 2004 dominated (Table 3). Twenty-six were tag status "1" (tag read OK) and 3 were tag status "2" (no tag). The 16 adults euthanized at the trap ranged from 40-61 cm FL and snouts from 15 were read; 6 were tag status "1", 8 were tag status "2" and 1 was tag status "3" (tag lost before read). CWT were primarily from BY 2002 Catherine Creek stock released at LH (Table 2).

Table 3. Spring Chinook salmon carcass recoveries (raw tag recoveries) by brood year, stock, coded wire tag code, and release location recovered on spawning ground surveys above, below and at the Lookingglass Hatchery trap, 2006.

BY	Stock	Tag Code	Release Location	Above	At Trap	Below
2003	CC/LKG	93824	LOOH		3	1
2003	LR	92348	LRAF		1	
2002	LR	93830	LRAF	1		
2002	UGR	93833	UGRAF	3		1
2002	CC	93836	CCAF			1
2002	CC/LKG	93837	LOOH	2	1	2
2002	CC/LKG	93838	LOOH	5	1	7
2002	CC	93840	CCAF	1		1
2001	UGR	93549	UGRAF	1		
			Totals	13	6	13

CC=Catherine Creek, UGR=upper Grande Ronde River, LR=Lostine River, CC/LKG= Catherine Creek captive broodstock progeny released into Lookingglass Creek, LOOH=Lookingglass Hatchery, LRAF=Lostine R. acclimation facility, UGRAF=upper Grande Ronde R. acclimation facility, CCAF=Catherine Creek acclimation facility.

1.5.2.5 Total Returns to the Stream

Estimating total returns to the stream presented a challenge. The number of fish spawning below the trap had to be estimated from the number of redds observed and what we believe to be a reasonable spawner/redd value. A known number of opercle-punched returns were released above the trap to spawn naturally. We assumed that

movement of opercle-punched spawners below and non-opercle punched spawners above the weir were similar. Therefore the total spawners above and below the hatchery weir are 47 (outplants above the hatchery weir) plus the product of redds below the hatchery weir (28) and 2.5 spawners/redd or 70. Added to these are the returns that were euthanized at the trap or retained for use in other broodstock programs at LH.
We assigned age groups to returns by FL (cm) group using separate age-FL (cm) keys for hatchery- and natural-origin returns. We separated stock of origin and rearing type using the presence or absence visual marks (ad-clip, VIE tag) and coded wire tags.

The estimated total returns to Lookingglass Creek in 2006 were 164. Age 3 made up 27.4%, age 4 67.7%, and age 5 4.9%. Hatchery-origin returns dominated and most of these were ad-clipped age 4 Catherine Creek captive broodstock progeny released into Lookingglass Creek (Table 4). Some of the ad-clipped age 3 fish without CWT or VIE were probably Catherine Creek stock returns, since 31,445 released in 2005 at the Catherine Creek acclimation facility were marked with just an adipose clip. Unclipped age 4 returns with CWT were from upper Grande Ronde River conventional broodstock released from the acclimation site on the upper Grande Ronde River (Table 5). Naturalized Rapid River stock (no clips, marks, or tags) returns were 28 or 17.1% of the total and were dominated by age 4 (Table 6). The estimate of naturalized Rapid River stock returns may have included unmarked strays from other streams. The estimated expanded returns by CWT code were dominated by Catherine Creek captive broodstock tag groups released into Lookingglass Creek (Table 7).

The smolt-to-adult ratio for unmarked (natural-origin) BY 2001 returns was 2.06% (38 returns of 1,844 smolts. The natural-origin smolt number was obtained by correcting the outmigrant estimate for survival to Lower Granite Dam. There were no recoveries for presmolt BY 2001 Catherine Creek stock released in Lookingglass Creek in May 2002 (tag code 93506).

Table 4. Catch at the Lookingglass Hatchery trap (LHT), disposition, and estimated total returns for hatchery-reared adipose-clipped spring Chinook salmon, 2006*.

Stock/Rear[a]	Age	LHT[b]	Euthanized	Sp Ab-LHT[c]	Sp LH[d]	Sp Bel-LHT[e]	Total Returns
CC/LKG	3	22	16	6		16	38
Age 3 %		33.3					
CC-Co	4	3			3	2	5
CC/LKG	4	39		39		30	69
Totals		42		39	3	32	74
Age 4 %		63.6					
CC/LKG	5	2		2		1	3
Totals		2		2		1	3
Age 5 %		3.0					

** Rounded to nearest whole number*

[a] CC/LKG= Catherine Creek captive broodstock progeny released into Lookingglass Creek

[b] LHT= assignment after capture at Lookingglass Hatchery trap

[c] Spawn Ab-LHT=released above the Lookingglass Hatchery trap to spawn naturally

[d] Spawn LH=conventional broodstock spawned at Lookingglass Hatchery

[e] Spawn Bel-LHT=estimated spawners in the 2.4 mi reach below Lookingglass Hatchery, from reddsx2.5 fish/redd and catch by age, mark, and release group at the Lookingglass Hatchery trap

Table 5. Catch at the Lookingglass Hatchery trap (LHT), disposition, and estimated total returns for hatchery-reared coded wire tagged only (adipose fin intact) spring Chinook salmon, 2006*.

Stock/Rear[a]	Age	LHT[b]	Spawn LH[c]	Spawn Bel-LHT[d]	Total Returns
UGR-Co	4	12	12	9	21
Totals		12	12	9	21

** Rounded to nearest whole number*

[a] *UGR=upper Grande Ronde River, Co=conventional broodstock progeny*

[b] *LHT= assignment after capture at Lookingglass Hatchery trap*

[c] *Spawn LH=conventional broodstock spawned at Lookingglass Hatchery*

[d] *Spawn Bel-LHT=estimated spawners in the 2.4 mi reach below Lookingglass Hatchery, from redds x2.5 fish/redd and catch by age, mark, and release group at the Lookingglass Hatchery trap*

Table 6. Catch at the Lookingglass Hatchery trap (LHT), disposition, and estimated total returns for unmarked (natural-origin) spring Chinook salmon, 2006*.

Age	LHT[a]	Euthanized	Sp Bel-LHT[b]	Total Returns
3	4	4	3	7
Age 3 Totals	4	4	3	7
Age 3 %	25.0			
4	9	9	7	16
Age 4 Totals	9	9	7	16
Age 4 %	56.3			
5	3	3	2	5
Age 5 Totals	3	3	2	5
Age 5 %	18.8			

** Rounded to nearest whole number*
[a]LHT=assignment after capture at Lookingglass Hatchery trap
[b]Spawn Ab-LHT=released above the Lookingglass Hatchery trap to spawn naturally
[c]Spawn Bel-LHT=estimated spawners in the 2.4 mi reach below Lookingglass Hatchery, from reddsx2.5 fish/redd and catch by age, mark, and release group at the Lookingglass Hatchery trap

Table 7. Estimated CWT returns (tag status codes "1" and 2, expanded) for hatchery-origin spring Chinook salmon, Lookingglass Creek, 2006.

BY	Stock[a]	Brood Type[b]	Tag Code	Euthanized	Spawn Ab-LHT[c]	Spawn LH[d]	Spawn Bel-LHT[e]	Totals
2003	LOS	Capt	92348	1			2	3
	CC(LKG)	Conv	93824	5	3		5	13
Tag status "2"				8	3		9	20
BY 2003 Totals				14	6		16	36
2002	LOS	Conv	93830		2			2
	GR	Conv	93833		6	12	9	27
	CC	Capt	93836		2			2
	CC(LKG)	Capt	93837	1	6		5	12
	CC(LKG)	Capt	93838	1	18		20	39
	CC	Conv	93840		4	3	2	9
Tag status "2"					2		5	7
BY 2002 Totals				2	40	15	41	98
2001	GR	Conv	93549		1		1	2
BY 2001 Totals					1		1	2

[a] LOS=Lostine R., CC=Catherine Creek, CC(LKG)= Catherine Creek captive broodstock progeny released into Lookingglass Creek, GR=upper Grande Ronde;

[b] Capt=Captive broodstock progeny, Conv=Conventional broodstock progeny;

[c] Spawn Ab-LHT=spawned naturally above the Lookingglass Hatchery;

[d] Spawn LH=conventional broodstock spawned at Lookingglass Hatchery;

[e] Spawn Bel-LHT=estimated spawners in the 2.4 mi reach below Lookingglass Hatchery, from reddsx2.5 fish/redd and catch by age, mark, and release group at the Lookingglass Hatchery trap

1.5.2.6 Length and Age at Recovery

Hatchery-origin males at ages 3 and 5 had greater mean FL than natural-origin, but the reverse occurred for age 4 (Table 8). One ad-clipped age 3 male may have had an erroneous FL recorded (745 mm), however, excluding this fish still resulted in a mean FL 32 mm greater for hatchery-origin. Age 4 females of both origins had similar mean FL.

Table 8. Summary of FL and age at recovery summary by origin and sex for spring Chinook salmon caught at the Lookingglass Hatchery trap or recovered on spawning ground surveys, 2006.

Origin	Sex	Age	$\bar{X}$ FL	Range	SE	n
Natural*	M	3	496.8	485-515	6.4	4
Hatchery**	M	3	571.6	475-745	46.2	5
Natural	M	4	754.2	710-791	13.1	5
Hatchery	M	4	667.0	595-782	20.0	12
Natural	M	5	841.7	795-870	23.5	3
Hatchery	M	5	919			1
Natural	F	4	680.5	666-695	14.5	2
Hatchery	F	4	680.0	620-745	10.2	14

** Natural=unmarked*
*** Hatchery=ad-clipped or unclipped with CWT*

1.5.3 Juvenile Spring Chinook Salmon

1.5.3.1 Brood Year 2004 Natural Production

The rotary screw trap was operated continuously during the outmigration period for juvenile spring Chinook salmon (essentially June 2005-May 2006), with some exceptions. On 12 July 2005, the trap was moved from the previous location near the mouth of Lookingglass Creek to about 100 m below the Lookingglass Hatchery adult trap. Trapping began again on 13 July 2005. The trap was not operated on the following days for each month: July 2005 (10); August 2005 (12); November 2005 (1); December 2005 (2); January 2006 (1); February 2006 (8); March 2006 (6); April 2006 (3); May 2006 (14).

Seven BY 2004 fry from 49-60 mm FL were caught from 6 June 2005-1 July 2005 but were not used for trap efficiency estimates or PIT tagged. Substantial numbers of presmolts were caught beginning on 11 September 2005 following a rainfall event. Catches remained high through the end of November 2005, with a slight decrease during the last two weeks of October. Spring 2006 (Jan E-May L) catches were much lower than the fall of 2005 (Aug E-Oct L).

The total number of new (first-time) captures used in the outmigration estimate was 1,223, including 42 that were measured only and 323 that were counted only before release below the screw trap and 11 mortalities. Newly-PIT tagged outmigrants totaled 726. A partial lower caudal clip was given as a trap efficiency mark to 121 outmigrants marked and released from 5 August-7 October. Recaptures of field group parr PIT-tagged in August 2005 were also used for trap efficiency estimates (48 of 49 total recaptures). The excluded field group recapture was not caught in the screw trap for the first time until 25 August 2006.

The total number of trap efficiency PIT tag recaptures was 107, including 7 from the field group and 1 mortality. Ninety-one percent of PIT-tagged juveniles released for trap efficiency were recaptured within 5 days. The longest elapsed time between release and recapture was 18 days (n=1). Fin clip trap efficiency recaptures totaled 11.

Data were grouped into 8 periods to use in DARR 2.0; 1 August-15 September 2005 (Aug E-Sept E), 16-30 September 2005 (Sept L), 1-14 October 2005 (Oct E), 15-31 October 2005 (Oct L), 1-15 November 2005 (Nov E), 16 November-31 December 2005 (Nov L-Dec L), 1 January-31 March 2006 (Jan E-Mar L), and 1 April-26 May 2006 (Apr E-May L). DARR 2.0 reduced these to 7 periods (combining the Oct E and Oct L periods for the estimate of 11,927 with SE 1,815 (Table 9). BY 2004 outmigrants per redd were 243 (11,927/49).

Table 9. Naturally-produced BY 2004 juvenile spring Chinook salmon captured in the Lookingglass Creek rotary screw trap, releases and recaptures from trap efficiency tests, estimated number of outmigrants and standard errs (SE), migration year (MY) 2006.

Period	u	m	r	C_p	N	SE
Aug E-Sep E	270	266	39	0.214	1,260	515
Sept L	227	222	13	0.062	3,632	1,475
Oct E-Oct L	227	124	5	0.048	4,691	1,867
Nov E	336	122	41	0.657	512	367
Nov L-Dec L	102	57	7	0.123	831	293
Jan E-Mar L	56	55	5	0.091	616	262
Apr E-May L	54	50	7	0.14	386	134
MY 2006 Totals	1,272	896	118		11,927	1,815

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=standard error(variance$^{0.5}$)

1.5.3.2 Brood Year 2004 Hatchery Production

A total of 122,426 ad-clipped BY 2004 progeny of Catherine Creek captive broodstock were released from two rearing ponds at Lookingglass Hatchery into Lookingglass Creek during 2005-2006. An experimental volitional release from one pond occurred from 12 September 2005-16 November 2005 (Fred Monzyk, personal communication). Some of these were seined from the stream below the pond outfall, PIT-tagged and released. Volitional release of the remainder of that pond occurred until forceout on 5 April 2006. Volitional release from the second pond began on 17 March 2006 with forceout on 5 April 2006.

1.5.3.3 Brood Year 2004 Life History

Totals of 726 natural-origin and 492 hatchery-origin juvenile spring Chinook salmon were PIT-tagged and used to describe life history. Median tagging dates for the natural-origin groups were 14 September 2005, 1 November 2005, and 31 March 2006, respectively. Mean FL increased the later the release group for natural-origin groups (Table 10). Mean FL for the hatchery group was 2.1 mm greater than for the spring 2006 natural-origin group. Mean K values varied by 0.05 between the three natural-origin groups. Mean K for the hatchery-origin group was 0.14-0.19 higher than any of the natural-origin groups.

Table 10. Mean FL, weight, and K factor summary for BY 2004 naturally-produced spring Chinook salmon for fall 2005 (tagged 24 August 2005-28 September 2005), winter 2005 (tagged 3 October 2005-28 December 2005), spring 2006 (tagged 5 January 2006-26 May 2006) and hatchery (released 17 March-5 April 2006) groups, Lookingglass Creek.

	Group			
Statistic	Fall 2005	Winter 2005	Spring 2006	Hatchery
Mean FL (mm)	84.7	88.8	94.6	96.7
SE	0.4	0.5	1.2	0.5
Min-Max	66-114	71-112	73-150	72-114
n	357	262	104	205
Mean Weight (g)	6.9	7.6	9.7	11.8
SE	0.1	0.1	0.4	0.4
Min-Max	3.1-14.7	3.8-16.0	3.6-33.5	6.2-17.8
n	351	260	99	53
Mean K	1.12	1.07	1.09	1.26
SE	0.005	0.01	0.01	0.02
Min-Max	0.77-1.62	0.82-1.50	0.89-1.35	0.91-1.58
n	250	260	99	53

Survival probability to Lower Granite Dam for the spring 2006 natural-origin group was more than double the rate of the fall 2005 and winter 2005 groups and slightly less than the hatchery group (Table 11). Capture probabilities were similar for all four groups. Median arrival date at Lower Granite Dam differed by only 1 d between the fall 2005 and winter 2005 groups. Median arrival date for the spring 2006 group was 15-16 d later than either the fall or winter 2005 groups and 6 d later than the hatchery group.

Table 11. Survival and capture probabilities, travel time, and arrival timing to Lower Granite Dam of BY 2004 naturally-produced spring Chinook salmon for fall 2005 (tagged 24 August 2005-30 September 2005), winter 2005 (tagged 1 October 2005-28 December 2005), spring 2006 (tagged 4 January 2006-26 May 2006) and hatchery (released 17 March-5 April 2006) groups, Lookingglass Creek.

	Group			
Statistic	Fall 2005	Winter 2005	Spring 2006	Hatchery
Survival Probability	0.2250	0.2220	0.5728	0.6079
SE	0.0671	0.0376	0.0933	0.0504
n	360	262	104	492
Capture Probability	0.2593	0.2579	0.2881	0.2574
SE	0.0877	0.0656	0.0713	0.0317
n	21	15	17	77
Travel Time (d)	218.374	177.065	24.095	40.921
SE	2.738	5.214	4.745	2.194
n	21	15	17	77
Median Arrival Date	22 April 2006	23 April 2006	8 May 2006	2 May 2006
10%	14 April 2006	11 April 2006	17 April 2006	24 April 2006
90%	7 May 2006	17 May 2006	20 May 2006	14 May 2006
n	21	15	17	77
n (expanded)	41	28	36	134

1.5.3.4 Brood Year 2004 Field Groups

A total of 481 BY 2004 spring Chinook salmon parr were collected from several locations above the Lookingglass Hatchery trap during 9-12 August 2005, PIT-tagged and released. BY 2004 spring Chinook salmon parr were collected, PIT tagged and released using similar methods from Catherine Creek (14-29 July 2005), the Minam River (23-25 August 2005), and the Lostine River (9-12 August 2005). Mean FL, weight, and K were greater for Lookingglass Creek parr than other streams (Table 12). Survival probabilities to Lower Granite Dam varied more than two-fold between the four streams (Table 13). Capture probabilities were slightly higher for Lookingglass Creek. Harmonic mean travel time for Catherine Creek parr was substantially higher than for the

other streams. Median arrival dates at Lower Granite were identical for Lookingglass Creek and the Lostine River, and 11-19 d earlier than for Catherine Creek and the Lostine River.

Table 12. FL, weight, and K factor summary for field group natural-origin BY 2004 spring Chinook salmon from Grande Ronde Basin streams, MY 2006.

	Stream			
Statistic	Lookingglass Cr.	Catherine Cr.	Minam R.	Lostine R.
Mean FL (mm)	72.3	67.1	68.2	68.3
SE	0.3	0.3	0.2	0.3
Min-Max	59-92	54-150	52-89	49-100
n	481	503	1,007	1,104
Mean Weight (g)	5.2	3.7	3.3	4.2
SE	0.1	0.1	<0.1	0.1
Min-Max	1.6-10.2	1.8-39.7	1.5-7.9	1.4-12.2
n	481	501	526	335
Mean K	1.29	1.18	1.14	1.18
SE	0.01	0.004	0.005	0.005
Min-Max	0.73-1.97	0.80-1.54	0.82-1.74	0.89-1.54
n	481	501	526	335

Table 13. Survival and capture probabilities, travel time, and arrival timing to Lower Granite Dam summary for field group natural-origin BY 2004 spring Chinook salmon from Grande Ronde Basin streams, MY 2006.

	Stream			
Statistic	Lookingglass Cr.	Catherine Cr.	Minam R.	Lostine R.
Survival Probability	0.1227	0.0616	0.1529	0.1170
SE	0.0150	0.0188	0.0151	0.0125
n	481	503	1,007	1,105
Capture Probability	0.4407	0.2258	0.3248	0.2242
SE	0.0646	0.0939	0.0433	0.0397
n	26	7	50	29
Travel Time (d)	257.775	286.999	255.233	262.689
SE	2.245	3.518	1.788	2.528
n	26	7	50	29
Median Arrival Date	28 April 2006	16 May 2006	8 May 2006	28 April 2006
10%	10 April 2006	28 April 2006	22 April 2006	16 April 2006
90%	8 May 2006	19 May 2006	20 May 2006	16 May 2006
n	26	7	50	29
n (expanded)	49	14	94	56

All but one of the MY 2006 field group recaptures occurred during September-November 2005 (Figure 15). Days elapsed between release and recapture were 20-59 d (n=22), 80-109 d (n=24), 152 d (n=1), and 381 d (n=1). Recaptures of the field group were 10.2% of the total PIT tagged and released in August 2005. One was recaptured in the screw trap on 25 August 2006.

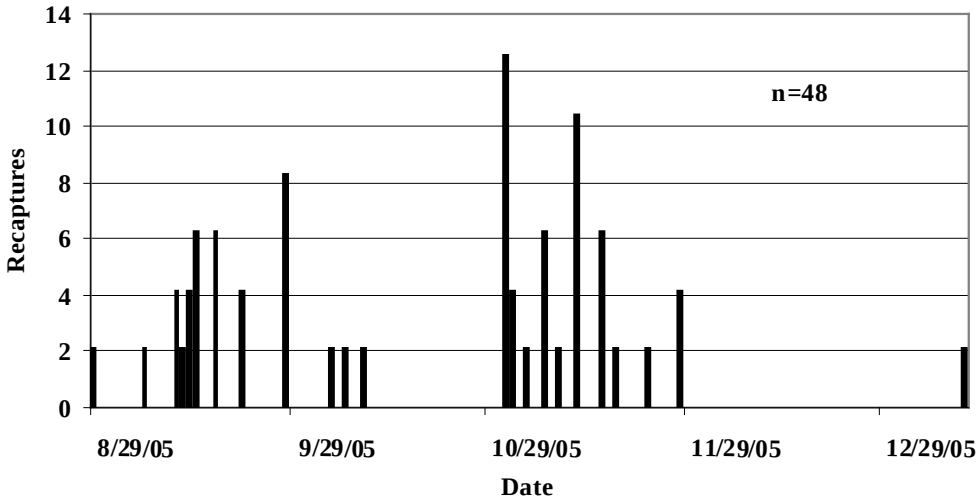


Figure 15. Recaptures of BY 2004 field group natural-origin juvenile spring Chinook salmon in the Lookingglass Creek screw trap by date, MY 2006 (excluding recapture on 25 August 2006).

1.5.3.5 Brood Year 2004 Growth

Mean FL of BY 2004 spring Chinook salmon parr collected at rm 5.5 (above the trap in the primary nursery area) was slightly less than those collected at rm 0.25 (near the mouth) for all four months sampled (Figures 16-17). Growth was approximately linear over June-September 2006 at both locations.

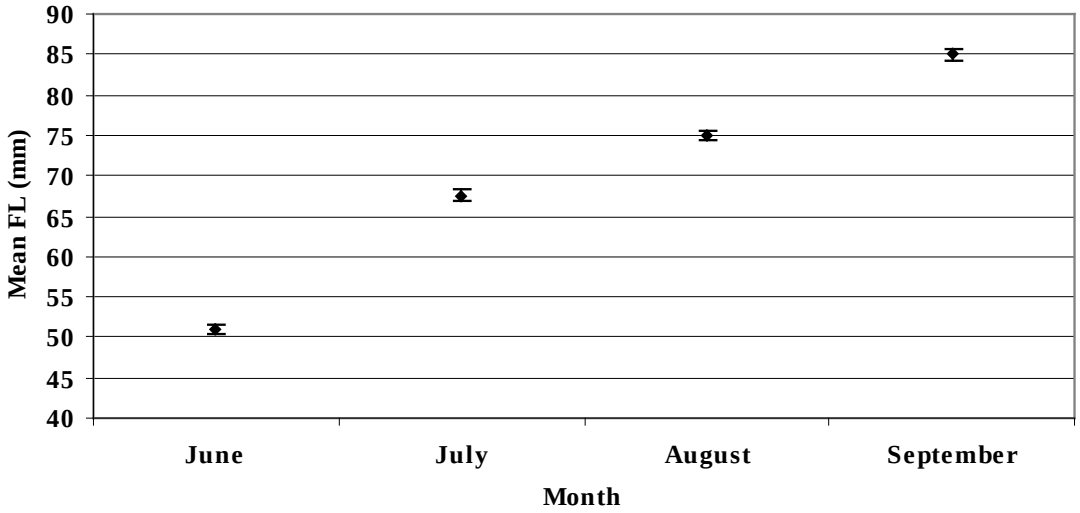


Figure 16. Mean FL (mm, +/- SE) for natural-origin BY 2004 juvenile spring Chinook salmon at rm 5.5, Lookingglass Creek, 2006.

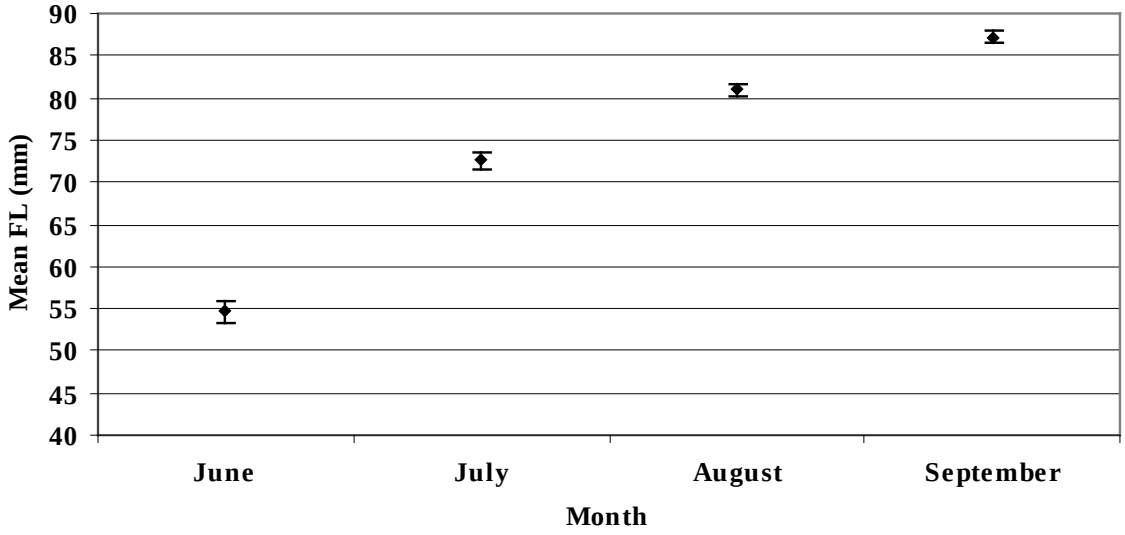


Figure 17. Mean FL (mm, +/- SE) for natural-origin BY 2004 juvenile spring Chinook salmon at rm 0.25, Lookingglass Creek, 2006.

1.6 Discussion

Stream flow conditions in Lookingglass Creek during 2006 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, or rainfall or warm weather during the winter. Passage and survival conditions in the Snake River-Columbia River migration corridor in 2006 were improved due to higher than normal runoff in both systems (DeHart 2007).

Water temperatures at the site below Eagle Creek were not in the ranges detrimental to adult migration or smoltification or that would increase disease risk (U. S. Environmental Protection Agency 2003). Temperatures at Eagle Creek were in the range where growth may have been sub-optimal under conditions of limited food. Maximum daily temperatures at the Lookingglass Hatchery site during July 2006 were often above 15^{o}C, in the range of impaired smoltification and increased disease risk.

Adult returns and juvenile production in 2006 reflected 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 releases. The first liberation of Catherine Creek juveniles was in September 2001, rather than the typical spring release that probably would have had better survival. The May 2002 release was almost a year early and 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 17,000-122,000 for brood years 2000-2004, with only one release (spring release of brood year 2004) over 62,000. Hatchery releases are currently limited by the low numbers of adult returns available for use as broodstock and rearing space.

Total BY 2004 juvenile production from adults spawning above the LH trap was 12-29% of the production from BY 1965-1969 (Burck 1993). Outmigrants per redd ranged from 230-493 (median 341) using data from Burck (1993). BY 2004 outmigrants per redd (243) for Catherine Creek stock spawning above the trap was near the low end of that range.

Life history attributes of both adults and juveniles of the endemic and Catherine Creek stocks have shown variations in run timing and growth. An assessment of productivity (progeny-per-parent) for the Catherine Creek stock awaits F_1 returns from the first substantial release of smolts (brood year 2004 released in the spring of 2006).

Adult spring Chinook salmon that return to Lookingglass Creek and spawn below the Lookingglass Hatchery trap are not enumerated or biological data collected at the trap. Estimates of total spawners below the trap, sex, age, and mark status have to be inferred from redd counts, and data collected at the trap and from carcasses recovered. Returns that spawn below the trap include substantial numbers from other stocks, some (e.g. upper Grande Ronde River, Lostine River) that were reared as juveniles at Lookingglass Hatchery. Some fish released above the trap were also from other stocks, showing that identification at the Lookingglass Hatchery trap is not 100% accurate or some returns passed the trap without being captured or both.

1.7 Literature Cited

Bjorkstedt, E. P. 2007. DARR 2.0: updated software for estimating abundance from stratified mark-recapture data. U. S. Department of Commerce, National Oceanic and Atmospheric Administration-Fisheries, Southwest Fisheries Science Center, NOAA Technical Memorandum NMFS-SWFSC-368, Santa Cruz, California.

Burck, W.A. 1993. Life history of spring Chinook salmon in Lookingglass Creek, Oregon. Oregon Department of Fish and Wildlife Information Report 94-1, Portland.

DeHart, M. 2007. Fish Passage Center Annual Report. Columbia Basin Fish and Wildlife Authority. Portland, OR.

Jonasson, B. C., A. G. Reischauer, F. M. Monzyk, E. S. Van Dyke, and R. W. Carmichael. 2006. Investigations into the early life history of naturally produced spring Chinook salmon and summer steelhead in the Grande Ronde Basin. 1 December 2003-31 January 2003. Oregon Department of Fish and Wildlife Annual Report to the Bonneville Power Administration. Portland, Oregon.

Lofy, P. T. and M. L. McLean. 1995. Lower Snake River Compensation Plan. Confederated Tribes of the Umatilla Indian Reservation Evaluation Studies for 1 January-31 December 1992. Report to U. S. Fish and Wildlife Service, Boise, Idaho

Mosher, K. H. 1969. Identification of Pacific Salmon and Steelhead Trout by Scale Characteristics. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries Circular 317.

Park, D. L. 1990. Status and future of spring Chinook salmon in the Columbia River Basin – Conservation and Enhancement. U. S. Department of Commerce, NOAA Technical Memorandum NMFS F/NWC-187.

Parker, S. J., M.-L. Keefe, and R. W. Carmichael. 1995. Natural escapement of spring Chinook salmon in the Imnaha and Grande Ronde River Basins. Annual progress report, Oregon Department of Fish and Wildlife, to the Lower Snake River Compensation Plan, U. S. Fish and Wildlife Service, Boise, Idaho.

PIT Tag Steering Committee. 1999. PIT Tag Marking Procedures Manual. Version 2.0. Columbia Basin Fish and Wildlife Authority. Available: http://www.pittag.org/Software_and_Documentation/MPM.pdf)

Roper, B. and D. L. Scarnecchia. 1996. A comparison of trap efficiencies for wild and hatchery age-0 Chinook salmon. North American Journal of Fisheries Management 16(1):214-217.

U. S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

Westhagen, P. and J. R. Skalski. 2006. Program PitPro 4.0. Columbia Basin Research, University of Washington, Seattle.

1.8 Appendix A. Draft Lookingglass Creek Management Guidelines

ODFW proposes aggressive weir management guidelines to expedite adult escapement (Table 1). The intent is to use the hatchery resource is to magnify adult numbers to provide 1) broodstock (170 spawners) to become self-sufficient, 2) escapement of 450 adults above the hatchery, and 3) harvest when escapement predictions exceed 620 adults. The longer-term objective is to modify weir management guidelines to transition escapement above Lookingglass Hatchery and broodstock to naturalized adults.

Table 1. Proposed long-term adult weir management guidelines for the Lookingglass Creek.

Estimated adult escapement to Lookingglass Creek[a]	Ratio of hatchery to natural adults at the mouth	Maximum % of natural adults to retain for broodstock	% of hatchery adults to retain as broodstock	% of adults released above the weir can be of hatchery origin	Minimum % of broodstock of natural origin	% known strays allowed above the weir
≤300 (below)	Any	50	na	na	na	≤5
301-449	Any	≤50	≤50	Any	Any	≤5
450-619	Any	≤25	≤35	Any[b]	≥90	0
≥620[c]	Any					

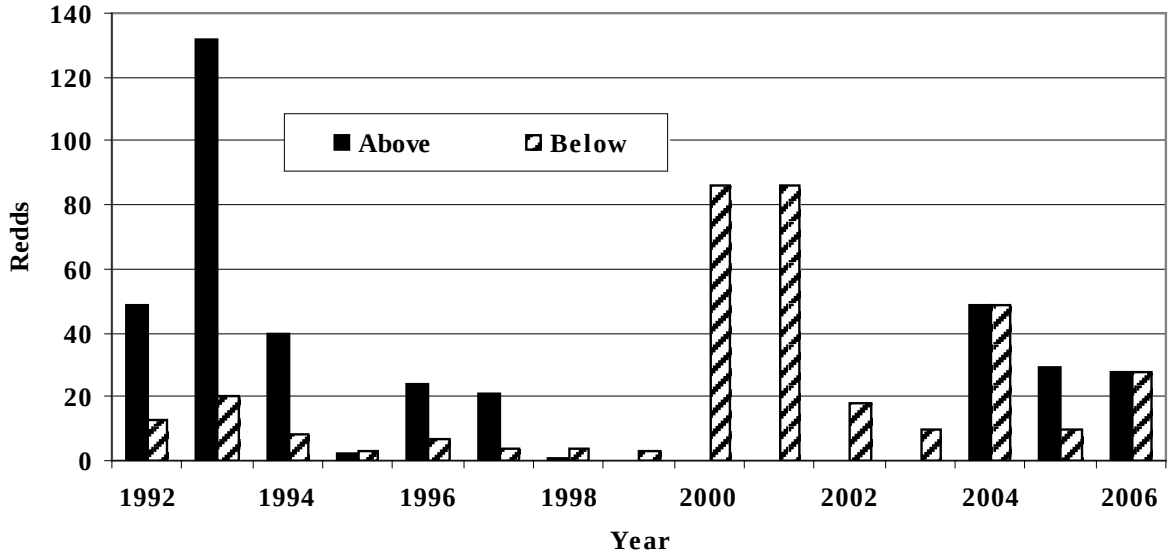
[a] Pre-season or adjusted season estimate for total escapement
[b] Not to exceed 450 total fish, no limit on naturalized adults
[c] Selective sport harvest threshold

In the near term or until there is an established Lookingglass Creek stock, collections will be based on the following agreement:

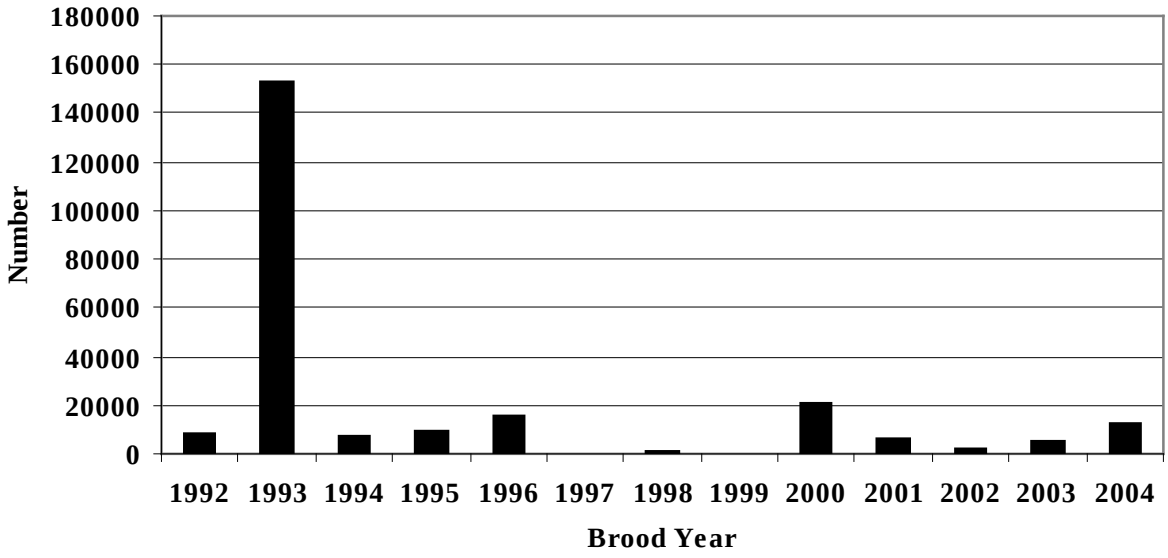
Adults available (swimins and CC surplus)		Percent to Pass	Keep
150		67	33
200	58	42	
250	53	47	
300	50	50	

> 300 adjustments based on brood needs

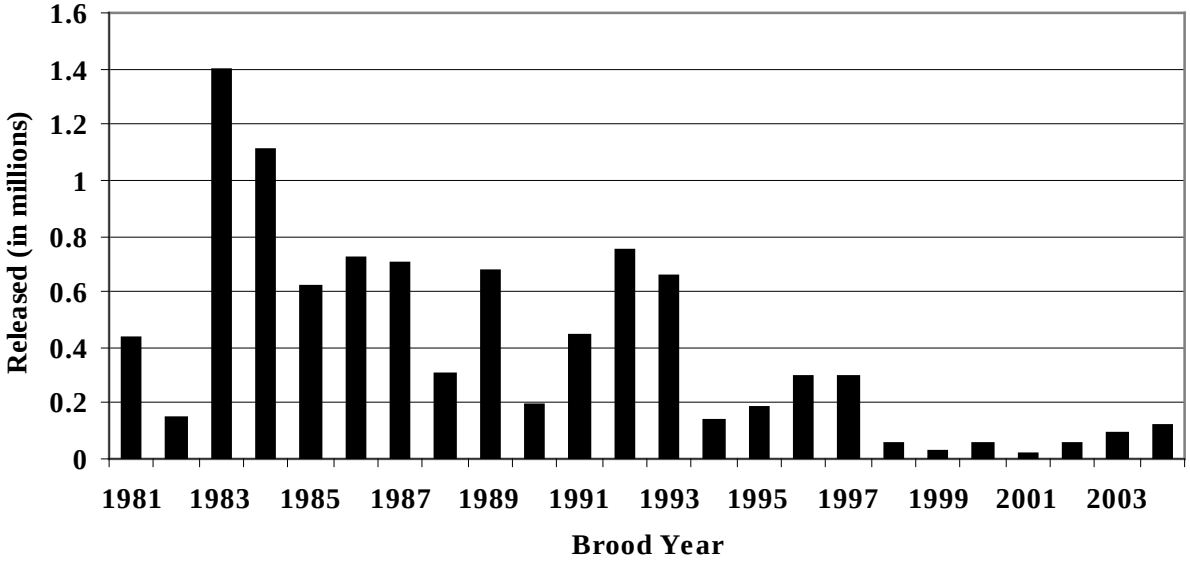
1.9 Appendix Figures



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



Appendix Figure 2. Lookingglass Creek spring Chinook salmon natural outmigrant production by brood year, 1992-2004.



Appendix Figure 3. Hatchery releases of spring Chinook salmon into Lookingglass Creek by brood year, 1992-2004

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

2.1 Abstract

Unclipped (wild) adult summer steelhead (*Oncorhynchus mykiss*) caught at the Lookingglass Hatchery adult trap from 16 March-29 May 2006 totaled 196 (122 females, 74 males). Twenty recaptures of returns previously handled occurred from 31 March-9 May 2006 and three adipose-clipped (hatchery-origin) adults were collected. Mean FL of wild males and females were 663.1 and 663.6 mm, respectively. Age composition of returns from an age-length key was 30.7% one-salt, 67.7% two-salt, and 1.6% three-salt. Outmigrants during 2006 totaled 15,258 and most left during the April-June and October-November periods. Trap capture probabilities ranged from 0.033-0.083. Mean FL for outmigrants PIT-tagged and released from 24 June 2005-28 December 2005 was 146.6 mm (n=225), survival probability to Lower Granite Dam was 0.1947 for 226 tagged and released and median arrival date at Lower Granite Dam was 1 May 2006 (n=32 detections expanded for spill). Mean FL for outmigrants PIT-tagged and released from 5 January 2006-8 June 2006 was 155.6 mm (n=348), survival probability to Lower Granite Dam was 0.5328 for 348 tagged and released and median arrival date at Lower Granite Dam was 2 May 2006 (n=140 detections expanded for spill). The number of summer steelhead trapped in 2006 was similar to the range observed since 2002, and higher than values recorded in the 1970s. The number of outmigrants in 2006 was about half of that observed in 2005, but above the range recorded in the 1970s. Life history characteristics observed in 2006 were similar to those observed during other years in Lookingglass Creek and other stocks of A-run summer steelhead in the Snake River Basin.

2.2 Introduction

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

The Oregon sport fishery for summer steelhead 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 summer steelhead due to the construction and operation of the four most downstream Snake River dams. The continued decline in wild summer steelhead populations resulted in the listing of Snake River populations as threatened under the Endangered Species Act of 1973 on 18 August 1997 (Federal Register Volume 62, Number 159).

ODFW began harvest augmentation programs in the Grande Ronde River using Wallowa Hatchery stock in the early 1980s and consumptive recreational harvest was reopened in 1986 (Flesher et al. 2004). High stray rates of Wallowa Hatchery stock have been observed, particularly in the Deschutes River. A biological opinion directed the gradual phase out of Wallowa Hatchery stock releases in the Grande Ronde Basin (National Marine Fisheries Service 1999).

The difficulty in operating traps during spring high flows when adult summer steelhead are ascending tributaries to spawn often limits the collection of escapement and life history data. Burck recorded the number of summer steelhead adults returning to Lookingglass Creek from 1965-1974 (unpublished data, summarized by McLean et al. 2001). Counts of returns to the Lookingglass Hatchery (LH) adult trap have been compiled since 1997.

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 activities and activities funded under other projects are being used to develop a long-term database for summer steelhead in the Grande Ronde Basin.

2.3 Methods

2.3.1 Adults

A picket weir diverted returning fish into a trap near the LH water intake. All adult summer steelhead captured were anesthetized, enumerated, examined for fin clips and other marks or tags, measured (mm FL), and sexed. Opercle tissue from each fish was removed with a hole punch and preserved in 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. Permanent scale impressions were made in cellulose acetate using heat and pressure and examined under magnification using a microfiche reader using standard criteria for annuli (Mosher 1969). Week of capture was designated by the first day of the week (e.g. week of 1 January included 1-7 January). Adipose-clipped (hatchery origin) fish were euthanized and removed from the stream. Unclipped (wild) fish were transported about 0.4 rm upstream and released. Post-spawn summer steelhead are rarely observed due to the design of the Lookingglass Hatchery weir. Downstream migrants can pass freely over the pickets without being trapped.

2.3.2 Juvenile *O. mykiss*

We operated a 1.52 m diameter rotary screw trap (Roper and Scarnecchia 1996) at rm 2.4 on Lookingglass Creek below the LH adult trap to collect outmigrating juvenile *O. mykiss*. The screw trap was operated continuously during 2006 except for brief periods of high flow, high water temperatures, low fish movement, or maintenance. The trap was usually checked 3 times a week or more frequently if catches or flows were high.

All O. *mykiss* captured 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 ≥ 110 mm FL in good condition (no injuries or obvious disease) were PIT-tagged using standard methods (PIT Tag Steering Committee 1999). Past data indicated that PIT-tagged fish <110 mm FL are rarely recaptured at the screw trap or detected at mainstem dams on the Snake or Columbia Rivers. All newly-tagged fish were released about 300 ft above the screw trap; recaptures were released 1,000 ft below the screw trap.
We used DARR 2.0 (Bjorkstedt 2005) to estimate the numbers of outmigrants. DARR 2.0 uses mark-recapture data stratified by time period and pools strata with similar capture probabilities. We used the "one trap" and "no prior pooling of strata" options offered in DARR 2.0.

O. mykiss juveniles outmigrate from Lookingglass Creek during the entire year, with peaks during the spring (March-May) and fall (September and October).
All outmigrants are wild since no hatchery steelhead are liberated in Lookingglass Creek. Fall outmigrants move downstream to continue rearing but are not detected at Lower Granite Dam until the following spring, or possibly as much as 2 years later. Most (but not all) spring outmigrants move directly downstream; those PIT-tagged are usually detected at Lower Granite Dam within 30 d of PIT-tagging and release. PIT-tagged outmigrants were placed into two groups (fall 2005 and spring 2006) for comparisons of life history. The earliest date of PIT-tagging in 2005 for any detection in the Columbia River-Snake River hydrosystem in 2006 was used as the separation date for the fall 2005 group. All fish PIT-tagged from that date until 31 December 2005 comprised the fall 2005 group. Similarly, the latest date of PIT-tagging in 2006 for the last detection in the hydrosystem in 2006 was used as the separation date for the spring 2006 group. Any outmigrant tagged and released from 1 January 2006 until that date comprised the spring 2006 group. These two groups represented essentially all of migration year 2006.

FL and weight at PIT-tagging, travel time, survival and capture probability to Lower Granite Dam data were obtained from the PIT tag database maintained by the Pacific States Marine Fisheries Commission at http://www.ptagis.org/. We estimated arrival timing to Lower Granite Dam using daily PIT tag detections 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. Survival, capture probabilities, and travel time to Lower Granite Dam were estimated using PitPro (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). Survival, capture probabilities, and travel time were estimated for only those outmigrants detected during the year following tagging.

2.4 Results

2.4.1 Adults

Trapping began 8 March 2006 and the first male and female unclipped (wild) summer steelhead were caught on 16 March. The catch of wild, prespawn adults totaled 196 (122 females, 74 males). Catches increased steadily through the week of 23 April then quickly decreased (Figure 1). Peak catch was the week of 26 March and the last return was collected 29 May. Approximately 58% of the wild, prespawn returns were caught before or during the week of 9 April. Three ad-clipped (hatchery-origin) prespawn adults ranging from 61-70 cm were caught from 14 April-24 May. There were 20 recaptures (13 males, 7 females) from 31 March-9 May of previously handled adults.

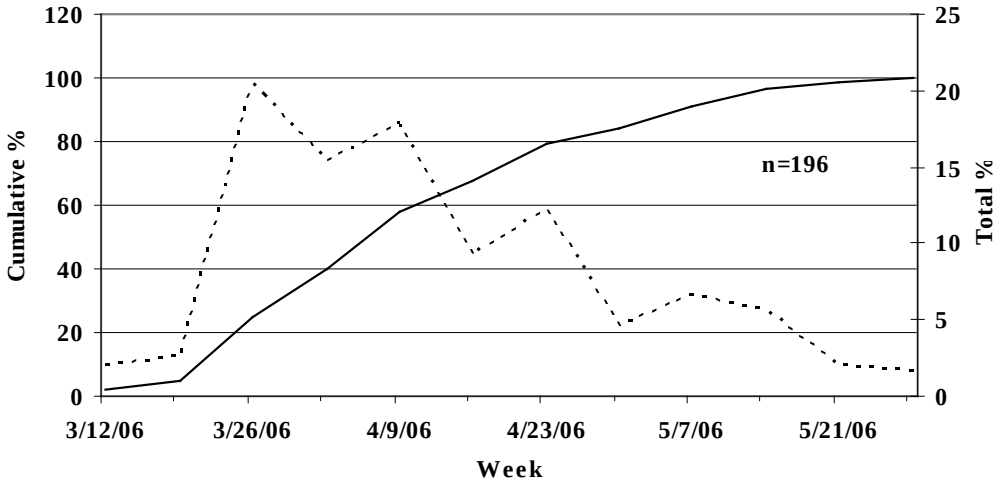


Figure 1. Total % (dashed line) and cumulative % (solid line) of total catch by week for wild summer steelhead caught in the Lookingglass Hatchery trap, 2006.

Females comprised 62.2% of the total. The peak of females occurred the week of 9 April compared to 26 March for males (Figure 2). Mean FL of males and females differed by only 0.5 mm (Table 1). The FL distribution for sexes combined was bimodal, with the strongest mode at 70 cm and a weaker one at 60 cm (Figure 3). The FL distribution for males was bimodal at 60 and 70 cm, with the strongest mode at 60 cm (Figure 4). The FL distribution was also bimodal for females, with a strong mode at 70 cm and a much weaker one at 57-58 cm (Figure 5).

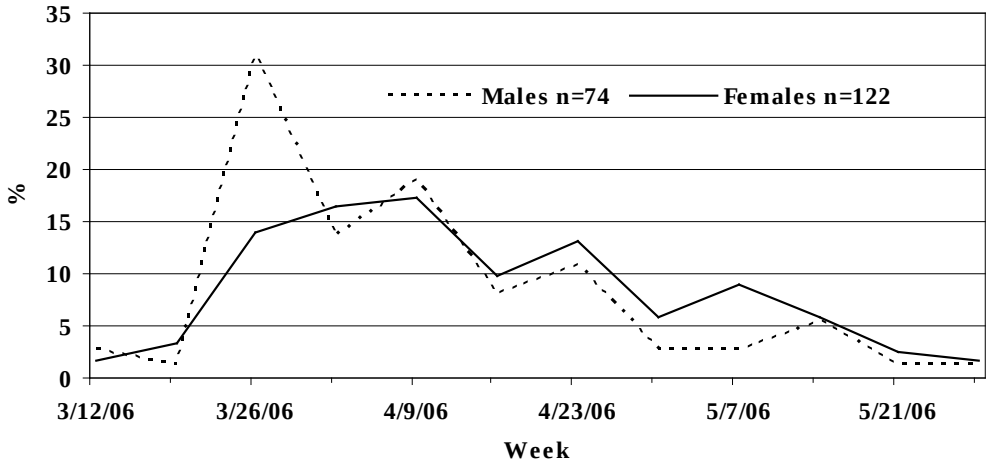


Figure 2. Percentages of total catch by week and sex for wild summer steelhead caught in the Lookingglass Hatchery trap, 2006.

Table 1. FL summary by sex for wild summer steelhead caught in the Lookingglass Creek trap, 2006.

Sex	$\bar{X}$ FL (mm)	SE	Min-Max	n
Male	663.1	9.5	420-810	74
Female	663.6	4.8	520-760	122
All	663.4	4.6	420-810	196

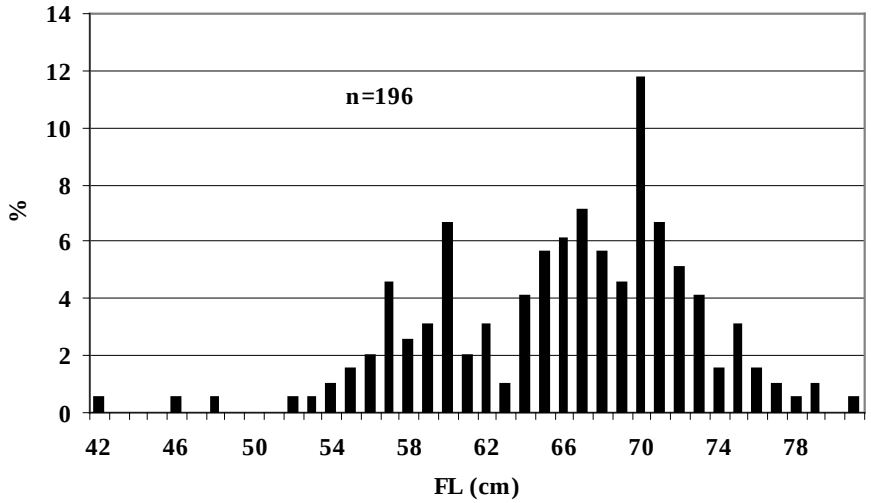


Figure 3. FL frequency of wild summer steelhead (sexes combined) caught in the Lookingglass Hatchery trap, 2006

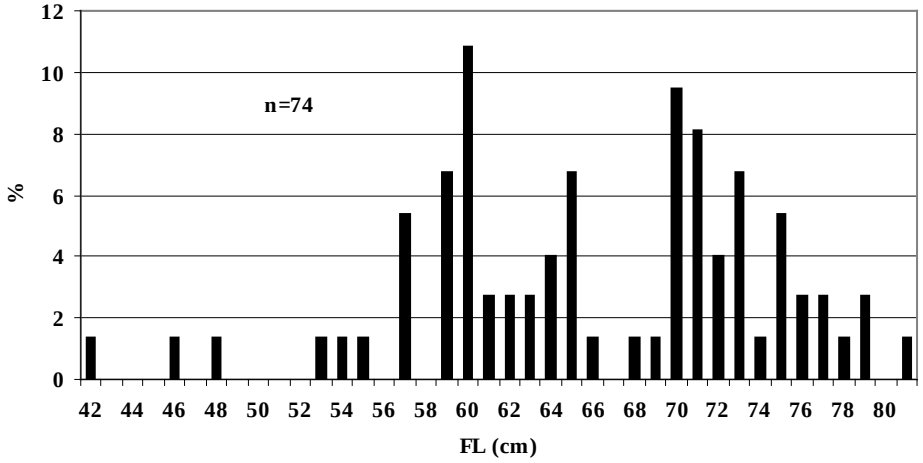


Figure 4. FL frequency of male wild summer steelhead caught in the Lookingglass Hatchery trap, 2006.

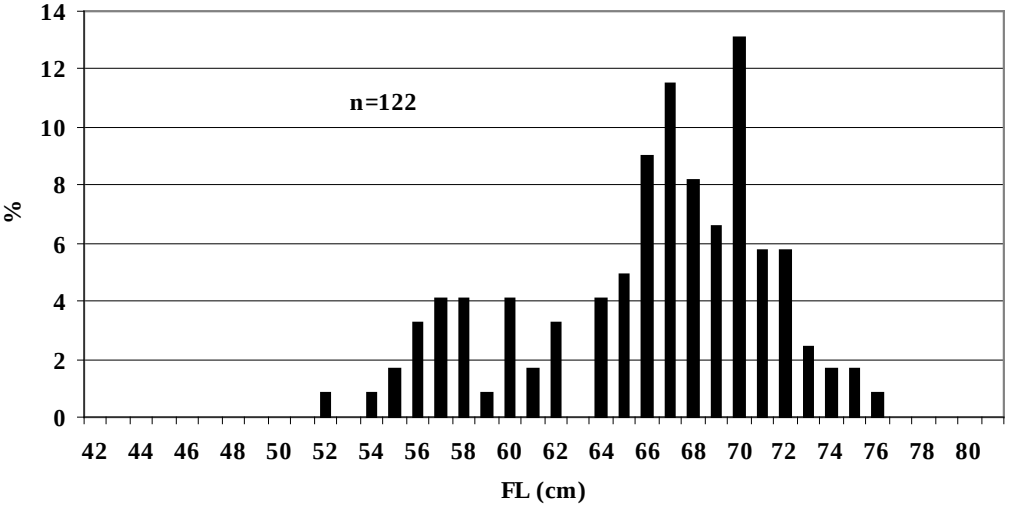


Figure 5. FL frequency of female wild summer steelhead caught in the Lookingglass Hatchery trap, 2006.

Scales were read for 181 returns (Table 2). Saltwater annuli present were one (29.8% of the total aged), two (68.5%), or three (1.7%). Mean FL of 1-salt males was 24.3 mm greater than 1-salt females and mean FL of 2-salt males was 25 mm greater than females. Expanding the observed age by FL (cm) distribution to all fish also resulted in an age-FL (cm) distribution dominated by 2-salt (Figure 6). One-salt returns were 30.7%, two-salt returns 67.7%, and three-salt returns 1.6%.

Table 2. FL summary by age and sex for wild summer steelhead caught in the Lookingglass Creek trap, 2006.

Sex	Age	$\bar{X}$ FL (mm)	SE	Min-Max	n
Male					
	1-salt	604.4	8.8	465-743	29
	2-salt	711.1	9.6	485-795	34
	3-salt	795.0	15.0	780-810	2
Female					
	1-salt	580.1	4.8	520-620	25
	2-salt	687.1	3.2	620-760	90
	3-salt	710			1

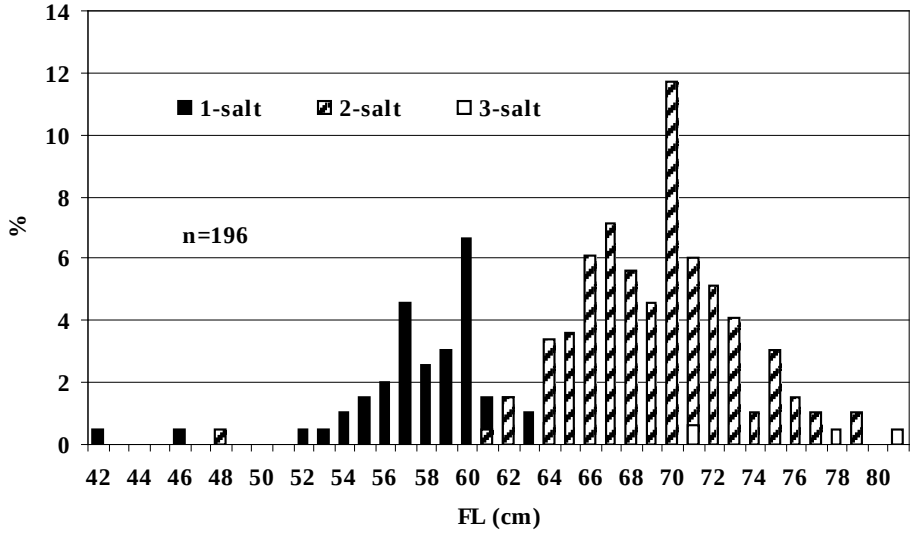


Figure 6. FL frequency by age for wild summer steelhead from Lookingglass Creek, 2006.

2.4.2 Juvenile *O. mykiss*

The rotary screw trap was operated for 288 of 365 d in 2006. The trap was not operated for 18 d during January-April, 14 d in May, 13 d in July and 32 d in November-December. The trap was removed for the year on 8 December. Outmigrants were collected on nearly every trap check date, with the highest numbers per day caught during early April, late May and early June, and late September and October.

The number of first-time captures ≥ 110 mm FL was 884, including 732 PIT-tagged, 147 measured only and released below the trap, and 5 mortalities. Juveniles >80< 110 mm FL that were measured and released below the trap without marking totaled 182, with

122 of these caught during April-June (Figure 7). There were 3 mortalities of fish >80< 110 mm FL. An additional 81 outmigrants ≤ 80 mm were counted only and released below the trap; 47 in May and June.

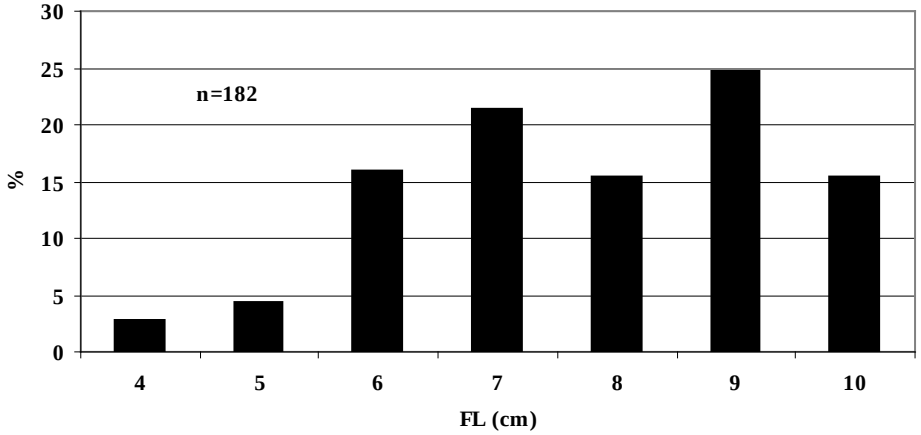


Figure 7. FL frequency for *O. mykiss* < 110 mm measured but not PIT-tagged, Lookingglass Creek screw trap, 2006.

The FL distribution by season for first-time captures showed that higher percentages of outmigrants <11 cm FL and 16-18 cm FL were caught during January-June and higher percentages of outmigrants 11-15 cm FL were caught during September-December Figure 8). Few outmigrants >17 cm FL were caught during July and August (Figure 9). Mean FL and weights of outmigrants were highest for March-April and lowest for the winter months of January, February, and December (Tables 3, 4).

The length-weight regression for 1,045 first-time captures was Log_{10} weight (g) - 4.783077+2.9079766*Log_{10} FL (mm). The adjusted R^2 was 0.978378.
The K – FL (mm) regression for the same 1,045 outmigrants was significant at P<0.0001. K decreased slightly as FL (mm) increased, according to the formula K=1.1666109-0.00078*FL (mm).

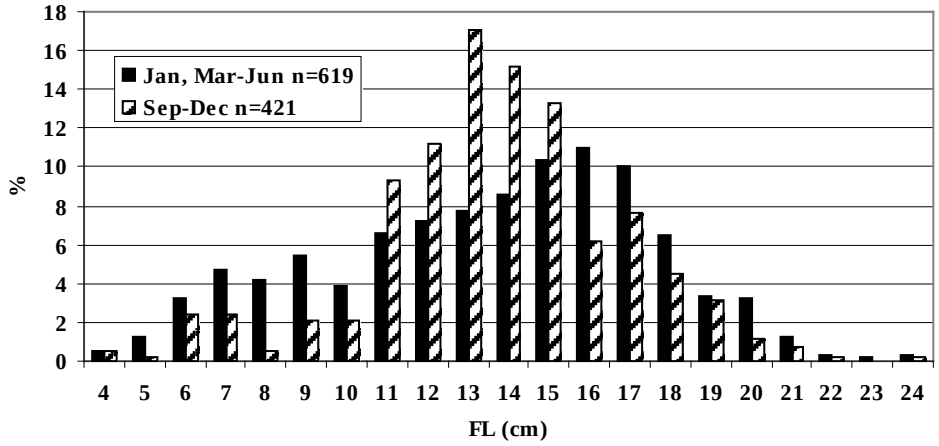


Figure 8. FL frequency for *O. mykiss* caught in the Lookingglass Creek screw trap, 2006.

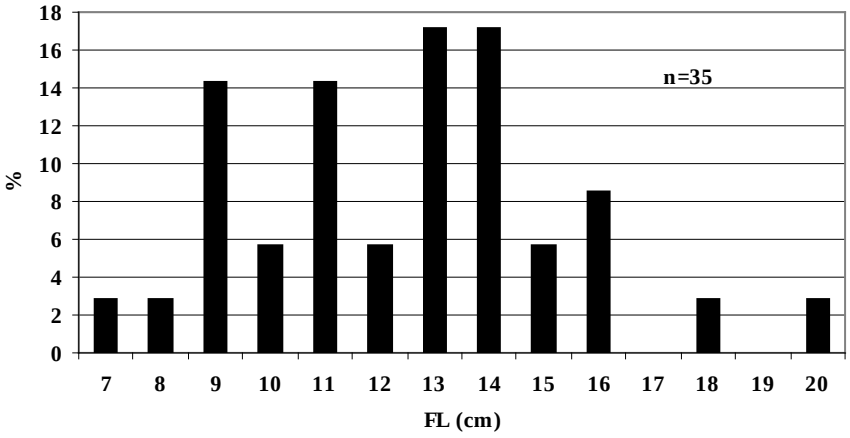


Figure 9. FL frequency for *O. mykiss* caught in the Lookingglass Creek screw trap, July-August 2006.

Table 3. FL (mm), weight (g), and K factor summary by month for *O. mykiss* caught in the Lookingglass Creek screw trap, January-June 2006.

FL	Jan	Feb	Mar	Apr	May	Jun
Mean	117.0	115	167.1	154.9	108.1	124.7
SE	10.1		4.1	2.0	2.9	3.0
Min	55	115	56	40	45	67
Max	206	115	240	246	200	218
n	25	1	72	286	119	116
Weight						
Mean	18.2		55.3	44.8	17.1	25.5
SE	4.1		3.2	1.4	1.4	1.9
Min	1.4		2.1	1.9	2.5	3.2
Max	60.0		121.8	166.2	89.5	108.7
n	19		66	278	118	115
K						
Mean	0.95		1.01	1.05	1.09	1.12
SE	0.02		0.01	0.01	0.01	0.01
Min	0.78		0.88	0.59	0.75	0.84
Max	1.09		1.26	1.43	1.43	1.57
n	19		66	278	118	115

Table 4. FL (mm), weight (g), and K factor summary by month for *O. mykiss* caught in the Lookingglass Creek screw trap, July-December 2006.

FL	Jul	Aug	Sep	Oct	Nov	Dec
Mean	135.4	123.4	139.2	146.2	133.5	87.7
SE	7.1	6.6	2.0	2.1	4.1	43.7
Min	95	74	65	54	62	42
Max	208	161	199	245	219	175
n	18	17	130	211	77	3
Weight						
Mean	28.0	23.4	31.0	37.0	27.7	19.3
SE	3.7	3.4	1.4	1.6	2.3	17.2
Min	8.6	5.3	4.9	1.5	2.4	2.1
Max	59.1	47.0	83.6	173.9	107.4	53.7
n	17	13	130	210	76	3
K						
Mean	1.12	1.02	1.06	1.04	0.99	2.03
SE	0.03	0.04	0.01	0.01	0.02	0.54
Min	0.97	0.91	0.48	0.63	0.25	1.00
Max	1.48	1.48	1.82	1.32	1.21	2.83
n	17	13	130	210	76	3

We initially tabulated the numbers caught, marked and released, and recaptures by month to estimate total outmigrants ≥ 110 mm FL. We pooled February-March, June-August, and October-December, for a total of 7 periods. DARR 2.0 further combined the January and February-March periods and the May and June-August periods to total 5 periods. The estimate of outmigrants ≥ 110 mm FL was 15,258 (Table 5).

Only first-time captures ≥ 110 mm FL were PIT-tagged and used to estimate outmigration; most were tagged and released during March-June and September-November 2006 (Figure 10). The first was tagged on 5 January and last on 8 December (median 30 June). We excluded 13 PIT-tagged individuals 68-109 mm FL from the outmigration estimate but retained them for estimates of survival and migration timing.

Table 5. *O. mykiss* caught in the Lookingglass Creek screw trap, releases and recaptures from trap efficiency tests, outmigrant estimates and standard errors, 2006.

Period	u	m	r	C_p	N	SE
January -March	82	77	4	0.046	1,777	1,052
April	260	168	14	0.083	3,120	797
May-August	162	150	5	0.033	4,860	2,136
September	121	108	8	0.077	1,562	758
October-December	258	229	15	0.066	3,939	981
2006 Totals and SE	883	732	46		15,258	2,721

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 (variance$^{0.5}$)

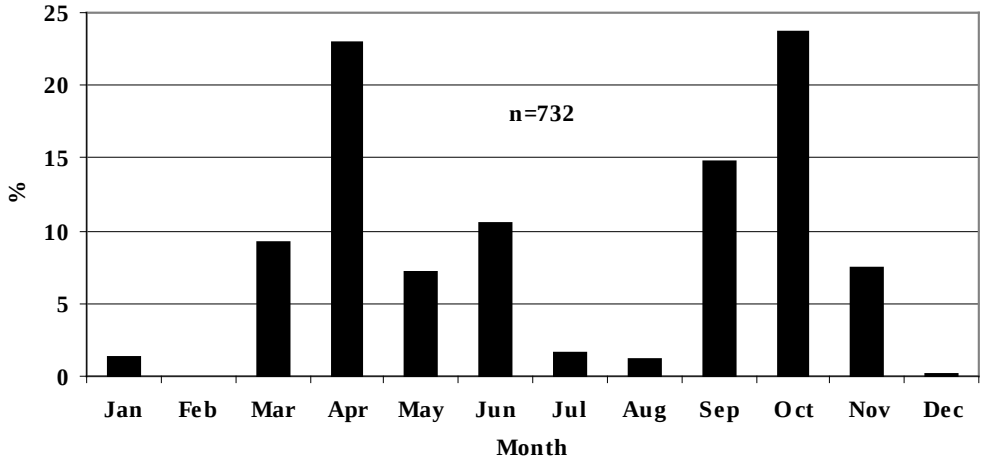


Figure 10. Percentages of *O. mykiss* ≥ 110 mm FL PIT-tagged and released in Lookingglass Creek by month, 2006.

There were 46 recaptures in 2006 of juveniles ≥ 110 mm FL that were PIT-tagged and released in 2006 (one fish was recaptured in 2007 and excluded). Mean FL at PIT-tagging was 149.3 mm (SE 3.2). Recaptures ranged from 116-194 mm FL. There were differences in the FL distributions of juveniles PIT-tagged and subsequently recaptured (Figure 11). We PIT-tagged 28 outmigrants ≥ 20 cm FL but none were recaptured. Days elapsed between release and recapture for 46 PIT-tagged outmigrants released and recaptured in 2006 ranged from 1-72 with 93% from 1-4 d. One each was recaptured 33, 59, and 72 d after release.

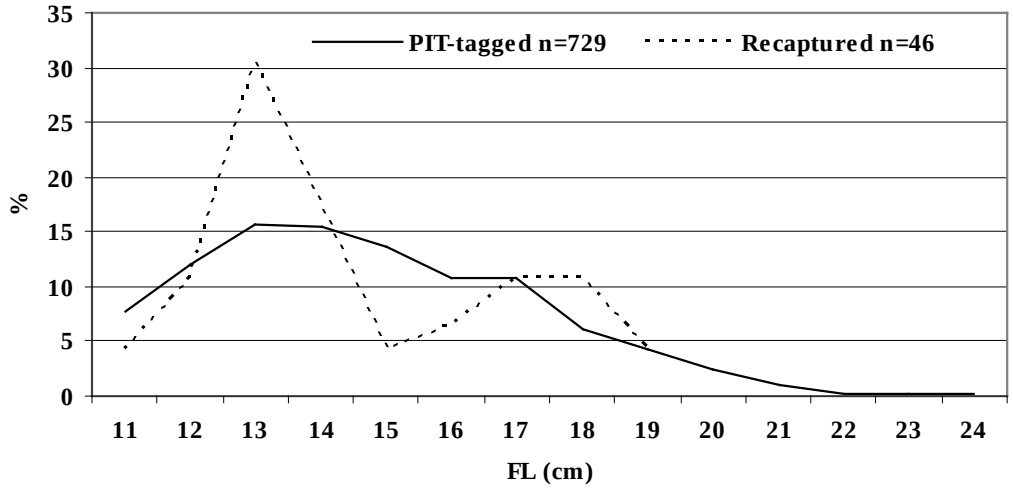


Figure 11. FL comparison of *O. mykiss* ≥ 110 mm FL caught, PIT-tagged and released and recaptures in the Lookingglass Creek screw trap, 2006 (FL not recorded for 3).

Mean FL of fish in the fall 2005 group was 9.0 mm less than the spring 2006 group, and mean weight was 9.0 g less (Table 6). K factors differed by 0.05. Survival for the spring 2006 group was more than double that of the fall 2005 group and capture probability was slightly higher (Table 7). Median arrival dates to Lower Granite Dam differed by only 1 d between groups, and most of the detections occurred within approximately the same dates.

Table 6. FL, weight, and K factor summary for *O. mykiss* caught in the Lookingglass Creek screw trap, PIT-tagged and released, fall 2005 (24 June 2005-28 December 2005), and spring 2006 (5 January 2006-8 June 2006) groups of *O. mykiss* outmigrants.

	Group	
Statistic	Fall 2005	Spring 2006
Mean FL (mm)	146.6	155.6
SE	1.5	1.5
Min-Max	85-220	68-240
n	225	348
Mean Weight (g)	33.8	42.8
SE	1.1	1.2
Min-Max	6.6-109.7	4.5-164.0
n	221	339
Mean K	1.00	1.05
SE	0.01	0.01
Min-Max	0.78-1.32	0.59-1.43
n	221	339

Table 7. Survival and capture probabilities, harmonic mean travel time, and median arrival date to Lower Granite Dam summary for fall 2005 (24 June 2005-28 December 2005), and spring 2006 (5 January 2006-8 June 2006) groups of *O. mykiss* outmigrants .

	Group	
Statistic	Fall 2005	Spring 2006
Survival Probability	0.1947	0.5328
SE	0.0263	0.0417
n	226	348
Capture Probability	0.3636	0.4045
SE	0.0725	0.0435
n	16	75
Travel Time (d)	208.229	10.372
SE	10.218	0.0878
n	16	75
Median Arrival Date	1 May 2006	2 May 2006
10%	17 April 2006	14 April 2006
90%	20 May 2006	22 May 2006
n	16	75
n (expanded)	32	140

Distributions of FL at PIT-tagging for released and detected fish for both the fall 2005 and spring 2006 groups were variable. Higher percentages of fish in the 12-13 and 17 cm FL groups were tagged than detected, with the reverse true for 14-16 and 19 cm fish of

the fall 2005 group (Figure 12). For the spring 2006 group, higher percentages of fish in the 11-13 cm FL groups were tagged than detected but and the reverse was evident for 14-16 and 18-20 cm fish (Figure 13).

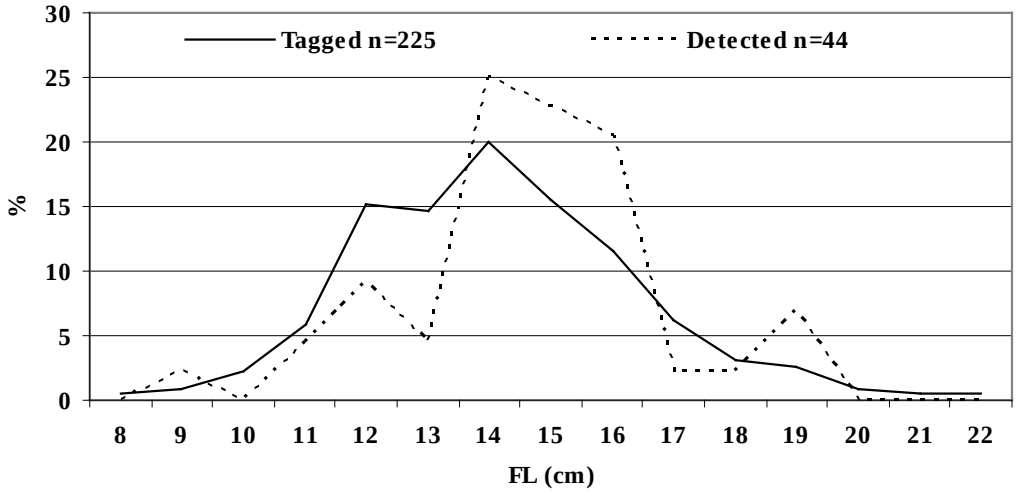


Figure 12. Percentages of *O. mykiss* PIT-tagged and released in Lookingglass Creek, fall 2005 group, and unique detections in the hydropower system by FL group during 2006.

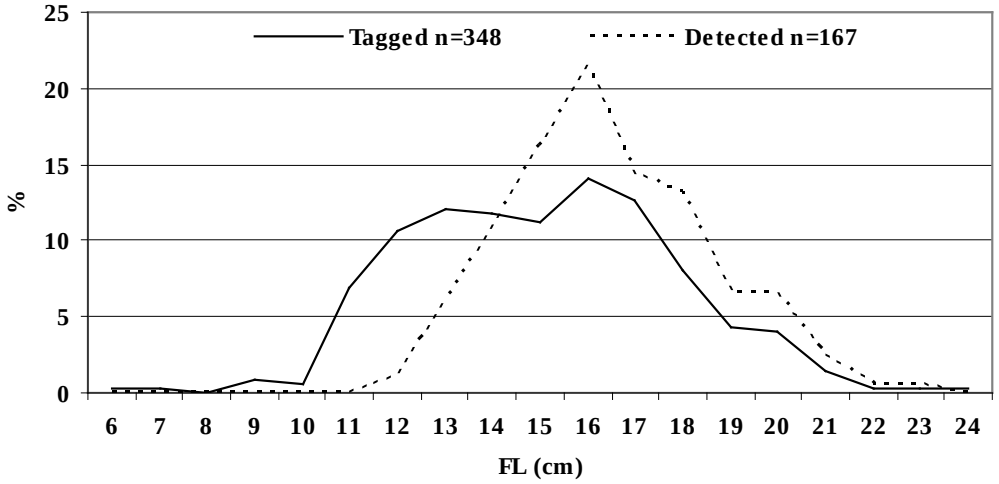


Figure 13. Percentages of *O. mykiss* PIT-tagged and released in Lookingglass Creek, spring 2006 group, and unique detections in the hydropower system by FL group during 2006.

2.5 Discussion

Events that typically generate peak stream flows in eastern Oregon include rainstorms, winter and spring rain-on-snow events, spring snowmelt, and cloudburst thunderstorms (Watershed Professionals Network 2001). Peak stream flow for Lookingglass Creek is typically in the range of 500-1,000 CFS (Herrett et al. 2005). Stream flow conditions in Lookingglass Creek during 2006 followed the typical pattern. Passage and survival conditions in the Snake River-Columbia River migration corridor in 2006 were improved due to higher than normal runoff in both systems (DeHart 2007). Water temperatures at the site below Eagle Creek were not in the ranges detrimental to adult migration or smoltification or that would increase disease risk, but were in the range where growth may have been sub-optimal under conditions of limited food (U. S. Environmental Protection Agency 2003). Maximum daily temperatures at the Lookingglass Hatchery site during July 2006 were often above 15^{o}C, in the range of impaired smoltification and increased disease risk.

The estimate of adult escapement above the trap in 2006 was the third-highest since 2001. Catches have varied slightly more than two-fold during 2001-2006 (median 180). Catches during 1965-1974 were substantially lower, with a range of 17-120 (median 56). The numbers of adult summer steelhead trapped from Lookingglass Creek have been similar to those trapped in Catherine Creek, and higher than for the upper Grande Ronde River (Boe et al. 2007).

The estimate of juvenile outmigrants in 2006 was the lowest observed for the years 2001-2006. The range observed from 2001-2005 was 27,090-67,275 (median 45,050). The lower estimate in 2006 was due partly to using only fish ≥ 110 mm FL for the trap efficiency estimates. However, even if fish of all sizes had been used, the outmigrant estimate still would have been at the lower end of the historical range. The outmigrant estimates observed during 2001-2006 were 2-6 times higher than the range of 7,727-13,261 (median 11,303) reported by Mullarkey (1971).

Arrival timing of adults at the Lookingglass Hatchery adult trap and outmigration timing of juveniles at the Lookingglass Creek screw trap during 2001-2006 both appear to differ the 1960's and 1970's (Burck, unpublished data). Peak catches of adults occurred in March or April during 2001-2006, compared to May or June during 1964-1975. Juvenile outmigrant catches in the fall months of September-November were commonly much lower than catches in the following spring during the late 1960's (Mullarkey 1971). In recent years, fall outmigrant catches appear to be higher relative to spring catches.

Most aspects of both adult and juvenile life history for Lookingglass Creek summer steelhead appear to be similar to the limited data available for Snake River A-run summer steelhead (Olsen et al. 1992) and summaries of life history data for steelhead across a broad geographical range (Burgner et al. 1992, Busby et al. 1996). Adults spend one (more common for males) or two (more common for females) in the ocean, and mean FL

of returning adults is commonly in the 625-675 mm. Juveniles outmigrate all year and at a wide range of sizes, but most commonly, 2 years are spent in freshwater, and outmigrating smolts are 110-200 mm FL, similar to results of Mullarkey (1971).

The 2006 estimate of outmigrants was comparable to other estimates from the Grande Ronde or Snake River Basins. Bumgarner and Dedloff (2007) reported a range of 13,245-35,051 from the Tucannon River (southeast Washington) for brood years 1995-2003. Van Dyke et al. (2008) reported outmigrant estimates ranging from 6,108-17,845 for 10 years in the upper Grande Ronde River, 19,628-45,799 for 10 years in Catherine Creek, 4,309-37,106 for 9 years in the Lostine River, and 24,846-105,853 for 6 years in the Minam River.

More detailed analysis of the life history of both adult and juvenile stages of summer steelhead from Lookingglass Creek may provide insights into interspecific relationships (spring Chinook salmon-summer steelhead) and productivity. Spring Chinook salmon adult escapement and juvenile production above the trap since1982 has been erratic and far reduced from pre-1982 levels. Lookingglass Creek has anadromous habitat that is less affected by human activities such as grazing, timber harvest, agriculture, and urban development than many other streams in the Grande Ronde Basin, and supports an abundant population of bull trout (*Salvelinus confluentus*) in the headwaters.

2.6 Literature Cited

Bjorkstedt, E. P. 2005. DARR 2.0: updated software for estimating abundance from stratified mark-recapture data. U. S. Department of Commerce, National Oceanic and Atmospheric Administration-Fisheries, Southwest Fisheries Science Center, NOAA Technical Memorandum NMFS-SWFSC-368, Santa Cruz, California.

Boe, S. J., C. A. Crump, and R. L. Weldert. 2007. Monitoring and evaluation of supplementation of spring Chinook salmon and life histories of wild summer steelhead in the Grande Ronde Basin. Annual Report for 1 January to December 31 2006 to Bonneville Power Administration, Portland, Oregon. Project 199800703.

Bumgarner, J. D., and J. Dedloff. 2007. Lyons Ferry Complex Hatchery Evaluation: Summer Steelhead Annual Report 2005 Run Year. Washington Department of Fish and Wildlife, Olympia, Washington report to the U. S. Fish and Wildlife Service, Lower Snake River Compensation Plan, Boise, Idaho.

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origin of steelhead trout (*Oncorhynchus mykiss*) in the offshore waters of the North Pacific Ocean. International North Pacific Fisheries Commission Bulletin Number 51. Vancouver, Canada.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Oregon, and California. U. S. Department of Commerce NOAA Technical Memorandum NMFS-NWFSC-27. Seattle, WA.

DeHart, M. 2007. Fish Passage Center Annual Report. Columbia Basin Fish and Wildlife Authority. Portland, OR.

Flesher, M. W., R. W. Carmichael, and J. R. Ruzycki. 2004. Summer steelhead creel surveys on the Grande Ronde, Wallowa, and Imnaha rivers for the 2001-02 run year. Oregon Department of Fish and Wildlife Annual Progress Report to the Lower Snake River Compensation Plan, U. S. Fish and Wildlife Service, Boise Idaho.

Herrett, T. A., G. W. Hess, M. A. Stewart, G. P. Ruppert, and M. L. Courts. 2005. Water-Data Report OR- 05-01. U. S. Department of the Interior, U. S. Geological Survey. Portland, Oregon.

Mosher, K. H. 1969. Identification of Pacific Salmon and Steelhead Trout by Scale Characteristics. U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries Circular 317.

Mullarkey, W. G. 1971. Downstream movement of juvenile steelhead trout (Salmo gairdneri) in Lookingglass Creek. Oregon Fish Commission Report. Portland, OR.

National Marine Fisheries Service. 1999. Biological Opinion on Artificial Propagation in the Columbia River Basin. Northwest Region, Portland, Oregon.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at a crossroads: stocks at risk from California, Oregon, Idaho and Washington. Fisheries 16 (2):4-20.

Olsen, E., P. Pierce, M. McLean, and K. Hatch. 1992. Stock summary reports for Columbia River anadromous salmonids. Volume II. Oregon Subbasins above Bonneville Dam. Report prepared for Bonneville Power Administration. Project No. 99-108, Contract No. DE-FC79-89BP94402. Portland, OR

PIT Tag Steering Committee. 1999. PIT Tag Marking Procedures Manual. Version 2.0. Columbia Basin Fish and Wildlife Authority. Available: http://www.pittag.org/Software_and_Documentation/MPM.pdf)

Roper, B. and D. L. Scarnecchia. 1996. A comparison of trap efficiencies for wild and hatchery age-0 Chinook salmon. North American Journal of Fisheries Management 16(1):214-217.

U. S. Army Engineer District. 1975. Special Report. Lower Snake River Compensation Plan. Walla Walla, WA.

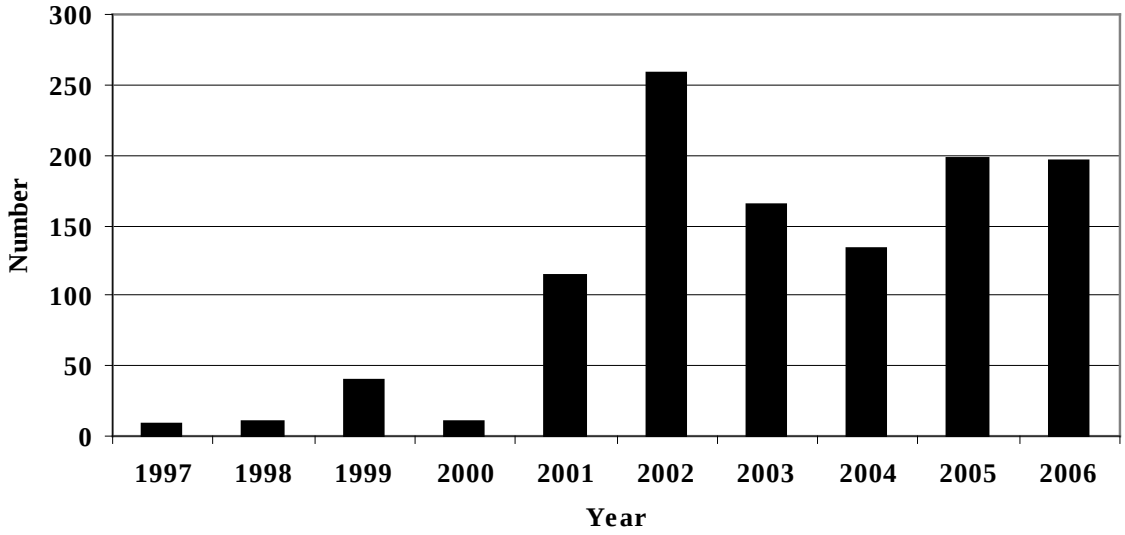
U. S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

Van Dyke, E. S., J. A. Yanke, J. W. Steele, B. C. Jonasson, and R. W. Carmichael. 2008. Investigations into the early life history of naturally produced spring Chinook salmon and summer steelhead in the Grande Ronde River Basin. Oregon Department of Fish and Wildlife, La Grande, Oregon, Annual Report prepared for the Bonneville Power Administration, Project 1992-026-04, Portland, Oregon.

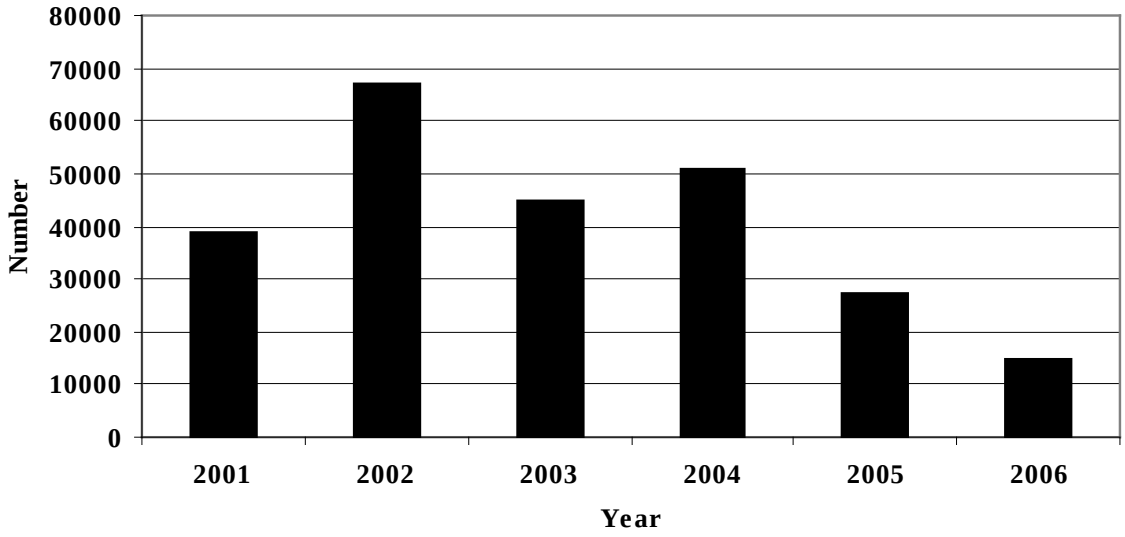
Watershed Professionals Network. 2006. Hydrologic process identification for eastern Oregon. Report prepared for Oregon Watershed Board.

Westhagen, P. and J. R. Skalski. 2006. Program PitPro 4.0. Columbia Basin Research, University of Washington, Seattle.

2.7 Appendix Figures



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



Appendix Figure 2. Lookingglass Creek wild juvenile *O. mykiss* outmigrant production, 2001-2006.

3 SECTION III ASSISTANCE PROVIDED TO LSRCP COOPERATORS AND OTHER PROJECTS

We assisted ODFW in ongoing hatchery evaluation research. CTUIR staff l completed spawning ground surveys for spring Chinook salmon in the Grande Ronde and Imnaha river basins. We also assisted in pre-release sampling of spring Chinook salmon and sampling of adult spring Chinook salmon at LH.

We assisted the ODFW Early Life History project funded by the Bonneville Power Administration (BPA) with fish and data collection. We assisted ODFW Native Fisheries Investigations by providing catch, FL and weight data for bull trout we have captured in the adult trap and screw trap in Lookingglass Creek.

4 ACKNOWLEDGMENTS

Thanks to Scott Marshall, Chris Starr, Margaret Anderson, and Tammy Froscher (Lower Snake River Compensation Plan, United States Fish and Wildlife Service) for administering this contract and coordinating project activities between the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and other agencies. Gary James, Michelle Thompson, Julie Burke, Celeste Reeves, and Brandie Weaskus (CTUIR) provided technical and administrative support. Mike McLean and the CTUIR La Grande O&M team provided valuable field assistance with monthly sampling, field group PIT tagging, and spawning ground surveys. Thanks go to members of the Oregon Department of Fish and Wildlife (ODFW) Research and Development Section in La

Grande for field and office assistance and providing unpublished data. Jo Miller and Mary-Louise Courts (United States Geologic Survey) and Stacia Peterson (United States Forest Service) provided stream flow and water temperature data. ODFW, NOAA-Fisheries, and CTUIR staff from other projects assisted in various field activities. We thank Forest Capital LLC and other private landowners along Lookingglass Creek for allowing us to access and work on their property. Lookingglass Hatchery (ODFW) staff tended the adult trap, collected tissues and data, provided the use of hatchery facilities and equipment, and kept an eye on the screw trap for us. Cecelia Noyes of the Grande Ronde Model Watershed did an excellent job in making the maps shown at the beginning of the report.