Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2008 to 31 December 2008

Section I
Evaluation of Reestablishing Natural Production of Spring Chinook Salmon in Lookingglass Creek, Oregon, Using a Within-Basin Stock (Catherine Creek)

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1 SECTION I. EVALUATION OF REESTABLISHING NATURAL PRODUCTION OF SPRING CHINOOK SALMON IN LOOKINGGLASS CREEK, OREGON, USING A WITHIN-BASIN STOCK (CATHERINE CREEK)

1.1 Abstract

This project was undertaken to evaluate the reintroduction of spring Chinook salmon into Lookingglass Creek using a stock from within the Grande Ronde Basin, beginning in September 2001 with the first release of juvenile Catherine Creek stock. Natural-origin spring Chinook salmon adults caught at the Lookingglass Hatchery weir from 14 May-3 September 2008 totaled 53. Hatchery-origin returns totaled 319. Age composition of natural-origin returns to the weir was 8% age 3, 83% age 4, and 9% age 5. Natural- origin returns were outplanted to spawn naturally above the hatchery weir (N=38) or used for conventional spawning at Lookingglass Hatchery (N=15). Hatchery-origin returns outplanted above the weir totaled 150. Outplanting occurred from 5-27 August 2008. Spawning ground surveys from 11 August-29 September 2008 yielded 104 redds above the weir and 39 below. Carcass recoveries totaled 67 above the trap and 33 below. Estimated spawners above the weir totaled 39 natural-origin (5% age 3, 82% age 4, and 13% age 5) and 155 hatchery-origin (6% age 3, 94% age 4, and <1% age 5).

We PIT-tagged and released 1,659 spring Chinook salmon parr from the main rearing area above Lookingglass Hatchery during 3-8 August 2007 (summer group). Outmigrants caught in the screw trap, PIT-tagged and released were 112 (fall group), 232 (winter group), and 127 (spring group). We estimated 12,502 (447/redd) brood year 2006 Spring Chinook salmon outmigrated from the area above Lookingglass Hatchery during migration year 2008. Percentages leaving for the fall, winter, and spring groups were 34, 49, and 17, respectively. Mean fork lengths of summer, fall, winter, and spring groups of PIT-tagged fish ranged from 71.5-94.9 mm. Survival probabilities to Lower Granite Dam ranged from 0.144-0.682 and median arrival dates at Lower Granite Dam from 3-8 May 2008 for the summer, fall, winter, and spring groups. Smolt equivalents (outmigrants adjusted for survival to Lower Granite Dam) totaled 3,653.

Hatchery-origin Catherine Creek stock spring Chinook salmon have returned to spawn in Lookingglass Creek, produced outmigrants, and these outmigrants have returned to Lookingglass Creek and spawned. Natural-origin adult returns and natural production of juvenile outmigrants in 2008 were below that of the endemic stock during the period 1964-1971. The number of redds above the Lookingglass Hatchery weir in 2008 was the highest since outplanting began in 2004 and spawners were dominated by hatchery-origin fish. Outmigrants/redd for brood year 2006 was higher than the range for the endemic stock. Median arrival dates and survival probabilities to Lower Granite Dam for brood year 2006 outmigrants differed from Catherine Creek. Median arrival dates for Lookingglass Creek outmigrants were 10-17 d earlier and survival probabilities for three of four groups were 0.077-0.302 higher. The first complete brood year of natural production from Lookingglass Creek since Catherine Creek stock spawned above the Lookingglass Hatchery weir will occur in 2009. Outmigrant survival benefited from favorable stream flows in 2008.

Median arrival dates to Lower Granite Dam were typically during the month of May for both Lookingglass Creek and Catherine Creek natural-origin outmigrants for brood years 2004-2006. Survival probabilities for summer, winter and fall groups were substantially higher for Lookingglass Creek natural-origin outmigrants than Catherine Creek (Favrot et al. 2010) for brood years 2004-2006.

1.2 Introduction

The endemic Lookingglass Creek stock (Grande Ronde Basin) of spring Chinook salmon was extirpated within a few years after establishment of Lookingglass Hatchery (LH) in 1982. Lookingglass Creek is within the "usual and accustomed" areas of gathering for the Confederated Tribes of the Umatilla Indians (CTUIR). CTUIR, along with comanagers Oregon Department of Fish and Wildlife (ODFW) and Nez Perce Tribe (NPT), began efforts in the early 1990s to reestablish natural production of spring Chinook salmon in Lookingglass Creek. Several stocks, including remnants of the endemic stock, Imnaha River, Wind River (Washington), Carson Hatchery (Washington), and Rapid River (Idaho) were used before comanagers selected Rapid River. The Rapid River stock was replaced with Catherine Creek spring Chinook beginning in 2001. The Catherine Creek spring Chinook is native to the Grand Ronde basin. Annual reports describing the historical efforts at reestablishing natural production of spring Chinook salmon in Lookingglass Creek are available at http://www.fws.gov/lsnakecomplan/CTUIR_Reports.html. Our project goal is to reintroduce spring Chinook salmon into Lookingglass Creek using the Catherine Creek stock to support natural population restoration, tributary harvest, and maintenance of a gene bank for the Catherine Creek stock. Our Research, Monitoring and Evaluation (RM&E) goal is to conduct studies to inform managers concerning use of a local spring Chinook salmon broodstock for reintroduction into Lookingglass Creek. Specific RM&E objectives are to compare performance metrics across three time periods of two reintroduced stocks, Rapid River, and Catherine Creek) with the extirpated endemic stock of spring Chinook salmon in Lookingglass Creek (Burck 1993) and to evaluate use of Catherine Creek F_1 captive broodstock progeny for natural spawning and hatchery production.

The above goals and objectives 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.**"** The tribal goals fit within the framework of mitigation goals established for the Lower Snake River Compensation Plan.

1.3 Study Area

The Lookingglass Creek watershed is part of the Grande Ronde Basin in the Blue Mountains of northeast Oregon with the headwaters at an elevation of 1,484 m above sea level (Figure 1). Flow is to the southeast for 25 river km (rkm) through the Umatilla National Forest then through private land before entering the Grande Ronde River at rkm 137 at an elevation of 718 m above sea level. Months of peak flow are usually April and May (Figure 2). Lookingglass Creek has five major tributaries: Lost Creek (rkm 17.3), Summer Creek (rkm 16.5), Eagle Creek (rkm 13.3), Little Lookingglass Creek (rkm 6.4), and Jarboe Creek (rkm 3.6). Lookingglass Creek and Little Lookingglass Creek (the largest tributary) are the only major areas where spring Chinook salmon spawning takes place with any regularity. LH is located from rkm 3.6-4.2 on Lookingglass Creek. Returning adult spring Chinook salmon are prevented from moving further upstream by the Lookingglass Hatchery weir and trap at rkm 4.2.

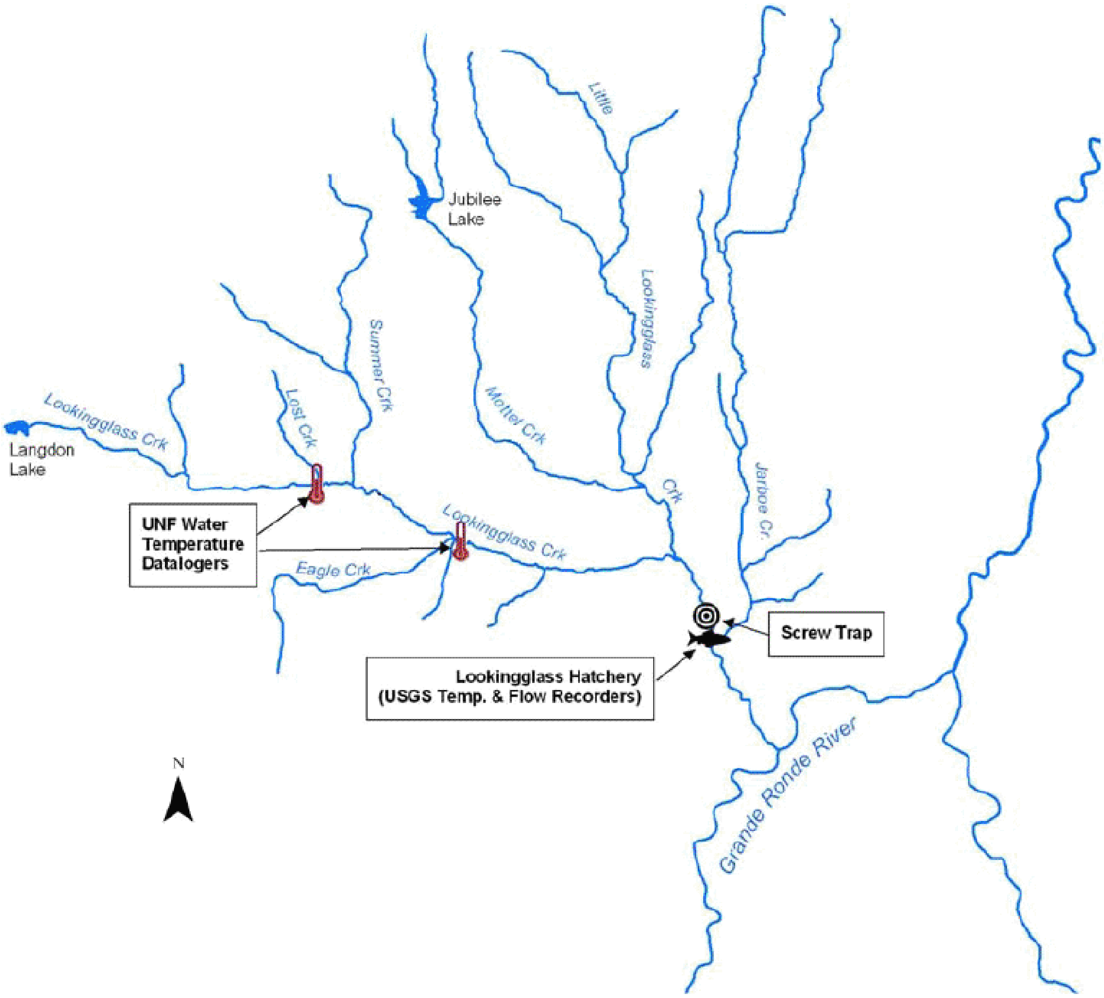

Figure 1. Map of the Lookingglass Creek basin showing the locations of major tributaries, temperature and flow recorders, screw trap and Lookingglass Hatchery.

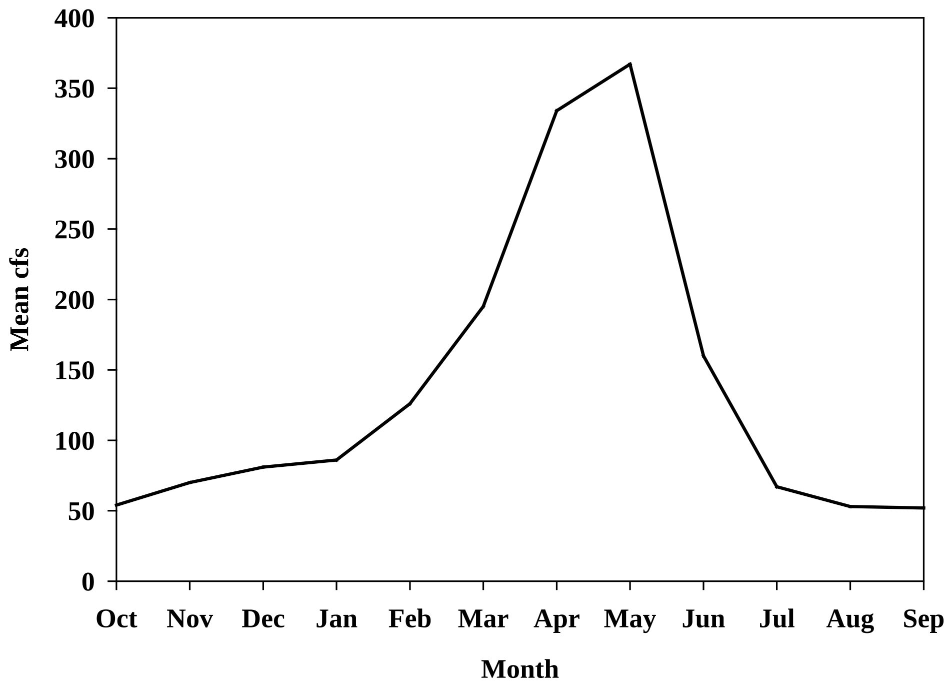

Figure 2. Mean stream flows (cfs) by month of the water year for Lookingglass Creek (data from Herrett et al. 2005).

1.4 Methods

1.4.1 Adult Spring Chinook Salmon

Adult spring Chinook salmon returning to Lookingglass Creek were diverted by a picket weir into a trap at the Lookingglass Hatchery water intake. ODFW Lookingglass Hatchery staff install and operate the picket weir and trap annually from 1 March through mid-September. The trap is checked at least 3 times (Monday, Wednesday, Friday) weekly. ODFW Lookingglass Hatchery staff record catch data and these are reported in detail in annual reports for the Spring Chinook Salmon Evaluation Studies, available at http://www.fws.gov/lsnakecomplan/Reports/ODFWreports.html.

Adult spring Chinook salmon captured in the Lookingglass Hatchery trap in 2008 could have been from several sources: Lookingglass Creek natural production above or below the hatchery weir, hatchery-reared Catherine Creek stock captive broodstock progeny released into Lookingglass Creek, hatchery-reared returns from other Grande Ronde Basin stocks (including Upper Grande Ronde River stocks) and naturally–produced adults from other streams. Juveniles released from Lookingglass Hatchery into Lookingglass Creek during 2005-2006 totaled 241,321. None were released in 2007. Hatchery-origin releases totaled 97,368 brood year 2003 smolts during March-April 2005 and 124,915 brood year 2004 smolts during March-April 2006. A release of 19,038 brood year 2004 presmolts occurred during September-November 2005. All were marked externally with adipose fin clips and internally with coded wire tags except 31,445 brood year 2003 smolts that received only adipose fin clips. Hatchery releases are normally made in the spring below the adult weir and rotary screw trap at approximately rkm 3.7.

Disposition of returns is determined based on a sliding scale (Appendix A). Natural-origin returns and hatchery-origin returns were placed in a holding pond at Lookingglass Hatchery for later release above the weir to spawn naturally or for use as hatchery broodstock. All fish released above the weir were measured (mm FL), sexed, and a small amount of tissue from the right opercle was removed with a round paper punch and preserved in 90% ethanol for later genetic analysis. Opercle punches were also used to distinguish any spawners above the weir that were not caught at the trap and for estimating the spawning population.

An observational experiment was conducted by ODFW/CTUIR in 2007 and 2008 to determine redd location for specific females. Females released above the weir were PIT-tagged in the body cavity prior to outplanting upstream of the hatchery weir. Redds and carcasses recovered on spawning ground surveys above the weir were scanned with a PIT tag reader to identify tags. Study findings will be discussed in a future report (Tim Hoffnagle, personal communication).

Scales were collected and used to make age determinations for a portion of the natural-origin returns, and the results were expanded to the entire group. Ages for a portion of the hatchery-origin returns were determined by CWT data from the Regional Mark Information System (RMIS) database maintained by the Pacific States Marine Fisheries Commission (http://www.rmpc.org/) and also expanded to the entire group.

Spawning ground surveys (Parker et al. 1995) were conducted during August-September 2008 to assess natural spawning. Surveys were conducted in 5 stream units weekly after adults were outplanted above the LH weir (Figure 3). Only completed redds were counted (Lofy and McLean 1995) and flagged to eliminate double counting. Carcasses were enumerated and FL (mm), sex, marks (including scanning for PIT tags), and percent spawned recorded. Tails were cut off to prevent double sampling. Snouts were taken from all carcasses with an adipose fin clip for CWT recovery. CWT data were used for determining strays that spawned above and below the weir in addition to growth. Kidney samples were taken from a portion of the carcasses to determine incidence of bacterial kidney disease (O'Connor and Hoffnagle 2007). Opercle punches were taken from carcasses recovered in units 2, 3L, 3U, and 4 without punches and the tissues preserved for genetic analysis.

Population estimates of spawners above the hatchery were made for fish $\leq$ 60 cm FL and $\geq$ 61cm by origin (hatchery or natural) using the Chapman modification of the Petersen method (Ricker 1975).

The number marked and released above the weir was decreased by the number of marked fish that were recovered below the weir if the number was substantial. The number of marked fish recovered below the weir is a minimum number since the actual number that spawned below the weir, drifted out of Lookingglass Creek, or were eaten by scavengers is unknown. Actual spawners were obtained by subtracting the percentage of prespawn mortalities observed (females ≤ 50% spawned out) on spawning ground surveys.

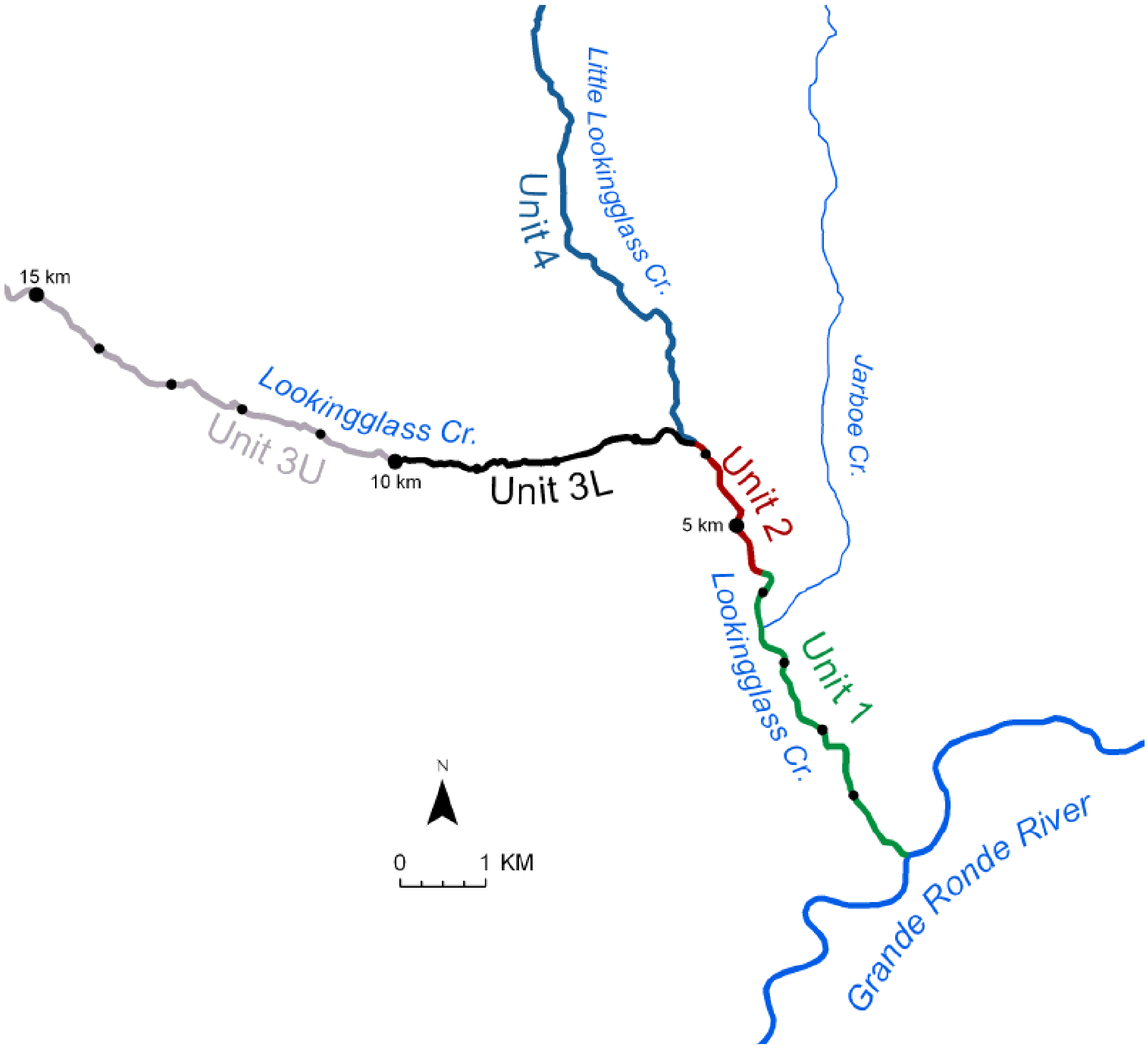

Figure 3. Spawning ground survey unit designations and river kilometers for Lookingglass Creek (modified from Burck 1993).

1.4.2 Juvenile Spring Chinook Salmon

We monitored seasonal growth of naturally-produced BY 2006 spring Chinook salmon by obtaining fork lengths (mm) and weights (0.1 g) of 50 fish collected by snorkel/seining at several locations above and below the Lookingglass Hatchery adult trap (rkm 0.4, 4.0, 8.9, and 10.5) on the 20th (+/- 5 d) of July, August, and September 2007. Burck (1993) used similar methods to describe growth of juvenile spring Chinook salmon during 1964-1970.

We captured (snorkel/seine) and PIT-tagged a group of BY 2006 parr from the primary rearing area above Lookingglass Hatchery in early August 2007. Parr were PIT-tagged using standard procedures (PIT Tag Steering Committee 1999) and released at site of capture. Recaptures of parr PIT-tagged and released in August 2007 (summer group of BY 2006) were not reused for trap efficiency but counted as unmarked and released below the screw trap.

We operated a 1.52 m diameter rotary screw trap at rkm 4.0 on Lookingglass Creek 0.2 rkm below the Lookingglass Hatchery adult trap to collect outmigrating naturally-produced juvenile spring Chinook salmon. Trap operation was suspended during the spring freshet, midsummer during low flows when temperatures were high and when iced up in winter. Except for the spring freshet, these are periods when historically there have been few outmigrants. We made no attempt to estimate outmigrants during these periods. The trap was checked three times per week or more frequently if catches or flows were high. All outmigrants were identified, counted, examined for external marks, scanned for PIT tags, measured (nearest mm FL), and weighed (nearest 0.1 g). Untagged fish captured for the first-time were PIT-tagged using standard methods (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.

We used DARR 2.0 (Bjorkstedt 2008) to estimate the numbers of outmigrants. DARR 2.0 uses stratified mark-recapture data and pools strata with similar capture probabilities. We used the “one trap” and “no prior pooling of strata” options.

Outmigrants collected at the screw trap could be distinguished into brood years based on marks or size. The fall 2007 group of natural-origin BY 2006 fish was caught, PIT-tagged or fin-clipped and released from 22 August-30 September 2007, the winter 2007 group from 1 October-31 December 2007, and the spring 2008 group from 1 January-31 July 2008. Some BY 2007 fry or parr were caught during January-May of 2008 and distinguished from BY 2006 by their much smaller size and lower abundance. BY 2007 juveniles were not marked or used in estimates of trap efficiency. Production and performance of BY 2007 natural-origin spring Chinook salmon will be described in the 2009 annual report.

We estimated survival, capture probability, and travel time using the Pacific States Marine Fisheries Commission PIT tag database at http://www.ptagis.org/ and PitPro (Westhagen and Skalski 2007). We used the standard configuration in PitPro, excluded the *.rcp file, and included the *.mrt file. Observation sites, in downstream order, were Lower Granite Dam, Little Goose Dam, Ice Harbor Dam, Lower Monumental Dam, McNary Dam, John Day Dam, Bonneville Dam, and the Estuary Towed Array (Juvenile). Lower Granite Dam was used as the last recapture site. Smolt equivalents for BY 2006 natural production above the weir were calculated as the number of outmigrants per season (fall, winter, spring) adjusted by seasonal survival probabilities.

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].

1.5 Results

1.5.1 Adult Spring Chinook Salmon

1.5.1.1 Unmarked Returns to the Lookingglass Hatchery Trap

Natural-origin returns to the LH weir caught from 14 May-3 September 2008 totaled 53 (15 F, 38 M). Monthly totals for June, July, August, and September were 25, 18, 9, and 1, respectively. Males could be placed in two size groups, 44-53 cm FL (N=4) and 66-84 cm FL (N=34). Females ranged from 67-80 cm FL. Natural-origin returns were 8% age 3 (N=4), 83% age 4 (N=44), and 9% age 5 (N=5), based on scales from 32 outplants and expanded to the total number trapped. Hatchery-origin returns to the trap totaled 319.

1.5.1.2 Outplants

Outplants (including both hatchery- and natural-origin returns) were released at rkm 10.5 above the Lookingglass Hatchery weir on 5 August (N=154), 13 August (N=11), and 27 August 2008 (N=23). Outplants totaled 101 females and 87 males and ranged from 44-85 cm FL (Figure 4). Hatchery-origin outplants could be separated into two groups based on FL, 44-53 cm (N=7) and 60-85 cm (N=143). Natural-origin outplants could also be separated into two groups based on FL, 48-51 cm (N=2) and 66-85 (N=36) cm. These length groups probably corresponded to age 3 (44-53 cm FL) and ages 4 and 5 (60-85 cm FL), based on previously collected scale and CWT data.

1.5.1.3 Spawning Ground Surveys

Spawning ground surveys were conducted from 11 August to 29 September 2008 (Table 1). The first redds were observed on 21 August and the last on 20 September. More redds were observed above the trap (N=104) than below (N=39). The peak number of new redds above (N=54) and below (N=22) the hatchery weir occurred on 29 August. Additional surveys of unit 3U on 26 September and units 2, 3L, and 4 on 29 September yielded additional carcasses, but no new redds. All but one of the new redds were observed from 21 August-10 September. Weather and visibility conditions were generally excellent during the survey period.

Carcass recoveries above the Lookingglass Hatchery adult trap totaled 67 and included 58 hatchery- and 9 natural-origin (Table 2). None of the hatchery- (N=36) or natural-origin females (N=6) recovered above the hatchery trap were prespawning mortalities.
Fish ≤ 60 cm FL released were hatchery- (N=9) and natural-origin (N=2).
Fish ≥ 61 cm FL released were hatchery- (N=141) and natural-origin (N=36).

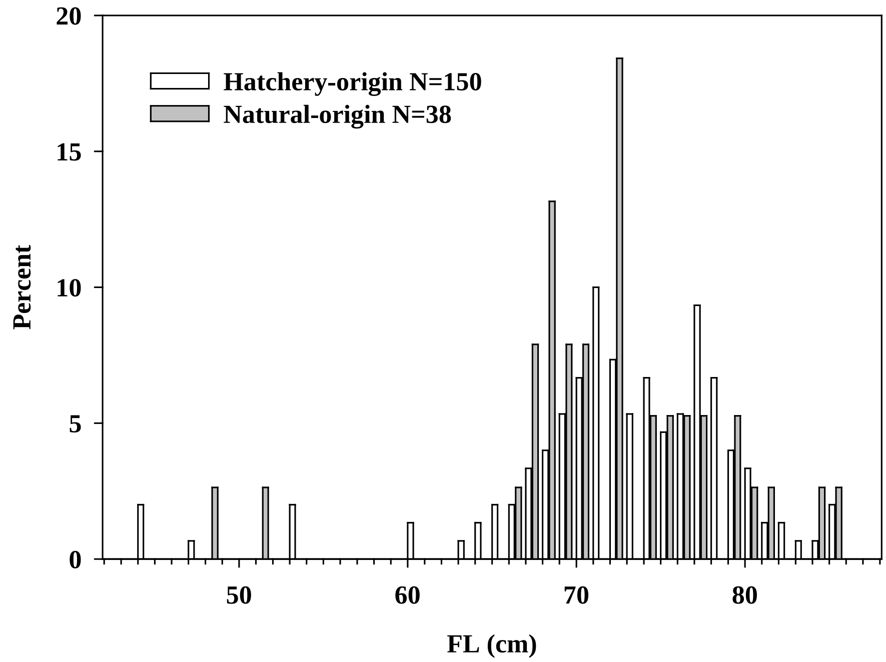

Figure 4. Fork length frequency for spring Chinook salmon (natural- and hatchery-origin) caught in the Lookingglass Hatchery adult trap and outplanted above the weir to spawn naturally in 2008.

Table 1. New redds observed on surveys of Lookingglass Creek by date and unit, 2008.

	Unit				
Date	1	2	3L	3U	4
8/11/08					
8/20/08					
8/21/08	6			10	
8/22/08			3		
8/27/08			7		
8/29/08	22			34	16
9/4/08	6	6			3
9/5/08			5	10	
9/10/08	4	4	4	2	
9/18/08					
9/19/08					
9/20/08	1				
9/26/08					
9/29/08					
Totals	39	10	19	56	19

The population estimate of hatchery-origin spawners ≤ 60 cm FL above the weir was 10 (SE = 0 due to no unpunched carcasses recovered). Two hatchery-origin carcasses ≤ 60 cm FL were recovered and both were opercle-punched. Natural-origin spawners ≤ 60 cm FL was assumed to be 2, since 2 were released above the weir and none were recovered.

The population estimates of spawners ≥ 61 cm FL above the weir were 145 with SE=3 (hatchery-origin) and 37 with SE=0 (natural-origin). The age composition of natural-origin spawners above the weir was 5% age 3, 82% age 4, and 13% age 5. Age composition of hatchery-origin spawners above the weir was 6% age 3, 94% age 4, and <1% age 5. Fish per redd above the weir (all sizes) was 1.87 (194/104) and adults (≥ 61 cm FL) per redd was 1.75 (182/104). Females released above the weir per redd was 0.97 (101/104).

Table 2. Spring Chinook salmon carcass recoveries above the Lookingglass Hatchery weir, 2008.

Origin	Sex	FL (cm) Range	OP-Punch	No OP-Punch	Unk OP-Punch
Hatchery	M	49	1		
	M	63-85	20	1	
	F	60	1		
	F	65-79	35		
Natural	M	74-82	2		1
	F	66-81	6		

Carcass recoveries below the trap totaled 27 hatchery- and 6 natural-origin (Table 3). None of the females recovered (17 hatchery-and 1 natural-origin) below the weir were prespawning mortalities.

Table 3. Spring Chinook salmon carcass recoveries below the Lookingglass Hatchery weir, 2008.

Origin	Sex	FL (cm) Range	OP-Punch	No OP-Punch	Unk OP-Punch
Hatchery	M	51		1	
	M	72-90	1	8	
	F	62-80		17	
Natural	M	41-53	1	1	1
	M	82-83		2	
	F	69		1	

Five tag codes were represented in the hatchery-origin carcasses recovered above the Lookingglass Hatchery weir (Table 4). One Lostine River recovery and two Catherine Creek recoveries made up 7% of the total and the remaining 41 recoveries were Lookingglass Creek stock. There were 12 hatchery-origin carcasses from 67-85 cm FL that were tag status 2 (no CWT present). There was 1 CWT (69 cm female) that was lost before being read and 1 (71 cm female) for which the snout had not been read.

Table 4. CWT recoveries by code from above the Lookingglass Hatchery weir, 2008.

BY	Code	Recoveries	Stock	Release Location
2005	94357	1	Catherine Creek	Catherine Creek
2004	94211	1	Lostine River	Lostine River
	94216	22	Lookingglass Creek	Lookingglass Creek
	94217	19	Lookingglass Creek	Lookingglass Creek
	94218	1	Catherine Creek	Catherine Creek
Total		44		

Five tag codes were also represented in the carcasses recovered below the Lookingglass Hatchery weir (Table 5). Three Lostine River recoveries and one Catherine Creek recovery made up 13% of the total. The remaining 19 recoveries were Lookingglass Creek stock or Catherine Creek stock released into Lookingglass Creek. There were 3 hatchery-origin carcasses from 51-74 cm FL without CWT and 1 (86 cm male) for which the snout had not been read.

Table 5. CWT recoveries by code from below the Lookingglass Hatchery weir, 2008.

BY	Code	Recoveries	Stock	Release Location
2004	94210	1	Lostine River	Lostine River
	94211	2	Lostine River	Lostine River
	94216	11	Lookingglass Creek	Lookingglass Creek
	94217	8	Lookingglass Creek	Lookingglass Creek
2003	93824	1	Catherine Creek	Lookingglass Creek
Total		23		

1.5.1.4 Length and Age at Recovery

Natural-origin returns aged were dominated by females (Table 6). Mean FL of age 4 females was 22 mm greater than age 4 males.

Table 6. Mean fork length at age of recovery by sex for natural-origin spring Chinook salmon caught at the Lookingglass Hatchery trap or recovered on spawning ground surveys, 2008.

Sex	Age	$\bar{X}$ FL	Range	SE	N
M	3	500.0	485-515	15.0	2
M	4	700.0	680-758	12.2	6
M	5	826.0	795-854	13.1	4
F	4	722.0	660-810	8.8	20

1.5.2 Juvenile Spring Chinook Salmon

1.5.2.1 Brood Year 2006 Natural Production

Mean FL of BY 2006 parr sampled at rkm 4.0-10.5 sites were similar in July 2008, differing by only 1.0 mm. Parr sampled in July 2008 at rkm 0.4 near the mouth of Lookingglass Creek had a mean FL 7.1-8.1 mm greater than parr sampled at upstream sites (Table 7). Mean FL of parr in September 2008 was greater at rkm 0.4 than at the two most upstream sites. Mean condition factors varied little between months or sampling locations. Staff constraints precluded sampling at all 4 sites during July-September 2008.

Spring Chinook salmon BY 2006 parr were collected from several locations above the LH weir from 3-8 August 2007, PIT-tagged and released. Recaptures of the Lookingglass Creek BY 2006 summer group totaled 52 and included 2 trap mortalities and 1 precocial parr captured on 16 September 2008. The first summer group recapture occurred on 31 August 2007. The largest numbers were caught in October 2007 (N=7), November 2007 (N=14), and December 2007 (N=12). A total of 44 from the BY 2006 Lookingglass Creek summer group were detected leaving the Catherine Creek (N=10), upper Grande Ronde River (N=16) and Lostine River (N=18) acclimation facilities in March and April 2008, meaning that they made their way from Lookingglass Creek to the Lookingglass Hatchery rearing ponds. After the spring high water receded in 2008, an inspection revealed that after some earlier repairs, the seal on one of the travelling screens had not seated properly, allowing fish to go from Lookingglass Creek into the rearing ponds. The number that went into the rearing ponds could not be accurately estimated, but it was probably substantial, and resulted in an underestimate of total outmigrant production from Lookingglass Creek upstream of Lookingglass Hatchery.

Table 7. Fork length and condition factor summary for BY 2006 spring Chinook salmon parr seined at three locations in Lookingglass Creek during July-September, 2007.

		Fork length (mm)				Condition Factor	
rkm	Month	Mean	Min	Max	N	Mean	N
0.4	July	71.7	53	87	54	1.37	54
	August	82.1	63	92	52	1.34	52
	September	91.7	76	105	55	1.20	55
4.0	July	64.6	53	85	49	1.32	49
8.9	July	64.1	55	81	55	1.29	55
	September	85.2	74	102	45	1.24	74
10.5	July	63.6	53	78	46	1.29	4
	September	83.0	72	93	53	1.31	53

The screw trap was fished 90 out of a possible 181 d (50%) during the period 1 January-30 June 2007 (first fished on 26 March 2007), 124 of 184 d (67%) during 1 July-31 December 2007, and 138 of 182 d (76%) during 1 January-30 June 2008.

BY 2006 outmigrants were collected in the screw trap starting on 2 April 2007 (one 33 mm FL and one not measured). Seven from 61-67 mm FL were caught from 11 June-3 July 2007. The first substantial numbers were caught beginning on 22 August 2007 (6 from 70-84 mm FL). Natural-origin precocials caught from 20 August-20 September 2007 ranged from 111-200 mm FL (N=11). Hatchery-origin precocials caught from 22 August-30 September 2007 ranged from 118-197 mm FL (N=12). Hatchery-origin precocials were fish that remained in the stream and matured after release from Lookingglass Hatchery.

Data were grouped into 10 periods to use in DARR 2.0; 16 August-15 September 2007, 16-30 September 2007, 1-31 October 2007, 1-15 November 2007, 16-30 November 2007, 1-15 December 2007, 16 January-29 February 2008, 1-31 March 2008, 1-15 April 2008, and 16-30 April 2008. DARR 2.0 pooled time periods with similar capture probabilities to reduce the number of periods used for the overall estimate to 5 (Table 8). We used the original number of time periods in Table 8 to show how outmigrants were distributed throughout the migration year. Estimated outmigrants per redd for BY 2006 were 447 (12,502 BY 2006 outmigrants/28 redds in 2006).

Table 8. Naturally-produced BY 2006 juvenile spring Chinook salmon caught in the Lookingglass Creek rotary screw trap, releases and recaptures from trap efficiency tests, outmigrant estimates and overall standard error, MY 2008.

Period	u	m	r	C_p	N
August-September E	54	50	2	0.028	1,918
September L	64	62	2	0.028	2,273
October	109	80	2	0.028	3,871
November E	102	79	11	0.139	733
November L	18	11	2	0.069	260
December	91	62	4	0.069	1,313
January L-February L	34	28	1	0.069	491
March	56	49	1	0.063	885
April E	45	40	7	0.063	711
April L	14	10	3	0.300	47
MY 2008 Total (SE)					12,502 (3,717)

u=newly caught, unmarked fish (includes fish not marked and released above the trap)
m=newly marked and released above the trap
r=recaptures summed across all time periods
Cp=capture probability (trap efficiency)
N=outmigration estimate
SE=standard error(variance$^{0.5}$)
E=1-15 of each month
L=16-end of each month

A total of 471 outmigrants were PIT-tagged for the fall 2007 (N=112), winter 2007 (N=232), and spring 2008 (N=127) groups. The fall 2007 group was tagged from 20 August-30 September 2007 (median 17 September 2007), the winter 2007 group from 2 October-6 December 2007 (median 10 November 2007), and spring 2008 group from 18 January-28 April 2008 (median 24 March 2008).

Mean FL and weight progressively increased for the summer 2007, fall 2007, winter 2007, and spring 2007 groups, but condition factor decreased (Table 9). Survival probabilities for the summer and fall 2007 groups were similar, increased substantially for the winter 2007 group, and was highest for the spring 2008 group (Table 10). Smolt equivalent estimates (outmigrants for each group surviving to Lower Granite Dam) for fall 2007, winter 2007 and spring 2008 were 604, 1,594, and 1,455, respectively, for a total of 3,653. Median arrival dates for three of the four seasonal groups were the same.

Table 9. Fork length, weight and condition factor summary by group for natural-origin BY 2006 spring Chinook salmon caught in the Lookingglass Creek screw trap, PIT-tagged and released.

	Group			
Statistic	Summer 2007	Fall 2007	Winter 2007	Spring 2008
Fork Length (mm)				
Mean	71.5	81.1	85.3	94.9
SE	0.2	0.8	0.4	1.1
Min-Max	54-98	62-109	68-104	61-186
n	1,657	112	232	127
Weight (g)				
Mean	4.6	6.3	6.8	9.8
SE	0.04	0.2	0.1	0.6
Min-Max	1.7-11.6	2.6-14.5	3.6-11.9	2.7-72.8
n	1,655	112	231	122
Condition Factor				
Mean	1.23	1.15	1.09	1.08
SE	0.003	0.01	0.01	0.01
Min-Max	0.75-1.93	0.81-1.64	0.62-1.85	0.82-1.31
n	1,651	112	231	122

Table 10. Survival probabilities, travel time, and arrival timing to Lower Granite Dam summary by group for natural-origin BY 2006 spring Chinook salmon caught in the Lookingglass Creek screw trap, PIT-tagged and released.

	Group			
Statistic	Summer 2007	Fall 2007	Winter 2007	Spring 2008
Survival Probability	0.157	0.144	0.258	0.682
SE	0.013	0.033	0.035	0.076
n	1,659	112	232	127
Travel Time (d)				
Harmonic Mean	277.4	225.9	175.8	37.9
SE	1.2	3.0	4.6	4.2
n	109	10	26	34
Arrival Date				
10%	4/29/2008	4/20/2008	4/30/2008	4/22/2008
Median	5/8/2008	5/3/2008	5/8/2008	5/8/2008
90%	5/25/2008	5/12/2008	5/18/2008	5/30/2008
n	109	10	26	34
n (expanded)	161	18	44	57

1.6 Discussion

Naturally-produced adult returns in 2008 were about 13% of the average returns from run years 1968-1974 (Burck 1993). The number of redds above the hatchery weir in 2008 was the highest since 2004, and about 53% of the average redds above the hatchery weir for run years 1964-1971 (Burck 1993). Spawners above the hatchery weir were mostly hatchery-origin and will likely produce higher numbers of juvenile outmigrants and adult returns than have been observed since 2004.

Redds in units 3U and 3L (Unit 3 of Burck 1993) were 72% of the total above the hatchery weir in 2008, compared to an average of 84% during run years 1964-1971 Burck (1993). The number of redds in unit 1 (from the hatchery weir to the mouth) is not comparable to the unit 1 totals in Burck (1993), since in some years surplus hatchery-origin fish from Catherine Creek are outplanted for harvest, and some survive to spawn naturally. The percentage of redds seen in 2008 in Little Lookingglass Creek (unit 4) of the total above the hatchery weir was 18, compared to an average of 13 reported by Burck (1993). Outplanting in some years occurs above the mouth of Little Lookingglass Creek, with few redds resulting. We will focus outplanting downstream of the mouth of Little Lookingglass Creek to allow fish a more natural opportunity to select spawning sites. New redds and carcass recoveries in 2008 occurred over a range of dates similar to those of Burck (1993).

Burck (1993) observed mean fork lengths at ages 3, 4, and 5 of 452, 671, and 808 mm, respectively, from a sample of 1,012 endemic stock returns. Mean fork lengths of natural-origin age 3-5 returns in 2008 were 18-48 mm greater than the endemic stock at all three ages, but the sample size was small (N=32)

Mean fork length of BY 2007 parr sampled at the rkm 8.9 site in July 2008 was similar to the range of mean for lengths obtained by Burck (1993) in July at a similar location over several years. Mean fork lengths for other sampling dates and locations in 2008 were generally greater than those obtained by Burck (1993) during the same months at similar locations. Condition factors in 2008 were consistently higher than those reported by Burck (1993). The differences in mean fork lengths and condition factors may result from lower densities in 2008 compared to the late 1960s and early 1970s, higher stream temperatures, a greater food supply or some combination of these factors.

The number of brood year 2006 juvenile outmigrants was approximately 21% of the average reported by Burck (1993) for brood years 1965-1969. Outmigrants per redd for the 2006 brood year was double the average reported by Burck (1993). Most brood year 2006 outmigrants left Lookingglass Creek during the fall as presmolts, similar to the endemic stock (Burck 1993) and the Catherine Creek (donor) stock (Favrot et al. 2010). Burck (1993) reported peak months of outmigration occurring during August (3 years), October (1 year) and September (1 year). Peaks for migration years 2006-2008 have occurred in September or October. Differences observed between the endemic stock and the current reintroduced stock may result have a genetic basis or possibly different sampling methods. Burck (1993) used a bypass trap that probably sampled smaller fish outmigrating during the low water periods of June, July, August, and September more effectively than the screw trap currently used.

Median arrival dates and survival probabilities to Lower Granite Dam for brood year 2006 Lookingglass Creek outmigrants differed from Catherine Creek. Median arrival dates were 10-12 d earlier for the Lookingglass Creek fall, winter, and spring groups, and 17 d earlier for the summer group. Survival probabilities for the Lookingglass Creek summer, winter, and spring groups were 0.077-0.302 higher than for Catherine Creek reported by Favrot et al. (2010). Survival of the fall group was 0.009 higher for Catherine Creek.

Medians of the survival probabilities to Lower Granite Dam for brood years 2004-2006 were higher for Lookingglass Creek outmigrants than Catherine Creek (Favrot et al. 2010) for all groups (summer, fall, winter, and spring). Median arrival dates to Lower Granite Dam were primarily in May for the 2004-2006 brood years across all groups for both Lookingglass Creek and Catherine Creek (Favrot et al. 2010).

Stray hatchery-origin adults spawned upstream of the Lookingglass Hatchery weir in 2008 but the percentage was less than the generally accepted standard of 5%. Strays from other streams or stocks spawning below the weir were greater than 5% and probably result from late-returning fish seeking cooler water temperatures in Lookingglass Creek (Richard Carmichael, personal communication).

No smolt-to-adult or progeny-per-parent ratios were reported this year, since 2009 will be the first completed returns for natural spawning above the weir (brood year 2004).

Peak flows in April-May 2008 were about double the long-term mean. Higher stream flows are generally associated with better migration conditions for both juvenile and adult anadromous salmonids. Occasional spikes in base flows resulted from rainfall events during the summer and fall, or rainfall or warm weather during the winter. Water supply in the Snake River-Columbia River hydrosystem was close to average, with runoff volumes ranging in the Columbia Basin at 87-130% of average (DeHart 2009). Increased survival of spring migrants was attributed to high spill levers (often in excess of court-ordered levels at Lower Granite Dam) and the delayed start of the smolt transport program resulting in a lower proportion of the run being transported (DeHart 2009).

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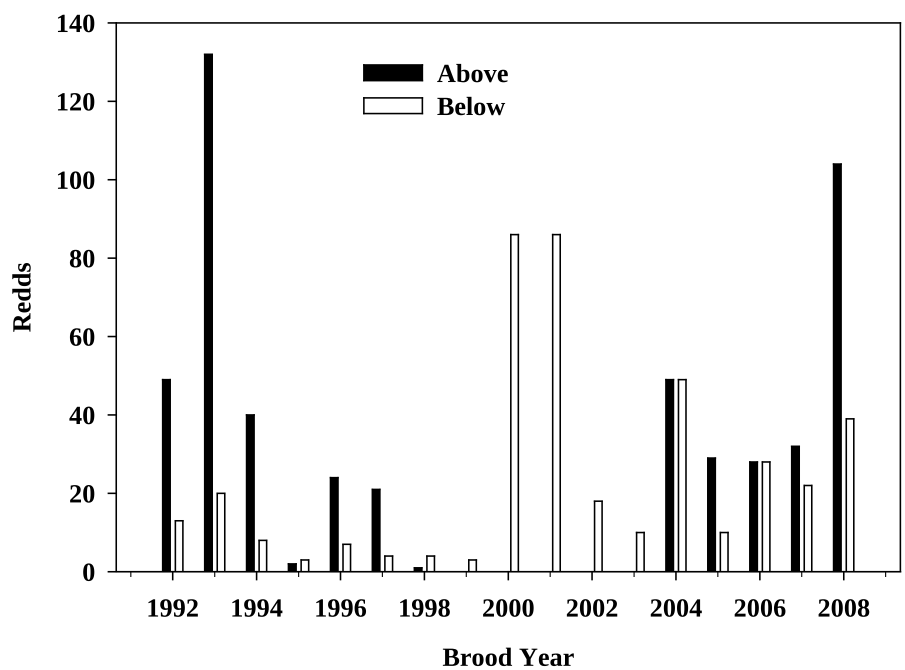
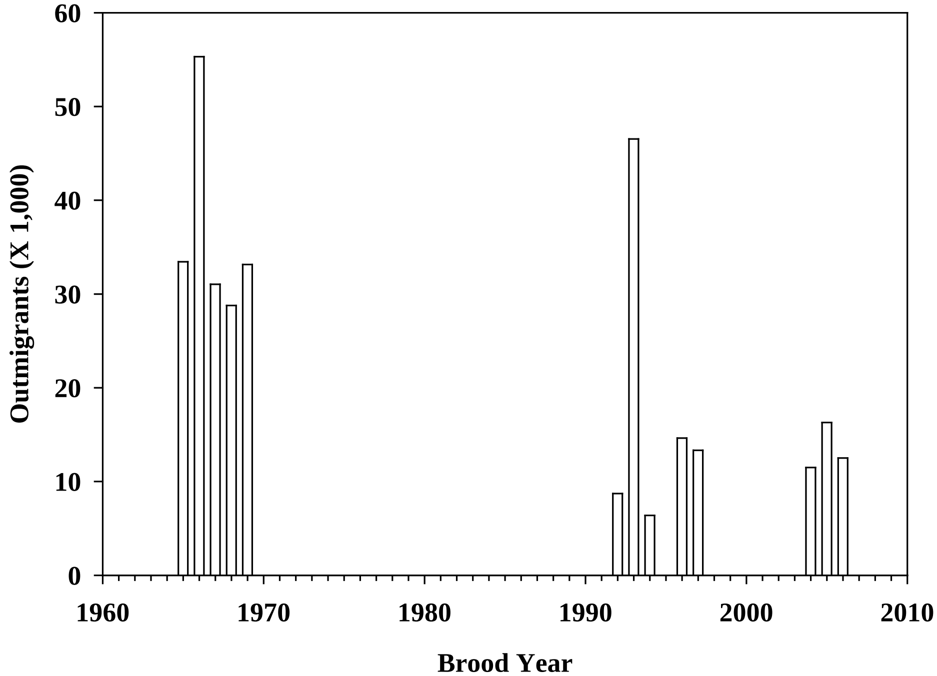
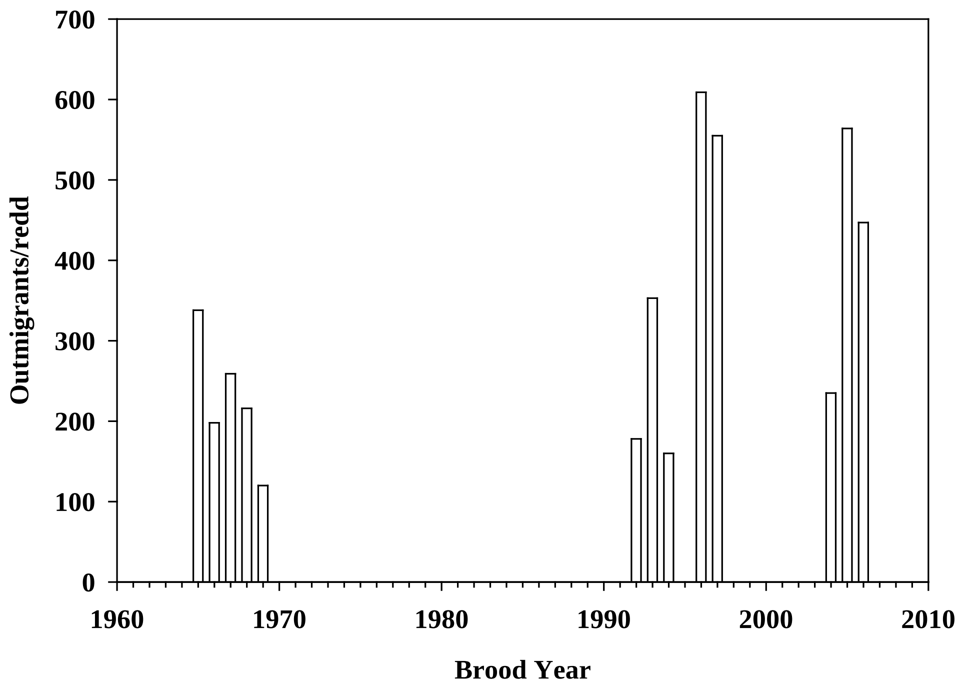
1.8 Appendix Figures



Appendix Figure 1. Spring Chinook salmon redds above and below the Lookingglass Hatchery trap, brood years1992-2008.



Appendix Figure 2. Spring Chinook salmon natural outmigrant production from Lookingglass Creek (above Lookingglass Hatchery), brood years 1965-2006.



Appendix Figure 3. Spring Chinook salmon outmigrants/redd (natural production above Lookingglass Hatchery) from Lookingglass Creek, brood years 1965-2006.

1.9 Appendix A Draft Lookingglass Creek Spring Chinook Salmon Management Plan (being reviewed by comanagers, October 2010)

Lookingglass Creek is co-managed by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Nez Perce Tribe (NPT), and Oregon Department of Fish and Wildlife (ODFW). The primary objective of this plan is to coordinate the restoration of spring Chinook into Lookingglass Creek using Catherine Creek stock and utilizing two hatchery programs; the Lower Snake River Compensation Plan (LSRCP) mitigation program and the Bonneville Power Administration (BPA) captive broodstock program. Activities in Catherine Creek will be outlined as they relate to the Lookingglass Creek restoration effort.

Program Goal

The goal of the Lookingglass Creek Spring Chinook Hatchery Program is to reintroduce spring Chinook into Lookingglass Creek using the Catherine Creek stock to support natural population restoration, tributary harvest, and maintenance of a gene bank for the Catherine Creek stock.

Adult Return Goals

There are no LSRCP or Tribal Recovery Plan (TRP) hatchery and natural adult return goals identified specifically for Lookingglass Creek. However, LSRCP does have a specific spring/summer Chinook goal of 58,700 hatchery adults for the Snake River and 5,820 hatchery adults into the Grande Ronde Basin. The TRP return goal for the Grande Ronde Basin is 16,000 adults. Restoration of a genetically independent Lookingglass spring Chinook population to a “viable status” is not necessary to achieve viable status of the Grande Ronde Major Population Group (MPG).

Historically, Lookingglass Creek abundance exceeded 1,000 adults based on redd count data from 1950s-1970s. The Interior Columbia Technical Recovery Team (ICTRT) has designated Lookingglass Creek as a “Basic Population” with a Minimum Abundance Threshold (MAT) of 500 natural adults.

Juvenile Production and Releases

To meet the LSRCP Grande Ronde Basin adult mitigation goal, a juvenile production target of 900,000 fish at 20 fish per pound with an estimated return rate of 0.87% was originally identified. In 2002, the Grande Ronde Spring Chinook Hatchery Management Plan (GRSCHMP) was developed which outlined more specific hatchery production goals for each tributary in the basin. The GRSCHMP identified an initial production target of 150,000 yearling smolts for Lookingglass Creek and 250,000 yearling smolts for Catherine Creek. After the captive brood evaluations were completed, the release goal for Lookingglass Creek was to be increased to 250,000 with a corresponding decrease to 150,000 for Catherine Creek. These changes have occurred and current production as listed in Table B1 of the 2008-2017 *United States v. Oregon* Management Agreement is outlined in Table 1.

Table 1. Lookingglass Creek (LGC) and Catherine Creek (CC) production at Lookingglass Hatchery (LOOH) outlined in Table B1 of 2008-2017 *United States v. Oregon*.

Release Site	Rearing Facility	Stock	Life Stage	Target Release #	Primary Program Purpose	Funding
LGC	LOOH/ Captive Brood	CC	Smolts	250,000	Fishery/ Reintroduction	LSRCP/ BPA
CC	LOOH/ Captive Brood	CC	Smolts	150,000	Supplementation/ Fishery	LSRCP/ BPA

The BPA captive brood program for Catherine Creek was established in response to low escapements in the mid to late 1990's. Production from this program not needed in Catherine Creek is available to meet any production shortfalls in the Lookingglass Creek program. However, this program is being phased out with brood year 2005. The last spawn of Catherine Creek captive adults should be 2010 with the last production available in 2012. Returns from this program would be expected through 2015

Releases for the Lookingglass Creek program occur on-station from Lookingglass Hatchery. Fish will be volitionally released for at least one week prior to force out in mid-April. Size at release goal is 20 fish per pound. Any changes in size or release strategies will be coordinated through the Lookingglass Hatchery Annual Operating Plan (AOP).

Marking

Marking for the Lookingglass Creek program has been outlined in Attachment C of the 2008-2017 *United States v. Oregon* Management Agreement. Conventional brood releases will be 100% Ad clipped with representative coded-wire-tag (CWT) groups. Captive brood releases will be 100% AdCWT.

Weir Management

All Lookingglass Creek adults arriving at the at the Lookingglass Hatchery intake weir prior to July 4 will be ponded into the adult holding ponds. Disposition of these adults will occur in early July according to the guidelines in Table 2 and adults designated to be passed upstream will be outplanted at that time. Disposition of Lookingglass Creek adults arriving after July 4 will be based on the percentages outlined in Table 2. All adults passed upstream will have genetic samples taken.

Adults arriving at the weir that are identifiable as Upper Grande Ronde or Lostine fish will be ponded into their respective brood ponds. Catherine Creek adults may be retained if needed for brood or spawning escapement or recycled into lower Lookingglass Creek

Table 2. Pass:Keep Disposition.

Escapement Level	% Passed Above	% Keep for Brood
150	67	33
200	60	40
250	55	45
300*	50	50

* *For escapements >300 – adjustments will be made based on brood needs. If brood need has been met remainder will be released upstream.*

Broodstock Management
Broodstock for the program will be collected from returns to either the Lookingglass Hatchery weir or the Catherine Creek weir. Either conventional or captive hatchery adults may be used for brood. The goal for broodstock composition will be to incorporate 30% natural origin adults to maintain genetic diversity and counteract domestication selection in the program. In addition, no more than 25% of the returning natural origin adults shall be retained for brood. The broodstock collection goal will not be constrained by the 25% cap on natural adult collection. If a shortage of natural adults occurs, then additional hatchery adults will be collected in order to meet the brood target. It is estimated that 158 adults (47 natural origin and 111 hatchery origin) will be required for brood to meet the 250,000 smolt production level.

Escapement
The ICTRT has established a MAT of 500 adults for Lookingglass Creek population in order to reach viable status with an estimated 90% of the historical habitat located upstream of the current weir site. Other documents have suggested that historically the full seeding level is much higher that this figure. In the near term, Lookingglass Creek in the reach above the weir will be managed for an escapement goal of 1,000 adults.

Jack Management
Hatchery jacks will be incorporated into the broodstock at a target rate of one for every 10 adult males collected. All natural jacks will be released upriver. No hatchery jacks will be released upriver. All CWT hatchery jacks will be sacrificed for tag recovery. Other hatchery jacks will either be sacrificed with carcasses provided to the Tribes or food banks or recycled into lower Lookingglass Creek for harvest benefits.

Surplus Production
Every attempt will be made to adhere to the production goals. However, surplus production may occur due to higher than anticipated fecundities or survival rates. Any production above the identified goals will be reared to full term yearling smolts if hatchery space is available. If space is not available, surplus production will be outplanted as fry or fingerlings in the fall into lower Lookingglass Creek. These fish would be 100% marked to indicate hatchery origin.

Fish Health
The Lookingglass Creek artificial production programs included within this management plan will follow the Integrated Hatchery Operations Team (IHOT) policies and

procedures for fish health. Bacterial Kidney Disease (BKD) is of special management concern within the spring Chinook program. Eggs from individual females will be incubated separately and eggs from females with an ELISA value of 0.8 or higher will be culled from the program. If a production surplus does occur, eggs from females with an ELISA reading higher that 0.4 may be culled rather than reared.

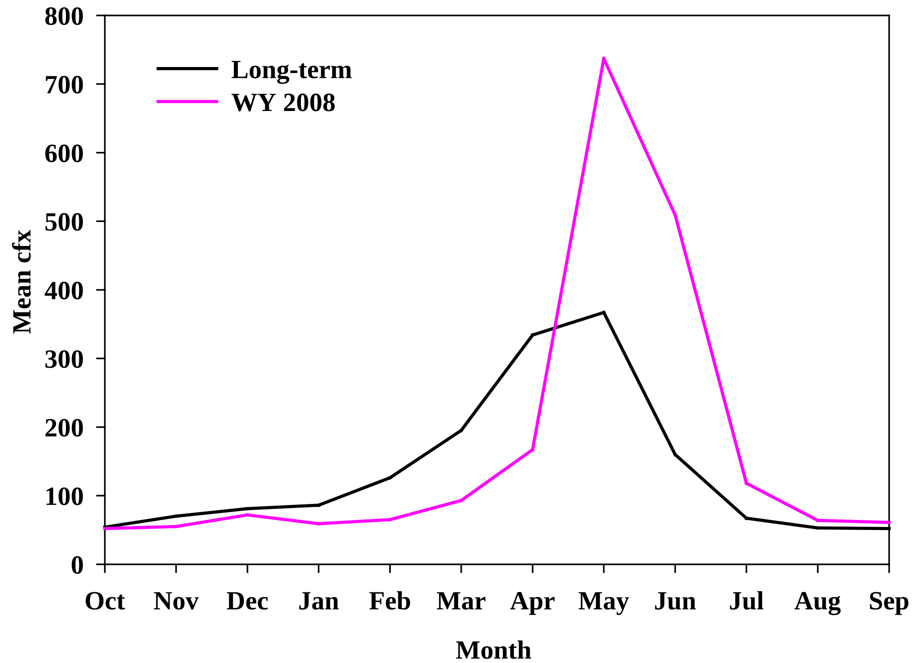
Harvest

It is anticipated that the run composition into Lookingglass Creek in the next few years will be heavily skewed toward hatchery origin adults. Large returns of hatchery origin spring Chinook may provide opportunities for harvest. Management details for harvest of spring Chinook in Lookingglass Creek and will be outlined in Tribal Resource Management Plans (TRMP), Fishery Management and Evaluation Plan (FMEP) and/or under the 4d Rule.

1.10 Appendix B Stream Environment in 2008

We obtained and summarized Lookingglass Creek stream flow data collected in 2008 by the United States Geological Survey (USGS) at USGS station 1332430 (Lookingglass Creek near Lookingglass, Oregon at rkm 4.0) near Lookingglass Hatchery. Historical flow and temperature data are available at:
http://waterdata.usgs.gov/or/nwis/uv/?site_no=13324300&PARAmeter_cd=00065,00060
Stream temperature data were obtained from electronic recording devices operated by the Umatilla National Forest (UNF) and USGS. The numbers and locations of temperature recorders used in the past varied; four were used in 2008. The UNF temperature recorders were located in Lookingglass Creek below the mouth of Eagle Creek, and at the "springs" site near Lost Creek. The USGS temperature recorder was located with the flow gauge near Lookingglass Hatchery.

Base flows during October-November 2007, months when substantial numbers of juvenile spring Chinook salmon outmigrate, were similar to the long-term mean (Appendix Figure 4). Flows were lower than the long-term mean during January-April 2007, months when many juvenile *O. mykiss* but much smaller numbers of juvenile spring Chinook salmon outmigrate. The May 2008 average monthly flow was double the long-term average for the month.



Appendix Figure 4. Long-term (water years 1982-2005, Herrett et al. 2005) and water year 2008 monthly mean cfs for Lookingglass Creek.

Water temperatures at the USGS site began rapidly increasing in late June 2008. The highest mean 7-d maximum of 16.2°C was recorded on 20 July and 18 August 2008. Mean 7-d maxima ≥ 10.0°C occurred from 17 June-7 October 2008 and ≥ 15.0 °C from 8 July-21 August 2008. Mean 7-d maximum water temperatures at the Eagle Creek site were ≥ 10.0°C from 26 July-20 August 2008 with a peak of 10.8 °C on 3 dates (29-31 July 2008). Mean 7-d maximum water temperatures at the "springs" site were ≥ 10.0°C from 3 August-4 September 2008 with a peak of 13.9 °C on 2 dates (19-20 August 2008).

Contor and Schwartz (2007) found a significant exponential relationship between maximum stream temperature and spring Chinook salmon prespawning mortality in the Umatilla River, Oregon, and that such data may be useful in modeling production potentials and recovery strategies.

2 SECTION II . *ONCORHYNCHUS MYKISS* INVESTIGATIONS IN LOOKINGGLASS CREEK

2.1 Abstract

A total of 129 wild summer steelhead were caught in the Lookingglass Hatchery adult trap from 17 March-16 June 2008, including 75 females and 54 males. Six hatchery-origin (4% of the combined total) were caught. Mean FL of males was greater than females at all three ocean ages sampled. Age composition was 46% 1-salt, 49% 2-salt, and 5% 3-salt. Approximately 28,491 wild juvenile outmigrants ≥ 80 mm FL left Lookingglass Creek from 1 July 2007-30 June 2008, with 94% leaving during January-June 2008. Capture probabilities ranged from 0.016-0.045. Mean FL for 53 fish PIT-

tagged and released from 20 August-5 December 2007 (fall group) was 158.2 mm, survival probability to Lower Granite Dam was 0.208, and median arrival date at Lower Granite Dam was 9 May 2008. Mean FL for 312 outmigrants PIT-tagged and released from 18 January-30 June 2008 (spring group) was 143.8 mm, survival probability to Lower Granite Dam was 0.553, and median arrival date at Lower Granite Dam was 8 May 2008. The trap catch of adult summer steelhead in 2008 was similar to the range observed since 2002 but substantially higher than the range observed during 1965-1974.. The number of outmigrants in migration year 2008 was higher than the range observed during 1965-1969. Outmigrants estimated using the screw trap may be overestimated due to avoidance behavior. Life history characteristics observed in 2008 were similar to those observed previously for Lookingglass Creek and other stocks of A-run summer steelhead in the Snake River Basin.

2.2 Introduction

Many anadromous salmonid stocks in the Snake River Basin have declined to the point of extinction, principally due to construction and operation of hydroelectric facilities, overfishing, and the loss and degradation of critical spawning and rearing habitat (Nehlsen et al. 1991). The Grande Ronde River Basin once supported large populations of fall and spring Chinook (*O. tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon and summer steelhead, and these populations have declined for similar reasons (U. S. Army Engineer District 1975, Nehlsen et al. 1991).

Hatcheries were built in Oregon, Washington and Idaho under the LSRCP to compensate for losses of summer steelhead due to the construction and operation of the four most downstream Snake River dams. Comanagers began hatchery augmentation in the Grande Ronde River using non-endemic Wallowa Hatchery stock in the early 1980s and sport harvest was reopened in 1986 (Flesher et al. 2008). Natural summer steelhead populations continued to decline and Snake River summer steelhead were listed as threatened under the Endangered Species Act of 1973 on 18 August 1997. Comanagers discontinued off-station releases of Wallowa Hatchery stock summer steelhead into Catherine Creek (1998) and the upper Grande Ronde River (1999) due to high stray rates. Wild adult summer steelhead return data for the Grande Ronde Basin prior to the year 2000 was essentially that of Lookingglass Creek (Olsen et al. 1985, McLean et al. 2001). Operation of traps on Catherine Creek and the Upper Grande Ronde River has expanded data collection since 2000 (Boe et al. 2010). ODFW reported wild juvenile *O. mykiss* life history data for Grande Ronde Basin tributaries beginning with migration year 1997 (Favrot et al. 2010). CTUIR has reported similar data since 1992 and began PIT-tagging *O. mykiss* outmigrants in 1999.
Annual reports for CTUIR are available at
http://www.fws.gov/lsnakecomplan/Reports/CTUIRreports.html.

2.3 Methods

2.3.1 Adult Summer Steelhead Returns

The picket weir and trap described in Section I of this report was used to collect adult summer steelhead returning to Lookingglass Creek. ODFW Lookingglass Hatchery staff operated the trap and collected data. All adult summer steelhead captured were counted, examined for fin clips and other marks or tags, measured (nearest mm FL), sexed (based on external characteristics), and scales collected for age determination. 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. Criteria for annuli were described by (Mosher 1969). Not all scales were readable, so the age composition of the aged sample was expanded to the total number trapped. A paper punch was used to remove opercle tissue from each fish passed upstream. Tissues were preserved in 95% ethanol and archived for future study. Week of capture was designated by the first day of the week (e.g. week of 1 January included 1-7 January). Hatchery-origin returns were euthanized. Wild adults were transported 0.6 rkm upstream and released.

2.3.2 Juvenile *O. mykiss*

We collected outmigrating juvenile *O. mykiss* using the 1.52 m diameter rotary screw trap described in Section I of this report. The trap was usually checked 3 times a week or more frequently if catches or flows were high. All *O. mykiss* were counted, examined for external marks, scanned with a PIT tag reader, measured (nearest mm FL), and weighed (nearest 0.1 g). Scale samples for age determination were collected from 5 fish per cm FL for the fall 2007 and spring 2008 groups. First-time captures ≥ 80 mm FL in good condition (no injuries or obvious disease) were PIT-tagged using standard methods (PIT Tag Steering Committee 1999). Some fish ≥ 80 mm FL received a partial fin clip (lower caudal) and were released above the trap to supplement the PIT-tagged sample for trap efficiency estimates. Recaptures of fin-clipped fish were apportioned to the various recapture periods using the percentages observed for PIT-tagged recaptures. All newly-PIT tagged and clipped outmigrants were released 0.1 rkm upstream of the screw trap; recaptures were released 0.3 rkm downstream of the screw trap. Some outmigrants were measured only and some less than approximately 80 mm FL were counted only; these fish were not tagged or marked and released below the screw trap.

We used DARR 2.0 (Bjorkstedt 2008) to estimate the number of outmigrants. DARR 2.0 uses mark-recapture data stratified by time period, pooling those with similar capture probabilities. We used the “one trap” and “no prior pooling of strata” options.

O. mykiss juveniles (all wild, no hatchery releases) outmigrate from Lookingglass Creek during the entire year, with a major peak in the spring (usually March-May) and a lesser peak in the fall (usually September and October). The conventional migration year was used (1 July of year *x* through 30 June of year *x*+1). The fall 2007 group was fish caught from 1 July-31 December 2007 and the spring 2008 group for fish caught from 1 January-30 June 2008.

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 2007). We used the standard configuration, 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. Outmigrants leave Lookingglass Creek at a wide range of sizes and may spend several years in areas of the Grande Ronde River between Lookingglass Creek and Lower Granite Dam before continuing their seaward journey and being detected in the hydrosystem. We estimated survival probabilities to Lower Granite Dam for two size groups of spring 2008 outmigrants, <115 mm FL and ≥115 mm FL (Favrot et al. 2010). We also totaled hydrosystem detections of both size groups of the spring 2008 release group.

2.4 Results

2.4.1 Adult Summer Steelhead Returns

Trapping began on 1 March 2008 and the first male and female wild adults were captured on 17 March and 24 March, respectively. The last male was collected on 16 June and the last female on 13 June. Weekly catches were steady from late March through late April, increased in early May, declined during late May, then increased again in early June (Figure 1). First time captures of wild adults included 75 females and 54 males. Cumulative percentages of males were higher than females for most of the trapping season (Figure 2). Recaptures of returns previously passed occurred from 9 April-14 May and totaled 8 (7 M, 1 F). Six hatchery-origin returns (4 males, 2 females)caught from 26 March-7 June made up 4% of the first-time captures. The FL distribution was bimodal for males and females but more distinct for females (Figure 3).

Mean FL of females was 14.8 mm greater than males (Table 1). Scales from 111 fish were aged. Length-at-age for males was greater than females at all three ages. The break for 1-salt and 2-salt was clear at about 66 cm FL. Fish from 45-65 cm FL were 82% 1-salt and 18% 2-salt. Fish from 66-79 cm FL were 4% 1-salt, 86% 2-salt, and 10% 3-salt. Age composition was estimated at 46% 1-salt, 49% 2-salt, and 5% 3-salt.

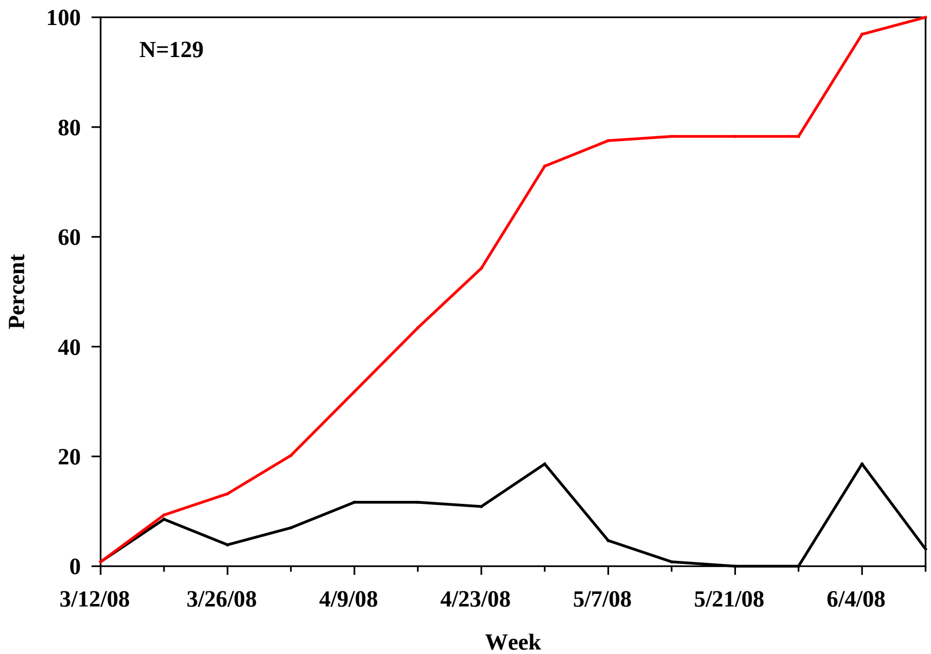


Figure 1. Total percent (solid line) and cumulative % (dashed line) catch by week for summer steelhead caught in the Lookingglass Hatchery trap, 2008.

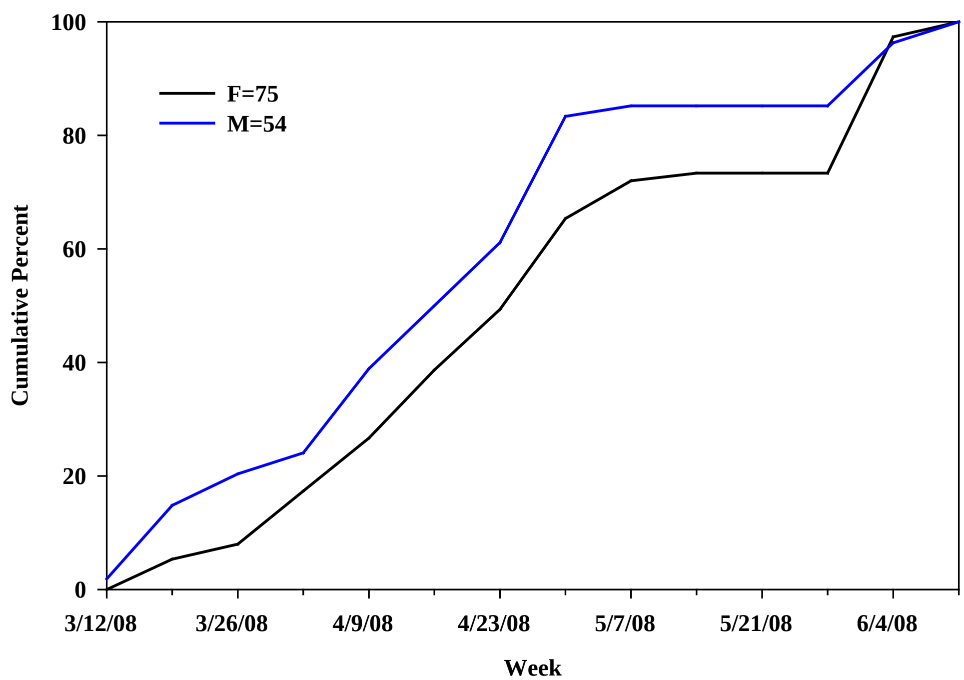


Figure 2. Cumulative percentages of total catch by week and sex for summer steelhead in the Lookingglass Hatchery trap, 2008.

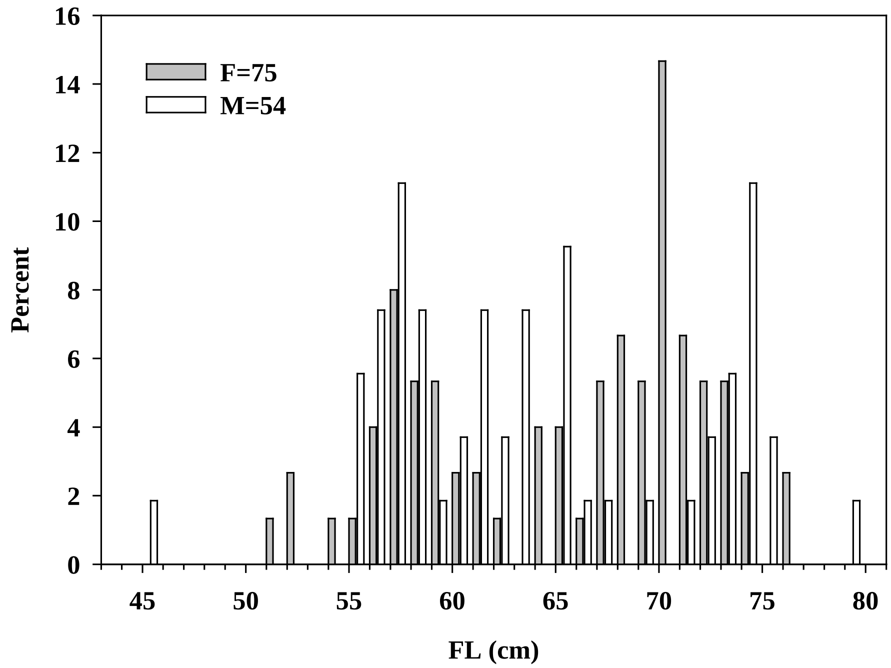


Figure 3. FL frequency of male and female summer steelhead caught in the Lookingglass Hatchery trap, 2008.

Table 1. Fork length summary for summer steelhead caught in the Lookingglass Creek trap by age and sex, 2008.

Sex	Age	$\bar{X}$ FL (mm)	SE	Min-Max	n
Male		639.5	10.1	450-790	54
	1-salt	596.7	8.9	450-714	29
	2-salt	703.2	14.3	575-750	14
	3-salt	762.5	27.5	735-790	2
Female		654.3	7.6	515-765	75
	1-salt	587.5	8.1	520-690	24
	2-salt	682.3	8.1	515-765	39
	3-salt	741.7	11.7	720-760	3

2.4.2 Juvenile *O. mykiss*

The trap was fished 124 of 184 d (67% of available) during 1 July-31 December 2007, and 138 of 182 d (72%) during 1 January-30 June 2008. We did not attempt to estimate the number of outmigrants during the period the trap was not operating. We used 3 periods for the estimating outmigrants due to the low number of recaptures (Table 2).

Table 2. *O. mykiss* ≥ 80 mm FL captured in the Lookingglass Creek screw trap, releases and recaptures from trap efficiency tests, outmigrant estimates and overall standard error, MY 2008.

Period	u	m	r	C_p	N	SE
August-December 2007	77	66	3	0.045	1,694	
January-April 2007	300	294	6	0.020	14,700	
May-June 2008	191	190	3	0.016	12,097	
MY 2008 Total and SE					28,491	9,174

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$^{0.5}$)

A total of 365 outmigrants was PIT-tagged and released (364 ≥ 80 mm FL and 1 <80 mm FL). PIT tag releases in the fall (July-December 2007) totaled 53 and spring releases (January-June 2008) totaled 312 (Figure 4). The numbers PIT-tagged in April and June 2008 comprised 70% the overall total.

We fin-clipped and released above the screw trap 13 *O. mykiss* from 83-215 mm FL for trap efficiency in addition to the 53 ≥ 80 mm FL PIT-tagged during the fall 2007 period. We measured and released below the screw trap 74 from 40-79 mm FL and 11 from 97-289 mm F.A single fish was counted only and released below the screw trap. There were no trapping or handling moralities of *O. mykiss* during the fall 2007 period. Recaptures totaled 1 PIT-tag and 2 fin-clips. The total catch on 7 dates from 13 November-5 December 2007 comprised 49% of the fall 2007 total.

Spring 2008 trap efficiency releases of *O. mykiss* totaled 311 ≥ 80 mm FL PIT-tagged and 173 from 80-198 mm FL fin-clipped. We measured and released below the screw trap 226 from 52-98 mm FL. We counted only and released below the screw trap 15 that were approximately 80 mm FL or less. We had 10 trapping moralities, 9 during April 2008. Recaptures totaled 1 PIT-tagged and 8 fin-clipped. The total catch during 4 periods (3-18 April, 27 April-4 May, 8-16 June, and 19-28 June) comprised 81% of the spring 2008 catch.

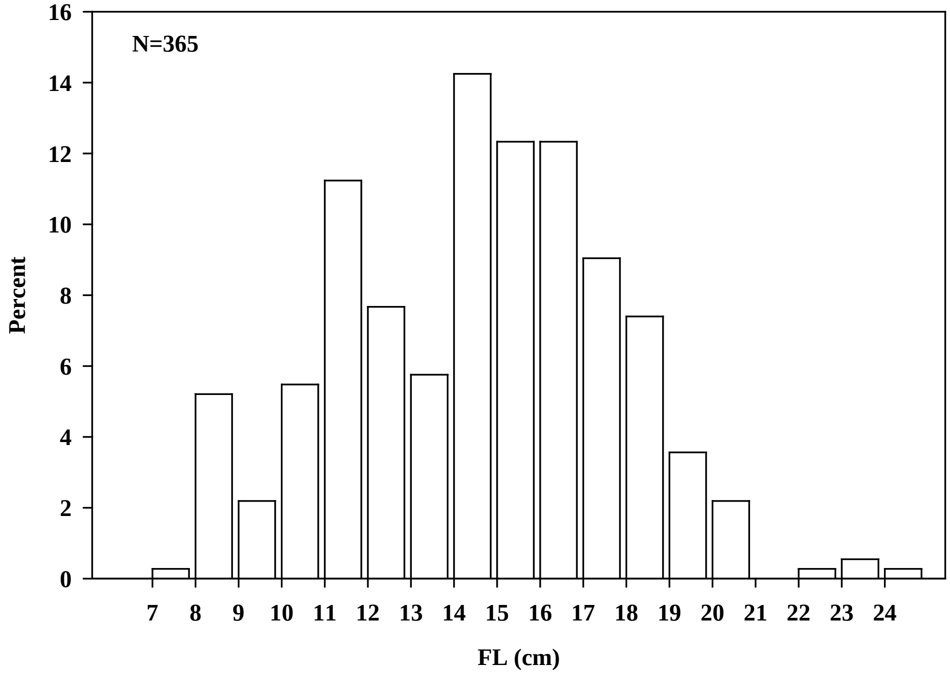


Figure 4. Percentages of *O. mykiss* PIT-tagged and released in Lookingglass Creek by cm group, MY 2008.

Outmigrants (<80 mm FL) were caught during both fall 2007 and spring 2008 periods, but fish > 200 mm made up a larger part of the catch in fall 2007 (Figure 5). Mean FL was highest in September and October of 2007 and January-April 2008 (Table 3). Mean condition factor varied by month without any discernible trend.

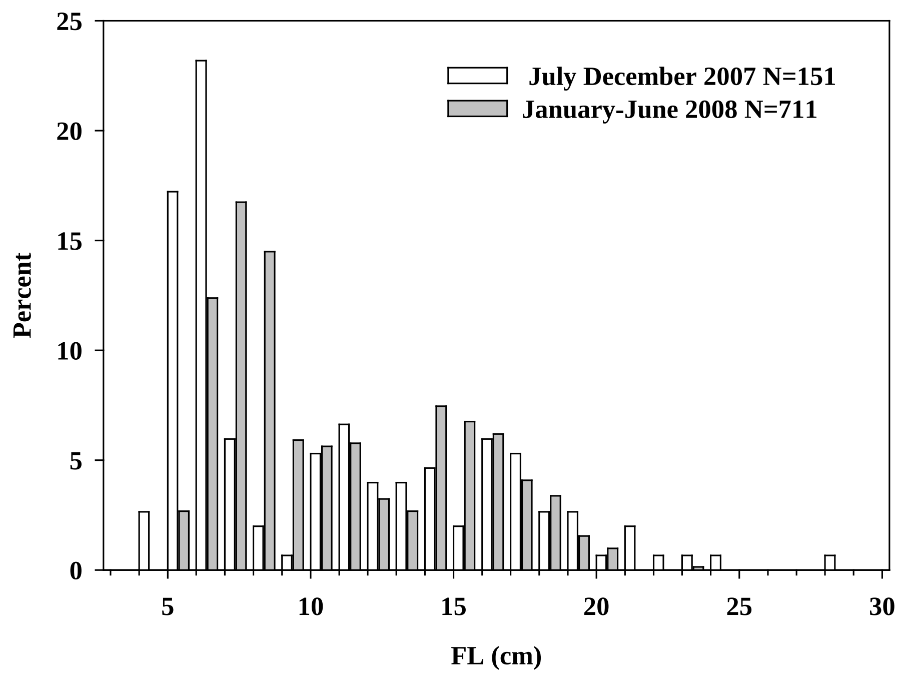


Figure 5. Fork length frequency for *O. mykiss* captured in the Lookingglass Creek screw trap, July-December 2007 (fall group) and January-June 2008 (spring group).

Table 3. Fork length (mm), weight (g), and condition factor summary by month for *O. mykiss* captured in the Lookingglass Creek screw trap, MY 2008.

Statistic	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Fork Length												
Mean	84.0	106.0	155.8	146.4	100.7	75.9	142.7	133.9	140.1	133.8	106.0	82.1
SE		18.2	7.8	12.7	9.2	4.2	38.3	13.7	14.3	2.2	3.8	1.2
Min	68	40	49	46	52	43	70	69	60	53	57	52
Max	100	178	215	289	237	245	200	190	233	204	192	207
n	2	7	28	17	37	60	3	10	12	318	77	291
Weight												
Mean	3.1	18.9	42.0	33.8	22.6	8.3	46.0	31.7	32.7	30.7	16.0	7.3
SE		10.8	4.5	4.6	6.2	2.9	24.3	8.2	11.5	1.2	1.7	0.5
Min	3.1	0.5	1.2	1.3	1.2	0.8	3.6	3.9	2.0	1.2	2.0	1.5
Max	3.1	59.6	78.3	64.6	148.8	146.1	87.7	79.2	125.1	91.8	73.1	89.3
n	1	5	26	16	37	51	3	10	10	317	77	290
Condition factor												
Mean	0.99	1.11	1.02	1.12	1.01	0.94	1.11	1.07	1.01	1.03	1.05	1.09
SE		0.16	0.02	0.03	0.02	0.02	0.04	0.04	0.03	0.01	0.01	0.01
Min	0.99	0.78	0.82	0.99	0.81	0.79	1.05	0.87	0.93	0.80	0.90	0.69
Max	0.99	1.71	1.23	1.39	1.48	1.49	1.18	1.22	1.26	1.78	1.50	1.80
n	1	5	26	16	37	51	3	10	10	317	77	290

The fall 2007 group was PIT-tagged from 20 August-5 December 2007 (median, 5 October 2007) and the spring 2008 group from 18 January-30 June 2008 (median, 29 April 2008). Fall 2007 PIT-tagged outmigrants were, on average, longer and heavier than spring 2008 fish, but with similar condition factors (Table 4). Survival probability of the spring 2008 group was more than double that of the fall 2007 group. Median arrival dates at Lower Granite Dam differed by only 1 d.

Table 4. Fork length, weight, condition factor, survival, travel time, and arrival timing to Lower Granite Dam summary by group for *O. mykiss* caught in the Lookingglass Creek screw trap, PIT-tagged and released, MY 2008.

	Group	
Statistic	Fall 2007	Spring 2008
Fork Length (mm)		
Mean	158.2	143.8
SE	4.5	1.7
Min-Max	104-245	78-233
n	53	312
Weight (g)		
Mean	46.6	34.7
SE	4.2	1.1
Min-Max	10.2-148.8	4.9-125.1
n	53	309
Condition Factor		
Mean	1.03	1.05
SE	0.02	0.005
Min-Max	0.86-1.39	0.83-1.46
n	53	309
Survival Probability	0.208	0.553
SE	0.056	0.077
n	53	312
Travel Time (d)		
Harmonic Mean	206.6	11.6
SE	10.0	0.8
n	6	53
10% Arrival Date	5/2/2008	4/25/2008
Median Arrival Date	5/9/2008	5/8/2008
90% Arrival Date	6/1/2008	5/20/2008
n	6	53
n (expanded for spill)	12	83

Mean FL at PIT-tagging of 11 fall 2007 outmigrants detected in the hydrosystem in 2008 was 149.7 mm (range 121-188). None of the outmigrants PIT-tagged in the fall 2007 group were detected as juvenile outmigrants in 2009, 2010, or 2011 (through 30 June). There were single detections of the fall 2007 group at adult detection sites in 2010 and 2011.

There were no detections at juvenile detection sites of the spring 2008 group of tagged outmigrants <115 mm FL in 2008, 7 detections in 2009, 2 in 2010, and none in 2011 (through 30 June). Mean FL at PIT-tagging of 7 spring 2008 outmigrants <115 mm FL and detected in 2009 was 104.3 mm (range 87-113). Two fish detected in 2010 were 81 and 86 mm FL.

There were 127 detections at juvenile detection sites of the spring 2008 group of tagged outmigrants ≥115 mm FL in 2008, 7 in 2009, 7 in 2010, and 1 in 2011 (through 30 June). There were 5 detections at adult detection sites of the spring 2008 group of tagged outmigrants ≥115 mm FL in 2009, 8 in 2009, and none in 2011 (through 30 June). Mean FL at PIT-tagging of 127 spring 2008 outmigrants ≥115 mm detected in 2008 was 163.6 mm (range 125-233). Mean FL at PIT-tagging of 7 spring 2008 outmigrants detected as juvenile outmigrants in 2009 was 135.7 mm (range 115-170) and for 3 outmigrants detected in 2010 was 171.7 mm (range 118-233). The lone detection in 2011 was 180 mm FL at the time of PIT-tagging.

2.5 Discussion

Abundance and arrival timing of adult summer steelhead in recent years differed compared to 1965-1974. Trap catches during 1965-1974 ranged from 17-120, with a median of 56 (Burck, unpublished data).Adult catches at the Lookingglass Hatchery trap during 2001-2008 varied two-fold with a median of 180. Peak catches in 2001-2008 occurred during March or April, compared to May or June during 1964-1975 (Burck, unpublished data).

Juvenile *O. mykiss* outmigration abundance varies substantially for Grande Ronde Basin streams. Favrot et al. (2010) reported 2-3 fold differences for Catherine Creek and the Lostine and Upper Grande Ronde rivers, and 10-fold differences for the Minam River. Late (spring) outmigrants dominated in most years (Favrot et al. 2010), a pattern also seen for Lookingglass Creek since 2001. Mullarkey (1971) found most outmigrants leaving in May or June and the lowest numbers leaving in August and December.

The annual estimates of juvenile outmigrants since 2001 have been substantially higher than those made by Mullarkey (1971). Some of the increase is explained by the larger number of adults escaping upstream to spawn. But the estimates made using screw trap data may be inflated due to violation of a critical assumption: that marked and unmarked fish behave similarly. There is some evidence that juvenile *O. mykiss* may be “trap-shy” (Jim Ruzycki, personal communication). The estimates by Mullarkey (1971) were derived from catches made with a different type of capture device, (a flume with a fyke and a small rotating debris drum at the rear) that may have caught fish more effectively.

Survival probabilities and arrival timing to Lower Granite Dam for fall and spring groups of outmigrating juvenile *O. mykiss* from Lookingglass Creek were similar to other Grande Ronde Basin tributaries for migration year 2008. Passage and survival conditions in the Snake River-Columbia River migration corridor in 2008 were better than average, resulting from average or above average stream flow, mandated spill, and the delayed start of the smolt transport program resulting in a lower proportion of the run being transported (DeHart 2009). Favrot et al. (2010) reported survival probabilities ranging from 0.079-0.420 for fall groups from Catherine Creek, the Lostine, Minam, and Upper Grande Ronde rivers and 0.520-0.819 for spring groups. Median arrival dates were 4-19 May for fall and spring groups from the same streams (Favrot et al. 2010).

The size distribution of outmigrants was similar to those reported by Mullarkey (1971) for Lookingglass Creek and Grande Ronde Basin tributaries by Favrot et al. (2010). Both Mullarkey (1971) and Favrot et al. (2010) reported most outmigrants leaving at ages 1 or 2. Ageing results for juvenile *O. mykiss* collected in 2008 will be reported in a subsequent report.

Adult and juvenile life histories of Lookingglass Creek summer steelhead were similar to other summer steelhead populations in the Pacific Northwest summarized by Burgner et al. (1992) and Busby et al. (1996). They reported adults typically spend one or two years in the ocean and mean fork lengths of returning adults ranging from 625-675 mm. They also reported juveniles outmigrating all year at a range of sizes with smolts commonly 110-200 mm fork length.

Continuing data collection and analysis provides a long-term perspective for recovery planning. 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 and productivity. 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 the most abundant population of bull trout other than the Wenaha River.

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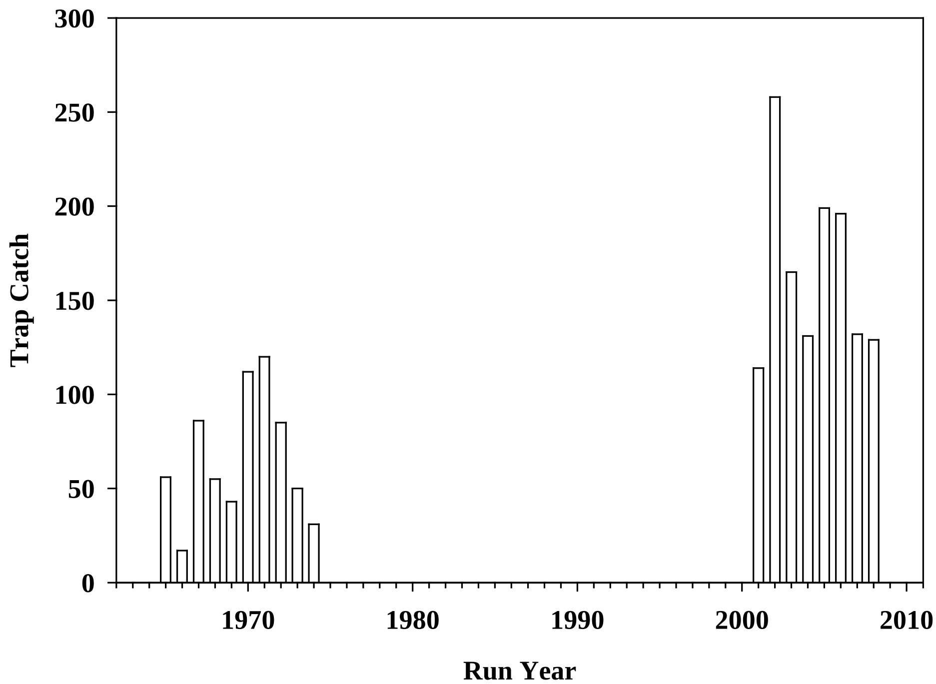
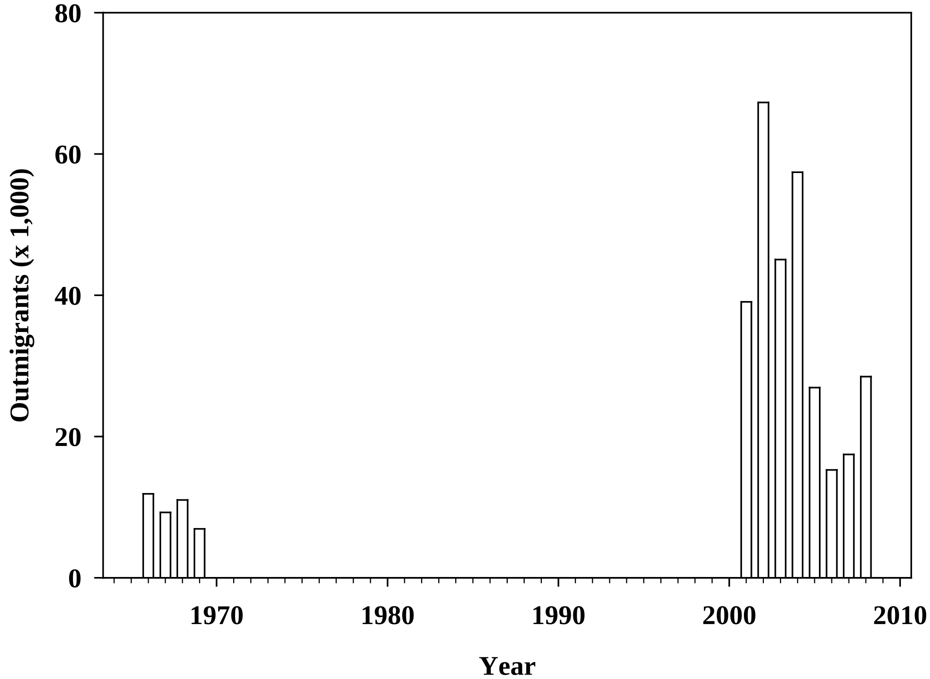
2.7 Appendix Figures



Appendix Figure 1. Catch of wild summer steelhead at the Lookingglass Creek trap, 1997-2008.



Appendix Table 2. Lookingglass Creek juvenile *O. mykiss* outmigrant production, 2001-2008 (calendar years used for 2001-2007, migration year (1 July 2007-30 June 2008) used for 2008 estimate).

3 SECTION III ASSISTANCE PROVIDED TO LSRCP COOPERATORS AND OTHER PROJECTS

We provided assistance to LSRCP cooperator ODFW in 2008 for ongoing spring Chinook salmon hatchery evaluation research. Project personnel completed spawning ground surveys in the Grande Ronde and Imnaha river basins, assisted in sampling of juveniles at Lookingglass Hatchery prior to transfer to acclimation facilities, and assisted in sampling of adult broodstock at Lookingglass Hatchery.

We assisted ODFW personnel who have been collecting data on bull trout (*Salvelinus confluentus*) in the Grande Ronde River basin by providing data from bull trout captured in the Lookingglass Creek screw trap.

4 ACKNOWLEDGMENTS

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