Annual Progress Report
Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2009 to 31 December 2010

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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

The objective of this study is to evaluate reintroduction of spring Chinook salmon in Lookingglass Creek above the Lookingglass Hatchery weir using standard sampling methods for anadromous salmonids in the Columbia River Basin. Natural-origin returns totaled 102 in 2009 and 150 in 2010. Adults released above the Lookingglass Hatchery weir in 2009 totaled 83 and produced 67 redds. Adults released in 2010 totaled 348 and produced 170 redds. Recruits per spawner for adults only were 0.6 and 2.0 for brood years 2004 and 2005, respectively. We estimated 7,847 (245/redd) brood year 2007 juveniles outmigrated during migration year 2009, with 16% in fall 2008, 64% in winter 2008 and 21% in spring 2009. The brood year 2008 outmigrant estimate was 30,289 (291/redd), with 21% in fall 2009, 55% in winter 2009 and 24% in spring 2010. Survival probabilities to Lower Granite Dam for brood year 2007 ranged from 0.225-0.460 for 4 seasonal groups (summer, fall, winter, and spring) from brood year 2007 and 0.173-0.593 for brood year 2008. Smolt equivalents (outmigrants surviving to Lower Granite Dam) for brood years 2007 and 2008 were 2,784 and 10,620, respectively. Smolt-to-adult ratios were 2.2 for brood year 2004 and 1.8 for brood year 2005. Median arrival dates at Lower Granite Dam ranged from 24 April-8 May 2009 for brood year 2007 and 27 April-14 May 2010 for brood year 2008. Life history and productivity metrics for spring Chinook salmon in the current reintroduction era have been generally similar to the endemic and Rapid River reintroduction eras and also to the Catherine Creek donor stock. Recruits per spawner was above replacement for brood year 2005 adults.

1.2 Introduction

Many stocks of anadromous salmon in the Columbia River Basin have experienced severe declines in abundance or become extirpated over the last several decades (Nehlsen et al. 1991). The endemic Lookingglass Creek (LGC) stock of spring Chinook salmon was extirpated within a few years after establishment of Lookingglass Hatchery (LH) in 1982. LGC is within the usual and accustomed areas of gathering for the Confederated Tribes of the Umatilla Indians (CTUIR) under the Treaty of 1855 (Gildemeister 1998). CTUIR, along with comanagers Oregon Department of Fish and Wildlife (ODFW) and Nez Perce Tribe, began work in the early 1990s to reestablish natural production of spring Chinook salmon in LGC. Several stocks, including remnants of the LGC endemic stock, Imnaha River, Wind River (Washington), Carson Hatchery (Washington), and Rapid River (Idaho) were all used before comanagers settled on Rapid River stock. The Rapid River stock was later replaced with Catherine Creek (CC) captive brood stock (Gee et al. 2014) progeny as the initial donor stock. CC stock are native to the Grande Ronde Subbasin. The first CC hatchery-reared release occurred in September 2001. CTUIR focuses on reestablishment of the natural population above the LH weir and ODFW on the hatchery component (Feldhaus et al. 2011).

CC stock hatchery-origin (HOR) spring Chinook salmon have returned to LGC, spawned successfully in nature, produced outmigrants, and these outmigrants have returned to LGC. Current management includes the release of both HOR and natural-origin (NOR) returns to spawn in nature above the LH weir, and use of both HOR and NOR returns in a conventional brood stock program at LH.

Annual reports describing past progress in reestablishing natural production of spring Chinook salmon in LGC are listed in the Literature Cited of this Section. This is the latest in the series of 18 annual progress reports. CTUIR project goals are to evaluate the reintroduction of spring Chinook salmon into LGC using the CC stock, increase tribal harvest, and maintain a gene bank for the CC stock. Specific Research, Monitoring and Evaluation objectives are to compare performance across three time periods or eras of two reintroduced stocks (Rapid River, CC) with the extirpated endemic stock of spring Chinook salmon in LGC (Burck 1993) and to evaluate the use of CC F_1 captive brood stock progeny for natural spawning and hatchery production.

This project is guided by the CTUIR Department of Natural Resources Mission Statement (Jones et al. 2008)

"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 using 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.

and the CTUIR Department of Natural Resources, Research, Monitoring and Evaluation Mission Statement:

"We will accomplish (CTUIR DNR Mission Statement) by using 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."

CTUIR goals are consistent with the mitigation goals established for the Lower Snake River Compensation Plan (USACE 1975) and the Grande Ronde Subbasin Plan (NPCC 2004). Reintroduction is defined as "intentional movement of an organism into a part of its native range from which it has disappeared or become extirpated in historic times" (IUCN 1987 cited in Ewen et al. 2012). The broad objective of reintroduction is to reestablish a self-sustaining population that has a high probability of persistence unaided by further intervention (Ewen et al. 2012). Assessment of reintroduction proceeds through phases of population establishment and persistence (Ewen et al. 2012). Reintroduction biology is a relatively new scientific discipline, and one of growing interest (Seddon et al. 2007, Armstrong and Seddon 2008). Introducing salmon and trout into streams within their native range where never present has been largely unsuccessful (Quinn 2005, citing Withler 1982 and Fedorenko and Shepherd 1986). Reintroduction into streams where the native stock has been extirpated is not precisely the same, but also involves establishing a non-native stock. There are at least 9 ongoing or proposed reintroductions of spring Chinook salmon in the Columbia Basin as of May 2012 (Peter Galbreath, personal communication). Previous reintroductions of spring Chinook salmon carried out by CTUIR include the Umatilla (Contor and Schwartz 2007) and Walla Walla Rivers (Mahoney et al. 2012). We expect the LGC evaluation to contribute both to improving the success of spring Chinook salmon reintroductions and the emerging discipline of reintroduction biology.

1.3 Study Area

LGC originates at Langdon Lake in the Blue Mountains of northeast Oregon 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. A 27 year data set showed mean monthly flows ranging from 1.5-2.3 m^3/sec during the base flow period of July-December to 9.5-11.2 m^3/sec during spring runoff in April and May. LGC stream flow information was collected by electronic data recorders operated by the U. S. Geological Survey near LH from August 1982-September 2009 (http:/nwis.waterdat.usgs.gov).

One major (Little Lookingglass Creek, rkm 6.4) and four smaller tributaries (Lost Creek, rkm 17.3; Summer Creek, rkm 16.5; Eagle Creek, rkm 13.3: and Jarboe Creek, rkm 3.6) contribute to LGC. All or nearly all spring Chinook spawning occurs in LGC and Little Lookingglass Creek (LLGC). LH is located from rkm 3.6-4.1 on LGC. Upstream migration of returning adult spring Chinook salmon is controlled by the LH weir and trap at rkm 4.1.

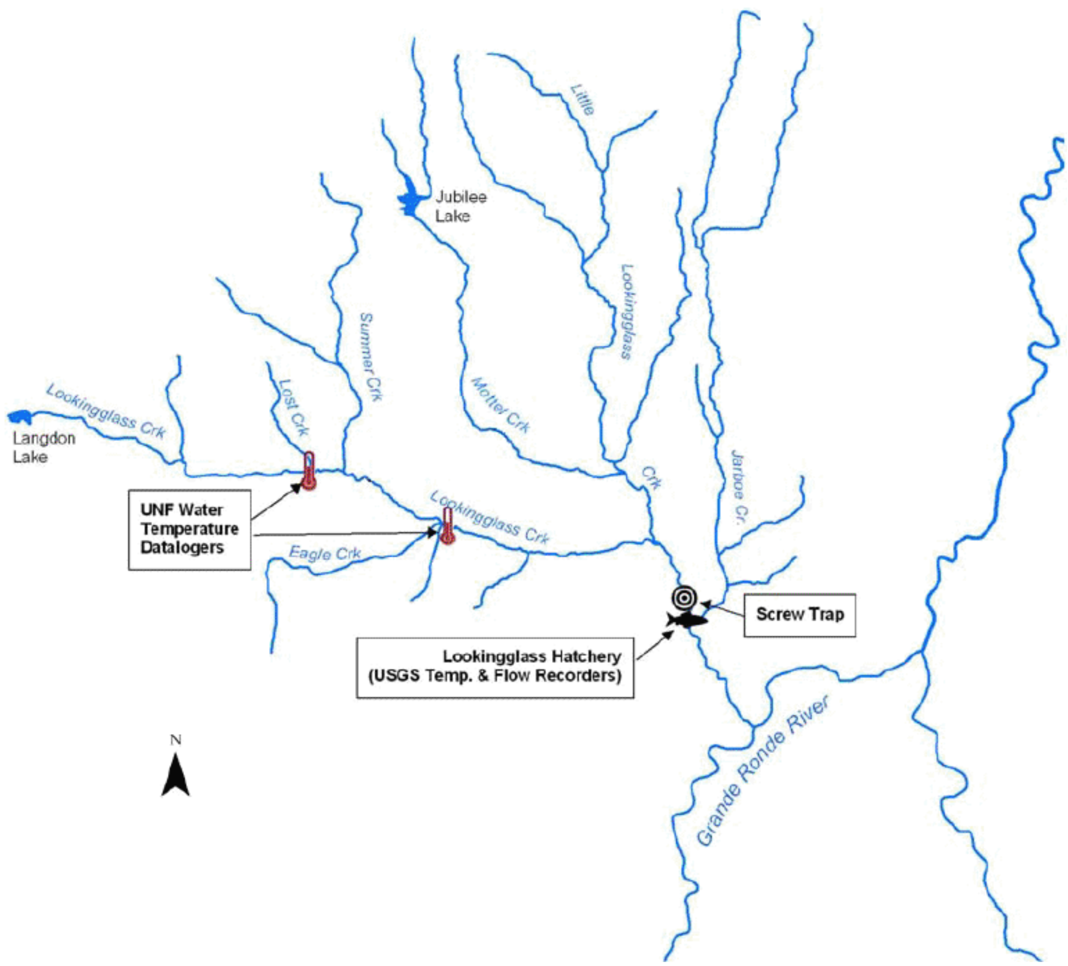

Figure 1. LGC and tributaries, temperature and flow recorders, screw trap and LH.

1.4 Methods

Metrics and methods used in this evaluation are based on those from Hesse et al. (2006) and Galbreath et al. (2008). Metrics are in the categories of abundance, productivity, and diversity for viable salmon populations (McElhany et al. 2000). Selected abundance and life history data from the endemic era published in Burck (1993) and previous annual reports for the Rapid River reintroduction era were used for comparison. Additional data for comparison was obtained from Anderson et al. (2011).

1.4.1 Adults

1.4.1.1 Abundance

Adult spring Chinook salmon returning to LGC are diverted by a picket weir into a trap operated and maintained by ODFW LH staff near the LH water intake at rkm 4.1. The trap is operated from the first of March through mid-September each year and checked at least 3 times (Monday, Wednesday, Friday) weekly and then daily as fish numbers increase. ODFW LH staff record catch data, including date of capture, origin, FL (mm), sex, and marks/tags.

Fish returning to the LH weir can be passed upstream to spawn, used for conventional brood stock at LH, provided for food bank or ceremonial purposes, or recycled below the weir to supplement harvest opportunities. Adults destined for outplanting were held in a pond at LH or, later in the trapping season, released as they swam into the trap. Returns captured in the LH trap in 2009 and 2010 could have been from several sources: LGC natural production above or below the LH weir, HOR CC stock captive brood stock progeny released into LGC, HOR returns from other Grande Ronde Subbasin stocks, and NOR adults from other stocks.

Fish released above the LH weir for natural production were transported 0.6 rkm upstream and released just above the carcass weir. The carcass weir is installed in early summer to prevent live fish or carcasses from falling back to the LH water intake near the weir and adult trap, and removed after the spawning season. All fish released above the carcass weir were measured (mm FL), sexed, and right opercle punches taken. Opercle punches were used to distinguish any spawners above the LH weir and provide a marked sample for a population estimate. Opercle samples were preserved in 95% ethanol or by drying on filter paper for a relative reproductive success study (BPA Project 2009-009-00). Scale samples were taken from NOR fish released above the LH weir.

Spawning ground surveys (Parker et al. 1995) were conducted from July-September annually. Surveys were conducted weekly after adults were released above the LH weir in 5 designated sections (Figure 2). Only completed redds were counted (Lofy and McLean 1995), and flagged to eliminate double counting. Latitude-longitude coordinates for each redd were logged with a handheld Garmin GPS unit. Carcasses were enumerated and measured to the nearest mm FL. Sex, marks, and percent spawned for females were recorded. Tails were cut off after collecting data to prevent double sampling. Snouts were taken from HOR carcasses for coded wire tag (CWT) recovery.

CWT data were used for identifying HOR strays that spawned above and below the LH weir and length at age of return. Kidney samples were taken from carcasses to determine incidence of bacterial kidney disease (O’Connor and Hoffnagle 2007). Opercle punches were taken from any unpunched carcasses recovered upstream of the LH weir and preserved for later genetic analysis.

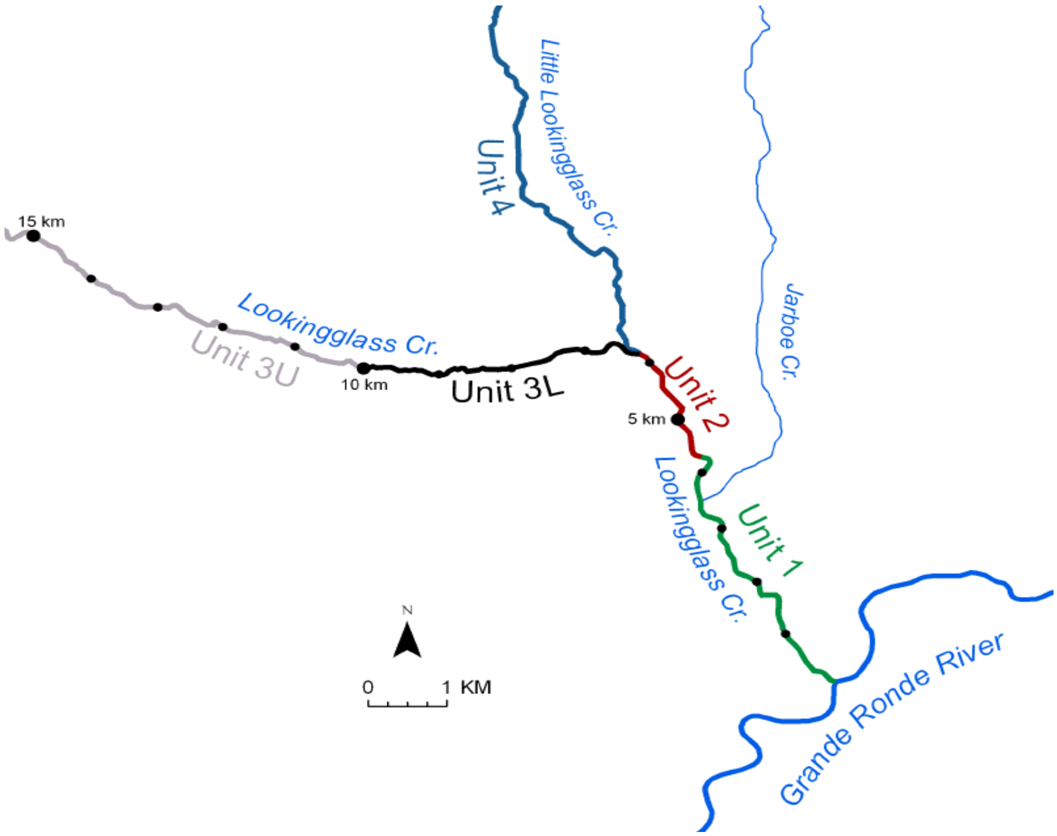

Figure 2. LGC spawning ground survey unit designations and rkm (modified from Burck 1993).

Population estimates above the LH weir just before the start of regular spawning ground surveys (appearance of first completed redd) were made using the Chapman modification of the Petersen method (Ricker 1975). Estimates were made for two size groups: jacks (FL $\leq$ 600 mm, age 3 males) and adults (FL $\geq$ 601 mm, ages 4/5 males and females). The marked sample was the opercle-punched fish released above the LH weir minus any punched fish that were recovered on surveys prior to the start of regular spawning ground surveys. The recapture sample was the sum of punched and unpunched carcasses recovered on regular spawning ground surveys. Fish per redd for above the LH weir was obtained from the adults or adults+jacks population estimates divided by redds. Spawners above the LH weir for adults and adults+jacks were obtained by adjusting the population estimate for prespawn mortality (Hesse et al. 2006, p. 40). Prespawn mortality for females was defined as those $\leq$50% spawned.

1.4.1.2 Life History

Scale samples taken at the LH trap were used to determine ages for a portion of the NOR returns using criteria from Mosher (1969), and the results were expanded to all returns using an age-length key (Ricker 1975). Ages for HOR returns were determined from CWT data obtained from the Regional Mark Information System database maintained by the Pacific States Marine Fisheries Commission.

1.4.1.3 Productivity

Recruits per spawner (R/S) were calculated for brood year (BY) 2004 NOR returns by summing the total NOR returns at age 3 in 2007, age 4 in 2008, and age 5 in 2009 and dividing by the number of ages 3-4-5 (jacks+adults) and 4-5 (adults only) NOR spawners above the LH weir in 2004. Total returns included all fish trapped at the LH weir and any unpunched, unclipped carcasses recovered above the LH weir. The same methods were used for BY 2005.

1.4.2 Juvenile Spring Chinook Salmon

1.4.2.1 Abundance

We operated a 1.52 m diameter rotary screw trap at rkm 4.0 on LGC approximately 0.2 km below the LH adult trap to collect outmigrating naturally-produced juvenile spring Chinook salmon. Trap operation was suspended during the spring freshet, midsummer during low flows if temperatures were high and when iced up in winter, all periods when there are 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.

BY 2007 NOR outmigrants were caught as fry beginning in January 2008 and continued for about 18 months. Any parr caught until the end of June were counted only. After June 2008, untagged fish ≥60 mm FL captured for the first-time were PIT-tagged using standard methods (PIT Tag Steering Committee 1999) and released about 200 m above the trap to estimate trap efficiency. We PIT tagged approximately 500 outmigrants in each season (fall, winter, and spring) to estimate outmigrants. The fall 2008 group included fish from 1 July-30 September 2008, the winter 2008 group from 1 October-31 December 2008, and the spring 2011 group from 1 January-30 June 2009. Outmigrant estimates are minimal since the trap could not be operated for the entire outmigration period. The migration year (MY) is from approximately 1 July of the year following spawning through the following June. We used DARR 2.0 (Bjorkstedt 2005) to estimate outmigrants. DARR 2.0 uses stratified mark-recapture data and pools strata with similar capture probabilities, and we used the “one trap” and “no prior pooling of strata” options. Lower caudal fin clips were taken from some outmigrants for a relative reproductive success study (BPA 2009-009-00). Tag recaptures or those not used for trap efficiency estimates were released about 0.3 rkm below the screw trap. The same methods were used for BY 2008.

1.4.2.2 Life History

We monitored seasonal growth of NOR spring Chinook salmon juveniles by snorkel/seining at rkm 8.9 and 10.5 above the LH weir, rkm 4.0 and 0.4 below, and 2.3 rkm above the mouth of LLGC on the 20th +/- 5 d of July, August, and September (Burck 1993). After a snorkeler locates fish, a seine is deployed about 50 ft. downstream. The snorkeler “herds” fish into the seine, which is then quickly lifted. Approximately 50 fish were collected for each site on each sampling date. Each fish was measured to the nearest FL (mm) and weighed (0.1 g). Fulton-type condition factor (K) was calculated using a scaling factor of 10^5 (Anderson and Gutreuter 1983, p. 294).

We collected approximately 1,000-1,400 BY 2004 and 2005 spring Chinook salmon parr in early August of both 2005 and 2006 by snorkel-seining in the main rearing area above the LH weir between rkm 8.5-11.0 Parr were PIT-tagged using standard procedures (PIT Tag Steering Committee 1999) then released at the capture site. Recaptures of these PIT-tagged summer group parr in the LGC screw trap downstream were treated as unmarked catches and released below the screw trap.

FL, weight, and K were summarized for PIT-tagged parr from the summer parr group and fall, winter and spring groups of outmigrants collected in the screw trap. PIT-tagged fish from each group (summer, fall, winter, spring) were used to describe and compare survival, arrival timing, and travel time to LGD and outmigration timing from LGC. We estimated survival probabilities for parr and outmigrants of both BY using the Pacific States Marine Fisheries Commission PIT tag database at http://www.ptagis.org/ and PitPro software (Westhagen and Skalski 2009). We used the standard configuration in PitPro, excluded the *.rcp file, and included the *.mrt file. Only mortalities recaptured at the screw trap were used in the *.mrt file. Observation sites, in downstream order, were Lower Granite Dam (LGD), Little Goose Dam, Lower Monumental Dam, Ice Harbor Dam, McNary Dam, John Day Dam, Bonneville Dam, and the Estuary Towed Array (Juvenile). LGD was used as the last recapture site. Smolt equivalents (S_{eq}, Hesse et al. 2006) for natural production passing the trap site were calculated as the number of outmigrants per seasonal group adjusted by seasonal survival probabilities and summed for the BY (Hesse et al. 2006). For comparative purposes, survival estimates for other populations in the Grande Ronde Subbasin from Anderson et al. (2011) were used. ODFW reported only 2 seasonal groups of outmigrants, fall, corresponding to our fall and winter groups combined, and spring. Survival estimates were also calculated for PIT-tagged groups from the Rapid River reintroduction era in LGC.

Smolt-to-adult ratios (SAR) for BY 2004 was obtained as the BY 2004 total natural returns (see Productivity above) divided by the BY 2004 S_{eq}. SAR estimates were made for jacks and adults combined and adults (ages 4 and 5) only. SARs for BY 2005 were estimated in the same manner.

We estimated arrival timing at LGD 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]. Dates when 10%, 50% (median), and 90% of the detections at LGD were reached were reported for each group. Travel time was calculated from PitPro (Westhagen and Skalski 2009).

1.5 Results

1.5.1 Adults

1.5.1.1 Abundance

NOR returns to the LH weir 2009
NOR returns to the LH weir in 2009 were 24 (24%) age 3, 69 (68%) age 4, and 9 (9%) age 5, for a total of 102.

Released above the LH weir 2009
Fish were released in 2009 at the Forest Service 62 bridge approximately 2.5 rkm above the LH weir to spawn naturally on 6 August in a group of 90 and thereafter as they were trapped.. The total of 103 released included 63 NOR and 40 HOR. Adults were 28 HOR and 55 NOR. Jacks were 12 HOR and 8 HOR. Females totaled 50 and were 28% HOR.

Spawning ground surveys 2009
We completed 25 spawning ground surveys on 14 dates from 5 August-16 September 2009 (Table 1). Redds were recorded from 21 August-11 September, with most from 21-28 August. There were 67 redds observed above the LH weir in Units 2, 3U, 3L, and 4 comprising 69% of the total. Weather and visibility conditions were excellent during the survey period.

Table 1. New redds observed on surveys of LGC by date and unit, 2009.

	Unit					
Date	1	2	3L	3U	4	Totals
8/5-8/28	26	2	18	28	1	75
9/3-9/16	4	0	5	12	1	2
Totals	30	2	23	40	2	97
%	31	2	24	41	2	100

Carcass recoveries 2009
Carcass recoveries above the LH weir from 28 August-16 September totaled 28, and carcass recovery efficiency was 16%. Carcasses recovered below the LH weir totaled 45.

Population estimates above the LH weir prior to 28 August were 84 adults and 25 jacks. Fish per redd was 1.63 for adults and jacks combined and 1.25 for adults only. Prespawning mortality was 12.5% from 8 females sampled above the weir and 0% from 13 females below the weir.

There were 23 snouts sampled from above the LH weir and 31 below. CWT representing 6 different codes were recovered from 16 carcasses above the LH weir in 2009. All but 2 were either LGC conventional broodstock or CC captive broodstock released into LGC. The 2 remaining were Upper Grande Ronde River (UGR) stock. There were 9 different codes were recovered from 25 carcasses below the LH weir. Fifteen were from CC captive broodstock released in LGC or LGC conventional broodstock, 4 were CC conventional broodstock released in CC, and 6 were UGR stock.

NOR returns to the LH weir 2010

NOR returns to the LH weir in 2010 were 9 (6%) age 3, 124 (83%) age 4, and 17 (11%) age 5, for a total of 150.

Released above the LH weir 2010

Returns in 2010 were also released at the Forest Service 62 Bridge above the LH weir on 6 July in a group of 185 and thereafter as they were trapped. The total of 376 released included 301 HOR and 75 NOR. Adults were 278 HOR and 70 NOR. Jacks were 23 HOR and 5 HOR. Females totaled 216 and were 83% HOR.

Spawning ground surveys 2010

We completed 26 spawning ground surveys on w 14 dates from 27 July-22 September 2010 (Table 2). Redds were recorded from 10 August through 22 September, with most during 25 August-10 September. There were 170 redds observed above the LH weir in Units 2, 3U, 3L, and 4 that comprised 66% of the total. Weather and visibility conditions were excellent during the survey period.

Table 2. New redds observed on surveys of LGC by date and unit, 2010.

	Unit					
Date	1	2	3L	3U	4	Totals
7/27-7/28		0	0	0		0
8/10-8/26	36	9	30	31	11	117
9/1-9/2	53	15	33	31	10	142
Totals	89	24	63	62	21	259
%	34	9	24	24	8	

Carcass recoveries 2010

There were 9 carcasses recovered on 3 surveys of Units 2, 3U, 3L prior to the appearance of the first redd on 10 August. All were adults and 5 were opercle-punched HOR, 1 was opercle-punched NOR, and 1 was opercle-punched of unknown origin. Six unspawned female carcasses were recovered.

Carcass recoveries above the LH weir on or after 10 August totaled 174, including 3 HOR precocials, and carcass recovery efficiency was 45%. Carcasses recovered below the LH weir totaled 124, including 1 HOR precocial.

Population estimates above the LH weir prior to 10 August were 342 adults and 29 jacks. Fish per redd was 2.18 for adults and jacks combined and 2.01 for adults only. Prespawning mortality was 2.27% for 88 females sampled above the weir and 0% for 65 females below the weir.

Snouts sampled from above the LH weir totaled 122 and 59 below. There were 10 different CWT codes recovered from 97 carcasses sampled above the weir and included 82 from CC captive broodstock released into LGC, 3 from LGC conventional broodstock, 8 from CC conventional broodstock, and 4 from either Lostine River or UGR stocks. There were also 10 different CWT codes recovered from 27 carcasses sampled below the weir, including 18 CC captive broodstock released into LGC, 5 from CC conventional broodstock, and 4 UGR stock.

1.5.1.2 Life History

Length-at-age 2009

HOR were larger on average than NOR at all 3 ages, using sexes combined data (Table 3). Differences ranged from 20 mm at age 3 to 44 mm at age 5. NOR females were larger than males at age 4, but males were larger than females at age 5. HOR males were larger than females at ages 4 and 5.

Table 3. Mean FL (mm) at age by sex and origin of LGC spring Chinook salmon, 2009.

Origin	Sex	Age	$\bar{X}$ FL	Range	SE	N
NOR	M	3	514	465-575	25	4
NOR	M	4	726	612-795	19	9
NOR	F	4	731	685-794	6	21
NOR	Combined	4	729	612-795	7	30
NOR	M	5	867	821-925	25	4
NOR	F	5	803	775-830	28	2
NOR	Combined	5	846	775-925	22	6
HOR	M	3	534	415-660	7	58
HOR	M	4	775	742-820	17	4
HOR	F	4	733	690-780	12	7
HOR	Combined	4	748	690-820	11	11
HOR	M	5	979	960-1005	13	3
HOR	F	5	852	810-905	12	7
HOR	Combined	5	890	810-1005	21	10

Length-at-age 2010

HOR were larger on average than NOR at ages 3 and 4, using sexes combined data (Table 4). Differences were 28 mm at age 3 and 24 at age 4. Age 4 males were larger than females for NOR and HOR.

Table 4. Mean FL (mm) at age by sex and origin of LGC spring Chinook salmon, 2010.

Origin	Sex	Age	$\bar{X}$ FL	Range	SE	N
NOR	M	3	470	360-580	110	2
NOR	M	4	736	628-800	9	23
NOR	F	4	722	630-788	7	29
NOR	Combined	4	728	628-800	6	52
HOR	M	3	498	380-615	10	29
HOR	M	4	765	431-900	8	77
HOR	F	4	744	630-844	3	118
HOR	Combined	4	752	431-900	4	195

1.5.1.3 Productivity

R/S were 0.6 for both jacks and adults combined and adults only for BY 2004 (Table 5). R/S were 1.8 for jacks and adults combined and 2.0 for adults only for BY 2005.

Table 5. Population estimates, natural spawners, and R/S for LGC NOR spring Chinook salmon.

	Population[a]		Spawners[b]		R/S Spawners	
BY	All	Adults	All	Adults	All[c]	Adults[d]
2004	100	100	100	100	0.6	0.6
2005	50	42	46	39	1.8	2.0
2006	60	55	60	55		
2007	72	66	66	61		
2008	190	180	190	180		
2009	109	84	95	74		
2010	371	342	363	334		

[a] *Fish present above LH weir prior to start of regular spawning ground surveys*
[b] *Adjusted for prespawning mortality*
[c] *(Sum of BY X returns at ages 3, 4, and 5)/S_{eq} BY X*
[d] *(Sum of BY X returns at ages 4 and 5)/S_{eq} BY X*

1.5.2 Juveniles

1.5.2.1 Abundance

BY 2007 Outmigrants
The rotary screw trap was fished 76% of days possible during 1 January-30 June 2008, 98% during 1 July-30 September 2008, 73% during 1 October-31 December 2008, and 85% during 1 January-30 June 2009. Outmigrating BY 2007 fry and parr caught during February-June 2008 totaled 72 and 69% were caught in April. There were 13 mortalities

of fry caught in April. FL ranged from 30-39 mm in April, 42-49 mm in May and 45-63 mm in June from samples of 2-12 each month.

First-time captures in the screw trap of BY 2007 outmigrants during July 2008 through July 2009 were 702, including 54 recaptures of the field group of parr PIT-tagged in August 2008. Mortalities were 1.0% of the first-time captures. The total PIT-tagged and released was 579. We caught 25 precocial males from 6 August-22 September 2008, ranging from 98-217 mm FL. One additional precocial was a PIT-tag recapture of a BY 2006 summer parr tagged in August 2007. The BY 2007 outmigrant estimate was 7,847 (SE 1,174). Outmigrants leaving by season were 16% fall 2008, 64% winter 2008, and 21% spring 2009. Estimated outmigrants per redd for BY 2007 were 245. Median dates of PIT-tagging for the fall 2008, winter 2008, and spring 2009 groups of outmigrants were 22 August, 24 October, and 23 March, respectively.

BY 2008 Outmigrants
The rotary screw trap was fished 100% of the days possible during the period 1 July-30 September 2009, 68% during 1 October-31 December 2009, and 96% during 1 January-30 June 2010. BY 2008 outmigrants were collected starting on 16 January 2009. Total catches of BY 2008 fry totaled 3 in January-February, 32 in March, 124 in April, 12 in May and 32 in June. FL ranged from 25-44 mm FL. Mortalities were 2.1% of the January-June catch. Outmigrants were large enough to PIT tag beginning in July 2009. First-time captures in the screw trap of BY 2008 outmigrants during July 2009 through June 2010 were 5,684, including 171 recaptures of the 2009 field group PIT tagged in August 2009. Mortalities totaled 0.5% of the first time catch. The total PIT-tagged and released was 2,107. We caught 41 precocials from 14 August-18 September 2009. We measured 37 from 112-200 mm FL, obtaining a mean FL of 136.1 mm. Two additional precocials were PIT-tag recaptures of BY 2007 tagged in early August 2008.

Estimated BY 2008 outmigrants were 30,289 (SE 2,266). Outmigrants per redd for BY 2008 were 291. The percentages of outmigrants by season for fall, winter, and spring were 21, 55 and 24 respectively. Median tagging date for the fall 2009, winter 2009, and spring 2010 outmigrant groups were 14 September, 26 October, and 26 March, respectively.

1.5.2.2 Life History

BY 2007 Monthly sampling
Parr growth in FL at the rkm 0.4 site was linear from July through September 2008 (Figure 3). Limited data were collected at the other sites. Parr sampled at the rkm 0.4 site were substantially larger than those at the other 3 sites in July and September. For a given sampling date, parr sampled from downstream to upstream sites showed a general pattern of decreasing mean FL and weight, similar to the pattern reported by Burck (1993).

Mean K decreased from 1.37-1.20 from July-September at the rkm 0.4 site, and ranged from 1.24-1.32 at the other sites. High flows precluded any June sampling. Burck

(1993) reported that mean K increased from April-September, then decreased. Most means for a given site and sampling date combination were from 1.0-1.1 (Burck 1993). The larger K values seen in 2008 may have been related to density, as the number of BY 2007 outmigrants was much lower than the range for the endemic era reported by Burck (1993).

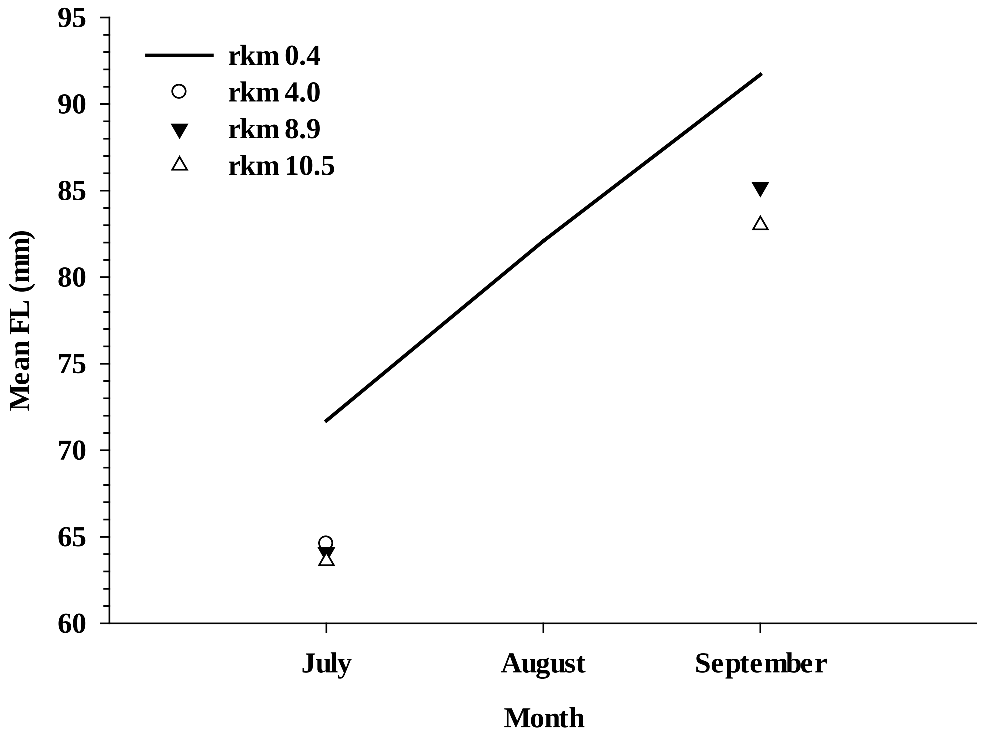

Figure 3. Mean FL (mm) of LGC BY 2007 NOR spring Chinook salmon parr, 2008.

BY 2007 PIT-tagging of summer parr

A total of 979 BY 2007 parr were PIT-tagged and released in several areas upstream of the LH weir during 30 July-1 August 2008. FL, weight, K, survival and migration timing for the BY 2007 parr are summarized below and compared to the 3 seasonal groups caught in the screw trap and PIT-tagged. Recaptures of the BY 2007 summer parr group totaled 51 from August-November 2008 and 5 in March-April 2009. Percentages of recaptures by season were 48 in the fall of 2008, 43 in winter 2008, and 9 in spring 2009. Two were caught in August and September 2009 as precocials.

BY 2007 Size, survival, smolt equivalents, arrival timing, and travel time for PIT-tag groups

Mean FL and weight increased progressively for the summer 2008, fall 2008, winter 2008, and spring 2008 PIT-tagged groups, but K slightly decreased (Table 6). Survival probability to LGD also increased progressively by season (Table 7). Median arrival date varied by 14 d between seasonal groups. S_{eq} for fall 2008, winter 2008, and spring 2009 were 313, 1,730, and 741 for a BY 2009 total of 2,784.

Table 6. FL, weight and K summary by group for PIT-tagged NOR BY 2007 spring Chinook salmon caught in the LGC screw trap, MY 2009.

	Group			
Statistic	Summer 2008	Fall 2008	Winter 2008	Spring 2009
Mean FL (mm)	68.3	73.0	89.7	97.3
SE	0.2	0.6	0.3	1.1
Min-Max	53-89	59-99	74-108	68-129
N	979	163	327	88
Mean Weight (g)	3.6	4.6	8.1	10.3
SE	0.03	0.1	0.1	0.4
Min-Max	1.8-7.8	2.0-10.9	4.4-13.7	2.8-25.2
N	979	163	325	88
Mean K	1.11	1.14	1.11	1.07
SE	0.003	0.009	0.004	0.014
Min-Max	0.80-1.60	0.93-1.68	0.94-1.45	0.77-1.60
N	979	163	325	88

Table 7. Survival probabilities, travel time, and arrival timing to LGD summary by group for PIT-tagged LGC NOR BY 2007 spring Chinook salmon caught in the LGC screw trap, MY 2009.

	Group			
Statistic	Summer 2008	Fall 2008	Winter 2008	Spring 2009
Survival Probability	0.225	0.250	0.347	0.460
SE	0.016	0.044	0.034	0.053
N	979	163	328	88
Travel Time (d)				
Harmonic Mean	275	240	187	41
SE	1	8	2	5
N	91	16	47	17
Arrival Date				
10%	4/13/09	4/6/09	4/14/09	4/26/09
Median	5/2/09	4/24/09	4/28/09	5/8/09
90%	5/18/09	5/26/09	5/18/09	5/20/09
N	91	16	47	17
N (expanded)	131	28	74	31

BY 2004 SAR
BY 2004 NOR returns at ages 3, 4, and 5 were 7, 46, and 9, respectively, and S_{eq} was 2,446, yielding SARs of 2.5 for jacks and adults combined and 2.2 for adults only.

BY 2008 Monthly sampling
June-July parr growth was greatest at the LLGC site (Figure 4). Growth was approximately linear from June-September at the rkm 4.0 and 10.5 sites. Mean FL at the rkm 0.4 site was greater than the other sites during all months except July. Mean FL were lower in upstream and higher in downstream areas for a given sampling date, similar to the pattern during the endemic era (Burck 1993).

Mean K ranged from 1.09-1.35 for 15 site/date combinations for LGC in 2009. There did not appear to be any temporal trend at any of the sites. Mean K at the LLGC site were 1.21 and 1.24 in August and September. K values in 2009 were higher than reported by Burck (1993) for the endemic era. Burck (1993) reported that mean K increased from April-September, then decreased. Most means for a given site and sampling date combination were from 1.0-1.1 (Burck 1993). The larger K values seen in 2009 may have been related to density, as the number of BY 2008 outmigrants was much lower than the range for the endemic era reported by Burck (1993).

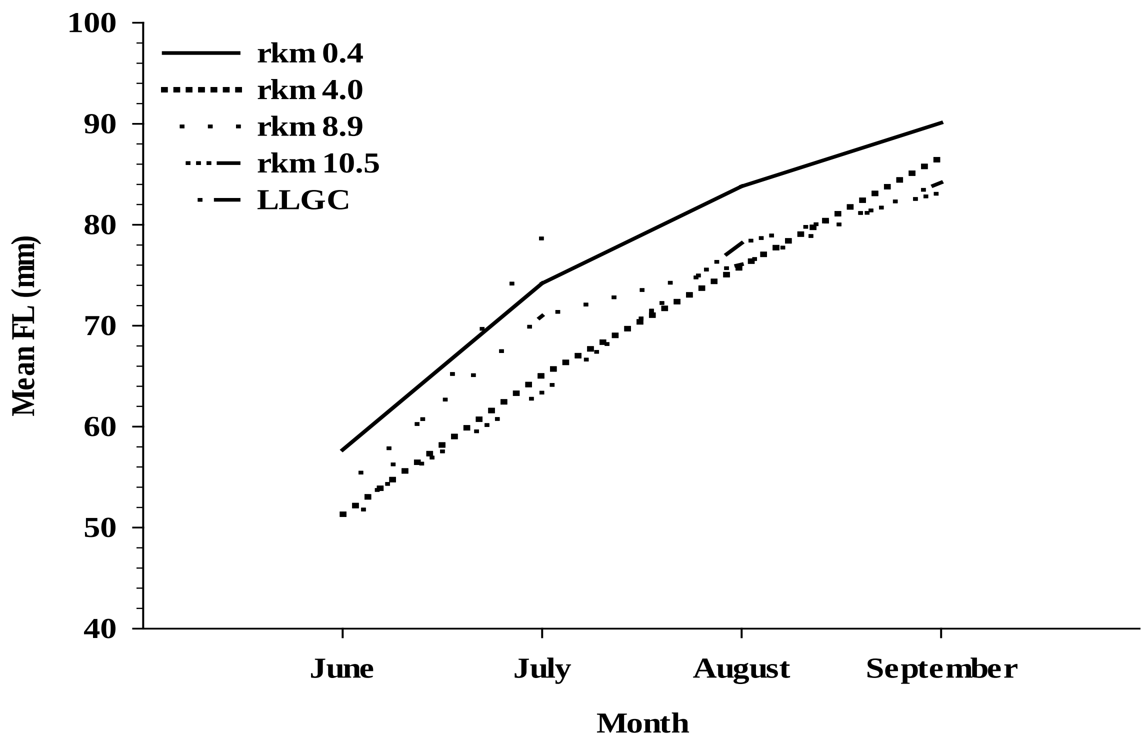

Figure 4. Mean FL (mm) of LGC BY 2008 NOR spring Chinook salmon parr, 2009.

BY 2008 PIT-tagging of parr
A total of 1,379 BY 2008 parr were collected from several locations above the LH weir from 30-July-1 August 2009, PIT-tagged and released. A single fish was detected

leaving the Upper Grande Ronde River acclimation facility on 13 April 2010. This fish made it past the traveling screen at the LH water intake and reared in one of the Upper Grande River ponds before being transported to the acclimation facility. Screw trap recaptures were 171, including 137 from August-November 2009 and 34 in February-April 2010. The percentages of the BY 2008 summer parr group recaptures by season were 37 in fall 2009, 43 in winter 2009, and 20 in spring 2010. Two of the BY 2008 field group were recaptured as precocials in September 2010.

BY 2008 Size, survival, smolt equivalents arrival timing, and travel time for PIT-tag groups

Mean FL and weight progressively increased for the summer 2009, fall 2009, winter, 2009, and spring 2010 PIT-tagged groups, but K decreased (Table 8). Survival probability to LGD was lowest for the summer parr group, similar between the fall 2009 and winter 2009 groups, and almost doubled between winter 2009 and spring 2010 (Table 9). Median arrival date for the spring 2010 group was 11-14 d earlier than the other groups. BY 2008 S_{eq} estimates for fall, winter, and spring groups were 1,829, 4,459, and 4,332, respectively, and totaled 10,620.

Table 8. FL, weight and K summary by group for PIT-tagged NOR BY 2008 spring Chinook salmon caught in the LGC screw trap, MY 2010.

	Group			
Statistic	Summer 2009	Fall 2009	Winter 2009	Spring 2010
Mean FL (mm)	72.1	79.4	88.3	97.4
SE	0.2	0.3	0.3	0.4
Min-Max	58-93	57-106	65-107	70-136
N	1,379	855	676	576
Mean Weight (g)	4.6	5.7	7.6	10.1
SE	0.03	0.1	0.1	0.1
Min-Max	2.0-10.0	1.9-14.7	3.0-14.1	3.4-27.6
N	1,377	853	676	567
Mean K	1.20	1.09	1.08	1.07
SE	0.003	0.003	0.003	0.003
Min-Max	0.75-1.82	0.82-1.40	0.91-1.75	0.79-1.66
N	1,377	852	676	567

Table 9. Survival probabilities, travel time, and arrival timing to LGD summary by group for PIT-tagged LGC NOR BY 2008 spring Chinook salmon caught in the LGC screw trap, MY 2010.

	Group			
Statistic	Summer 2009	Fall 2009	Winter 2009	Spring 2010
Survival Probability	0.173	0.294	0.266	0.593
SE	0.023	0.099	0.044	0.068
N	1,379	855	676	576
Travel Time (d)				
Harmonic Mean	276	229	184	39
SE	1	3	2	2
N	44	29	39	83
Arrival Date				
10%	4/24/10	4/22/10	4/24/10	4/28/10
Median	5/3/10	4/27/10	4/28/10	5/14/10
90%	5/18/10	5/10/10	5/9/10	5/24/10
N	44	29	39	83
N (expanded)	73	48	62	126

BY 2005 SAR

BY 2005 NOR returns at ages 3, 4, and 5 were 4, 69, and 9, respectively, and S_{eq} was 4,280, yielding SARs of 1.9 for jacks and adults combined and 1.8 for adults only. BY 2005 SAR values were 2.0% for jacks and adults combined and 1.9% for adults only.

1.6 Discussion

The initial releases of CC F_1 captive broodstock in 2004, 2005, and 2006 have successfully spawned in nature above the LH weir, and produced progeny that have returned to spawn. CC F_1 captive broodstock progeny used as conventional broodstock at LH have also returned and been released to spawn in nature. Releases above the LH weir and those used for conventional broodstock production are mixtures of HOR and NOR. Only HOR returns were available to release above the LH weir in 2004-2006, and in most years since, spawners above the LH weir have been about 80% HOR. When large numbers of HOR adults return to LGC, tribal fishers are able to harvest any that are surplus to production needs, providing cultural fulfillment and generating enthusiasm among tribal members.

BY 2004-2009 spawners and redds have been similar to the Rapid River reintroduction era, but lower than during the endemic. BY 2010 was the first year since the start of the current reintroduction era that the abundance of spawners above the LH weir has approached that of the endemic stock.

Length-at-age of current reintroduction era NOR has been greater than the endemic stock at all 3 ages. Other adult life history metrics for the current reintroduction era have been similar to those from previous reintroduction eras and the CC donor stock, including return timing, size at return, spawn timing, redd distribution, and prespawning mortality. Releases have been made in the mainstem of LGC above the mouth of LLGC in some years. Fewer redds in LLGC seem to result and may be due to a reluctance of fish to move back downstream, then upstream. Future releases should be made further downstream of LLGC or pass fish as they are caught at the trap (no holding at LH) to afford more natural spawning conditions.

Stray HOR adults spawned upstream of the LH weir in both 2009 and 2010. Weir efficiency, and correct marking and mark recognition, and return numbers will affect the number of strays above the LH weir. Multiple stocks are reared at LH on LGC water, so it is not surprising that some return to LGC to spawn. Some strays (both HOR and NOR) may result from the better water temperatures in LGC for fish returning later in the season (Richard Carmichael, personal communication).

R/S was less than replacement for BY 2004, but greater for BY 2005. SARs were lower than needed for reestablishing a self-sustaining natural population (NWPCC 2014). R/S for CC NOR adults+jacks combined were 0.1-0.7 for BY 2001-2005 (Feldhaus et al. 2012[a,b]). SAR (jacks+adults) for CC NOR in BY 1999-2004 ranged from approximately 0.3-0.9% (Carmichael et al. 2011). Only 2 complete BY are available to this point for LGC, and many more are needed in order to evaluate the success of the program in reestablishing a NOR population in LGC.

Life history and abundance metrics for juvenile spring Chinook salmon have been generally similar to the endemic stock and Rapid River reintroduction eras, but with some differences. Outmigrant abundances during the Rapid River and current reintroduction eras have been 26-38% of the endemic. Outmigrants per redd during both reintroduction eras have been 97-115% of the endemic.

Most BY 2007 and 2008 outmigrants left LGC during the fall as presmolts, similar to the endemic era (Burck 1993), the Rapid River reintroduction era, and the CC population (Anderson et al. 2011). Burck (1993) reported peak months of outmigration occurring during July for 3 MY, and August for 2. Peaks for MY 2009-2010 occurred in September or October. Differences observed between the endemic era and the current reintroduced era may have a genetic basis or result from different sampling methods. Burck (1993) used a bypass trap that may have sampled smaller fish outmigrating during the low water periods of June, July, August, and September more effectively than the screw trap currently used. Burck (1993) observed low numbers of fry and small parr caught during January-May. The numbers of fry outmigrants seen in January-June 2008 and 2009 appeared to be low but no trap efficiencies were estimated because of the small numbers caught. Quantifying catches during the period shortly after emergence until flows drop in June is very difficult due to the small size of fish, and large amounts of debris encountered in the live box. Early outmigration of fry and early parr may result from a density dependent effect or life history diversity (Quinn 2005).

1.7 Literature Cited

Note: Annual progress reports for the Lookingglass Creek Spring Chinook Salmon Reintroduction Program, including the Rapid River reintroduction era, are available at the U. S. Fish and Wildlife Service Lower Snake River Compensation Plan website (http://www.fws.gov/lsnakecomplan/reports.html).

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1.8 Appendix A. Lookingglass Creek Management Guidelines (adapted from draft 2013 LSRCP Annual Operations Plan).

The goal of the LGC spring Chinook hatchery program is to reintroduce spring Chinook into LGC using CC stock to support tributary harvest, natural population restoration, and maintenance of a gene bank for the CC stock.

Current production targets for CC and LGC production, per the *2008-2017 United States v. Oregon* Management Agreement are outlined in Table 1.

Appendix Table A-1. LGC and CC production outlined in Table B1 of the *2008-2017 United States v. Oregon* Management Agreement.

Release Site	Rearing Facility	Stock	Life Stage	Target Release Number	Primary Program Purpose	Funding
LGC	LGC/Capt Br	CC	Smolt	250,000	Fishery/Reintro	LSRCP/BPA
CC	LGC/Capt Br	CC	Smolt	150,000	Suppl/ Fishery	LSRCP/BPA

LGC=Lookingglass Creek
CC=Catherine Creek

All LGC adults arriving at the LH 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 LGC adults arriving after July 4 will be based on the percentages outlined in Table 2. All adults passed upstream will have genetic samples taken.

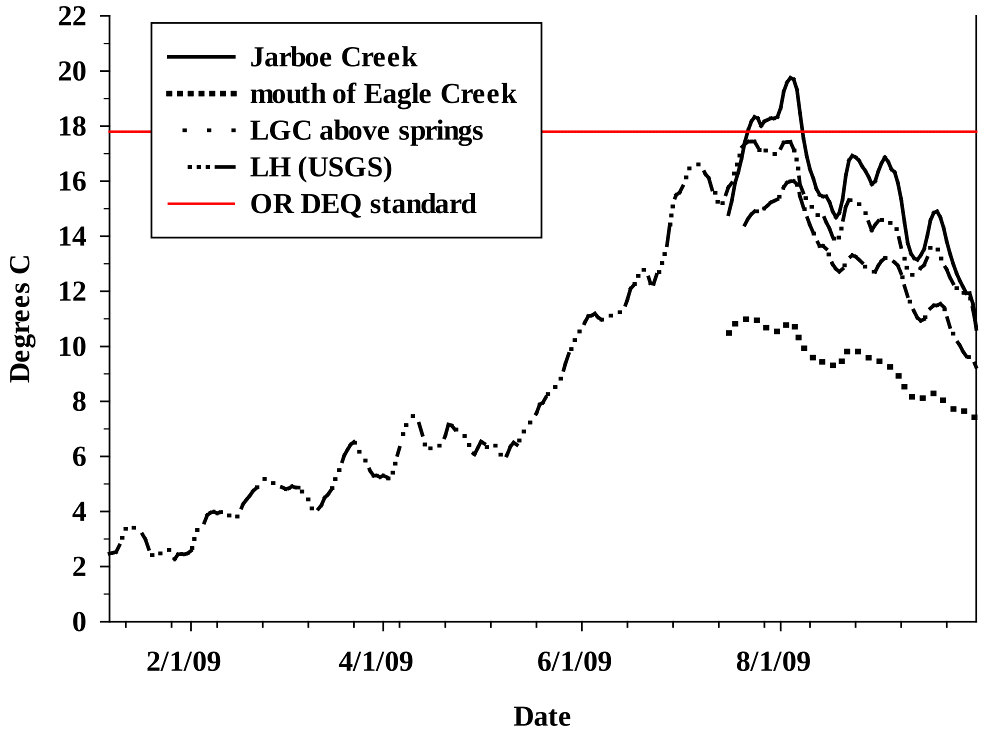
Appendix Table A-2. Disposition of LGC adult spring Chinook salmon arriving at the LH intake weir.

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

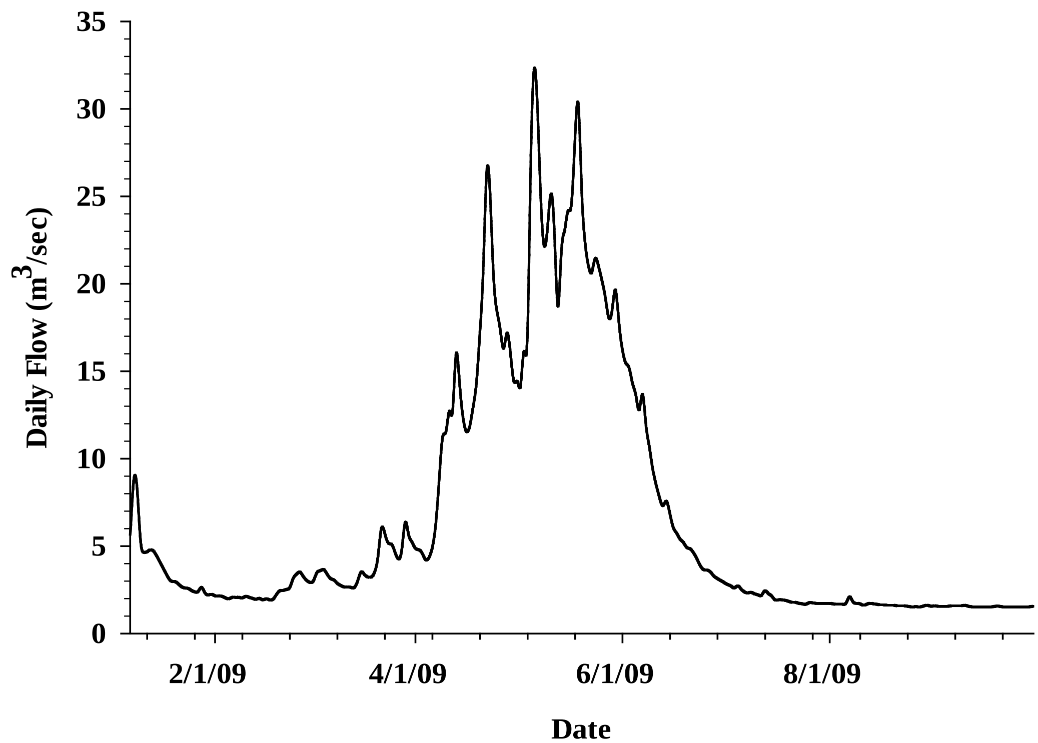
*if greater than 300, adjustments will be made based on brood needs. If brood need has been met, remainder to be released upstream.

An estimated 158 adults (47 natural origin and 111 hatchery origin) required to meet 250,000 smolt production level. Broodstock for the program will be collected from returns to either the LH weir or the CC 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, with no more than 25% of the returning natural origin Chinook retained for brood. If a shortage of natural origin adults occurs, then additional hatchery adults will be collected to meet the brood target.

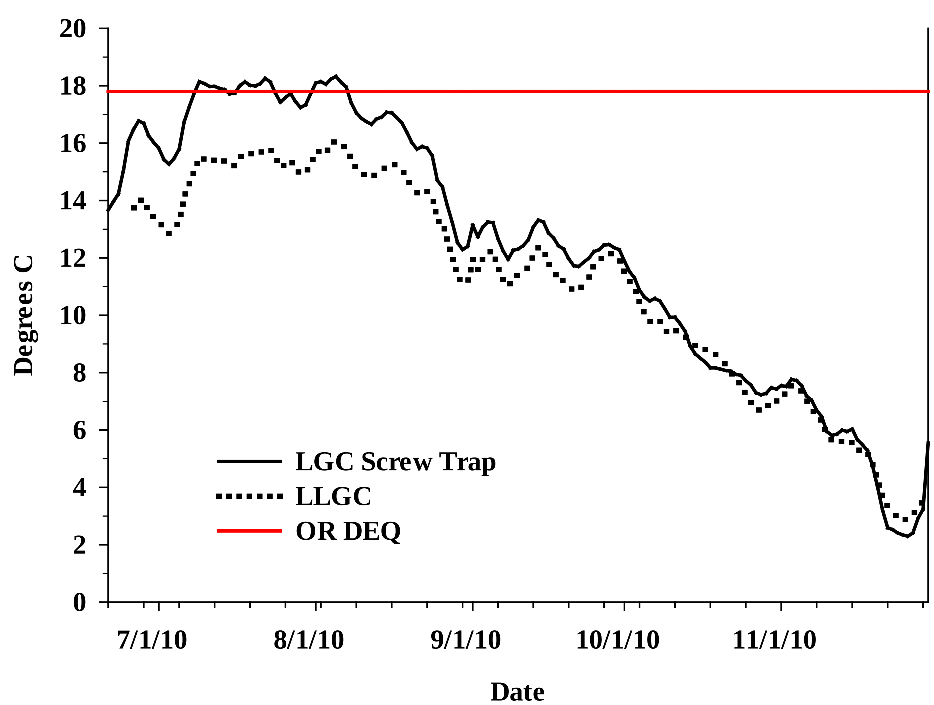
1.9 Appendix B. LGC water temperatures and stream flows in 2009 and 2010.



Appendix Figure B-1. Water temperatures in LGC and tributaries during 2009 (7-d average maximum) and the OR DEQ standard, (Jarboe Creek, Eagle Creek, and Lookingglass Creek above springs data courtesy Umatilla National Forest).

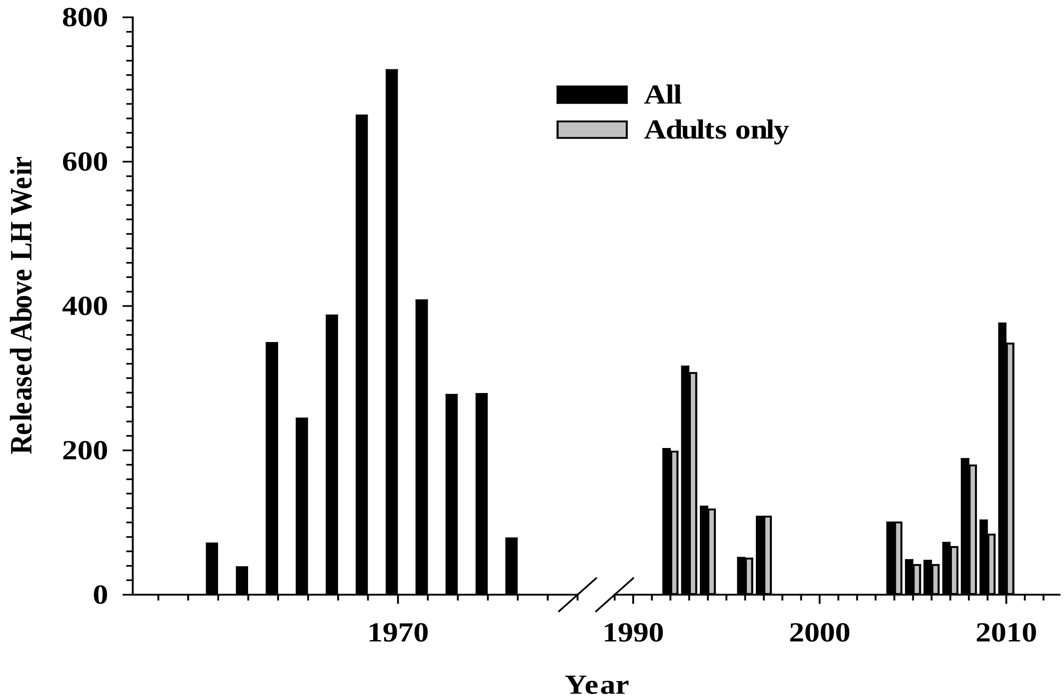


Appendix Figure B-2. Daily stream flows in LGC (USGS site) during 2009.



Appendix Figure B-3. Water temperatures in LGC and LLGC during 2010 (7-d average maximum), and the OR DEQ standard.

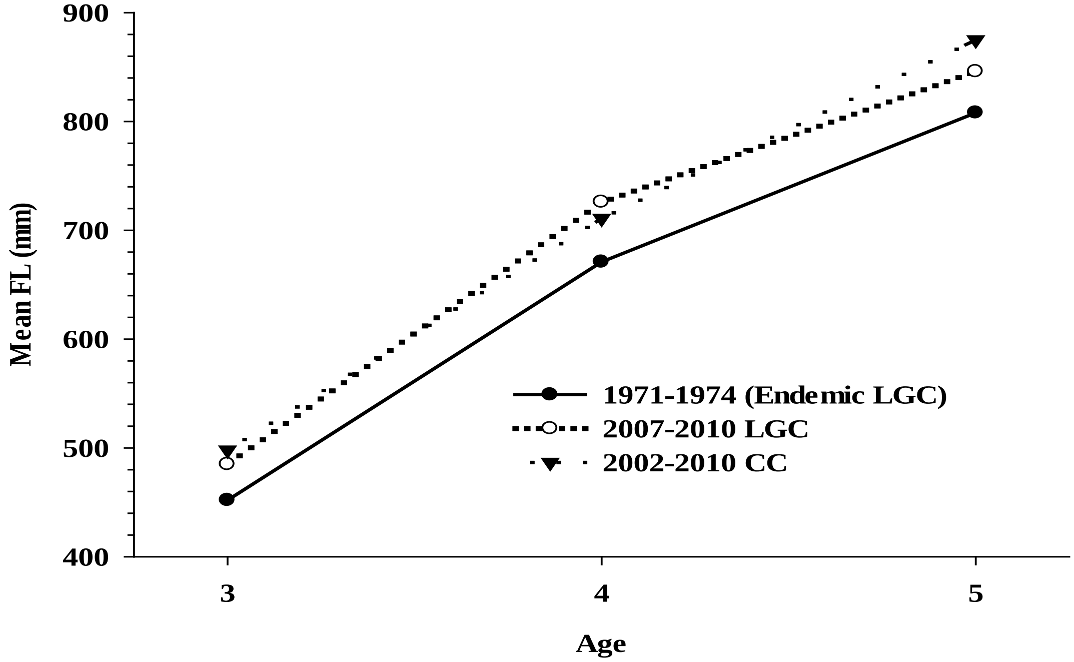
1.10 Appendix C. Spring Chinook salmon data summaries BY 1964-1974[a], 1992-1994, 1996-1997, and 2004-2010.



Appendix Figure C-1. Spring Chinook salmon released above the LH weir to spawn in nature. *Note: The LH adult trap was not operating effectively in 1964 and 1965, resulting in a significant underestimate for those two years.*

Appendix Table C-1. Fish/redd and prespawning mortality for natural spawning spring Chinook salmon above LH weir, BY 2004-2010.

	Fish/redd		
BY	Adults only	Jacks and Adults	Prespawning mortality
2004	2.04	2.04	0.00
2005	1.45	1.72	8.33
2006	1.95	2.13	0.00
2007	2.06	2.25	8.33
2008	1.73	1.83	0.00
2009	1.25	1.63	12.50
2010	2.01	2.18	2.27
Mean	1.75	1.93	4.86

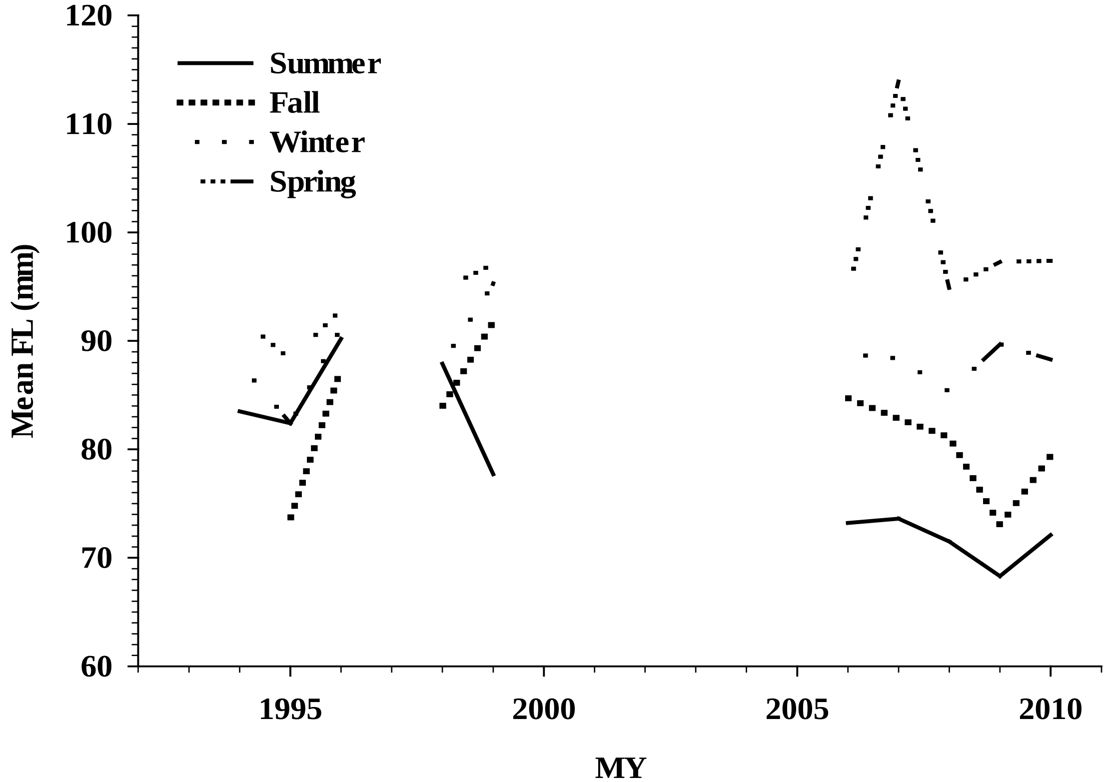


Appendix Figure C-2. Mean FL (mm) at age for LGC NOR spring Chinook salmon adults 1971-1974 (endemic era), 2007-2010 (current reintroduction era), and CC NOR.

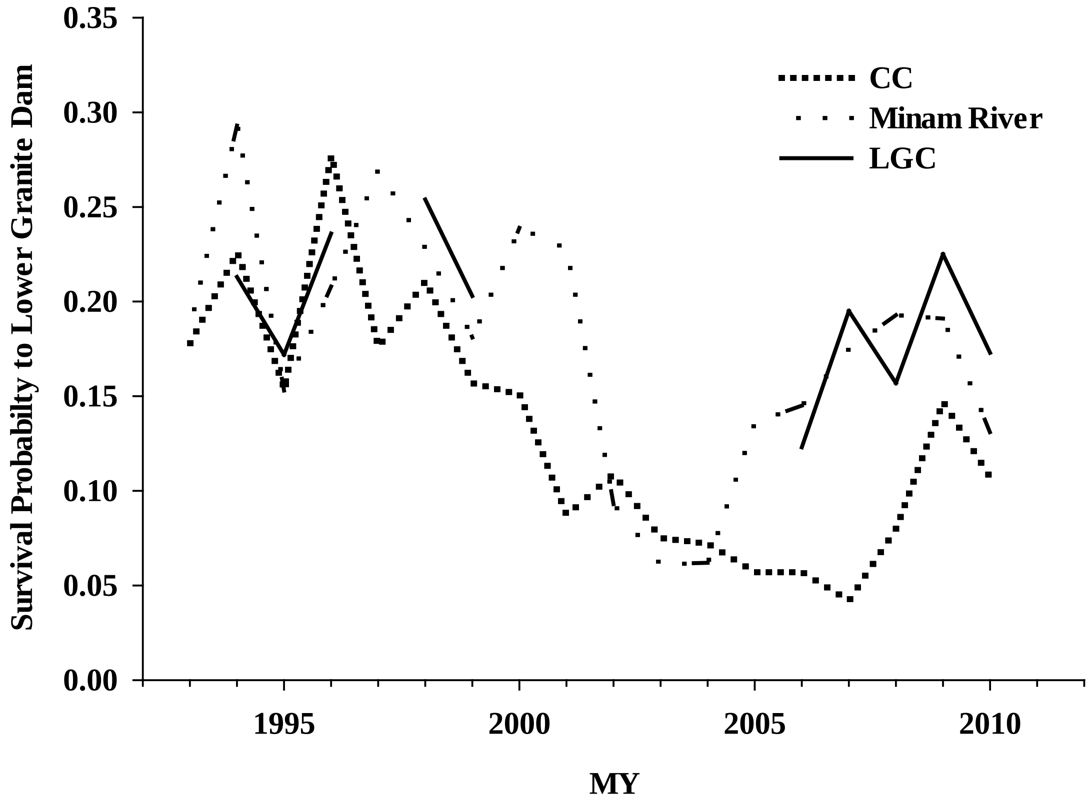
Appendix Table C-2. LGC NOR spring Chinook salmon outmigrant summary[a].

BY	MY	Total Outmigrants	Outmigrants by Period (Jul-Jun) Jun-Sept	%	Oct-Dec	%	Jan-Jun	%	Redds AW[c]	Outmigrants/ Redd AW	Redds BW[c]	Total Redds
1965	1967	48,374	30,118	62	14,351	30	3,905	8	99	489	22	121
1966	1968	93,625	62,743	67	23,162	25	7,721	8	279	336	92	371
1967	1969	40,166	30,176	75	7,616	19	2,375	6	120	335	31	151
1968	1970	42,031	27,599	66	8,778	21	5,655	13	133	316	12	145
1969	1971	61,987	51,212	83	7,542	12	3,232	5	276	224	78	354
1992	1994	8,713			6,273	72	2,440	28	49	178	13	62
1993	1995	65,082	38,240	59	19,193	29	7,689	12	132	493	20	152
1994	1996	6,707	2,592	39	3,945	59	170	3	40	168	8	48
1996	1998	14,713	3,550	24	5,282	36	5,881	40	24	613	7	31
1997	1999	14,140	6,451	46	6,107	43	1,582	11	28	505	4	32
2004	2006	9,404	4,071	43	4,377	47	956	10	49	192	49	98
2005	2007	14,091	4,717	33	9,055	64	319	2	29	486	10	39
2006	2008	12,208	4,401	36	5,398	44	2,409	20	28	436	28	56
2007	2009	7,847	1,250	16	4,987	64	1,610	21	32	245	22	54
2008	2010	30,289	6,220	21	16,762	55	7,306	24	104	291	39	143
Means*		14,768	4,132	30	8,116	55	2,520	15	48	330	30	78

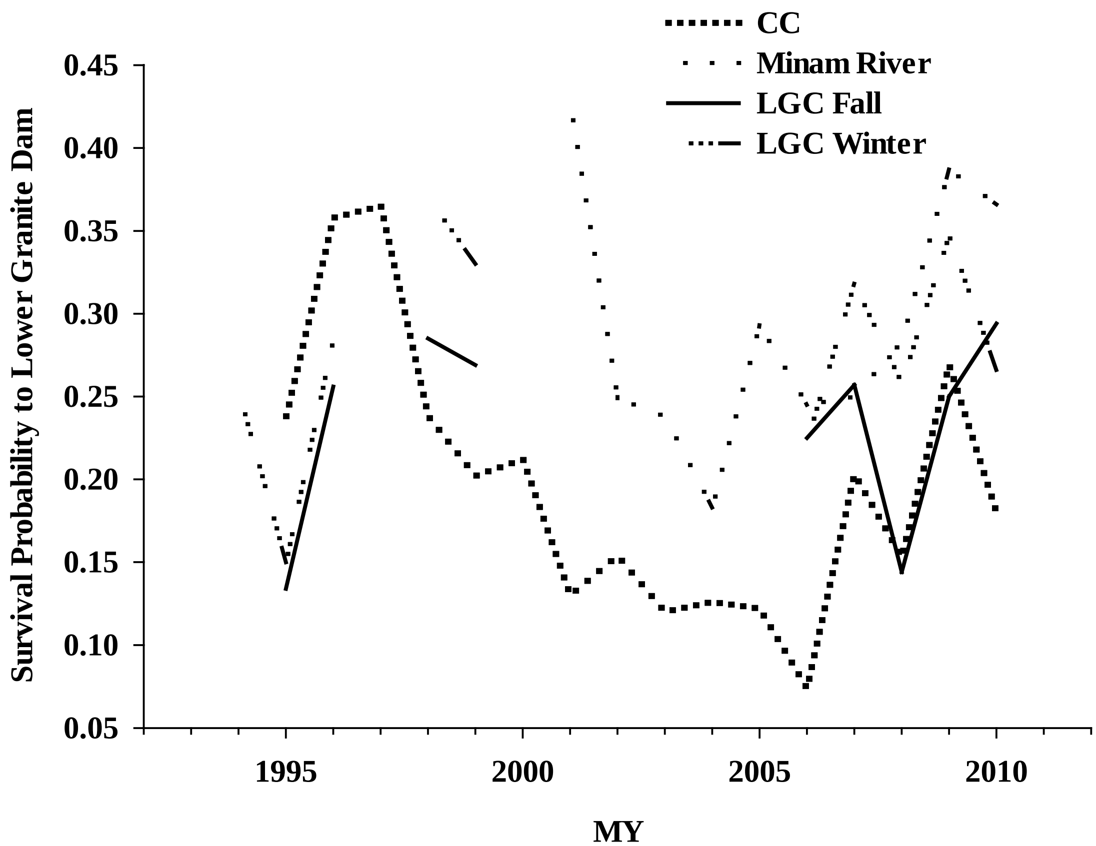
*[a] PIT tags only used for estimate; [b] AW=above the LH weir, [c] Trapping began in November 1993, *BY 2004-2009*



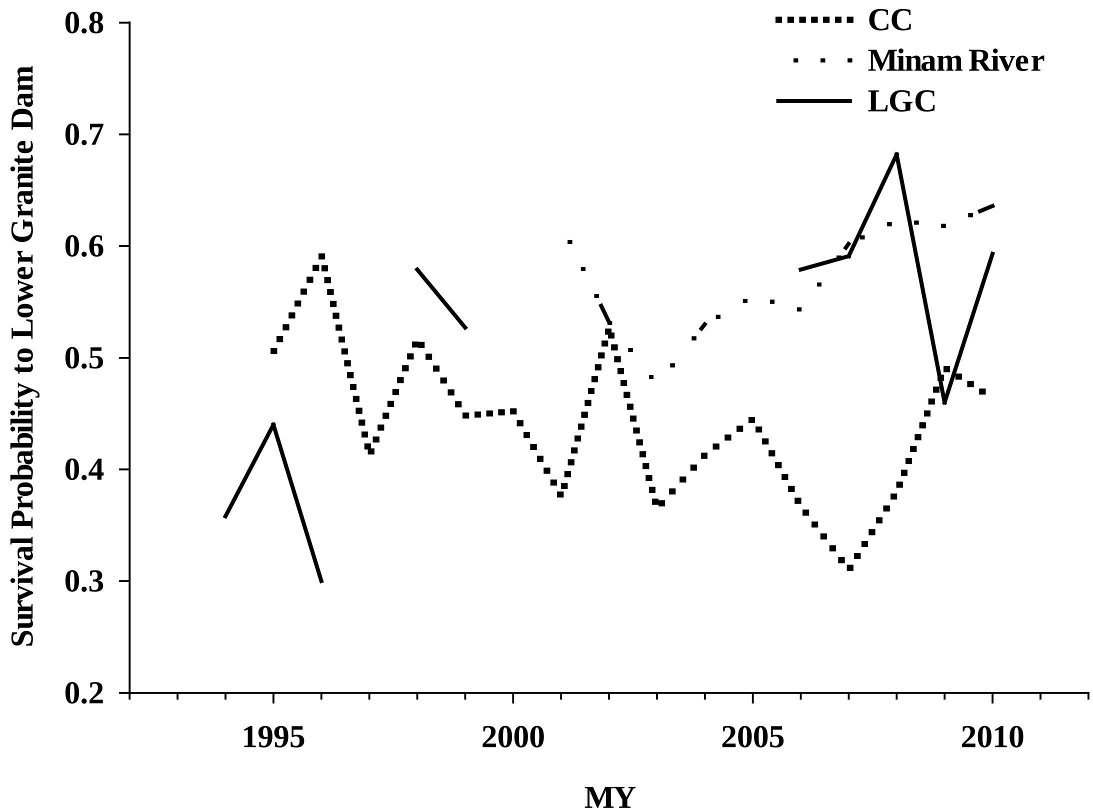
Appendix Figure C-3. Mean FL (mm) of LGC NOR summer parr and outmigrants by MY.



Appendix Figure C-4. Survival probabilities for spring Chinook salmon summer parr from Grande Ronde River Subbasin streams by MY.



Appendix Figure C-5. Survival probabilities for fall/winter groups of spring Chinook salmon outmigrants from Grande Ronde River Subbasin streams by MY.



Appendix Figure C-6. Survival probabilities for spring groups of spring Chinook salmon outmigrants from Grande Ronde River Subbasin streams by MY.

Appendix Table C-3. Population estimates, spawners, and R/S for LGC NOR spring Chinook salmon.

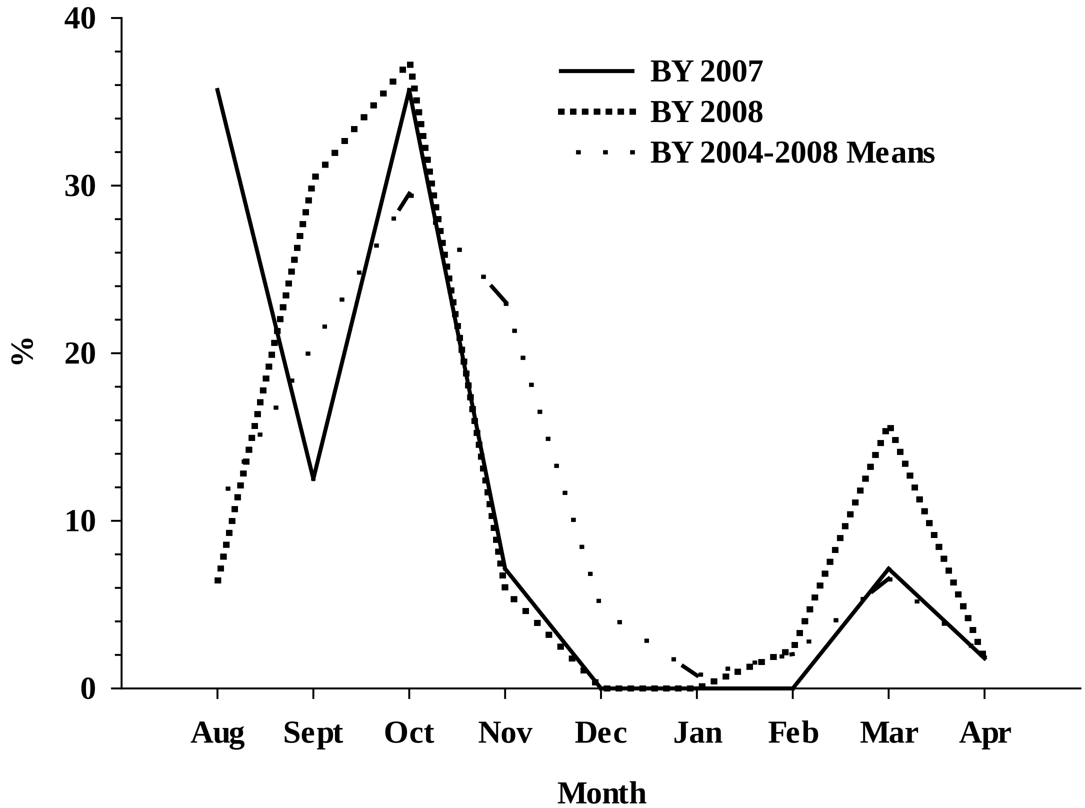
	Population[a]		Spawners[b]		R/S Spawners	
BY	All	Adults	All	Adults	All[c]	Adults[d]
2004	100	100	100	100	0.6	0.6
2005	50	42	46	39	1.8	2.0
2006	60	55	60	55		
2007	72	66	66	61		
2008	190	180	190	180		
2009	109	84	95	74		
2010	371	342	363	334		

[a] *Fish present above LH weir prior to start of regular spawning ground surveys*
[b] *Adjusted for prespawning mortality*
[c] *(Sum of BY X returns at ages 3, 4, and 5)/BY X All spawners*
[d] *(Sum of BY X returns at ages 4 and 5)/BY X Adult spawners*

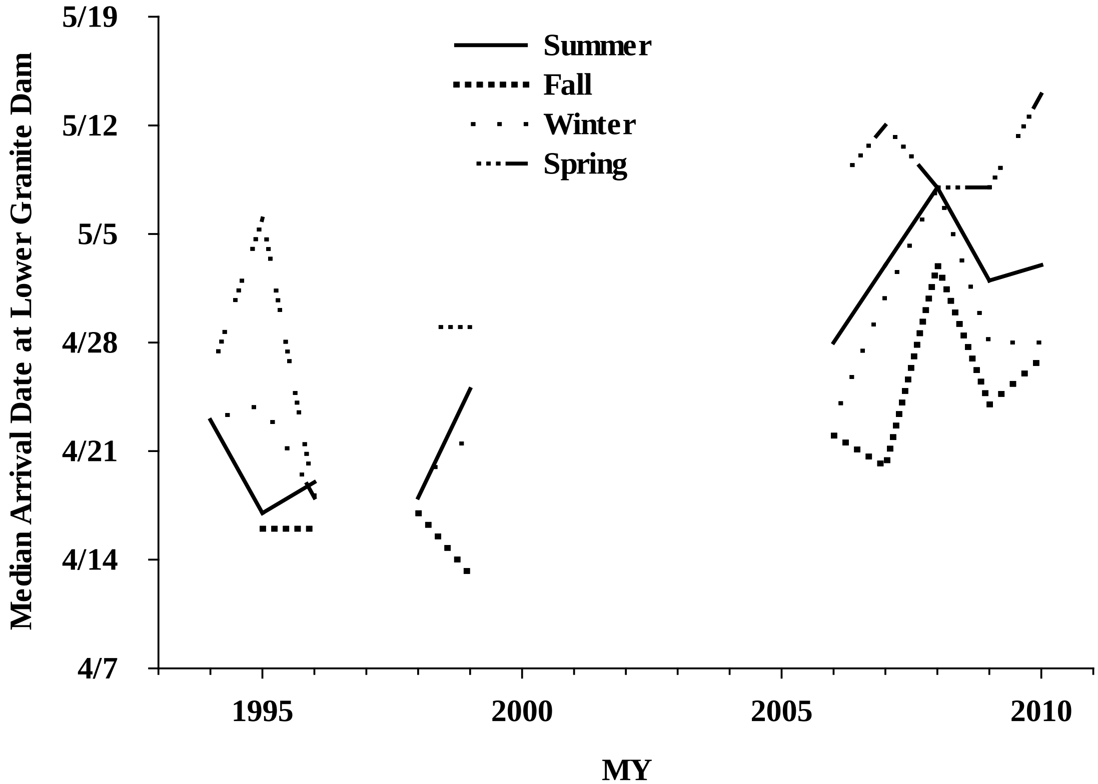
Appendix Table C-4. S_{eq} to LGD, returns by age, and SAR for LGC NOR spring Chinook salmon.

		Returns by Age					SAR (%)	
BY	S_{eq}	3	4	5	All	Adults	Alla	Adultsb
1992	2,454	9	101	17	127	118	5.2	4.8
1993	11,380	3	79	25	107	104	1.0	1.0
1994	1,839	0	32	5	37	37	2.1	2.1
1996	6,371	5	51	15	71	66	1.1	1.0
1997	4,584	5	34	5	44	39	1.0	0.9
2004	2,446	7	46	9	92	55	2.5	2.2
2005	4,280	4	69	9	82	78	1.9	1.8
2006	3,669	24	124					
2007	2,784	17						
Means*	3,295	13	80	9	87	67	2.2	2.0

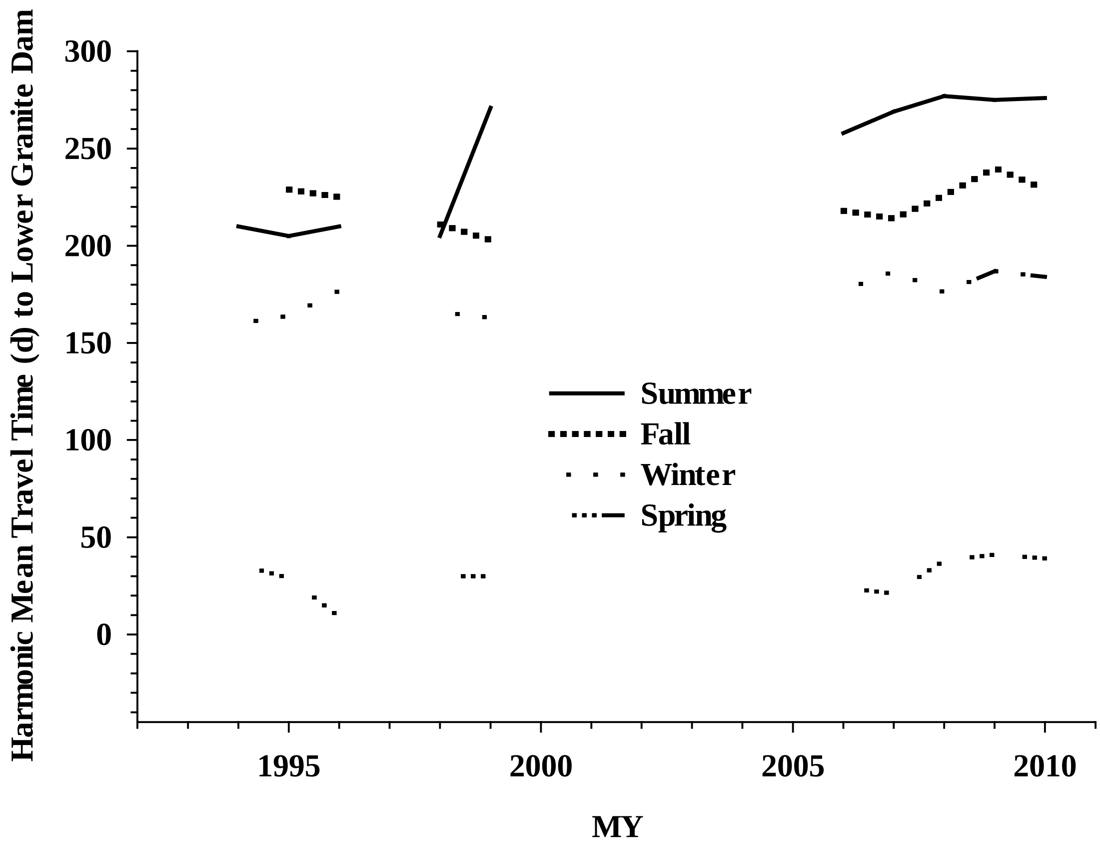
[a] *(Sum of BY X returns at ages 3, 4, and 5)/S_{eq} BY X*
[b] *(Sum of BY X returns at ages 4 and 5)/S_{eq} BY X*
**BY 2004-2005*



Appendix Figure C-7. Percentages of LGC NOR spring Chinook salmon summer parr PIT-tag recaptures in the LGC screw trap by month for BY 2007 and 2008 and 2004-2008 combined.



Appendix Figure C-8. Median arrival dates at LGD for LGC NOR spring Chinook salmon summer parr and outmigrants by seasonal group and MY.



Appendix Figure C-9. Harmonic mean travel time (d) to LGD for LGC NOR spring Chinook salmon summer parr and outmigrants by seasonal group and MY.

2 SECTION II. *Oncorhynchus mykiss* Investigations in Lookingglass Creek

2.1 Abstract

Wild summer steelhead caught in the Lookingglass Hatchery adult trap totaled 194 in 2009 and 311 in 2010. Counts were highest in March of both years, and dominated by females. Age composition of 2009 returns was 54% 1-ocean and 24% 2-ocean. Fall 2008 outmigrants 11,141. Mean FL for 222 fall 2008 PIT-tagged outmigrants was 127.8 mm, survival probability to Lower Granite Dam 0.184, and median arrival date at Lower Granite Dam 8 May 2009. Mean FL for 103 spring 2009 outmigrants was 122.1 mm, survival probability was 0.260, and median arrival date was 5 May 2009. Migration year 2010 outmigrants totaled 13,676. Mean FL for 380 fall 2009 outmigrants was 158.7 mm, survival probability 0.284, and median arrival date 17 May 2010. Mean FL for 540 spring 2010 outmigrants was 132.9 mm, survival probability 0.511, and median arrival date 15 May 2010. Adult catches since 2001 have been higher than during 1965-1974 and arrival timing appears to be earlier. The Lookingglass Creek population comprises a substantial portion of the Upper Grande Ronde Major Population Group. Juvenile outmigrants for migration years 2001-2008 were higher than the late 1960s and 1970s, but decreased substantially in migration year 2010. The Lookingglass Creek summer steelhead population is doing well compared to other wild A-run populations in the Grande Ronde Subbasin and Snake River Basin. Life history characteristics observed are generally similar to those observed during other years in Lookingglass Creek and for other stocks of A-run summer steelhead in the Grande Ronde River Subbasin.

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 habitat (Nehlsen et al. 1991). The Grande Ronde River Subbasin once supported large populations of fall and spring Chinook (*O. tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon and summer steelhead (USACOE 1975, Nehlsen et al. 1991). Lookingglass Creek (LGC) provided significant tribal fisheries for both spring Chinook salmon and summer steelhead (Gildemeister 1998).

Hatcheries were built in Oregon, Washington and Idaho under the Lower Snake River Compensation Plan (LSRCP) to compensate for losses of summer steelhead resulting from the construction and operation of the four most downstream Snake River dams (USACOE 1975). Following closure of the sport fishery in 1974, comanagers began augmenting populations in the Grande Ronde Subbasin using non-endemic Wallowa Hatchery stock in the early 1980s, and sport harvest was reopened in 1986 (Flesher et al. 2008, Carmichael et al. 2012). Natural summer steelhead populations continued to decline and Snake River summer steelhead were listed as threatened under the Endangered Species Act in 1997.

Life history data for the LGC population and others in the Grande Ronde Subbasin prior to the 1990s is sparse. McLean et al. (2001a) summarized unpublished 1965-1974 return data for LGC summer steelhead collected by Oregon Department of Fish and Wildlife (ODFW). Adult counts at the Lookingglass Hatchery (LH) trap have also been compiled since 1997. Life history of juvenile *O. mykiss* in the Grande Ronde River Basin was summarized by Anderson et al. (2011) and in subsequent reports. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) has captured juvenile *O. mykiss* in the LGC screw trap since 1992 during screw-trapping to evaluate reintroduction of spring Chinook salmon. CTUIR began PIT-tagging juvenile *O. mykiss* during the spring of 1999 to investigate arrival timing and survival to Lower Snake and Columbia River dams. These life history investigations provide context for stock status and management decisions for the Upper Grande Ronde Major Population Group and Snake River Evolutionarily Significant Unit (Ford 2011).

2.3 Methods

2.3.1 Adult Summer Steelhead Returns

Returning wild summer steelhead were diverted by a picket weir into a steep-pass ladder into a trap near the LH water intake operated by ODFW LH staff. The weir has sections of both horizontal and vertical pickets and as long as flows over the horizontal pickets are adequate, fish can drop back downstream and be trapped again as they reascend the ladder. All first-time captures were enumerated, checked for fin clips and other marks or tags, measured (nearest mm FL), sexed, date of capture recorded, and scales collected for age determination. Returns >508 mm were considered anadromous steelhead, and those smaller as resident rainbow trout (RBT). 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). Age data were summarized using both the ocean age and European age (Koo 1962) conventions. The ocean age composition of the sample was expanded to the total number trapped using an age-length key (Ricker 1975). Opercle tissues were removed with a paper punch, preserved in 95% ethanol, and archived for future genetics analysis. Wild returns were transported 0.6 rkm upstream and released but hatchery-origin (HOR, adipose fin-clipped) were euthanized.

2.3.2 Juvenile *O. mykiss*

We collected outmigrating juvenile *O. mykiss* using a 1.52 m diameter rotary screw trap at rkm 4.0 on LGC approximately 0.3 rkm below the LH adult weir. The screw trap was operated continuously during 2008-2010 except for brief periods during the spring freshet, when flows were low and temperatures high (July-August), and when iced up in winter. The trap was checked 3 times a week or more frequently if catches or flows were high. All *O. mykiss* were enumerated, examined for external marks, scanned with a PIT tag reader, and a sample measured (mm FL), and weighed (0.1 g). First-time captures ≥ 70 mm FL, in good condition (no injuries or obvious disease) were PIT-tagged using standard methods (PIT Tag Steering Committee 1999). All newly-PIT tagged outmigrants were released about 0.1 rkm above the screw trap; recaptures were released about 0.3 rkm below the screw trap. A small number of outmigrants < 70 mm FL were counted and released below the trap without any marks or tags.

DARR 2.0 (Bjorkstedt 2005) was used to estimate the numbers 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. Outmigrant estimates are minimal since the trap could not be operated for the entire outmigration period.

LGC *O. mykiss* juveniles (all wild, no hatchery releases) outmigrate during the entire year, with spring (usually March-May) and fall (usually September and October) peaks. The conventional migration year (MY) was used (1 July of year *x* through 30 June of year *x*+1). For example, within MY 2009, the fall 2008 group included fish caught from 1 July-31 December 2008 and the spring 2009 group fish caught during 1 January-30 June 2009.

Data from PIT-tagged outmigrants were obtained from the PIT tag database maintained by the Pacific States Marine Fisheries Commission at http://www.ptagis.org/. FL, weight, and K were summarized for each seasonal group. Fulton-type condition factor (K) was obtained using the formula from Anderson and Gutreuter (1983, p. 294) and a scaling factor of 10^5.

We estimated arrival timing to LGD 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 LGD for each group was obtained using the date of 50% expanded daily detections. Survival, capture probabilities, and travel time were estimated using PitPro (Westhagen and Skalski 2009). We used the standard configuration, and included the *.mrt files only if recaptured at the LGC screw trap. Observation sites from upstream to downstream were LGD, 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 outmigrants detected during the year following tagging. Outmigrants leave LGC at a wide range of sizes and may be detected as outmigrating through the hydrosystem for several years, spending time in the Grande Ronde River below LGC to add growth before continuing their outmigration.

2.4 Results

2.4.1 Adult Summer Steelhead Returns

A total of 191 wild returns were caught during March-June 2009, and 3 RBT. Females made up 55% of the steelhead. Steelhead catch was highest in April at 45% of the total. No HOR returns were caught. Wild steelhead returns during March-June 2010 totaled 309; 2 RBT were caught. Females made up 59% of the steelhead. Steelhead catch was highest in April at 65% of the total. First-time catches of HOR returns totaled 23. Some of the HOR returns were recycled below the trap for the sport fishery but none were intentionally passed above the LH weir. FL distributions were bimodal for the total catch in run years (RY) 2009 and 2010 (Figure 1).

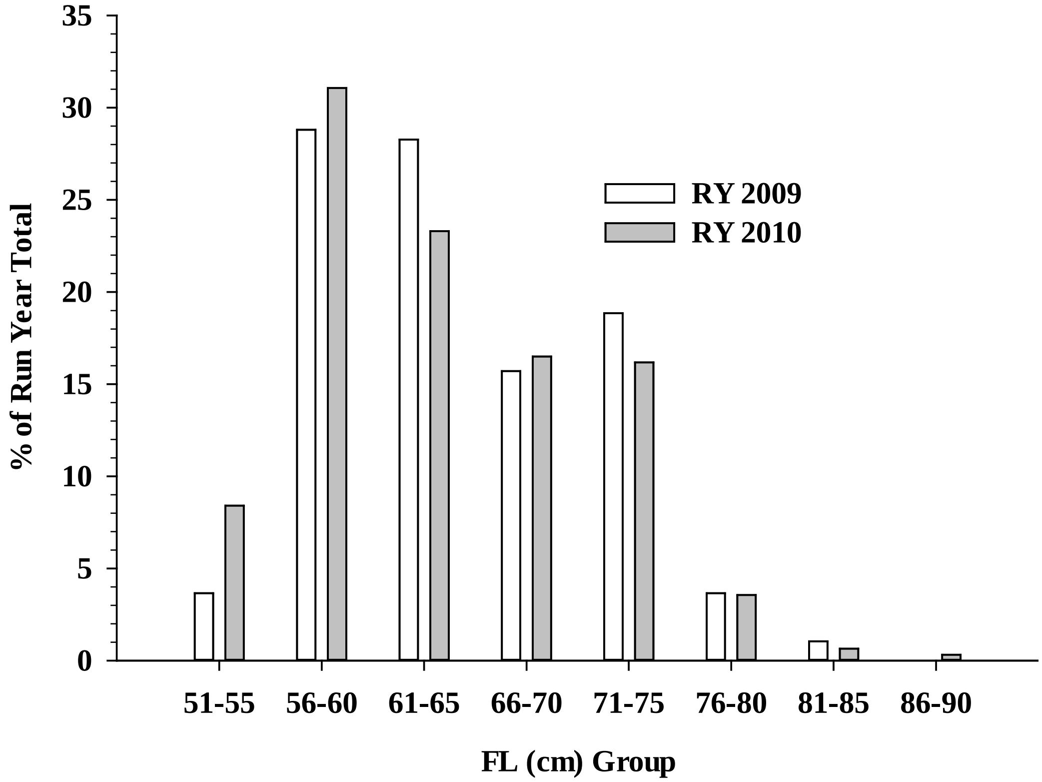


Figure 1. FL (cm) by sex of LGC wild summer steelhead collected at the LH trap, RY 2009-2010.

Mean FL of females was greater than males in both years (Table 1). Scales from 150 of the 191 steelhead caught in 2009 were aged. Mean FL-at-age was slightly greater for females than males at 1-ocean, but 2-ocean males were larger than females (Table 2). Applying the ocean age-FL (cm) distribution of the sample to the entire catch resulted in an age distribution of 63% 1-ocean, 36% 2-ocean, and 1% 3-ocean. One-, two-, and three-ocean adults were collected, and 2.1 and 2.2 were the most common European age designations (Table 3). Scales collected in 2010 were not dried properly and unusable. Assuming the FL (cm) at age distribution for 2009 held for 2010, age distribution was similar to 2009 at 65% 1-ocean, 33% 2-ocean, and 1% 3-ocean. The total did not sum to 100 due to rounding.

Table 1. FL summary for LGC wild summer steelhead caught at the LH trap by sex, RY 2009-2010.

Year	Sex	X̄ FL (mm)	SE	Min-Max	N
2009	M	629	7	525-820	85
	F	666	6	520-845	106
	Combined	650	5	520-845	191
2010	M	636	6	525-893	128
	F	645	5	520-790	181
	Combined	641	4	520-893	309

Table 2. FL (mm) summary for LGC wild summer steelhead caught at the LH trap by ocean-age and sex, RY 2009.

Age	Sex	X̄ FL (mm)	SE	Min-Max	N
1-ocean	M	607	4	525-685	55
	F	610	7	820-735	40
	Combined	609	4	520-735	95
2-ocean	M	731	35	590-820	7
	F	711	4	655-755	46
	Combined	713	6	590-820	53
3-ocean	F	768	78	690-845	2

Table 3. European age designation of LGC wild summer steelhead caught at the LH trap, RY 2009.

	European Age						
	1.3	2.1	2.2	2.3	3.1	3.2	Totals
N	1	85	44	1	10	9	150
%	0.7	56.7	29.3	0.7	6.7	6.0	100.1*

**Percentages do not sum due to rounding*

2.4.2 Juvenile *O. mykiss*

The rotary screw trap was fished 85% of the days during 1 July-30 September 2008 and 85% of the days from 1 January-30 June 2009. Total first-time catches were 418 for MY 2009 with 0.5% mortalities. The outmigrant estimate for July-November 2008 was 11,141 (SE 4,958). There were no recaptures in the spring of 2009, precluding any outmigrant estimate. Mean FL and weight were highest in September-November 2008 and March-April 2009 (Table 4). Mean K appeared to be slightly higher the spring 2009 period than fall 2008.

Table 4. FL, weight, and K summary by month for LGC *O. mykiss* captured in the screw trap, MY 2009 (July 2008-June 2009).

	Month							
Statistic	Jul	Aug	Sep	Oct	Nov	Mar-Apr	May	Jun
FL (mm)								
Mean	87.4	100.7	144.4	148.8	159.6	116.0	102.2	96.2
SE	2.3	3.2	4.7	3.6	10.6	6.3	3.8	3.8
Min	61	66	80	67	84	54	65	49
Max	147	170	198	214	221	230	165	181
N	67	53	42	78	14	58	33	61
Weight (g)								
Mean	8.3	12.5	35.4	38.2	48.5	25.1	13.3	12.8
SE	0.9	1.3	3.3	2.5	8.4	3.7	1.6	1.7
Min	2.1	3.5	6.2	2.9	7.2	2.0	2.9	1.7
Max	33.8	43.9	89.6	99.5	109.9	127.7	48.8	72.9
N	66	52	42	77	14	56	33	61
K								
Mean	1.07	1.05	1.03	1.03	1.03	1.10	1.09	1.12
SE	0.01	0.01	0.01	0.01	0.02	0.048	0.02	0.02
Min	0.90	0.85	0.83	0.91	0.89	0.82	0.90	0.87
Max	1.46	1.29	1.25	1.16	1.21	2.86	1.30	1.77
N	66	52	42	77	14	56	33	61

Median tagging dates were 30 September 2008 for the fall 2008 group and 18 April 2009 for spring 2009. FL (mm) and weight of the PIT-tagged fall 2008 group were larger on average than the spring 2009 group but survival probability was higher for the spring 2009 group (Table 5).

Mean FL of 36 PIT-tagged outmigrants released in the fall 2008 group and detected in the hydrosystem during spring 2009 was 154.1 mm. Mean FL at tagging of 3 detections a year later in the spring of 2010 was 117.0 mm. Mean FL of 23 tagged outmigrants released above the screw trap in the spring 2009 group and detected in the hydrosystem during spring 2009 was 160.2 mm. Mean FL of 7 detections a year later in the spring of 2010 was 115.4 mm. Two fish of the spring 2009 group were detected two years later in the spring of 2011.

Table 5. FL, weight, K factor, survival, travel time, and arrival timing to LGD summary by season for LGC *O. mykiss* caught in the screw trap, PIT-tagged and released, MY 2009 (N=raw counts, N*=expanded for spill).

	Season	
Statistic	Fall 2008	Spring 2009
Mean FL (mm)	127.8	122.1
SE	2.5	3.1
Min-Max	72-221	81-230
N	222	103
Mean Weight (g)	27.1	23.5
SE	1.5	2.1
Min-Max	3.6-109.9	5.0-127.7
N	220	102
Mean K	1.04	1.08
SE	0.005	0.012
Min-Max	0.83-1.29	0.82-1.77
N	220	102
Survival	0.184	0.260
SE	0.028	0.054
N	222	103
Travel Time (d)	212	18
SE	8	2
N	25	17
10% Arrival Date	4/21/09	4/22/09
Median Arrival Date	5/8/09	5/5/09
90% Arrival Date	5/21/09	5/21/09
N	25	17
N*	43	30

FL (cm) distributions for releases and detections of the fall 2008 PIT-tag group were substantially different (Figure 2). The distribution of tagged outmigrants was relatively uniform from 7 cm to 17 cm, then slowly dropped off. The distribution of detections rose rapidly beginning at 12 cm, peaked at 14 cm, and then dropped rapidly. The spring 2009 distributions also differed substantially, and showed similar patterns (Figure 3).

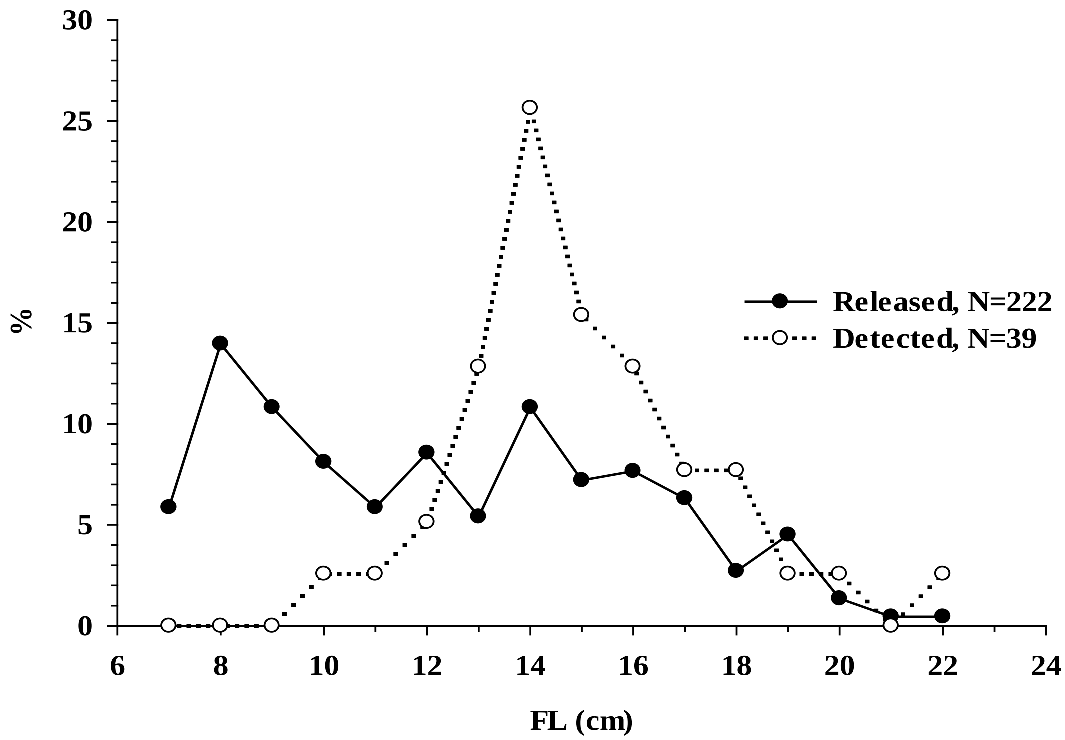


Figure 2. FL (cm) distribution of MY 2009 Fall 2008 group *O. mykiss* PIT-tags released and detected in the hydrosystem during the same MY.

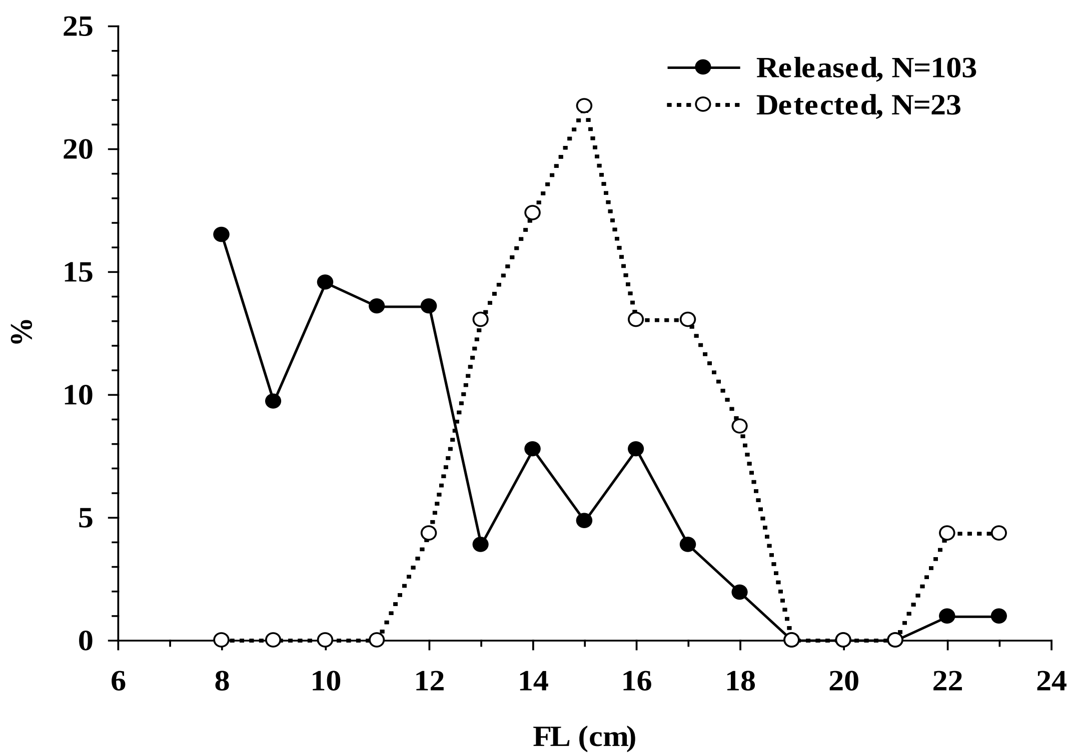


Figure 3. FL (cm) distribution of MY 2009 Spring 2009 group *O. mykiss* PIT-tags released and detected in the hydrosystem during the same MY.

The trap fished 84% of possible days during 1 July-31 December 2009 and 96% of possible days during 1 January-30 June 2010. During the fall 2009 period, the trap was not operated for 7 d over the Thanksgiving holiday, and was pulled for the season on 7 December. Spring high water and debris prevented operation for 3 brief periods in the spring of 2010 (one in March, one in May and one in June).

The total catch for first-time captures was 1,319 with 1.2% mortalities. The outmigrant total for July 2009-June 2010 was 13,676 (SE 1,713). Fall 2010 outmigrants were 32% of the MY total and spring 2010 68%. Median tagging dates were 29 September for the fall 2009 group and 18 April for the spring 2010 group. Mean FL 39 PIT tag recaptures in the screw trap from the fall 2009 tag group was 156.7 mm compared to 144.9 for 53 recaptures from the spring 2010 group.

Mean FL and weight were highest in September 2009 and showed little variation from August 2009 through April 2010. Mean K varied 0.09 during the MY (Table 6).

Table 6. FL, weight, and K summary by month for *O. mykiss* captured in the LGC screw trap, MY 2010 (July 2009-June 2010).

	Month								
Statistic	Jul	Aug	Sept	Oct	Nov-Dec	Jan-Mar	Apr	May	Jun
FL (mm)									
Mean	114.7	144.9	159.7	154.5	149.3	141.6	145.2	100.1	95.1
SE	5.7	9.5	2.5	2.6	8.4	3.9	2.0	4.5	1.6
Min	55	57	40	46	52	55	58	45	60
Max	202	200	267	225	236	274	220	173	216
N	33	18	164	190	41	133	449	48	213
Weight (g)									
Mean	19.6	35.7	45.6	42.4	46.4	36.3	34.0	13.7	10.6
SE	2.8	6.1	1.7	1.6	5.8	2.5	1.4	1.9	0.7
Min	1.9	2.0	1.3	2.3	1.7	1.5	2.2	3.4	2.3
Max	78.4	87.4	201.4	109.9	142.5	209.7	104.9	53.3	75.9
N	33	16	160	182	37	133	333	47	212
K									
Mean	1.05	1.02	1.00	1.01	0.98	1.00	0.99	1.04	1.07
SE	0.014	0.012	0.005	0.005	0.011	0.006	0.004	0.015	0.006
Min	0.90	0.93	0.86	0.84	0.87	0.81	0.79	0.88	0.79
Max	1.30	1.09	1.20	1.21	1.22	1.27	1.24	1.43	1.35
N	33	16	160	182	37	133	333	47	212

Fall 2009 PIT-tagged outmigrants were on average longer and heavier than spring 2008 and mean K varied 0.02(Table 7). Survival probability of the spring 2010 group was higher than the fall 2009 group.

Mean FL at PIT-tagging of 67 fall 2009 outmigrants detected in the hydrosystem in 2010 was 164.5 mm. Two outmigrants PIT-tagged in the fall 2009 group were detected as juvenile outmigrants a year later in 2011. Mean FL at PIT-tagging of 124 spring 2010 outmigrants detected in 2010 was 170.6 mm. Mean FL at PIT-tagging of 29 outmigrants from the spring of 2010 and detected as juvenile outmigrants a year later in 2011 was 111.5 mm. Mean FL at PIT-tagging of 4 outmigrants from the spring of 2010 and detected as juvenile outmigrants two years later in 2012 was 89.8 mm.

Table 7. FL, weight, K, survival, travel time, and arrival timing to LGD summary by group for LGC *O. mykiss* caught in the screw trap, PIT-tagged and released, MY 2010 (N=raw counts, N*=expanded for spill).

	Season	
Statistic	Fall 2009	Spring 2010
Mean FL (mm)	158.7	132.9
SE	1.4	1.7
Min-Max	76-267	71-216
N	380	540
Mean Weight (g)	43.5	29.6
SE	1.1	1.0
Min-Max	4.5-201.4	3.6-112.9
N	380	539
Mean K	1.00	1.02
SE	0.003	0.004
Min-Max	0.84-1.30	0.79-1.35
N	380	539
Survival	0.287	0.511
SE	0.065	0.126
N	380	540
Travel Time (d)	221	17
SE	4	2
N	28	37
10% Arrival Date	4/24/10	4/24/10
Median Arrival Date	5/17/10	5/15/10
90% Arrival Date	6/4/10	5/29/10
N	28	37
N*	46	61

FL (cm) distributions for releases and detections of the fall 2009 PIT-tag group were similar (Figure 4). The spring 2010 distributions differed substantially, showing a bimodal distribution for releases, but unimodal with a peak at 17 cm (Figure 5). Fall 2009 and spring 2010 detection distributions rose and fell rapidly with peaks at 17-18 cm.

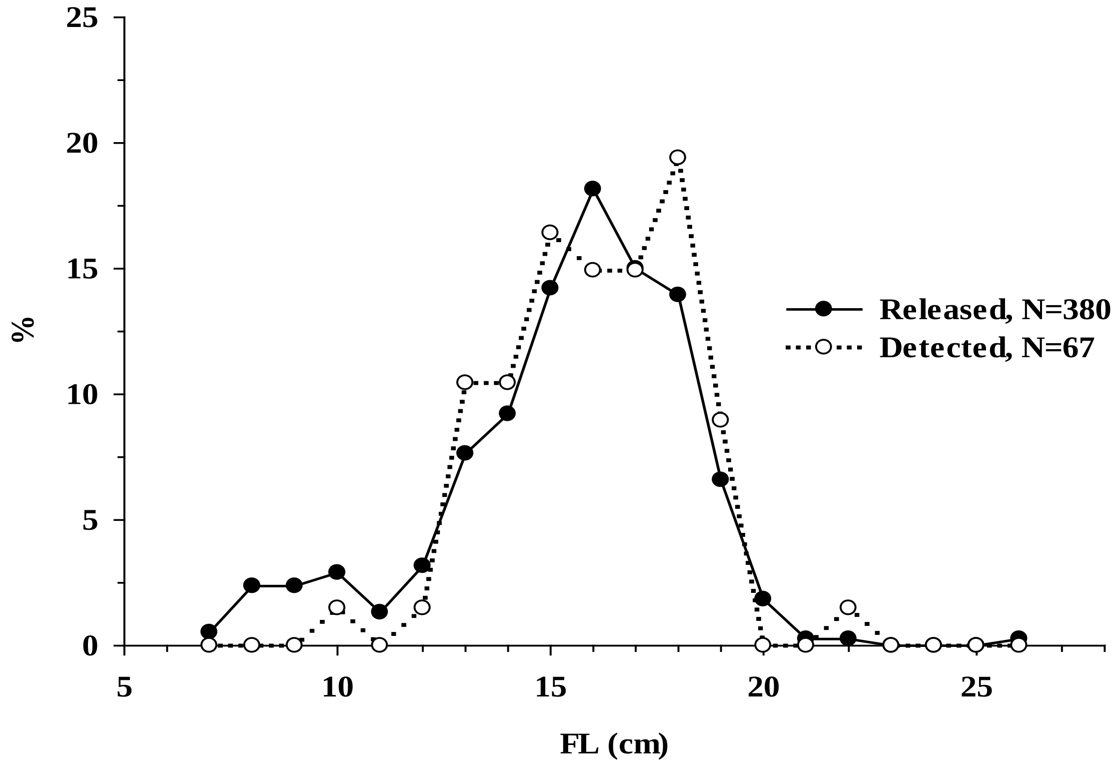


Figure 4. FL (cm) distribution of MY 2010 Fall 2009 group *O. mykiss* PIT-tags released and detected in the hydrosystem during the same MY.

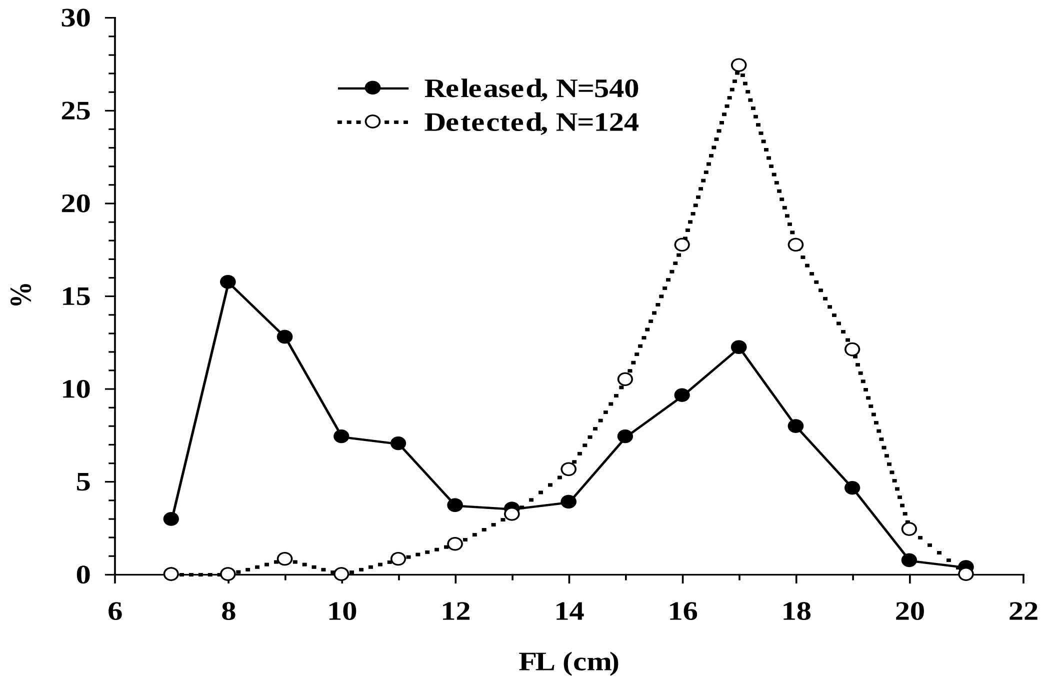


Figure 5. FL (cm) distribution of MY 2010 Spring 2010 group *O. mykiss* PIT-tags released and detected in the hydrosystem during the same MY.

Four freshwater age groups were present in pooled samples from the fall and spring seasons of 2008-2010 (Figures 6 and 7).

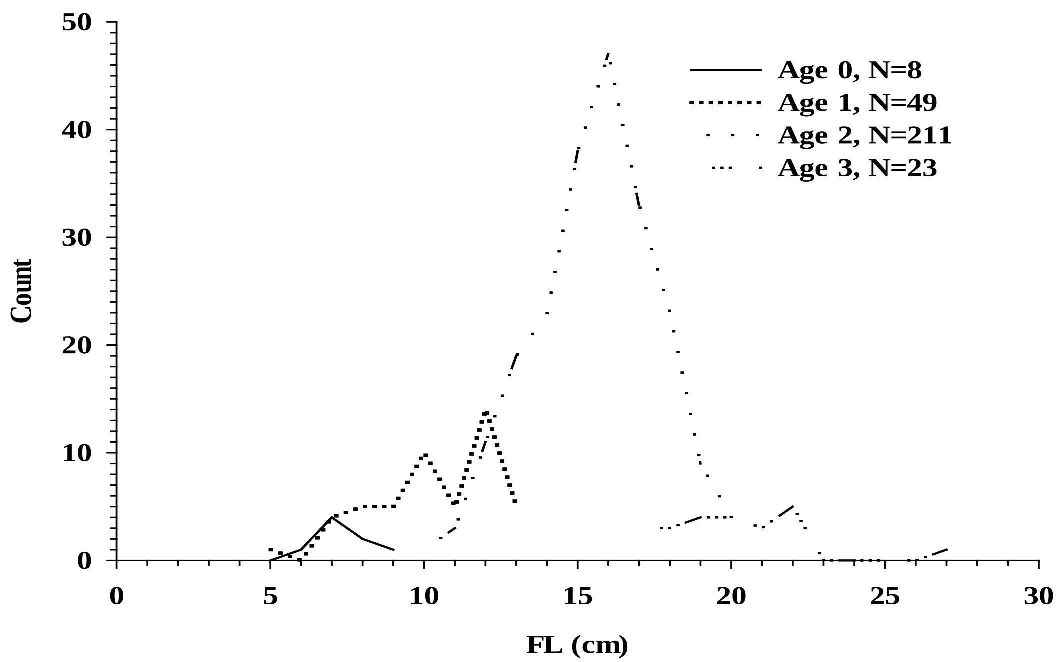


Figure 6. Freshwater age-FL (cm) distribution for juvenile LGC *O. mykiss* captured in the screw trap, fall seasons, 2008-2010.

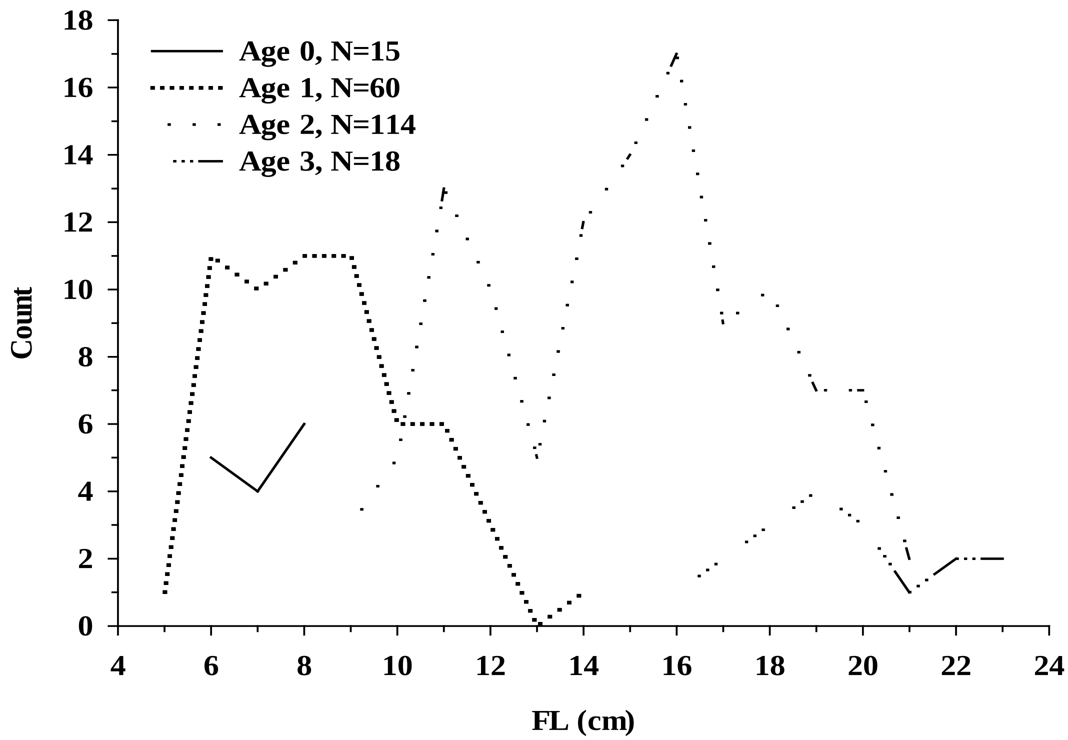


Figure 7. Freshwater age-FL (cm) distribution for juvenile LGC *O. mykiss* captured in the screw trap, spring seasons, 2008-2010.

2.5 Discussion

LH adult trap catches in 2009 and 2010 were two of the highest since 2001. The LGC population is doing well compared to other A-run wild populations in the Snake River Basin, and probably due to the generally good habitat present. LGC has been less affected by mining, agriculture, and water withdrawals than many other streams in the Grande Ronde Subbasin. Catches were much lower during 1965-1974, years just prior to the completion of LGD. It is unknown why catches increased in LGC between the two time periods, while in several other Grande Ronde Subbasin streams and at LGD, catches were decreasing. HOR returns as a percentage of the total catch were unusually high in 2010, but are typically 1-2%. Any influence of HOR returns above the LH weir is probably slight, but some spawning probably occurs below the weir.

The LGC population comprises a significant portion of the Upper Grande Ronde Major Population Group (Ford 2011). The geometric mean from 2003-2008 of wild summer steelhead spawners in the Upper Grande Ronde MPG was 1,425 (Ford 2011) and 174 for LGC for 2001-2010. The Grande Ronde portion of wild summer steelhead returns to LGD ranged from 6,917-7,212 (16-23% of the total) in 2009 and 2010 (Schrader et al. 2011, 2012).

Adult arrival timing at the LH trap during 2001-2010 appeared to differ from the 1965-1974 period (Burck, unpublished data). Peak catches of adults occurred in March or April during 2001-2010, compared to May or June during 1964-1975. The percentages of females in the wild summer steelhead catches from LGC in 2009-2010 were slightly lower than for all wild summer steelhead at LGD. Schrader et al. (2011, 2012) reported 62-67% females using sex-specific genotyping. Other aspects of adult life history appear to be similar to the limited data for Snake River A-run summer steelhead available from earlier years (Olsen et al. 1992), and summaries of life history data for steelhead across wide geographic areas (Burgner et al. 1992, Busby et al. 1996).

LGC juvenile outmigrants in general displayed life history characteristics to other summer steelhead populations. Juveniles outmigrate all year and at a wide range of sizes (Mullarkey 1971, McLean et al. 2001a, 2001b). The numbers of “small”, “medium” and “large” outmigrants were variable from month to month for calendar years 1994-2000, however, across all years, the numbers of “small” and “medium” outmigrants were similar (McLean et al. 2001a). Sizes of outmigrants in MY 2009 and 2010 appeared to be similar. The size range of outmigrating LGC smolts passing through the hydrosystem is consistent with the range of 110-200 mm FL reported by Peven et al. (1994).

The numbers of juvenile outmigrants estimated from screw trap catches in MY 2002-2008 were higher than the estimates made by Mullarkey (1971), but decreased substantially in MY 2010. Raw counts of LGC outmigrants for calendar years 1994-2001 varied 5-fold (McLean et al. 2001a, 2001b). Outmigrant estimates for other populations in the Grande Ronde Subbasin have been highly variable, between populations and between years for a single population (Anderson et al. 2011). It appears higher percentages of juvenile outmigrants left during the fall seasons in recent years compared to the years reported by Mullarkey (1971). During the current study, most outmigrants spent 2 years rearing in LGC, similar to previous observations by Mullarkey (1971).

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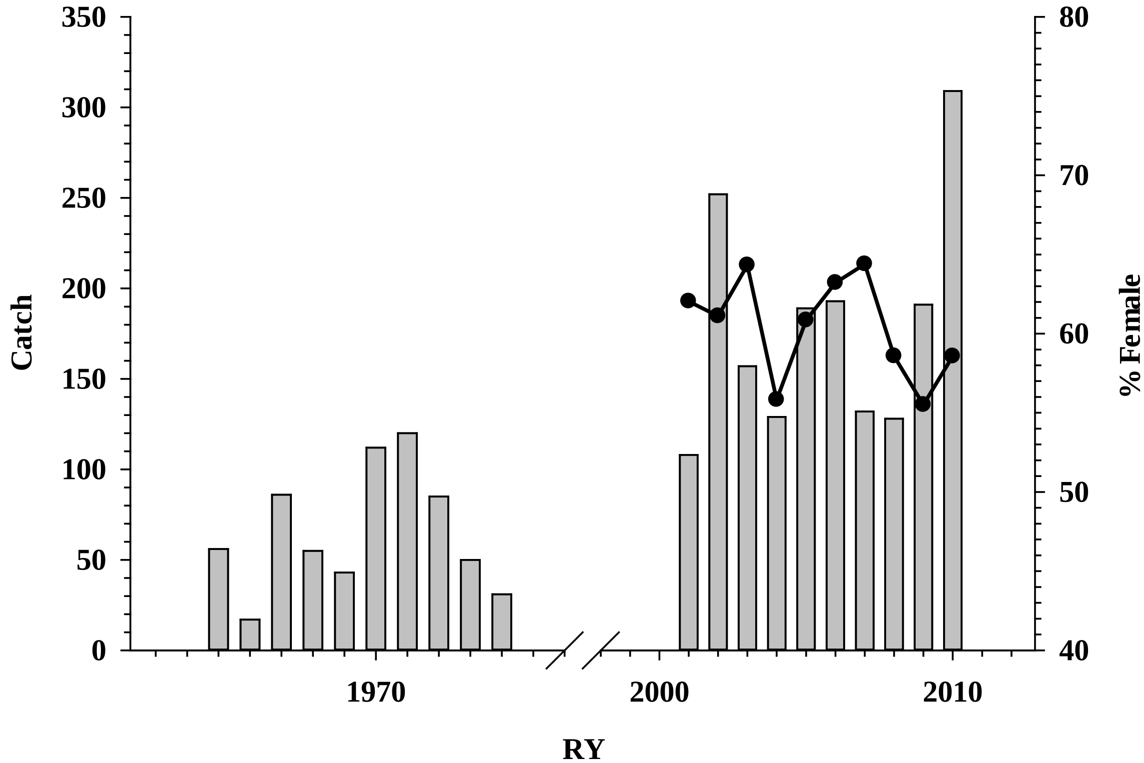
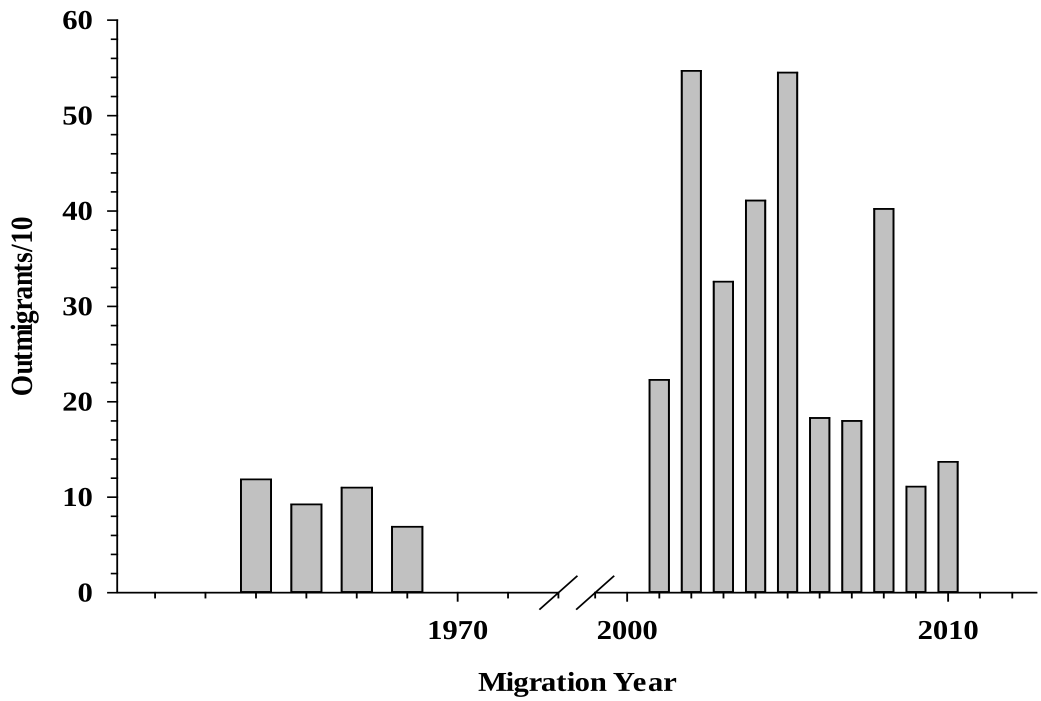
2.7 Appendix A. Wild summer steelhead data summaries for Lookingglass Creek.



Appendix Figure A-1. Catches of wild *O. mykiss* LH adult trap, 1965-1974 and 2001-2010.



Appendix Figure A-2. Catches of wild *O. mykiss* outmigrants in the LGC screw trap, migration years 1966-1969 and 2001-2010*.
* *PIT tags only for all except MY 2008. Only spring 2001 total (MY 2001) was available. The screw trap was moved from rkm 0.4 to 4.0 on 13 July 2005. Fall estimate only for MY 2009.*

3 SECTION III ASSISTANCE PROVIDED TO LSRCP COOPERATORS AND OTHER PROJECTS

We provided assistance to Lower Snake River Compensation Plan cooperator ODFW in 2009-2010 for ongoing hatchery evaluation research. Project personnel completed spawning ground surveys for spring Chinook salmon in the Grande Ronde and Imnaha river basins. We provided assistance in pre-release sampling of spring Chinook salmon at LH and adult spring Chinook salmon at Oregon Lower Snake River Compensation Plan facilities.

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

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