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Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2015 to 31 December 2015

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

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1.1 Abstract

The objective of this study is to evaluate the reintroduction of a local hatchery-origin spring Chinook salmon stock in Lookingglass Creek using standard sampling methods for anadromous salmonids in the Columbia River Basin. Total returns to the Lookingglass Hatchery trap in 2015 were 1,061, of which 274 were natural-origin. Releases above the Lookingglass Hatchery weir totaled 769 and spawning ground surveys yielded 185 redds upstream of the weir, and 91 downstream. Brood year 2010 recruits per spawner was 0.6 for adults only. We estimated 10,191 (170 outmigrants/redd) brood year 2013 juveniles outmigrated from above Lookingglass Hatchery during migration year 2015. During the fall and winter 2014 migration, 90% of juveniles emigrated, and only 10% emigrated in the spring of 2015. Survival probabilities to Lower Granite Dam ranged from 0.088-0.318 for summer, fall, winter, and spring PIT-tagged groups. Smolt equivalents (outmigrants surviving to Lower Granite Dam) totaled 1,152. Brood year 2010 smolt-to-adult ratio was 5.6 for adults only. Mean travel time (in days) to Lower Granite Dam for brood year 2013 was 257, 202, 170, and 35 for summer, fall, winter, and spring groups, respectively.

1.2 Introduction

This is the latest in the series of annual progress reports documenting the reintroducing of spring Chinook salmon to Lookingglass Creek, tributary to the Upper Grande Ronde River in the Snake River Basin in northeastern Oregon (Figure 1). 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. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR), along with comanagers Oregon Department of Fish and Wildlife (ODFW) and Nez Perce Tribe (NPT), began work in the early 1990's 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, since CC stock are native to the Grande Ronde Subbasin and has similar habitat and attributes to LGC. The first CC hatchery-reared release occurred in September 2001. CC stock hatchery-origin (HOR) spring Chinook salmon have returned to LGC, spawned successfully in nature, produced outmigrants, and these outmigrants have returned as adults to LGC. Current management practices include 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.

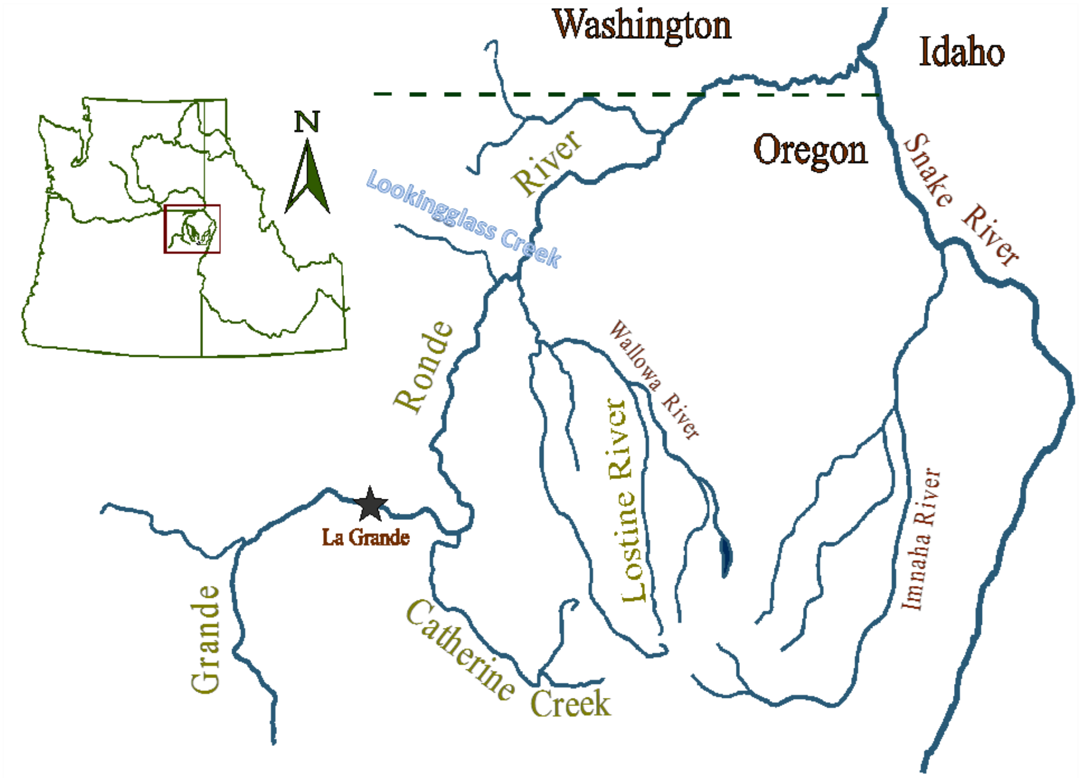

Figure 1. Location of LGC and the Grande Ronde River.

Annual reports describing past progress in reestablishing natural production of spring Chinook salmon in LGC are in the Literature Cited of this Section. The 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 donor stock. LGC is within the usual and accustomed areas of gathering for the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) under the Treaty of 1855 (Gildemeister, 1998). The CTUIR focuses on reestablishment of the natural population above the LH weir and ODFW on the hatchery component (Feldhaus, et al., 2011). Using the natural component of Lookingglass fish, the CTUIR will study status and trends based on the Viable Salmonid Population metrics of abundance, population growth, spatial distribution and diversity. For abundance metrics we look at total returns of adults, hatchery vs natural proportions, sex ratios, redd counts, and juvenile abundances. Metrics evaluated for population growth include Recruits per Spawner, smolt-to-adult-returns (SAR's), and juvenile survival to the dams. Spatial distribution includes redd distribution and juvenile rearing. Genetic diversity is studied by looking at genetic tissues and thus relative reproductive success, age structure, migration and spawn timing, and juvenile emigration. All of these metrics will be outlined and discussed in this report.

1.3 Study Area

Lookingglass Creek originates at Langdon Lake in the Blue Mountains of northeast Oregon at an elevation of 1,484 m above sea level. Gradient is approximately 3% and flow is to the southeast for 25 river km (rkm) through a relatively steep walled canyon within the Umatilla National Forest. The creek then flows through private land with a comparatively wider floodplain for approximately 2.7 km before entering again a narrow canyon down to the Grande Ronde River at rkm 137 (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. Peak flow during this period was recorded in 1996 at 60.0 m^3/sec. 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 tributary (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 (Figure 2). All or nearly all spring Chinook spawning occurs in LGC and Little Lookingglass Creek (LLGC). Lookingglass Hatchery is located from rkm 3.6 to 4.1 on LGC. Upstream migration of returning adult spring Chinook salmon is controlled by the LH weir and trap at rkm 4.1.

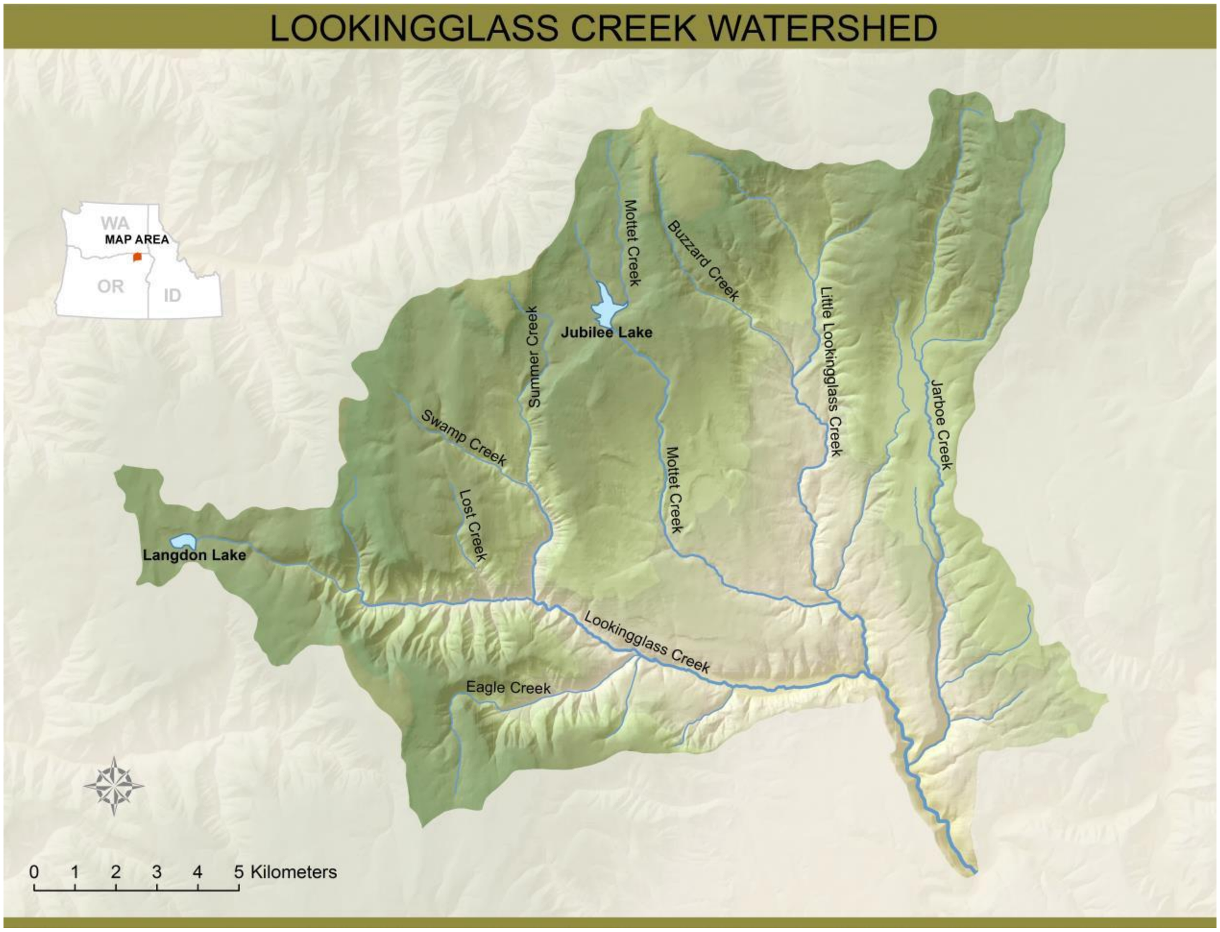

Figure 2. LGC watershed showing major and minor tributaries.

1.4 Program Objectives

The goal of the LGC Spring Chinook Hatchery Program is to reintroduce spring Chinook into LGC using the CC stock to support tributary harvest, natural population restoration, and maintenance of a gene bank for the CC stock (ODFW, 2011).

Program specific goals stated in the Hatchery and Genetic Management Plan (HGMP) for the LGC program include:

1. Restore and maintain viable naturally spawning populations of Chinook salmon in LGC.
2. Contribute to recreational, commercial and tribal fisheries in the mainstem Columbia River consistent with agreed abundance based harvest rate schedules established in the 2008 – 2017 U.S. vs. Oregon Management Agreement.
3. Establish adequate broodstock to meet annual production goals.
4. Establish a consistent total return of Chinook salmon that meets the LSRCP mitigation goal. There are no LSRCP or Tribal Recovery Plan (TRP) hatchery and natural adult return goals identified specifically for LGC. 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.

5. Re-establish historic tribal and recreational fisheries.
6. Minimize impacts of hatchery programs on other indigenous species.
7. Operate the hatchery program so that the genetic and life history characteristics of hatchery fish mimic those of natural fish, while achieving mitigation goals.

This project is guided by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Department of Natural Resources (DNR) 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."

1.4 Methods

1.4.1 Adult Spring Chinook Salmon

Adult Returns to the LH Weir
Adult spring Chinook salmon returning to LGC are diverted by a picket weir into a trap near the LH water intake (Figure 3). ODFW LH staff installs 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 LH 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.


Figure 3. LH adult trap located at rkm 4.1.

Adult spring Chinook salmon captured in the LH trap in 2015 could have been from several sources: LGC natural production above or below the hatchery weir, hatchery-reared Catherine Creek (CC) captive broodstock progeny released into LGC, or hatchery or naturally reared returns from other Grande Ronde Basin stocks (including Upper Grande Ronde River stocks) that have strayed from other streams. Disposition of returns is determined based on a sliding scale (Section 1.7 of this report). NOR and HOR returns were either passed upstream to spawn in nature or held for broodstock needs. In years where there are surplus HOR jacks, they may be sacrificed and provided to the local food bank, or recycled downstream of the weir to supplement the fishery.

Releases Above the LH Weir

Fish released above the weir were hauled to the 62 road bridge and released at rkm 6.2. It was thought that hauling the fish that far upstream may prevent further fallbacks near the water intake to the LH. All fish released above the weir were measured (mm FL), sexed, scanned for PIT tag, and a small amount of tissue from the right opercle was removed with a round paper punch and placed in Rite in the Rain envelopes for later genetic analysis. The presence or absence of these 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. Scales were collected and used to make age determinations for a portion of the NOR returns passed above the weir. 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/).

Spawning Ground Surveys

Spawning ground surveys (Parker, et al., 1995) were conducted during August-September 2015 to assess natural spawning. Several pre-spawn mortality surveys are conducted after fish are released above the weir, to collect carcass information and determine when the first redd is observed. Surveys were conducted in all 5 stream units weekly after the first redd was observed (Figure 4). Only completed redds were counted (Lofy, et al., 1995) flagged, and a GPS point taken to eliminate double counting.

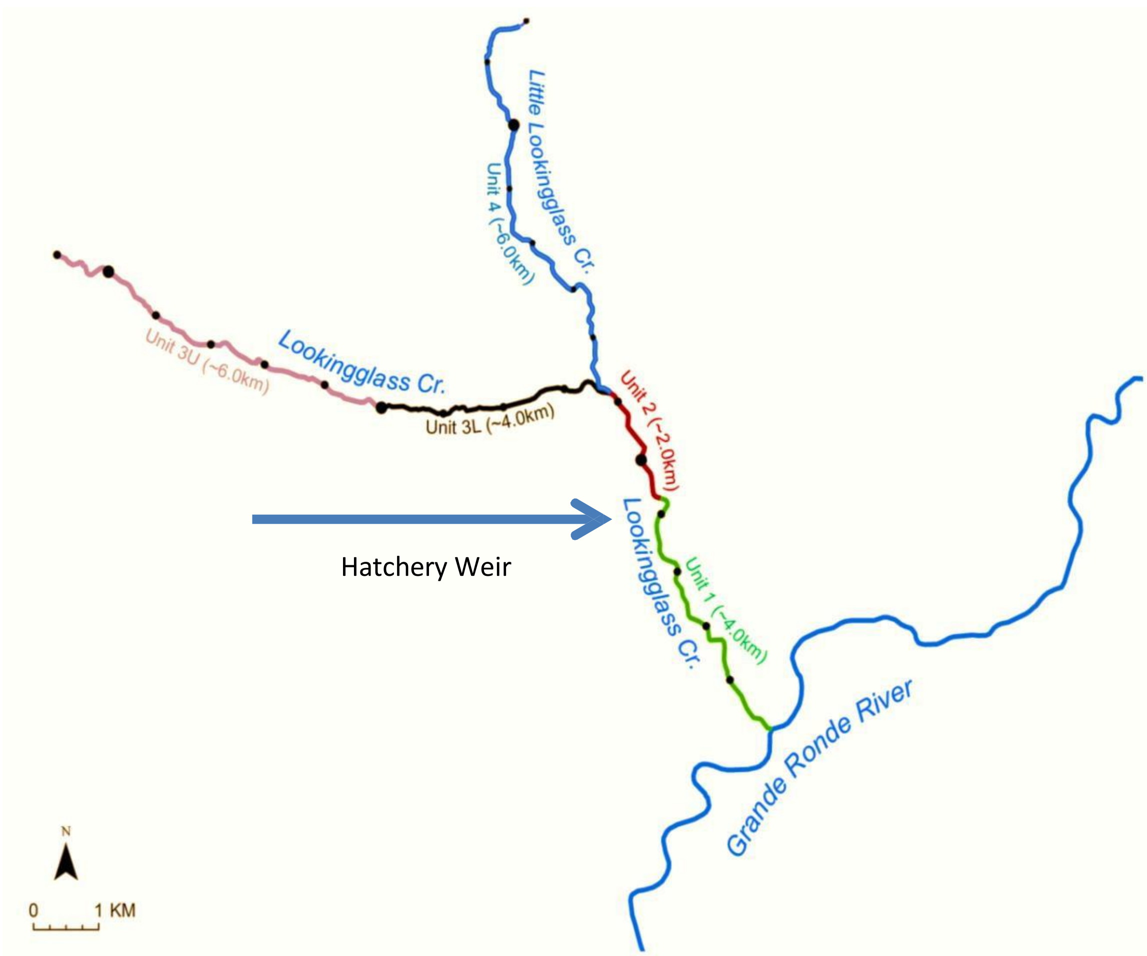

Figure 4. LGC section breaks for spawning surveys. Unit 1 is below the weir, all others are above the weir.

Carcass Recoveries

Carcasses were enumerated and FL (mm), sex, marks, and percent spawned recorded for females. Fish that had spawned $\leq$50% were considered pre-spawn mortalities. Tails were cut off carcasses to prevent double sampling. Snouts were taken from a large proportion of carcasses with an adipose fin clip for CWT recovery (above the weir) or on unclipped fish with a CWT present (below the weir). CWT data were used for determining strays that spawned above and below the weir in addition to identifying the age of the fish. Kidney samples were taken from a portion of the carcasses to determine incidence of bacterial kidney disease (O'Connor, et al., 2007).

Population Estimate Above the Weir
Adult returns were hauled to rkm 6.2 for release above the LH weir in 2015. This was an attempt to keep fish from falling back to the water intake pool like they have in the past when only released at rkm 4.5, just upstream of the adult weir. However, fish still fell back, which resulted in approximately 15-20 fish getting stuck between the pickets and the concrete wall near the adult trap. The pickets were then pulled and these fish were flushed downstream below the weir. These fish had an opercle punch, but the exact numbers are unknown. For determining the population estimate the number marked and released above the weir was decreased by the number of marked fish that were recovered below the weir on spawner surveys. The number of marked fish recovered below the weir is a minimum estimate since the actual number that dropped below the weir, drifted out of LGC, or were eaten by scavengers is unknown. Population estimates of spawners above the LH weir were made for fish ≤ 600 mm FL (jacks) and ≥ 601mm (age 4, 5) using the Chapman modification of the Petersen method (Ricker, 1975). It was evident that trucking fish upstream was also an added stress and we observed an increase in early mortality (June). The spawner estimate above the weir was obtained by applying the percent of female pre-spawn mortality recoveries (those ≤50% spawned out) on spawning ground surveys to the population estimate above the weir.

Recruits/Spawner
Recruits per spawner is calculated by dividing the total number of spawners (HOR and NOR) estimated to be above the weir for a given BY, by the total number of NOR offspring returning to LGC for the complete BY.

1.4.2 Juvenile Spring Chinook Salmon

Outmigrants
We operated a 1.52 m diameter rotary screw trap at rkm 4.0 on LGC, which is 0.1 rkm below the LH adult trap. The rotary trap captures outmigrating naturally-produced juvenile spring Chinook salmon, as well as O. *mykiss*, dace, sculpin, and bull trout (Figure 5). Trap operation was suspended during high spring freshets, midsummer during low flows when temperatures were high and also 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, and scanned for PIT tags. A portion of these were also PIT tagged, measured (nearest mm FL), and weighed (nearest 0.1 g) each week. Fish used for trap efficiency were either PIT tagged using a 10ml hand held syringe, while inserting the PIT tag on the belly of the fish (PIT Tag Steering Committee, 1999) or marked with a lower caudal fin clip (only during June, July when size is under 60 mm) and released about 100 m above the trap.

Figure 5. LGC rotary screw trap located at rkm 4.0.

Outmigrant Estimate

We used DARR 2.9.1 (Bjorkstedt, 2008) to estimate the numbers of outmigrants. DARR 2.9.1 uses stratified mark-recapture data and pools strata with similar capture probabilities. Darr calculates an estimate by using the total number of first time captures, the total number of marked individuals, and the recaptures of those marked fish over the migration period. We used the “one trap” and “no prior pooling of strata” options available in Darr. Outmigrants collected at the screw trap could be distinguished into brood years based on marks or size. Some BY 2013 fry or small parr were caught during January-May of 2014 and were not marked or used in trap efficiency or outmigration estimates. The fall group of NOR BY 2013 fish was caught, PIT-tagged and released from 1 June-30 September 2014, the winter group from 1 October-31 December 2014, and the spring 2015 group from 1 January-30 June 2015. Metrics are described by Hesse et al. (2006) and correspond to the basic categories of abundance, productivity, and diversity for viable salmonid populations (McElhany, et al., 2000).

Survival Estimates

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, et al., 2009). 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, The Dalles, Bonneville Dam, and the Estuary Towed Array (Juvenile). Bonneville Dam was used as the last recapture site. Smolt equivalents for BY 2013 natural production above the weir were calculated as the number of outmigrants per season (fall, winter, spring) multiplied by each seasonal survival estimate to Lower Granite Dam.

SAR's
Smolt to Adult Returns are calculated as the number of returning NOR adults from a given BY divided by the estimate of outmigrating smolts surviving to LGD (S_{eq}) for that BY.

Monthly Sampling
We monitored seasonal growth of naturally-produced BY 2014 spring Chinook salmon by obtaining fork lengths (mm) and weights (0.1 g) of 50 fish collected by snorkel/seining at several locations above the LH adult trap (rkm 8.9, and 10.5) on the 20th (+/- 5 d) of July, August, September and October 2015. Burck (1993) used similar methods to describe growth of juvenile spring Chinook salmon during the endemic era (1964-1970) and also sampled juveniles at rkm 8.9.

Precocials
We capture a small amount of sexually mature juvenile Chinook salmon in the rotary screw trap each year, usually during the August and September months when adult Chinook are spawning. We also capture a small number during our monthly sampling efforts. We take fork length and weights, as well as genetic samples from these fish, so that their contribution to the population can be identified from the relative reproductive success study that is ongoing.

Summer Parr Sampling
We target approximately 1,000 BY 2013 parr using snorkel/seine methods from the primary rearing area (rkm 8.9- 12.0) above LH in early August 2014. A remote tag station was set up at rkm 10.0 to process these fish. These fish were then PIT-tagged using standard procedures (PIT Tag Steering Committee, 1999) and released back to site of capture. Recaptures in the screw trap of these PIT-tagged parr (referred to later in document as summer group) were not reused for trap efficiency but counted as unmarked first time captures and released below the screw trap.

1.5 Results and Discussion

1.5.1 Adults

1.5.2 Abundance

Returns to the LH weir
There were a total of 788 HOR and 273 NOR returns to the weir in 2015. There was also one unpunched, unclipped carcasses recovered above the LH weir, producing 274 total NOR returns in 2015. Total returns to the LH trap based on fork length (FL) were 35 (13%) age 3, 228 (83%) age 4, and 11 (4%) age 5 (Table 1). Age composition of NOR returns in past years has been dominated by age 4, but substantial numbers of age 3

returns occurred in 2009-2011 and 2013-2015. In 2013, age 3 NOR returns surpassed both age 4 and 5 returns combined. Completed brood year (BY 2010) NOR returns were 245, the highest since the start of the current reintroduction era. In direct correlation, redd numbers above the weir in 2010 were also the highest since reintroduction efforts began (n=170).

Table 1. NOR returns to the LH weir for Return Year (RY), and by completed Brood Year (BY).

Returns by RY					Returns by Completed BY				
	Age					Age			
RY	3	4	5	Totals	BY	3	4	5	Totals
2007	7			7	2004	7	46	9	62
2008	4	46		50	2005	4	69	9	82
2009	24	69	9	102	2006	24	124	14	162
2010	17	124	9	150	2007	17	120	15	152
2011	30	120	14	164	2008	30	129	12	171
2012	3	129	15	147	2009	3	47	15	65
2013	60	47	12	119	2010	60	174	11	245
2014	35	174	15	224					
2015	35	228	11	274					

Releases above the LH weir

There were 551 HOR and 218 NOR passed above the weir in 2015, for a total of 769. All of the 551 HOR released were adults. The HOR jacks captured at the weir were either released downstream for supplementing the fishery or sacrificed for ceremonial subsistence. Of the 218 NOR released, 184 were adults and 34 jacks. There were a total of 445 females released, which were 74% HOR.

The early years of the current reintroduction era saw low numbers released above the LH weir (Figure 6). The population since then has been on an upward trend as they have begun establishing themselves in LGC. In 2012 and 2015, the current reintroduction era numbers released above the weir surpassed the endemic study era high of 727, with 926 and 769 respectively. While NOR numbers are not yet at the recovery goal of 500 returns, numbers in the last few years have increased (Figure 7). In 2004, 78 HOR outplants from CC were hauled to LGC and released upstream since there were not enough naturally produced returns. While the sexes of these fish were not recorded, the ratio of male to female was near 1:1. These 78 fish were excluded from 2004 data in Figure 8 below describing sex ratios above the weir for this reason. In general, the sex ratio above the weir has been very near 1:1 for most years. HOR fish were 100% of the adults released above the LH weir in 2004-2007. Since then, HOR adult releases have ranged from 39% to 90%, with an average over those 8 years of 72%. While we do release some NOR jacks upstream, beginning in 2012, HOR jacks have not been intentionally allowed upstream of the weir.

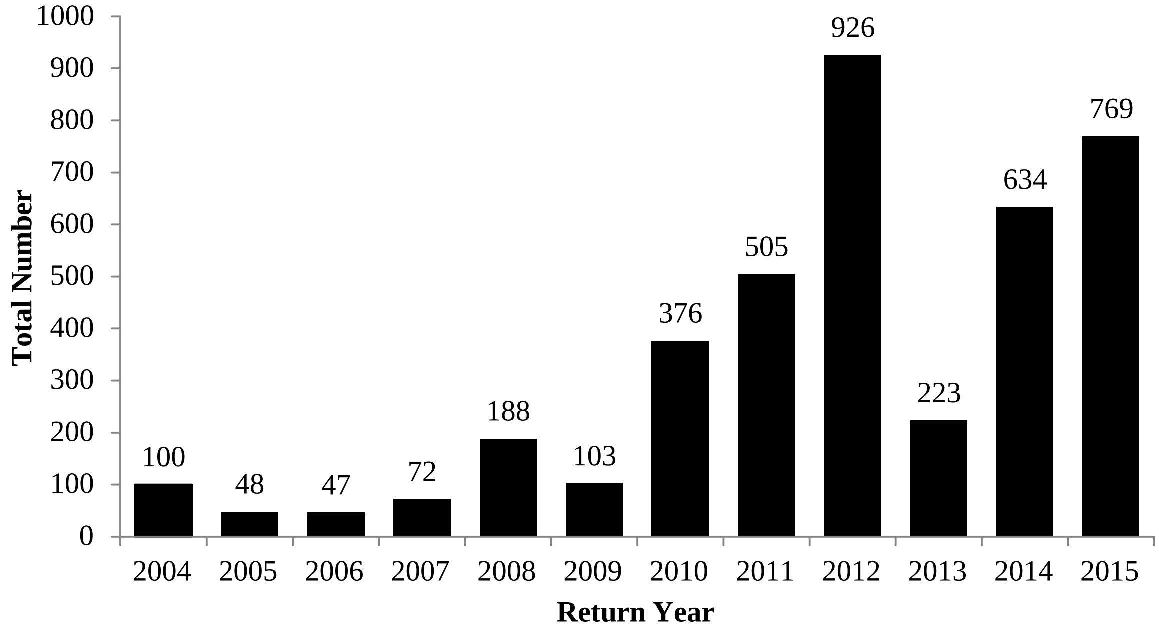

Figure 6. LGC stock spring Chinook salmon total releases above the LH weir, 2004-2015.

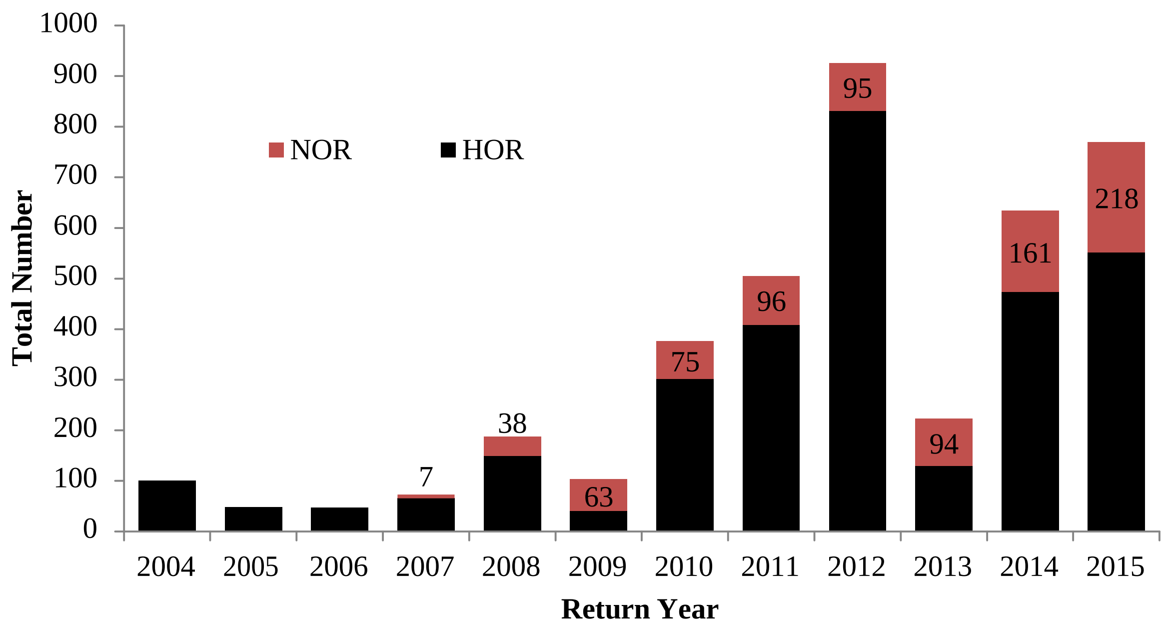

Figure 7. LGC stock spring Chinook salmon HOR vs NOR releases above the weir, 2004-2015.

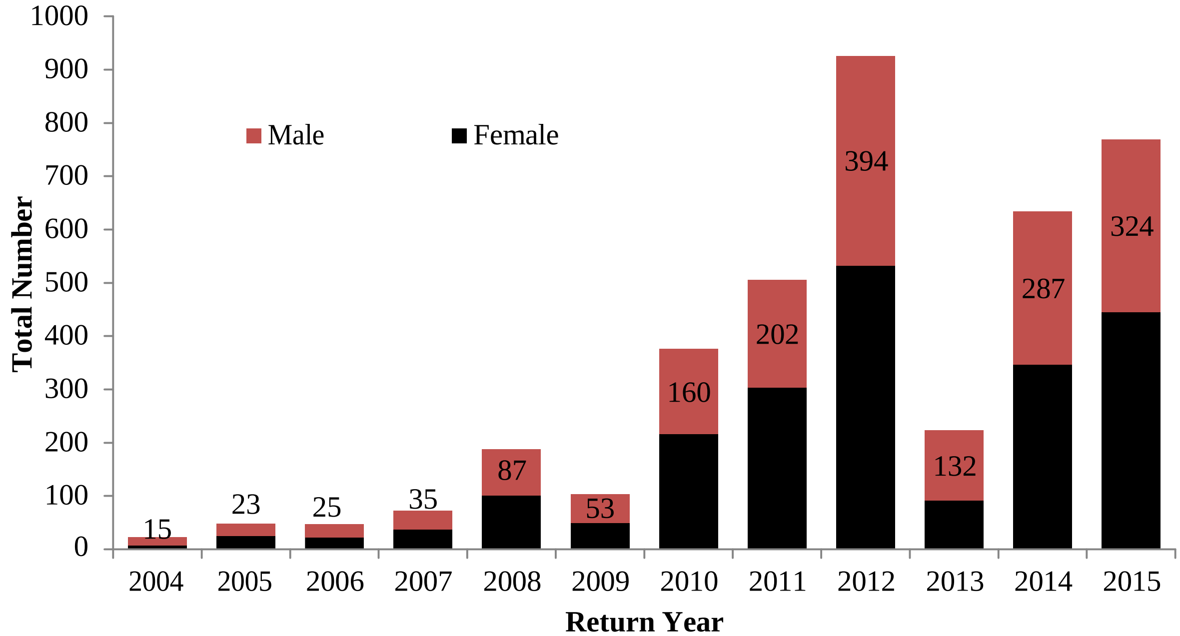

Figure 8. LGC stock spring Chinook salmon Male vs Female releases above the LH weir, 2004-2015.

Spawning Ground Surveys

We completed 21 spawning ground surveys on LGC during 13 August-17 September and observed, flagged, and took GPS coordinates on 276 total redds (Table 2). The first complete redd was observed on 13 August in Unit 3L and the last on 17 September in Unit 1. There were 185 redds observed in Units 2, 3L, 3U, and 4 above the LH weir and 91 in Unit 1 below the weir. Redds in Units 3L and 3U made up 71% of all redds observed above the LH weir in 2015. Peak numbers of new redds above and below the weir were observed in late August. A general pattern of redds being constructed higher in the system early on, and then moving downstream as the season progresses is evident each year. The last redds observed are consistently in Unit 1.

Table 2. New redds observed on surveys of LGC by work week and unit in 2015.

	Unit				
Period	1	2	3L	3U	4
Rkm/section	4	2	4	6	6
8/10-8/14	0	0	4	0	0
8/17-8/21	1	0	0	0	1
8/24-8/28	22	22	7	53	11
8/31-9/4	42	7	39	12	9
9/7-9/11	18	4	10	2	0
9/14-9/18	8	0	4	0	0
Totals	**91**	**33**	**64**	**67**	**21**
2015 Percentage by Unit (%)	**33**	**12**	**23**	**24**	**8**
2004-2015 Percentage by Unit (%)	**35**	**7**	**21**	**29**	**8**

A high density of redds was observed near LH in Unit 1 (Figure 9). There were several areas upstream of the weir with medium densities of redds in Units 2, 3L and 3U. The smaller numbers of redds observed in Unit 4 during some years may be due to releasing fish above the mouth of LLGC at rkm 6.6.

Figure 9. Distribution of spring Chinook salmon redds in LGC by unit in 2015.

Since fish began being released above the weir in 2004, Unit 3L and 3U have consistently had the highest numbers of redds (Table 3). Since 2010, as numbers above the weir have increased, we are observing more redds located in Unit 2 and 4, presumably as suitable spawning habitat becomes more limited. There are large numbers of fish that never enter the weir and spawn in Unit 1. In some years, outplants from CC have been placed below the weir in LGC to supplement the fishery and these fish also spawn in Unit 1. With only approximately 4.1 rkm of available spawning habitat below the weir, the redds/per mile is much higher and redds are often superimposed over one another (Figure 10). These large numbers of redds below the weir are likely contributing a great deal to our NOR returns.

Table 3. Numbers of spring Chinook salmon redds by unit, 2004-2015.

RY	Unit 1	Unit 2	Unit 3L	Unit 3U	Unit 4	Total
2004	49	7	11	20	11	98
2005	10	4	5	20	0	39
2006	28	5	10	12	1	56
2007	22	2	7	23	0	54
2008	39	10	19	56	19	143
2009	30	2	23	40	2	97
2010	89	24	63	62	21	259
2011	129	15	71	105	21	341
2012	133	31	100	136	47	447
2013	47	4	25	30	1	107
2014	105	24	71	82	28	310
2015	91	33	64	67	21	276

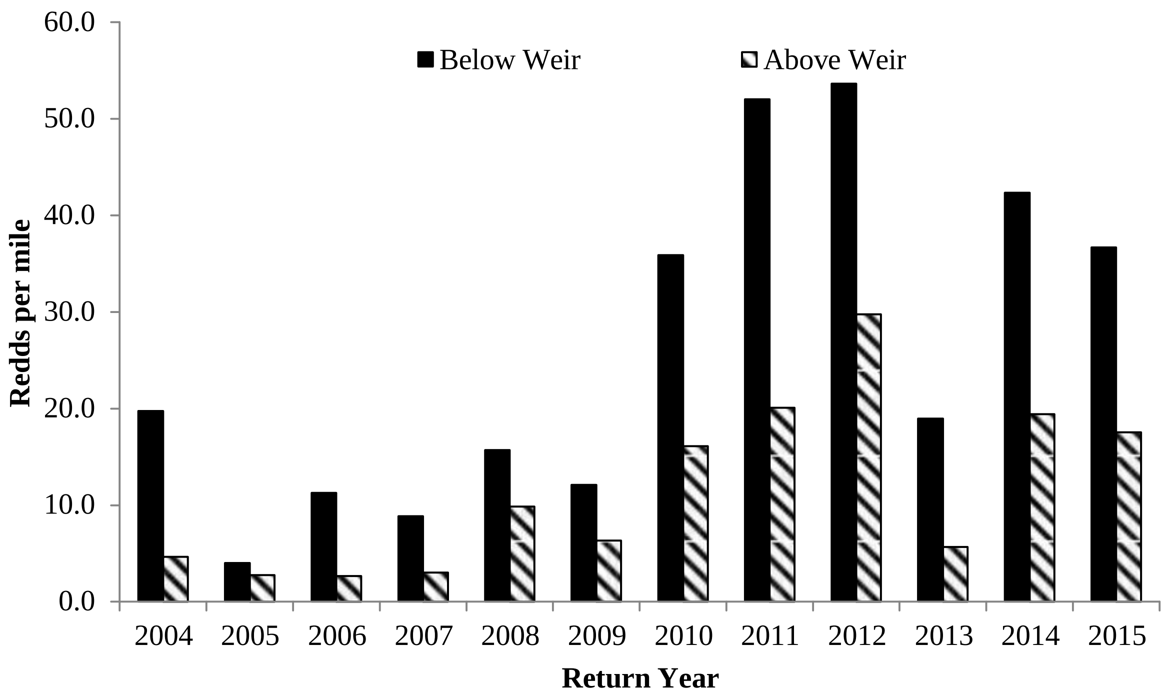

Figure 10. Redds per mile above and below the LH weir, 2004-2015.

Carcass Recoveries

Carcasses recovered above the LH weir from 9 June-15 September totaled 86, with 53% of those being recovered in June and July. All of these recovered carcasses were adults and only one carcass did not have an opercle-punch. There were 50 female carcasses recovered, 34 male, and 2 of unknown sex. Of 86 carcass recoveries above the weir, 65 were HOR, 16 were NOR, and 5 were too badly decomposed to identify origin. Carcass recovery efficiency for opercle-punched fish released above the LH weir was 11%, much lower than in most years. As we have observed increased amounts of Chinook above the weir and thus carcasses, we have also seen an increase in scavengers and predators. They rapidly consume carcasses before they can be recovered. This likely is the reason for the very low percent of recovered carcasses this year above the weir, and a large number recovered below where there are fewer scavengers.

Carcasses recovered below the LH weir totaled from 3 June- 17 September totaled 161, of these 30 had a 1ROP indicating they had been sampled at the weir, passed upstream, and then dropped back below the weir. It is likely that these are the aforementioned “flushed” fish that had become trapped between the pickets and the concrete wall and had to be released downstream. These 30 fish were removed from the numbers of fish released above the weir for calculating the population estimate. Of the 161carcasses, 110 were HOR, 50 were Unclipped, and 1 was unknown. It is not clear if the unclipped fish recovered below the weir were LGC NOR returns or unclipped UGR HOR strays returning to LGC.

Population and Spawner Estimate Above the Weir

The total numbers passed above the weir was 769, then that number was decreased by the 30 adults that had an ROP that were recovered below the weir during spawning surveys. These were likely the “flushed” fish that we released below the weir that had become trapped between the pickets and the concrete wall. The Chapman modification of the Peterson method was then applied using marked/unmarked recoveries. The population estimate of jacks was 35, and the adult estimate was 725 (Table 4). Fish per redd estimates were 3.92 for adults, with an average of 2.24 since reintroduction began.

Table 4. Population estimates, redds, and fish/redd of naturally spawning spring Chinook salmon above the LH weir, 2004-2015.

	Population Estimate			Fish/Redd	
RY	Adults Only	All Ages	Redds	Adults/redd	All/redd
2004	100	101	49	2.04	2.06
2005	41	48	29	1.41	1.66
2006	48	55	28	1.73	1.98
2007	66	73	32	2.06	2.28
2008	180	190	104	1.73	1.83
2009	84	153	67	1.25	2.29
2010	345	374	170	2.03	2.20
2011	440	509	212	2.07	2.40
2012	942	943	314	3.00	3.00
2013	165	233	60	2.69	3.83
2014	612	648	205	2.98	3.16
2015	725	760	185	3.92	4.11
Means	312	341	121	2.24	2.56

Spawner estimates above the weir (adults only) have ranged from 38-742, with a mean of 235 over the reintroduction period. The early years yielded low numbers, with numbers since 2010 being much higher and more stable. Prespawn mortality has seen an increase in recent years, with a mean of 15% (Table 5). We observed very high mortality in 2015 which is likely a combination of factors. One key factor is the near record low flows due to a scant snow pack, coupled with little rain in the spring. The higher prespawning mortality above the LH weir in some years may be due also be due to transporting to a different location for release, which dramatically increased the time they were held in a tank. In 2015, the fish were hauled upstream to rkm 6.2 which equated to a 30 minute drive to the release site. Of the 50 female carcasses recovered during surveys, 2 were of unknown percent spawn due to degradation of the body cavity, and 26 were ≤50% spawned out. This equates to a 54% pre-spawn mortality (26/48 known % spawn). Partially spawned females were rarely encountered. Prespawning mortality has varied from zero to a high of 54.2% during the current reintroduction era.

Table 5. Population Estimates, PreSpawn Mortality, and spawner estimate for spring Chinook salmon above the LH weir, 2004-2015.

	Population Estimate			Spawner Estimate	
RY	Adults Only	All Ages	PSM	Adults Only	All Ages
2004	100	101	0.000	100	101
2005	41	48	0.083	38	44
2006	48	55	0.000	48	55
2007	66	73	0.083	61	67
2008	180	190	0.000	180	190
2009	84	153	0.125	74	134
2010	345	374	0.085	316	342
2011	440	509	0.136	380	440
2012	942	943	0.212	742	743
2013	165	233	0.263	119	169
2014	612	648	0.299	429	455
2015	725	760	0.542	332	348
Means	312	341	0.150	235	257

**Spawner estimate is Population estimate above the weir X pre spawn mortality of females above the weir.*

1.5.2.1 Life History

Length at Known Age

Scales were collected on a portion of returning NOR fish and were used to determine age, and snouts were collected on spawner surveys from a portion of the HOR and CWT data was used for determining age. These known ages are represented in the table below (Table 6). Snouts were collected from 54 carcasses above the LH weir and 88 below. It was unclear at the time of collection if all snouts collected had a wire present since a CWT wand was not always available. The snouts were all scanned for the presence of a wire prior to submittal to the ODFW Clackamas lab. If the snout did not have a wire, it was discarded. A total of 87 snouts were ultimately submitted to Clackamas lab for retrieval of the CWT, and data for 83 snouts was processed and returned to CTUIR. Of the 83 recoveries, 70 were LGC releases, 4 were from CC, 7 from UGR, and 2 were Lostine River releases. Only 2 of the releases from other streams were recovered upstream of the weir (1 UGR, 1 CC).

Mean FL at age was 30 mm greater for NOR than HOR at age 3, but the sample size for NOR was only 1 (Table 6). At age 4, mean FL was nearly equal for males for both HOR and NOR, although female NOR were 48 mm larger than HOR females. There was one verified HOR age 4 male that was 890 mm in length. There were very small sample sizes for known age 5 fish for both HOR and NOR.

Table 6. Mean FL (mm) at known age by sex and origin of LGC spring Chinook, Run year 2015.

Origin	Sex	Age	$\bar{X}$ FL	Range	SE	N
NOR	M	3	560	560	0	1
NOR	M	4	752	590-820	15	14
NOR	F	4	766	734-799	5	15
NOR	Both	4	759	590-820	8	29
NOR	M	5	754	754	0	1
NOR	F	5	810	810	0	1
NOR	Both	5	782	754-810	28	2
HOR	M	3	530	460-630	14	13
HOR	M	4	749	650-890	11	23
HOR	F	4	718	610-805	6	46
HOR	Both	4	728	610-890	6	69
HOR	M	5	800	800	0	1

Female Fork Lengths:

Using data from 2007 to 2015, an analysis was carried out to look for differences between both NOR and HOR females from the UGR, CC, and LGC stocks (Table 7). Analysis was based on mean FL with categorical variables of origin, stock, and year. Data was removed from the analysis that pre-dated 2007, as these data could have Rapid River stock influences that could upwardly skew LGC mean fork lengths, and 2007 was the first naturally spawned returns to LGC (jacks).

Table 7. Mean FL (mm) from 2007-2015 by stock and origin.

Stock	Origin	Mean fork length (mm)
CC	NAT	724.6 (n= 1160, SE = 1.69)
LGC	NAT	725.0 (n= 531, SE = 2.11)
GR	NAT	722.5 (n= 459, SE = 3.16)
CC	HAT	726.6(n= 1537, SE = 1.15)
LGC	HAT	721.0(n= 2083, SE = 0.89)
GR	HAT	722.8(n= 1993, SE = 0.90)

Differences between the NOR females for the three stocks varied from year to year, however pooling data over the 9-year period (2007 to 2015) showed mean fork lengths that were not significantly different between the stocks (Table 8), whereas hatchery origin females had statistical differences between the stocks (Table 9). CC HOR females were larger than both LGC stock (p = 0.0002) and UGR stock (p = 0.0219). However, the CC females were only 5.5 mm larger than the LGC females and this statistical difference may not necessarily equate to a biological difference.

Table 8. Result of a one-way analysis of FL (mm) by stock for NOR female spring Chinook using a Tukey-Kramer HSD test.

Level	Level	Difference	Std Err Diff	Lower CL	Upper CL	p-Value
LGC	GR	2.510912	3.697639	-6.16128	11.18310	0.7757
CC	GR	2.105713	3.199253	-5.39759	9.60902	0.7877
LGC	CC	0.405198	3.039878	-6.72432	7.53472	0.9903

Table 9. Result of a one-way analysis of FL (mm) by stock for HOR female spring Chinook using a Tukey-Kramer HSD test.

Level	Level	Difference	Std Err Diff	Lower CL	Upper CL	p-Value
CC	LGC	5.581614	1.408134	2.28049	8.882737	0.0002
CC	GR	3.768537	1.421569	0.43592	7.101157	0.0219
GR	LGC	1.813077	1.312170	-1.26308	4.889229	0.3505

Frequency distributions of FL showed a bimodal distribution for NOR females (Figure11) but not for HOR (Figure 12), which is possibly a function of few five-year-old hatchery returns.

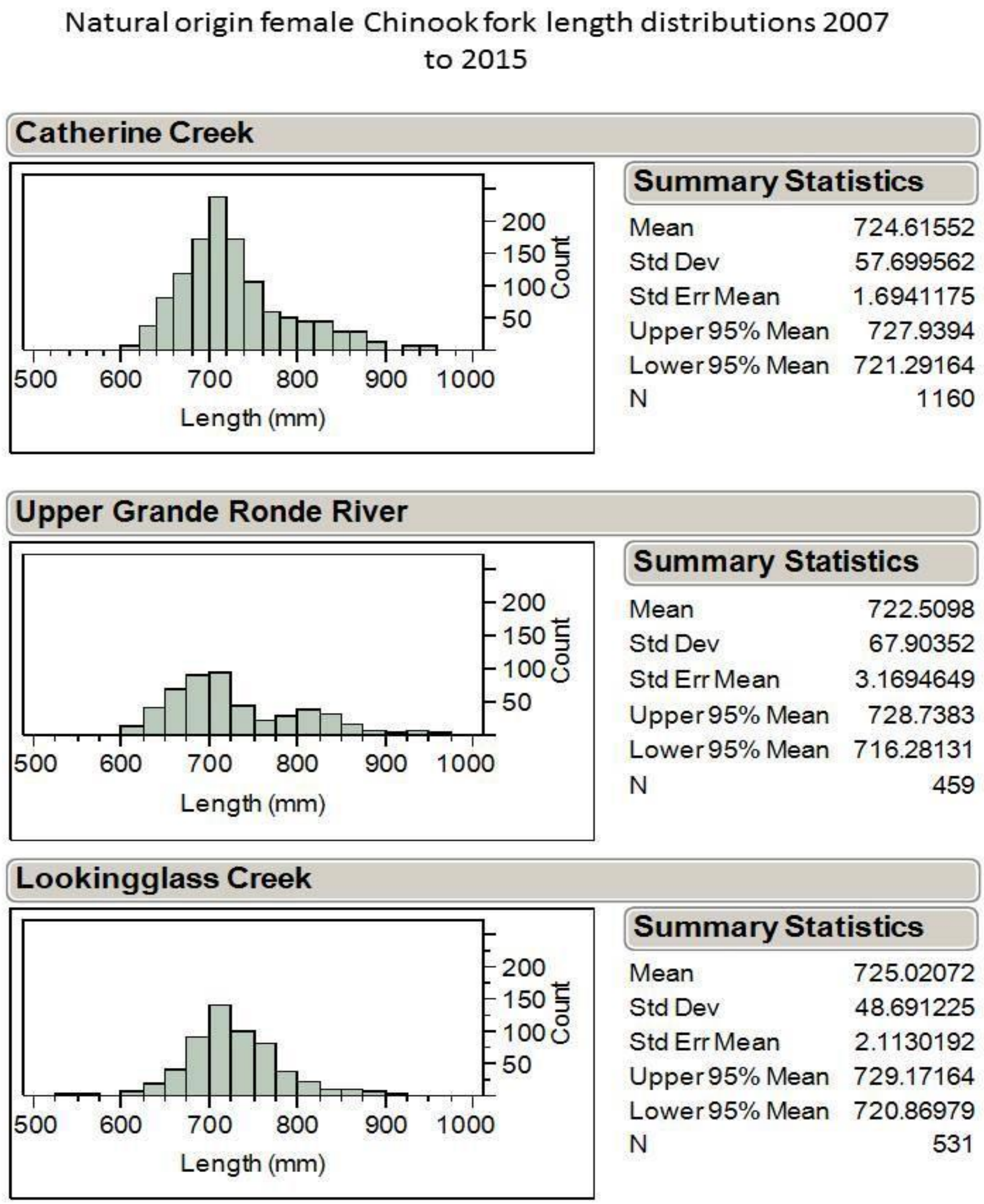

Figure 11. Frequency distribution of NOR FL (mm) of returning adult female spring Chinook for three stocks (Upper Grande Ronde [UGR], Catherine Creek [CC], and Lookingglass Creek [LGC]) 2007-2015.

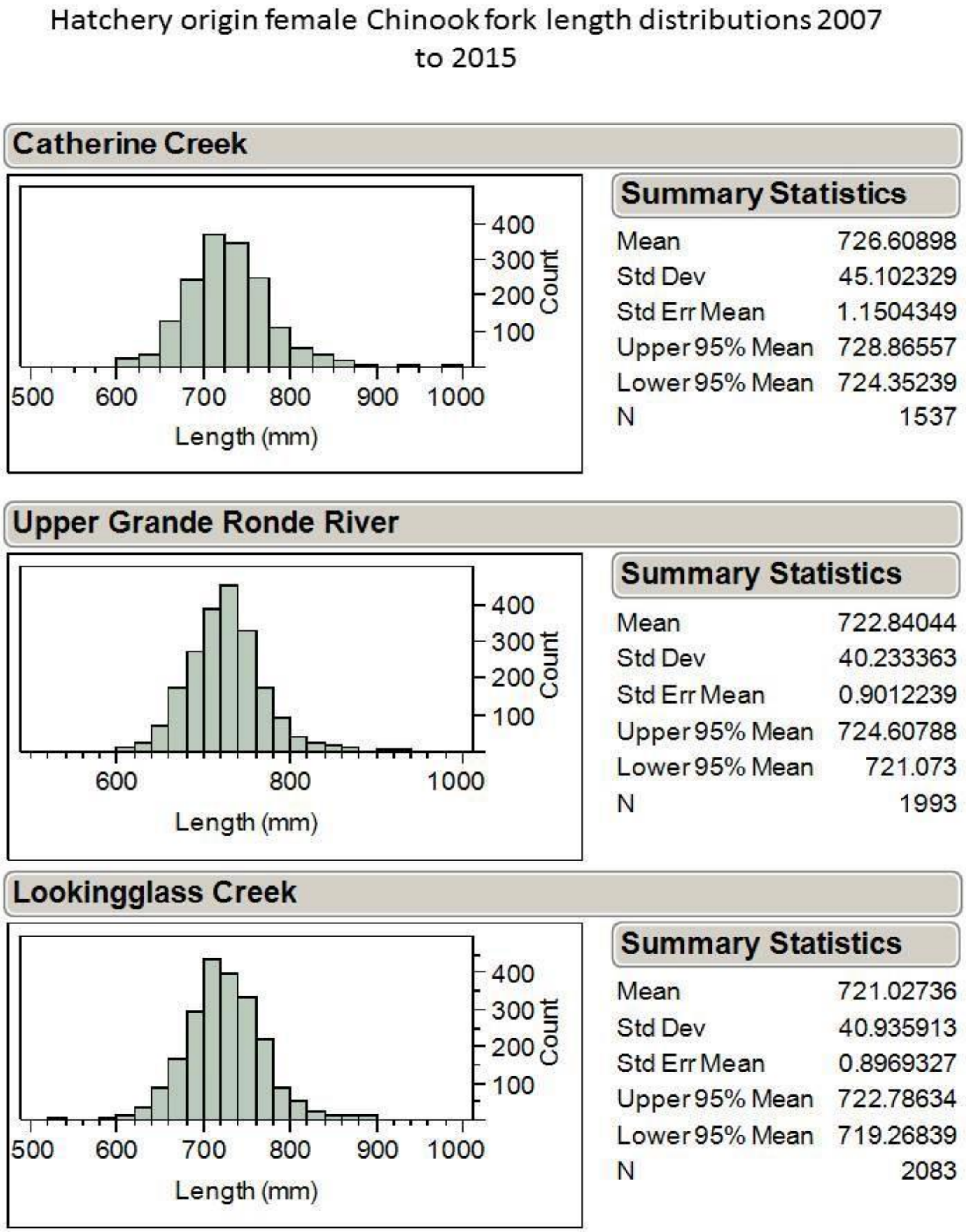

Figure 12. Frequency distribution of HOR FL (mm) for returning adult female spring Chinook for three stocks (Upper Grande Ronde [UGR], Catherine Creek [CC], and Lookingglass Creek [LGC]) 2007-2015.

1.5.2.2 Productivity

Recruits per Spawner (R/S)

BY 2010 Recruits per spawner for adults (excluding jacks) was similar to most years at 0.6 (Table 10). Recruits per spawner for BY 2001-2005 CC NOR (adults+jacks) ranged from 0.1-0.7 (Feldhaus, et al., 2012) and increased to 2.2 in BY 2006 and 3.2 in BY 2007 (Feldhaus, et al., 2011). Recruits per spawner (adults + jacks) were also higher for LGC NOR in 2006 and 2007, at 2.9 and 2.3, respectively. It is not clear what factor may have led to higher R/S in those 2 years in both streams. Recruits per spawner has been below the replacement value of 1.0 for 4 out of the last 7 completed brood years. In the latest status review update, spring Chinook populations in CC and UGR remained at high risk for both abundance and productivity, even though short-term natural spawner abundance had increased in CC (NOAA, 2011).

Table 10. Population estimates, spawners and R/S for LGC NOR spring Chinook salmon, BY 2004-2015.

	Population[a]		Spawners[b]		R/S	
BY	Adults	All	Adults	All	All[c]	Adults[d]
2004	100	101	100	101	0.6	0.6
2005	41	48	38	44	1.9	2.1
2006	48	55	48	55	2.9	2.9
2007	66	73	61	67	2.3	2.2
2008	180	190	180	190	0.9	0.8
2009	84	153	74	134	0.5	0.9
2010	345	374	316	342	0.7	0.6
2011	440	509	380	440		
2012	942	943	742	743		
2013	165	233	122	172		
2014	612	648	429	455		
2015	725	760	332	348		
Means	312	341	235	258	1.4	1.4

[a] *Fish population estimate present above LH weir*
[b] *Adjusted for prespawning mortality*
[c] *(Sum of BY X NOR returns at ages 3, 4, and 5)/BY X All spawners;* [d] *(Sum of BY X NOR returns at ages 4 and 5)/BY X Adult spawners*

1.5.3 Juvenile Spring Chinook Salmon

1.5.3.1 Abundance

Outmigrants

The rotary screw trap was fished 76% of the possible days during January-June 2015, and 83% during July-December 2015. The rotary trap was only pulled if flows and debris were very high, the trap was iced up, or repairs were needed. Repairs were made only when there are typically very low numbers of salmonids emigrating (January-February). We began catching a few newly-emerged fry (BY 2014) in the screw trap in January and continued through June. Numbers were only 4 and 6 for January and February respectively, but increased from March to June, totaling 315 fry. There were no attempts at estimating these fry and they were not included in the outmigrant estimate as they appeared to not be emigrating, but instead were getting flushed into the trap during high flows. BY 2013 first-time captures in the screw trap from 1 July 2014-30 June 2015 totaled 3,854 with 0.1% mortalities.

Outmigrant Estimate

The BY 2013 outmigrant estimate was derived using Darr and was calculated to be 10,191 (SE 610) and did include a few marked fish in June that were large enough to tag (Table 11). This is a relatively low outmigrant year, although there were only 60 redds above the weir for BY 2013. The mean outmigrants per redd for the current reintroduction era is 236.

Table 11. LGC NOR spring Chinook salmon outmigrant summary, BY 2004-2013.

BY	MY	Outmigrants	Redds AW[a]	Outmigrants/Redd
2004	2006	9,404	49	192
2005	2007	14,091	29	486
2006	2008	12,208	28	436
2007	2009	7,847	32	245
2008	2010	30,289	104	291
2009	2011	12,279	67	183
2010	2012	13,749	170	81
2011	2013	21,517	212	101
2012	2014	54,759	314	174
2013	2015	10,191	60	170
Means		18,633	107	236

[a]*AW=above the LH weir*

Outmigration timing

Obtaining an accurate estimate of January-June (fry) outmigrants is difficult because of high flow and debris during the spring and the small size of fish which limits the marking options available. The fry captured during these times are counted and passed from January through early/mid-June. At that point, a small number are lower caudal fin-clipped (over 50 mm) and used for trap efficiency and abundance estimates. Fish leaving LGC during July and August are relatively low as flows decrease and water temperatures increase. Low flows make screw trapping difficult, as the cone may turn very slowly, or become "hung up" on rocks in the shallow water. We used deflectors on the bank to direct as much flow as possible into the cone. Outmigrants by season estimated from the screw trap catch were 30% for fall 2014, 60% winter 2014, and 15% spring 2015 (Table 12). That is a slight shift from the previous year where 73% left in June- September and 24% from October-December. In general, most of the LGC stock tend to leave LGC as pre-smolts in the fall/winter. The mean from BY 2004-2013 indicates that number to be 85%, with only 15% leaving in the spring (Table 12). This observed pattern was similar to that reported for the previous RR reintroduction era (McLean, et al., 2001) and Burck (1993). However for both reintroduction eras, higher percentages left during the winter months while Burck observed more leaving in the fall. We are not clear why there is a slight shift in outmigration timing. A similar pattern of most outmigrants leaving as presmolts during fall/winter occurs for CC outmigrants, our donor stock (Anderson, et al., 2011).

Table 12. Summary of seasonal outmigration of LGC NOR spring Chinook salmon, BY 2004-2013.

BY	MY	Jun-Sept %	Oct-Dec %	Jan-Jun %
2004	2006	43	47	10
2005	2007	33	64	2
2006	2008	36	44	20
2007	2009	16	64	21
2008	2010	21	55	24
2009	2011	9	69	22
2010	2012	34	49	17
2011	2013	26	55	20
2012	2014	73	24	4
2013	2015	30	60	10
	Means	32	53	15

* *MY totals may not sum to 100 due to rounding*

Size of tagged outmigrants in the screw trap by season

Sample sizes for PIT-tagged outmigrating juvenile Chinook were 127, 301, and 198 for fall, winter and spring respectively. Mean FL of these tagged fish were 78, 85, and 93 mm for fall, winter and spring groups, respectively. Mean weights increased from 5.2-9.3g from fall to spring. Mean K was 1.05, 1.04, and 1.11 for the fall, winter, and spring groups, respectively. As expected, fish increased in size from fall to spring (Figure 13), and had a higher K factor in the spring when conditions are more favorable. Fish were much larger this year compared to recent years, likely due to only 60 redds being above the weir for BY 2013 and fish having ample rearing and food supply available.

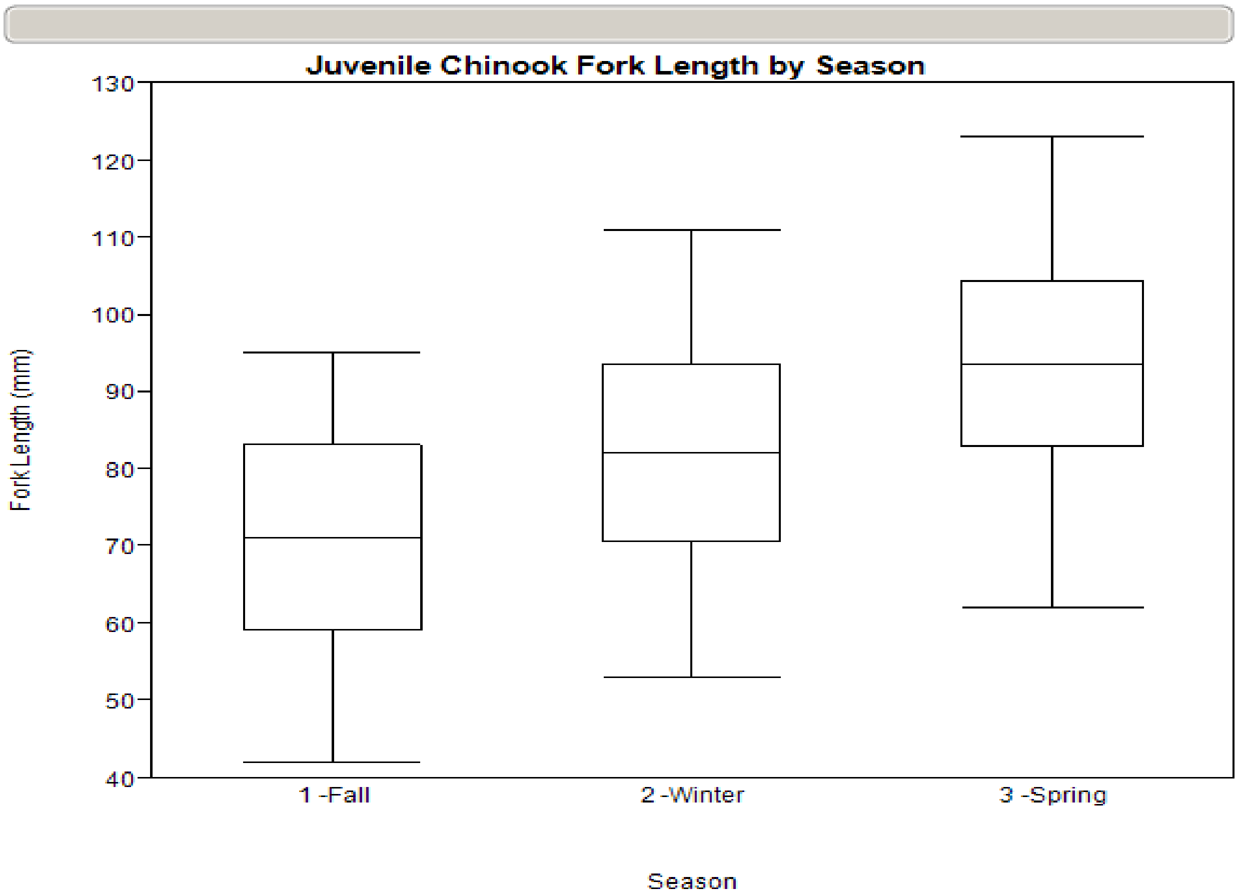

Figure 13. Box plots of FL (mm) by seasonal group for NOR spring Chinook outmigrants tagged or measured in the LGC screw trap, BY 2013.

Outmigrants per redd plotted against redds above the LH weir seem to indicate that there is potentially a carrying capacity level that has been reached. Based on the figure below (Figure 14) showing that in general, there are higher outmigrants per redd when there are fewer redds above the weir. The BY 2012 outmigrant total was the highest observed during the current reintroduction era correlating well with the largest amount of redds above the weir; however the outmigrant estimate was not as high as expected. This could indicate spawner saturation, though observing this pattern is not necessarily proof of a negative pattern, (Peter Galbreath, personal communication). This will be looked at more in depth with multiple metrics and discussed with managers and co-managers in the future.

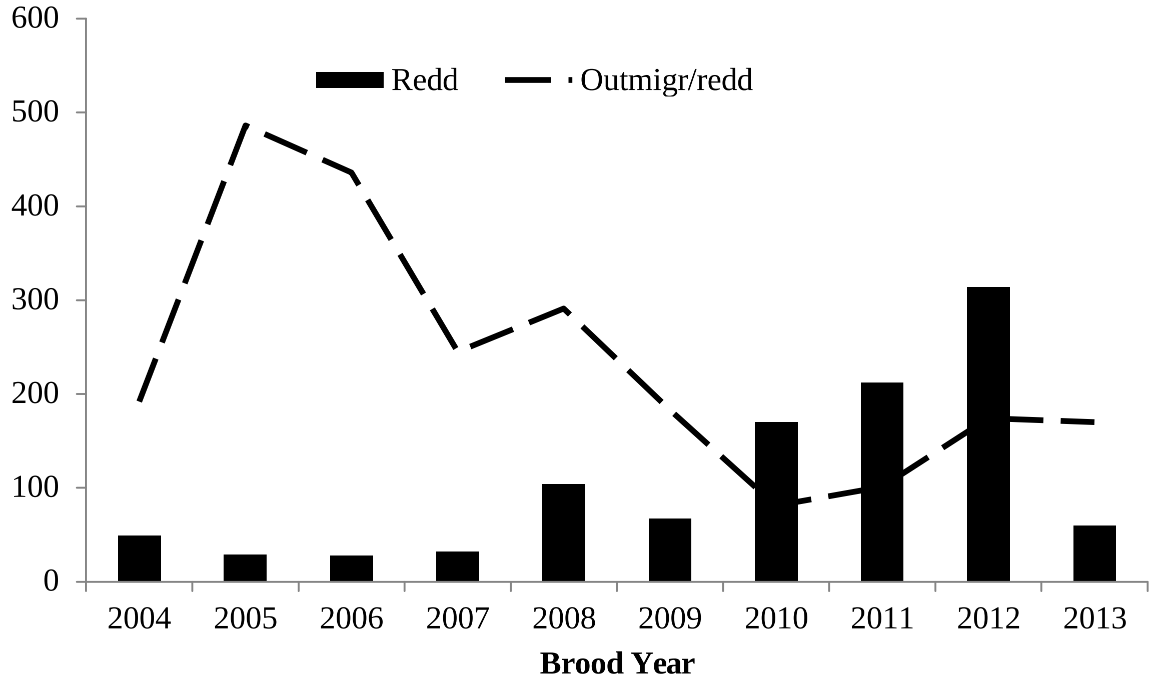

Figure 14. Number of Outmigrants per redd and total redds above the LH weir for BY 2004-2013.

1.5.3.2 Life History

Survival Estimates

Survival probabilities (SE) to Lower Granite Dam (LGD) were 0.147 (0.029), 0.096 (0.035), 0.088 (0.021), and 0.318 (0.128) respectively for the summer, fall, winter, and spring groups of BY 2013. Spring survival is substantially higher than the summer, fall and winter groups on a consistent basis (Figure 15). This could be in part due to the much shorter travel time to LGD for the spring group and is typically a time of year when flows are favorable (Figure 17). The fish that are leaving in the fall and winter are overwintering somewhere within the Grande Ronde Subbasin where conditions are also much less complimentary. We are also observing increased numbers of redds above the weir may have led to a slight decrease in survival for all seasonal groups (Figure 16).

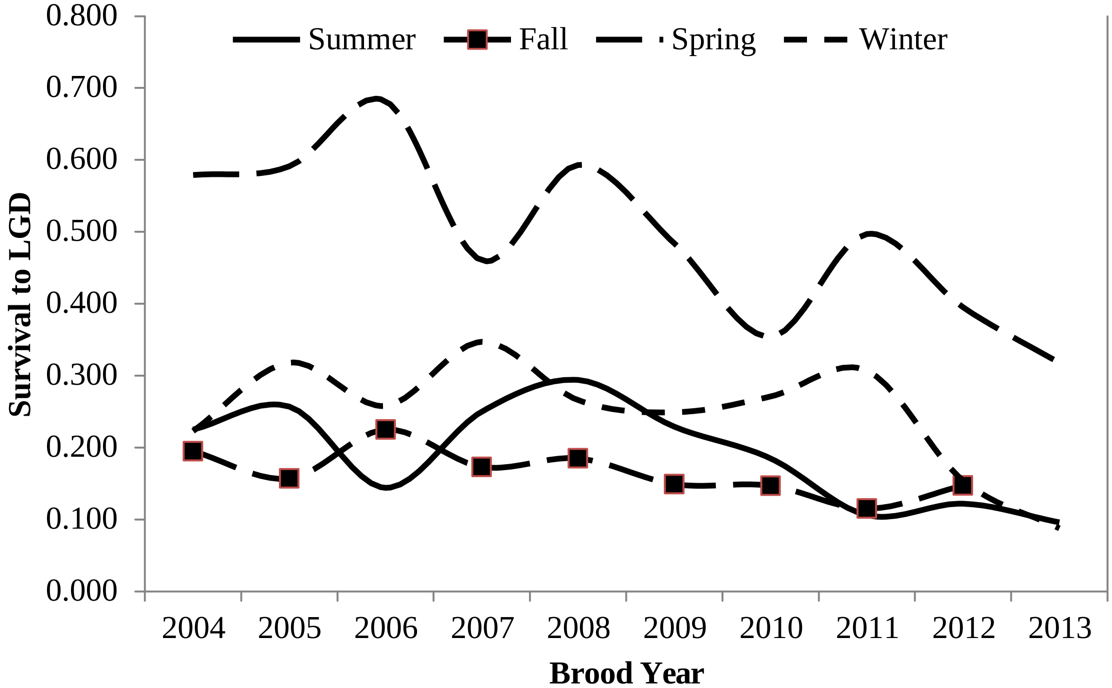

Figure 15. Survival probabilities of NOR spring Chinook salmon for summer, fall, winter, and spring groups, BY 2004-2013.

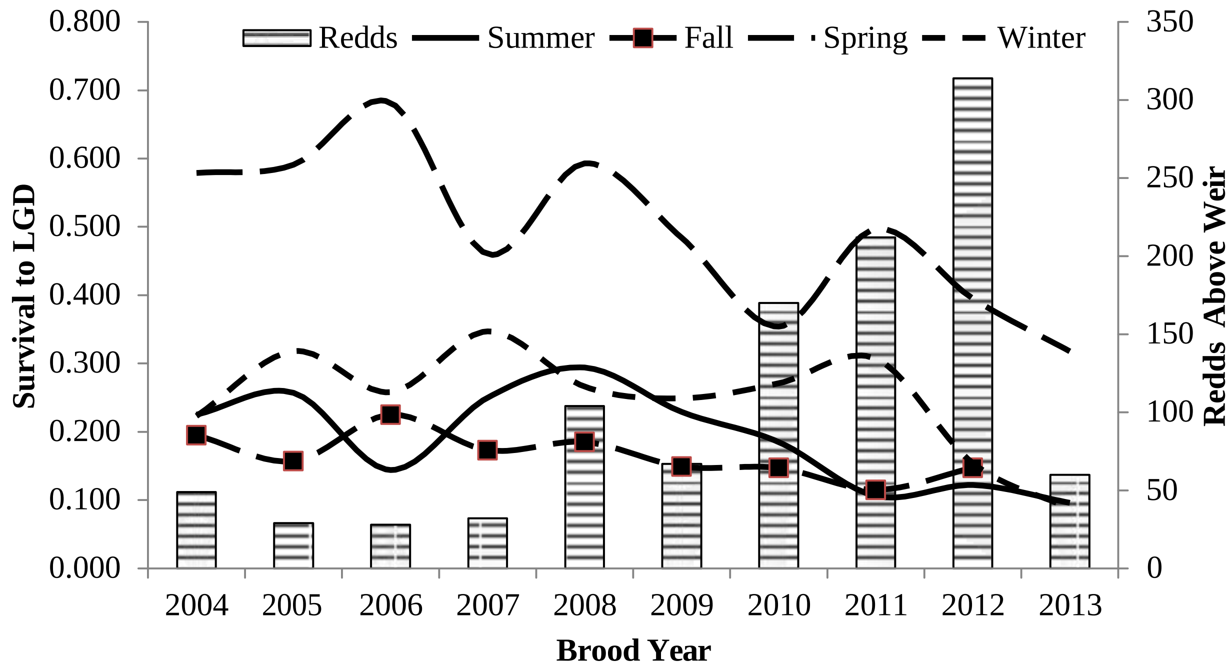

Figure 16. Survival probabilities of NOR spring Chinook salmon for summer, fall, winter, and spring groups, BY 2004-2013, with redds by BY on the z axis.

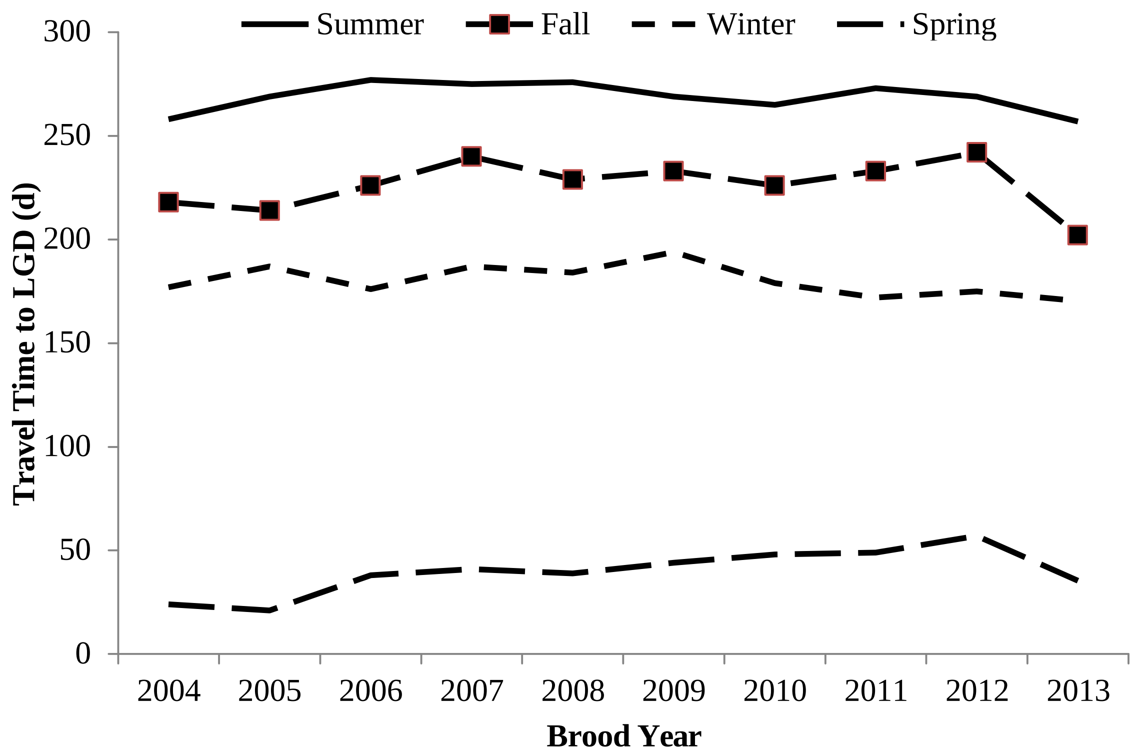

Figure 17. Harmonic mean travel time (d) to LGD for LGC NOR spring Chinook salmon summer parr, and fall, winter, and spring outmigrants, BY 2004-2013.

During the current re-introduction era, we have observed more fish now leave during the winter months (Oct-Dec) than in the fall. Juveniles emigrating in the winter also have a higher survival rate to LGD compared to the fall, (Figure 18). Mean survival for fall, winter and spring is 19%, 25%, and 50%, respectively. The mean percent of juveniles emigrating for the fall, winter, and spring is 32%, 53%, and 15 %, respectively. Unfortunately, while spring LGC survival is the highest at 50%, only 15% of all LGC juveniles are emigrating at that time, (Figure 18).

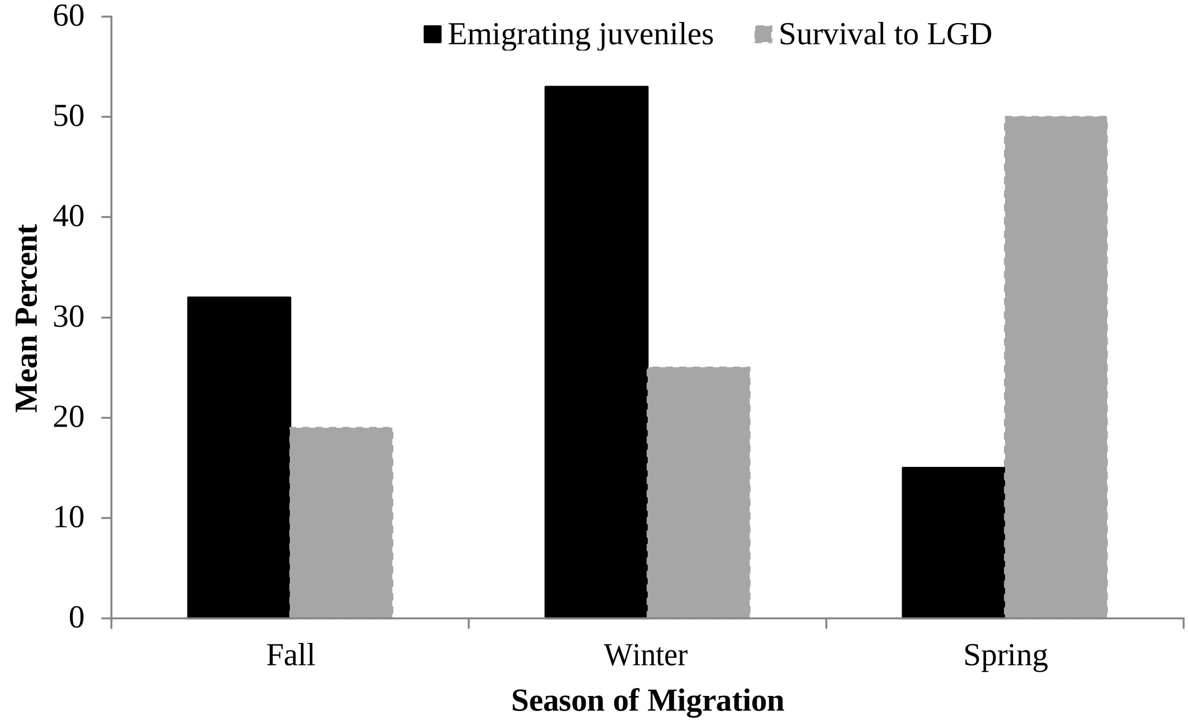

Figure 18. Plot of the mean percent of fish downstream migrating and the corresponding mean percent of survival rates by season, BY 2004-2013.

Smolt equivalent (S_{eq}) estimates (outmigrants for each group surviving to LGD) for fall 2014, winter 2014 and spring 2015 were 298, 532, and 322, respectively, for a BY 2013 total of 1,152. BY 2013 S_{eq} was the lowest recorded during the current era, but this is likely attributed to the very low redd count above the weir in 2013, coupled with the very low flows which increased spill over LGD and thus lowered detections substantially (Brian Jonasson, Brandon Chockley, personal communication). Expectedly, the S_{eq}/spawner was also the lowest recorded during this time period (Table 13).

BY 2010 NOR SARs were well above the BY 2004-2010 means. The BY 2004-2010 adult only mean of 3.0% is at the low end of the 2-6% range and below the 4% average recovery objectives for Snake River Chinook and steelhead (NWPCC , 2014).

Table 13. S_{eq} to LGD and SAR for LGC NOR spring Chinook salmon, BY 2004-2013.

BY	S_{eq}	S_{eq}/spawner[a]	SAR (%) All[b]	SAR (%) Adults[c]
2004	2,446	24	2.5	2.2
2005	4,280	113	1.9	1.8
2006	3,669	76	4.4	3.8
2007	2,784	47	5.5	4.8
2008	10,620	59	1.6	1.3
2009	3,671	50	1.8	1.7
2010	3,319	11	7.4	5.6
2011	5,925	16		
2012	7,596	10		
2013	*1,152	9		
Mean	4,923	41.5	3.6	3.0

[a] *Adult spawners from Table 10*

[b] *(Sum of NOR BY X returns at ages 3, 4, and 5)/S $_{eq}$ BY X*

[c] *(Sum of NOR BY X returns at ages 4 and 5)/S $_{eq}$ BY X*

**Caveat for 2015, Smolt equivalent low due to spill and low detects at LGD caused by uncharacteristically low flows that MY.*

Monthly sampling

The section of LGC known as 3L (formerly Nielson's property) has been purchased by the CTUIR and has future restoration work planned to restore the floodplain. This work is slated for implementation in the near future, possibly as early as 2018. This section contains the "standard site" that has been sampled consistently during the endemic era, the RR reintroduction era, and currently with the LGC stock (Boe, et al., 2014). The standard site (rkm 8.9) in the future may be used as the "treatment" location and the upstream site at the section break of 3U/ 3L at the footbridge (rkm 10.5) is used as the "control" while we evaluate habitat usage before, during, and after in stream work is completed. A target of 50 fish at each of these sites is the goal per sampling effort and in most months that is achieved. We typically are not able to snorkel for parr in June, though conditions allowed for it this year so these data are in text below. BY 2013 parr sampled totaled 77 in June, 75 in July, 88 in August and 91 in September 2014. Mean FL increased in a generally linear pattern from June-September at both sites, as expected. For BY 2013 parr at the standard site, mean fork length for June, July, August, and September was 61mm, 70 mm, 77 mm, and 84 mm, respectively. For BY 2013 parr at the footbridge site (rkm 10.5), mean fork length for June, July, August, and September was 62mm, 66 mm, 74 mm, and 81 mm, respectively. Parr at the footbridge site were slightly smaller than at the standard site, likely due to colder water temperatures. At the standard site (rkm 8.9), the average FL over a ten year period for July was 68 mm, August was 76mm, and September was 85 mm (Figure 19).

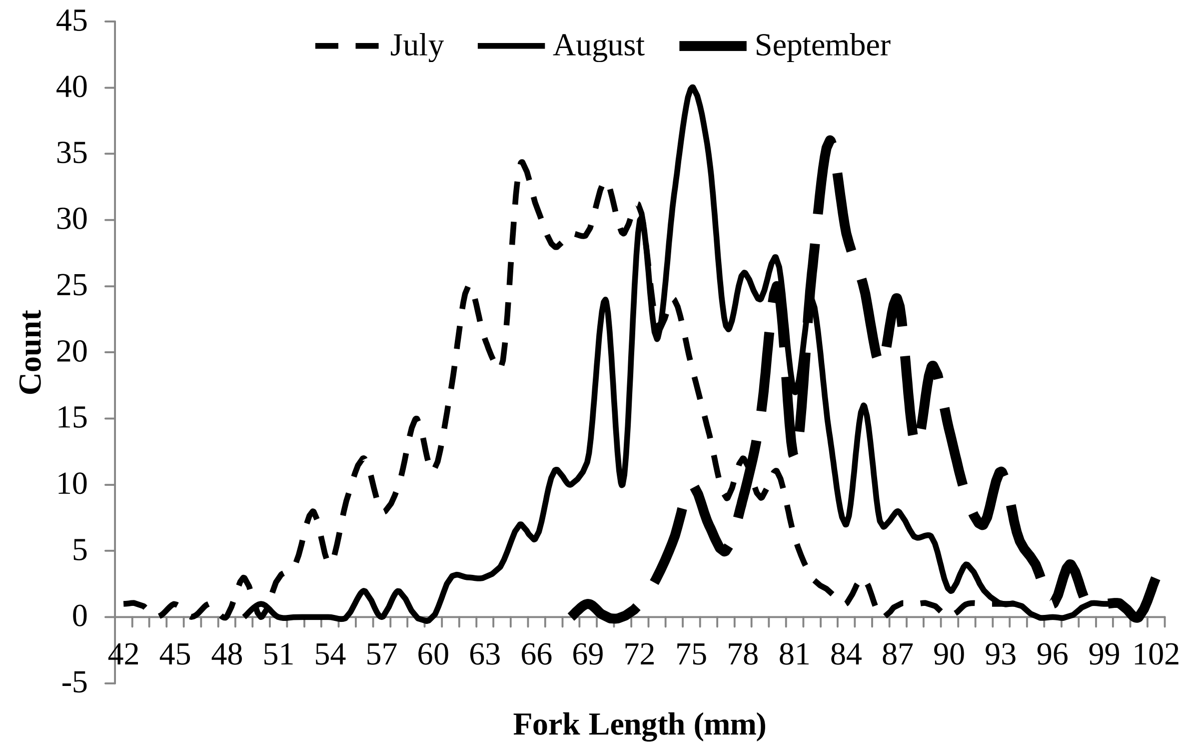

Figure 19. Fork length histograms of captured Chinook salmon for July, August, and September at the standard site (rkm 8.9) on LGC, BY 2004-2013.

At the footbridge site (rkm 10.5) over a ten year period, the July average was 64 mm, August was 73 mm, and September was 83 mm. There was much more variability a few kilometers upstream at the footbridge site, with much smaller fish observed in August and September and a much wider area of overlap between months (Figure 20). It was also noted frequently that there were fewer fish caught in those months as fish begin moving downstream before winter.

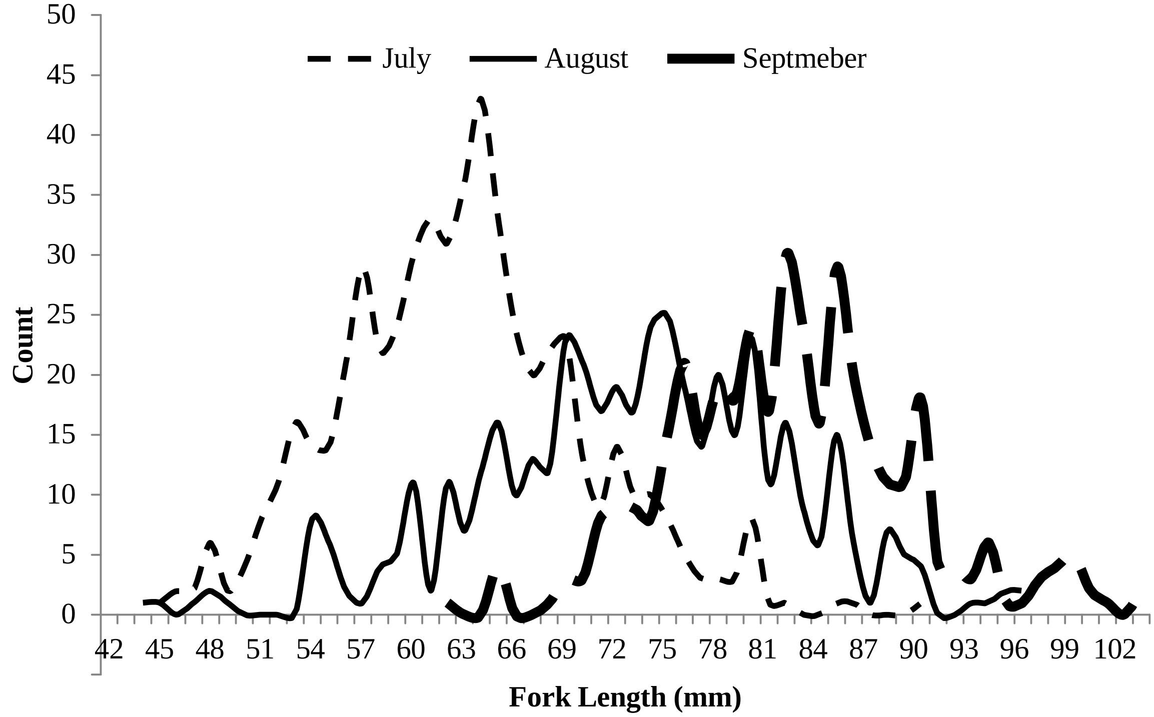

Figure 20. Growth of juvenile Chinook captured during monthly sampling for July, August, and September at the footbridge site (rkm 10.5) on LGC, BY 2004-2013.

**There were no BY 2005 fish sampled at this site*

Precocials

There were 30 NOR precocials caught in the screw trap from 29 June-14 September 2015 and mean FL was 111 mm. The fork length range observed was 84-183 mm. Mean weight and K factor were 17.5 and 1.13, respectively. We also observed 3 adipose clipped precocials that must have moved upstream from the LH and then down again looking for potential mates. Each year several are caught in the screw trap. These are scanned for PIT tags, a genetic sample taken, measured, weighed and released downstream of the trap. The numbers of precocials Burck (1993) reported in the bypass trap ranged from 158-575 annually, much higher than the numbers seen during the current reintroduction era. The lower numbers seen recently are probably a function of the overall lower abundance of outmigrants, but this is an interesting difference in population dynamics.

Summer Parr Sampling

A total of 1,059 BY 2013 parr where collected using snorkel/seine methods from 4 August to 8 August 2014. These fish were collected from the upper rearing areas of LGC in the upper portion of section 3L and lowest section of 3U between rkm 8.9 and 12.0 (Figure 21). The CTUIR tagged these fish and returned them to the stream reach from which they were collected. A percentage of these (23%) were also measured and weighed (Figure 22). Mean fork length of these parr was 73 mm, mean weight was 4.5 g, and mean K factor was 1.13. There were 227 recaptures of the BY 2013 summer parr group in the screw trap from 22 August 2014 to 29 April 2015. Only 2 field group fish were re-captured in August right after tagging and release. The vast majority were captured in September, October and November at 33, 141, and 34 respectively. This corresponded to the rest of the fall/winter out-migration of parr captured in the screw trap.

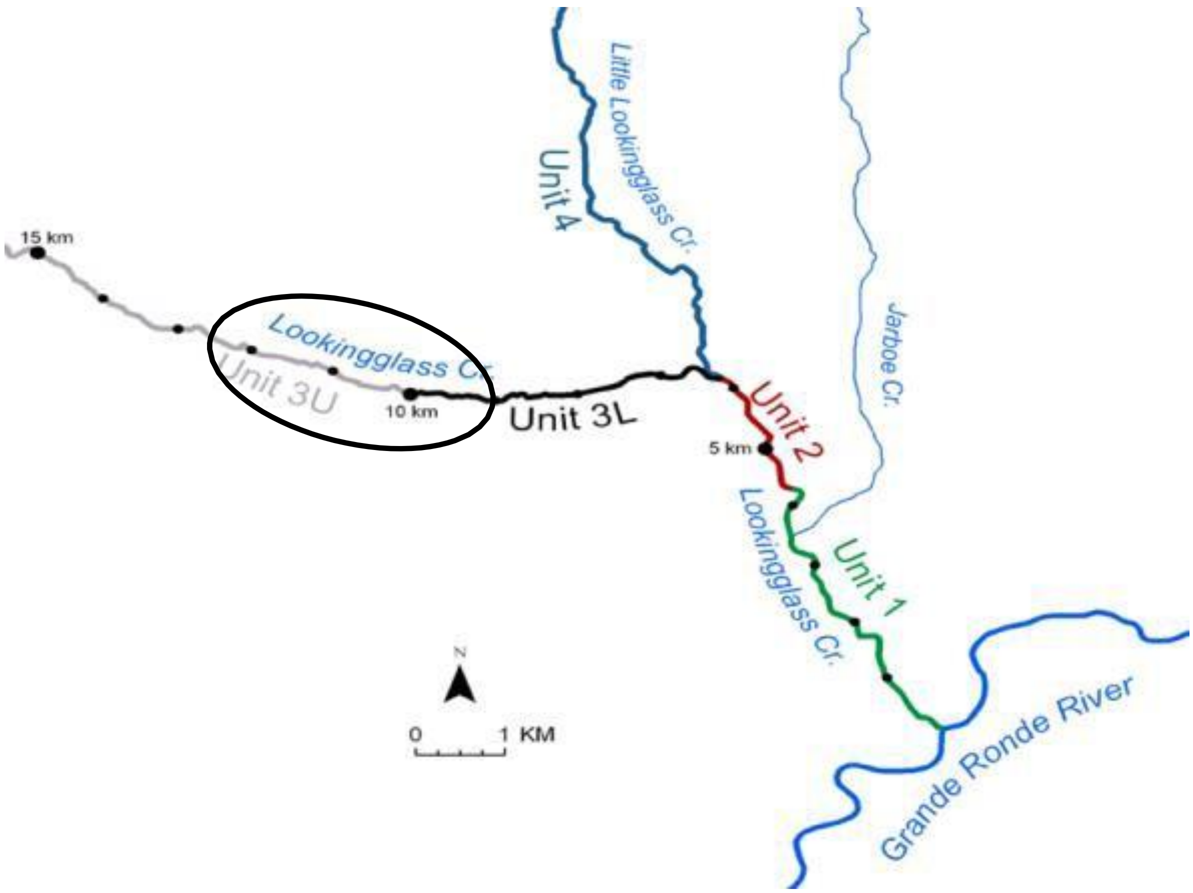

Figure 21. Circled area shows where fish are collected each year for the summer parr collection of 1,000 juveniles.

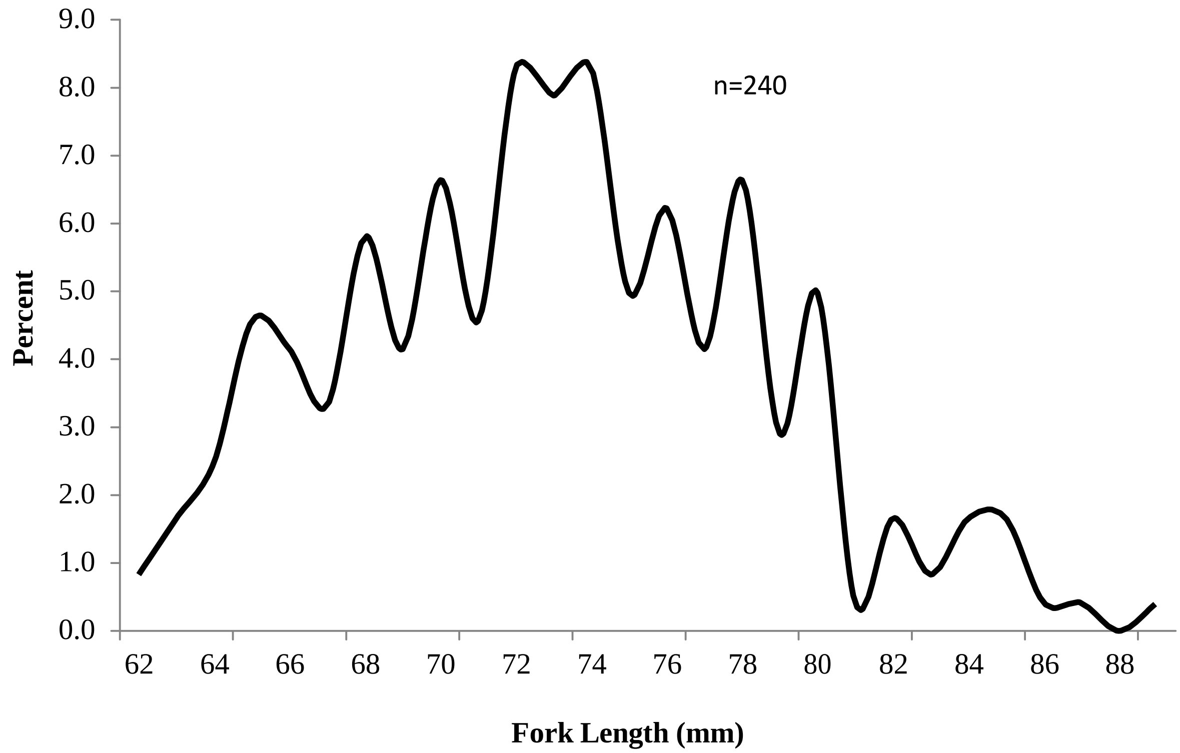

Figure 22. Percent of each FL category for the BY 2013 summer parr Chinook collected in early August of 2014.

1.6 Adaptive Management

Current NOR adult returns display an upward trend, but are still below our minimum threshold numbers for recovery. For RY 2013-2015, a larger than normal percentage of pre-spawning mortality was observed during recovery surveys. In 2015, that number reached approximately 50% for the female carcasses recovered. This may be due to the fish being transported upstream to rkm 6.2 for release, a nearly 30 minute transport in a liberation vehicle. Releasing them this far upstream was an attempt to prevent them from falling back near the hatchery water intake area as they had in the past, and thus reduce pathogens in the water used for rearing of hatchery juveniles. This year also happened to be an uncharacteristically low water year, with higher water temperatures. This combined effect proved detrimental to our adults. In 2016, we will be attempting to release fish almost directly at the trap, even though this is at the hatchery water intake area. We are hoping that with less stress from holding and transporting, these fish will readily move upstream and not drop back. We will also place a safe blockage for them upstream of the concrete dam that will not allow them to fall back. In the past, fish would drop into this small area between the pickets and the concrete dam (approximately 20 x 20 meters) and become stuck, and would have to be herded out and transported upstream again. If less mortality is not observed or fish continue to drop back, we will re-evaluate in 2017. Adapting a “whoosh” system is also being discussed which will mean that fish handled are only out of the water for seconds and released back into the stream through a fish safe tube (Figure 23).

Figure 23."Whoosh" set up demonstrating adult fish release at the CTUIR Mission office.

In 2015 CTUIR purchased 667 acres of Lookingglass Creek as a conservation property, (Figure 24). The lower section of this 2-mile reach had been cut off from its floodplain and held alongside the canyon in the 1970/80’s (Figure 25). A road was built and several levees and ponds were put in place to keep the stream in that location. This created a section of high gradient, large cobble and boulders, exposed bed rock, and a lack of spawning and rearing habitat for Chinook, steelhead and bull trout. Our belief is that restoring the rivers natural floodplain and meanders will increase the available habitat for juveniles to rear, as well as increase the area available for spawning and thusly increase natural production.

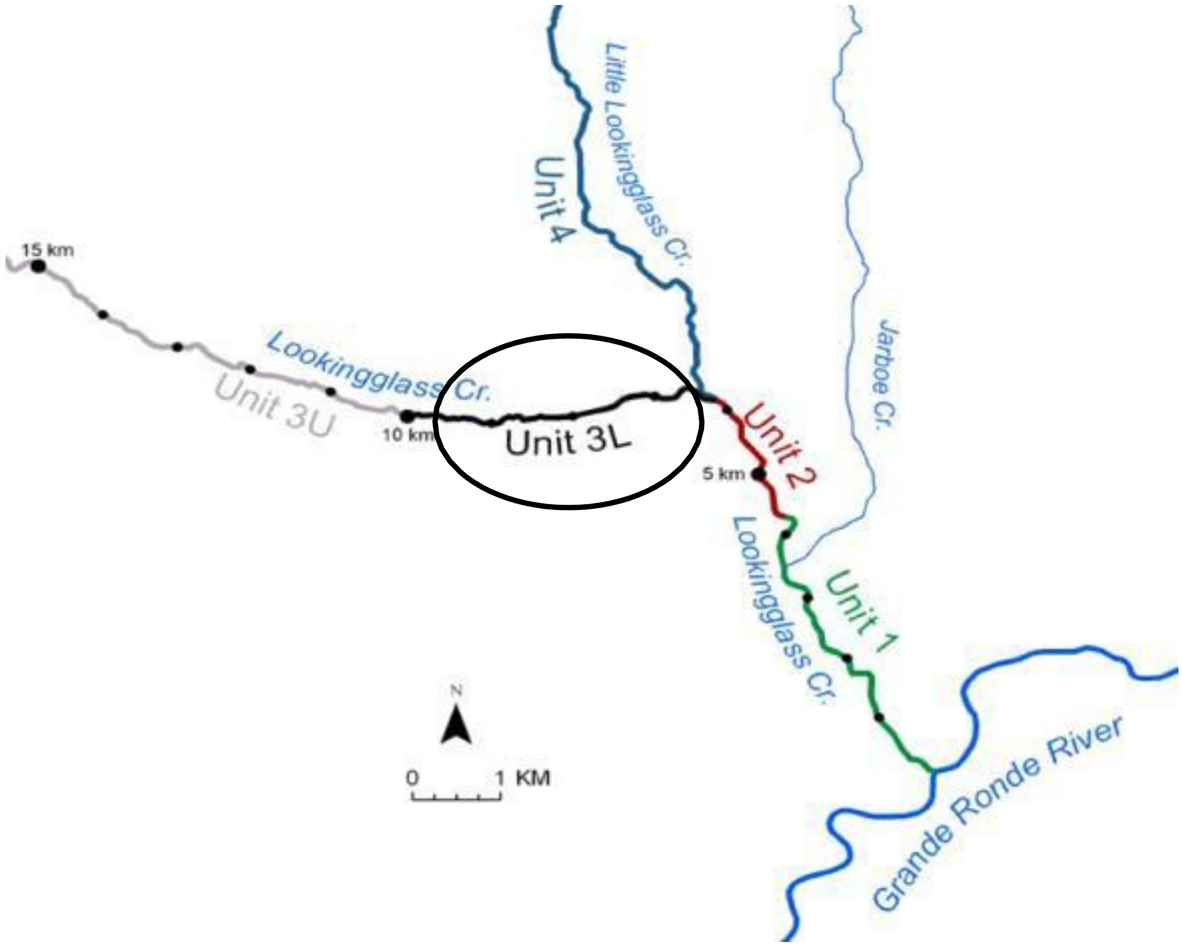

Figure 24. LGC section breaks for spawning surveys. The circled area indicates the acquired conservation property slated for stream restoration in the future.

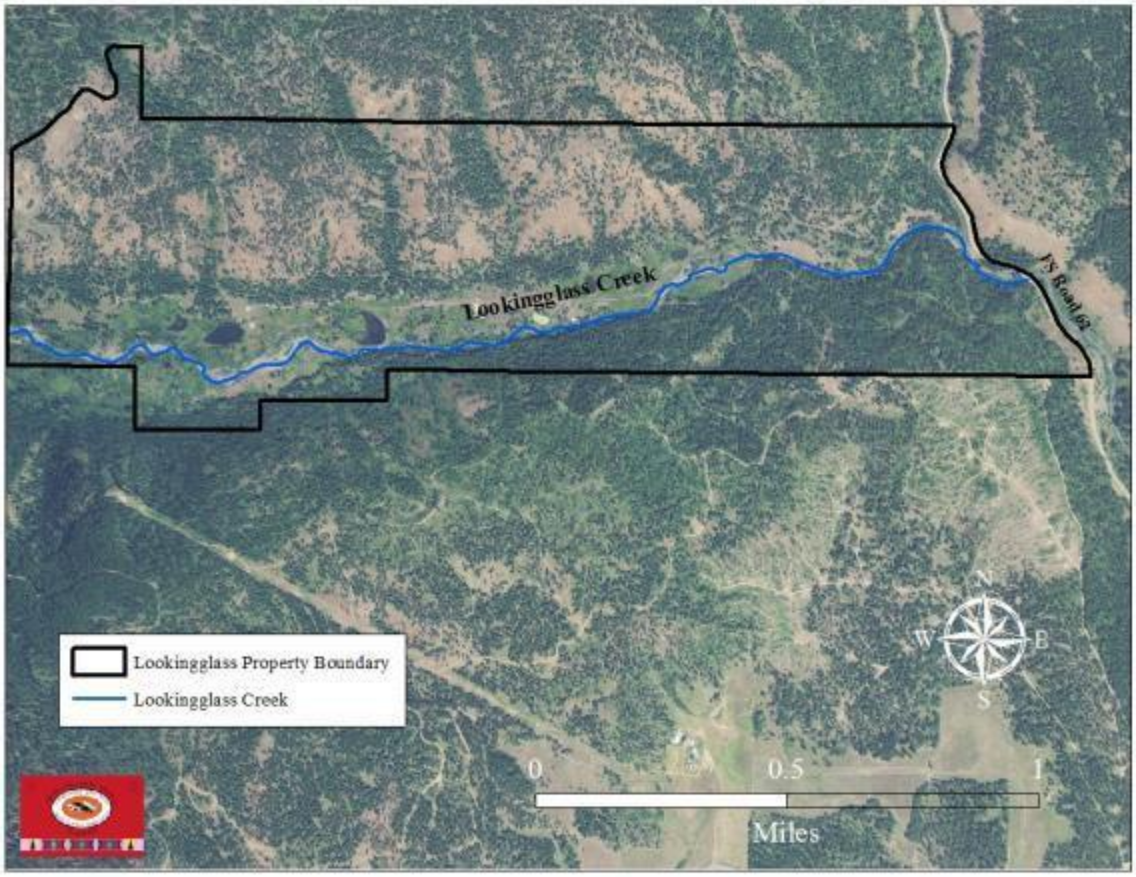

Figure 25. The section of property recently purchased by CTUIR, 2015.

In May of 2016, Lamprey were released into LGC near the standard site (rkm 8.9) on the conservation property. This is of great historical and cultural significance to the CTUIR. We will monitor there recovery by taking genetic samples, conducting spawner surveys, and PIT tagging them if captured in the screw trap. Lamprey have never been released into LGC, however, there is documentation that they were present here over 50 years ago, (Burck, 1993).

1.7 Summary

The CTUIR has studied the NOR "fish in and fish out" metrics on LGC to obtain stock-specific life history strategies which help guide our management practices. We have observed status and trends for the re-introduced CC hatchery donor stock since 2004 and have observed life stage specific metrics to identify VSP criteria and help assess the effectiveness of our program in increasing natural production of re-introduced spring Chinook Salmon. While some of our methods have varied slightly over the years, the overall experimental design has remained the same and will continue to be replicated to observe across year variation as well as achieve stronger statistical power.

We have observed a shift in juvenile outmigration from fall months (September) to winter months (October and November) and observed smaller parr leaving in years where there are many redds above the weir. This may be an indication of carrying capacity or density dependent factors. The purchasing of the (formerly) Nielson property will allow us to investigate this in the future. Burck (1993) also suggested density dependent seasonal movement of outmigrants, with more leaving early as fry or small parr in brood years when there were more redds. He suggested that this movement was habitat-related and a tradeoff of higher growth for the risk of higher mortality, since outmigrants moving into the Grande Ronde River encountered higher water temperatures and more predators and competitors.

In general, we have observed an increasing trend in the number of adults returning to LGC which has provided tribal harvest for the last six consecutive years. There has also been an increase in the number of NOR returns to LGC, steady survival estimates of emigrating juveniles to LGD, and consistent R/S and SAR's. A sustained improvement in productivity will be needed to rebuild and maintain a naturally reproducing population above the LH weir. It is unlikely that without the continued HOR component to this program that the NOR would be able to self-propagate and increase each year, as well as provide tribal harvest.

Management 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 14.

Table 14. LGC management plan 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

Disposition of these adults will be determined in early July according to the guidelines in Table 15, and adults designated to be passed upstream will be released. Disposition of LGC adults arriving after July 4 will be based on the percentages outlined in Table 15. All adults passed upstream will have genetic samples taken.

Table 15. Disposition of LGC adult spring Chinook salmon arriving at the LH 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 NOR and 111 HOR) are required to meet 250,000 smolt production levels. 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% NOR adults, with no more than 25% of the returning NOR Chinook retained for brood. If a shortage of NOR adults occurs, then additional HOR adults will be collected to meet the brood target.

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2.1 Appendices of Water Temperatures and Diurnal Fluctuations

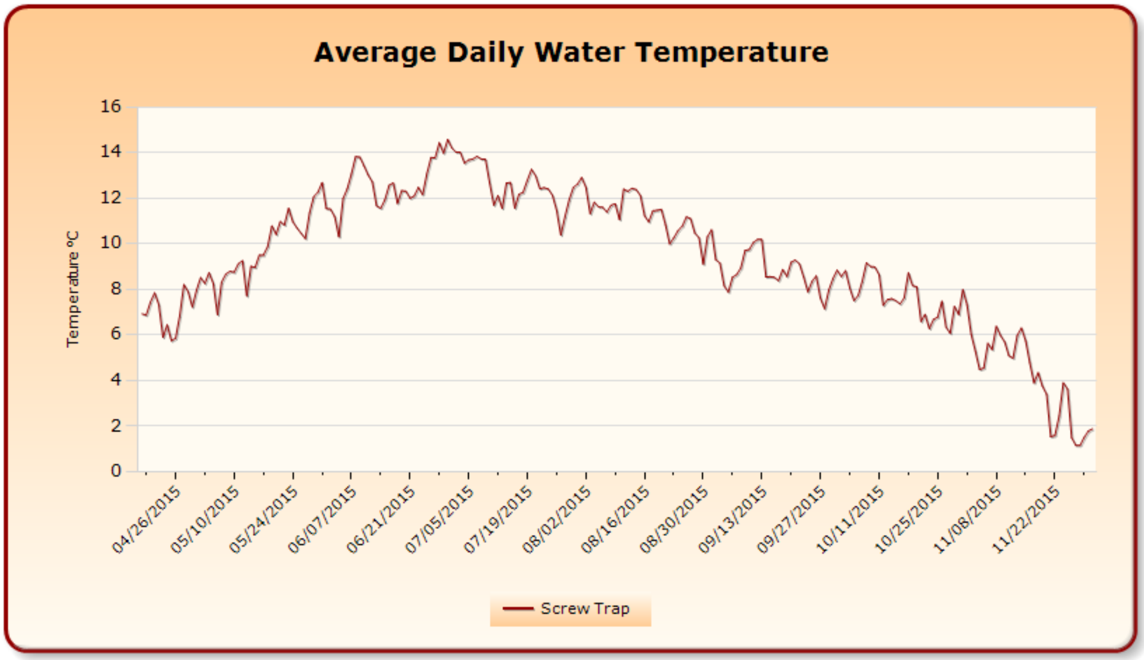

Figure 26. Average daily water temperature at LGC (screw trap) site.

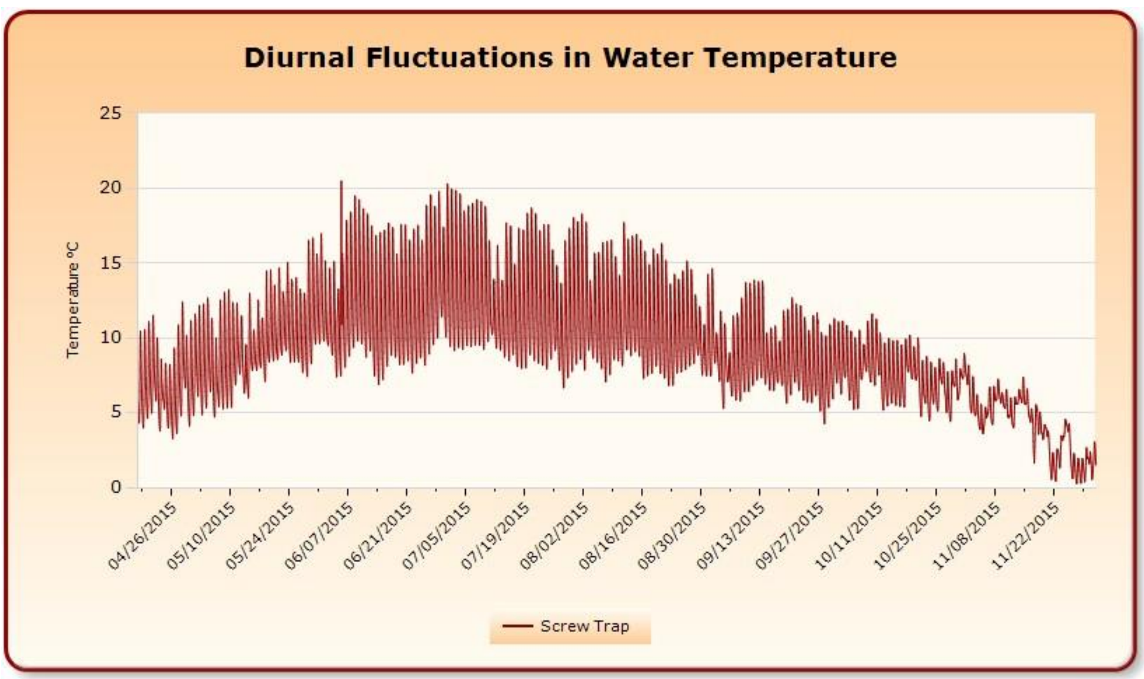

Figure 27.Diurnal fluctuations at the LGC (screw trap) site.

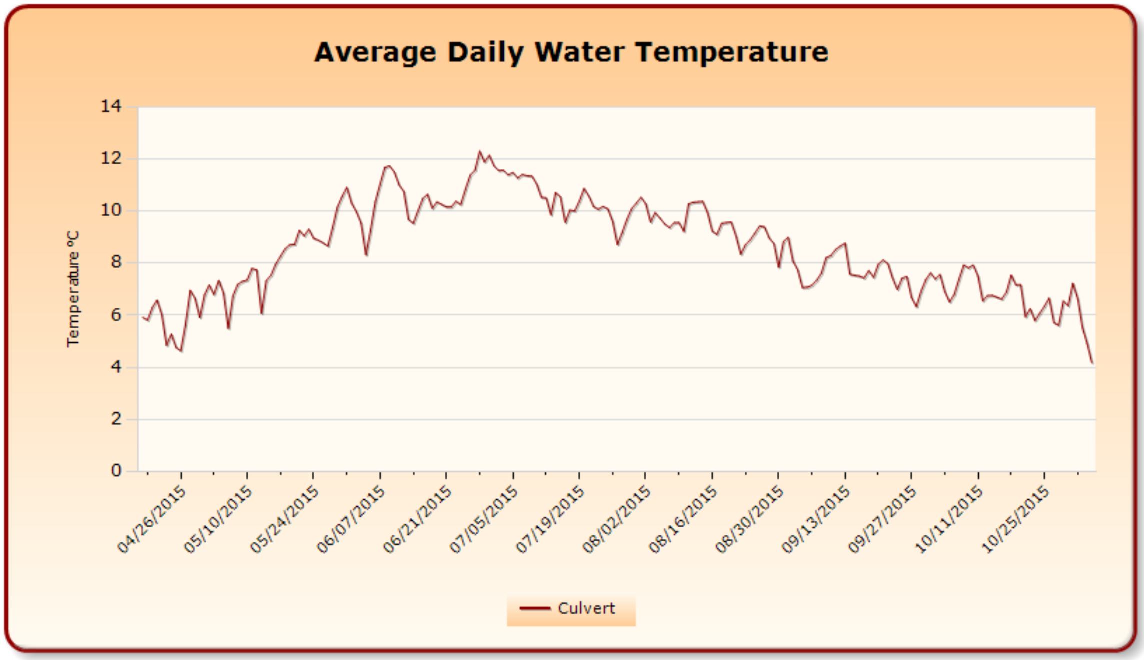

Figure 28. Average daily water temperature at the LLGC (culvert) site.

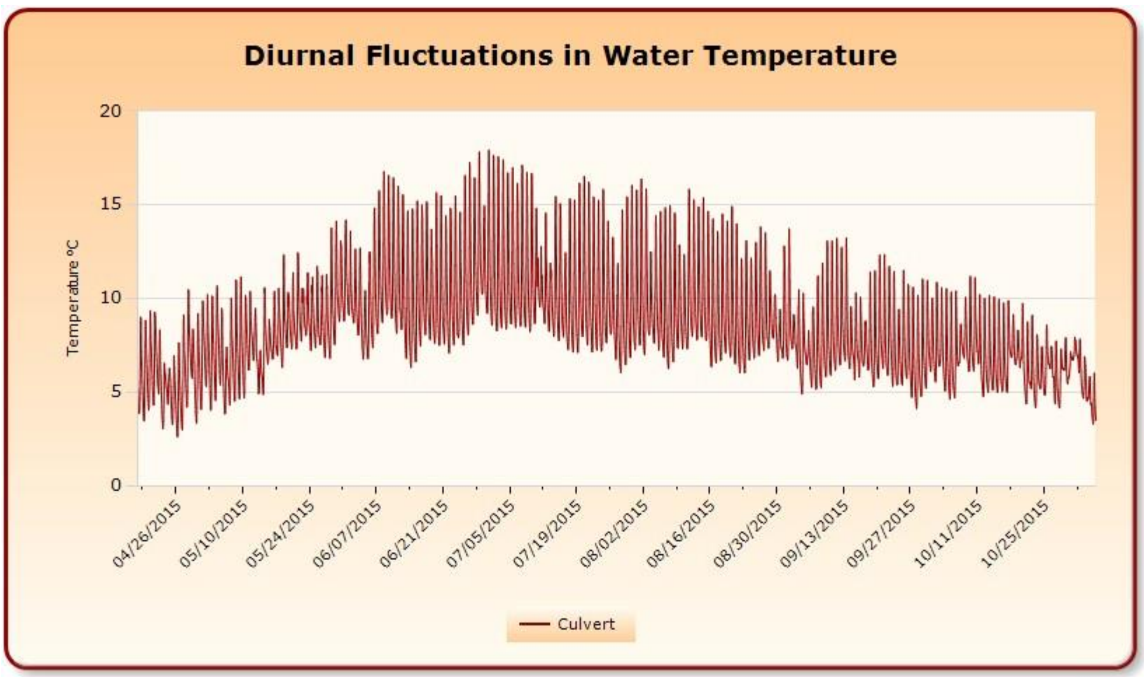

Figure 29. Diurnal fluctuations at the LLGC (culvert) site.

2.2 Appendices of Methods Previously Used

Methods described below for determining "population estimates above the weir" were used from 2004-2014. While these methods were not <u>incorrect</u>, they were not consistent with how our other co-managers and cohorts calculate population estimates. In an effort to maintain comparability and consistency basin wide, these methods were abandoned and recalculations of these numbers are in the body of this report and in tables and figures. Since some of these data may have been used by others, we will continue to list them in our appendices, as well as methods used to calculate them. The former method is stated below. Data was calculated both ways for 2015 so that you may observe the difference in outcome from each method.

2004-2014 Previous Method of Calculating Population Estimate Above the Weir
Actual "population estimate" above the weir were obtained by subtracting any mortalities (male or female) observed prior to the flagging of the first redd on spawning ground surveys from the total numbers released above the weir and then applying the Chapman modification of the Peterson method using marked/unmarked recoveries. After determining this estimated population above the weir, the percent of female pre-spawn mortalities ONLY recovered during the regular spawning season is applied to calculate the "spawner estimate".

The three tables below have the data that was calculated in this manner. Since past population estimates were calculated by removing all mortalities recovered prior to the flagging of the first redd from the "population" these population estimates differ from the 2015 calculations. We currently remove any 1ROP fish recovered below the weir on surveys from the total number passed upstream of the weir, and then use the Chapman modification to the Peterson method using marked/unmarked recoveries. The prespawn mortality was also calculated differently since we currently do not "remove" any females that died prior to the first redd being flagged from the calculation of pre-spawn mortality. Therefore, the pre-spawn mortality is simply calculated as the total number of females recovered on spawning surveys that are, ≤50% spawned out, with no reference to when the first redd was observed. This in turn, effects the "spawners above the weir" and thus R/S, Seq/spawner, and fish/redd (Table 16, 17, 18). The corresponding tables in this body of this report will have updated data using methods described here and in the methods section.

Table 16. Previous method of calculating population estimates, spawners, and R/S for LGC NOR spring Chinook salmon, BY 2004-2015.

	Population[a]		Spawners[b]		R/S	
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	2.7	2.5
2007	72	66	66	61	2.3	2.2
2008	190	180	190	180	0.9	0.8
2009	109	84	95	74	0.7	0.9
2010	371	342	363	334	0.7	0.6
2011	500	431	470	405		
2012	937	937	772	772		
2013	210	154	210	154		
2014	620	583	564	531		
2015	711	676	678	644		

[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*

Table 17. Previous method for calculating Fish/redd and prespawn mortality for naturally spawning spring Chinook salmon above the LH weir, BY 2004-2015.

	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
2011	2.03	2.36	6.00
2012	2.98	2.98	17.56
2013	2.56	3.50	0.00
2014	2.84	3.02	8.96
2015	3.65	3.84	4.70
Means	2.21	2.46	5.72

Table 18. Previous method for calculating Seq to LGD and SAR for LGC NOR spring Chinook salmon, BY 2004-2013.

BY	S_{eq}	S_{eq}/spawner[a]	SAR (%) All[b]	SAR (%) Adults[c]
2004	2,446	24	2.5	2.2
2005	4,280	110	1.9	1.8
2006	3,669	67	4.4	3.8
2007	2,784	46	5.5	4.8
2008	10,620	59	1.6	1.3
2009	3,671	50	1.8	1.7
2010	3,319	10	7.4	5.6
2011	5,925	15		
2012	7,596	10		
2013	*1,152	*8		
Mean	4,546	40	3.6	3.0

[a] *Adult spawners from Table 16 (Old Method)*

[b] *(Sum of NOR BY X returns at ages 3, 4, and 5)/S_{eq} BY X*

[c] *(Sum of NOR BY X returns at ages 4 and 5)/S_{eq} BY X*

**Caveat for 2015, Smolt equivalent low due to spill and low detects at LGD caused by uncharacteristically low flows that BY.*

2.3 Assistance Provided to LSRCP Cooperators and Other Projects

We provided assistance to Lower Snake River Compensation Plan (LSRCP) cooperator Oregon Department of Fish and Wildlife (ODFW) in 2015 for ongoing hatchery evaluation research. Project personnel completed spawning ground surveys for spring Chinook salmon in the Grande Ronde basin. CTUIR provided assistance in pre-release sampling of spring Chinook salmon at LH and conventional spawning of adult spring Chinook salmon at Oregon LSRCP facilities. CTUIR assisted with production tagging of hatchery origin fish in October.

We assisted Bonneville Power Administration (BPA) projects with data collection in 2015. Tissues taken with the opercle punch on adult returns to LGC weir were placed in dry rite in the rain envelopes for a study of relative reproductive success. We assisted ODFW personnel who have been collecting data on bull trout (*Salvelinus confluentus*) in the Grande Ronde River basin by providing estimated fork length data from bull trout captured in the LGC screw trap and during monthly sampling of juveniles.

2.4 Acknowledgments

We thank the private landowners along LGC, including Hancock Properties for allowing us to access and work on their property. Thanks to Rod Engle, Chris Starr, Margaret Anderson, and Renee Heeren (LSRCP, United States Fish and Wildlife Service) for administering this contract and coordinating project activities between the CTUIR and other agencies. Gary James, Michelle Thompson, Julie Burke, Celeste Reves, Dora Sigo (CTUIR), provided technical and administrative support. Thanks go to members of the ODFW NE Oregon Fish Research Section for field and office assistance. Tim Hoffnagle and Joseph Feldhaus (ODFW) provided information on their methods of population calculations. CTUIR O&M staff and CTUIR staff from other projects assisted in various field activities. Bureau of Reclamation seasonal staff – Brian Knees, Elena Bronisz, and Katie Fisher assisted with spawning surveys and screw trap checks. ODFW LH staff tended the adult trap and collected tissues and trap data for Chinook, provided the use of hatchery facilities and equipment to CTUIR, and kept an eye on stream conditions for us. Colette Coiner (CTUIR) provided the redd density map. Gene Shippentower (CTUIR) and Rod Engle reviewed previous drafts of this report.