Annual Progress Report
Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January 2014 to 31 December 2014

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

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Table of Contents

1 SECTION I. EVALUATION OF REESTABLISHING NATURAL PRODUCTION OF SPRING CHINOOK SALMON IN LOOKINGGLASS CREEK, OREGON, USING A LOCAL 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 to the Lookingglass Hatchery trap in 2014 totaled 218. Adults released above the Lookingglass Hatchery weir totaled 599 and spawning ground surveys yielded 205 redds. Brood year 2009 recruits per spawner was 0.9 for adults only. We estimated 54,759 (174/redd) brood year 2012 juveniles outmigrated from above Lookingglass Hatchery during migration year 2014. Fall 2013 outmigrants were 73% of the total, winter 2013 24%, and spring 2014, 4%. Survival probabilities to Lower Granite Dam ranged from 0.115-0.395 for summer, fall, winter, and spring PIT-tagged groups. Smolt equivalents (outmigrants surviving to Lower Granite Dam) totaled 7,596. Brood year 2009 smolt-to-adult ratio was 1.7 for adults only. Median arrival dates at Lower Granite Dam for brood year 2012 ranged from 22 April-11 May 2014 the 4 PIT-tagged groups. 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 has been above replacement for 3 of 6 brood years.

1.2 Introduction/Study Area/Methods

This is the latest in the series of 22 annual progress reports documenting the success of reintroducing spring Chinook salmon to Lookingglass Creek, tributary to the Upper Grande Ronde River in the Snake River Basin in northeastern Oregon. We focus this report on results and discussion, as there were no significant changes to the methods reported previously (Boe et al. in review). One change was a population estimate of outmigrating parr for the period 17-30 June 2013 using both fin-clipped and PIT-tagged fish and the estimation method described by Burck (1993). Metrics are described by Hesse et al. (2006) and correspond to the basic categories of abundance, productivity, and diversity for viable salmon populations (McElhany et al. 2000). Results from the current reintroduction era were compared to those of the extirpated endemic stock (Burck 1993) and the Rapid River reintroduction era for brood years (BY) 1992-1994 and 1996-1997. Survival estimates for other populations in the Grande Ronde Subbasin were also used in comparisons (Anderson et al. 2011, Jonasson et al. 2013, Jonasson et al. 2014).

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."

1.3 Results/Discussion

1.3.1 Adults

1.3.2 Abundance

Natural-origin (NOR) returns to the Lookingglass Hatchery (LH) weir

NOR returns to the LH weir totaled 218 in run year (RY) 2014. This includes fish caught at the LH trap and unpunched, unclipped carcasses recovered above the LH weir. Total returns to the LH weir were 34 (16%) age 3, 170 (78%) age 4, and 14 (6%) 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 2013-2014. Age 3 percentages in those years ranged from 11-52. Average returns during 1966-1974 (endemic era) averaged 379 and ranged from 78-727 (Burck 1993). "Small" returns were those ≤508 mm FL and made up on average 17% of the total trap catch, ranging from 4-37 (Burck 1993).

Completed brood year (BY) returns were 67, the second lowest since the start of the current reintroduction era.

Table 1. NOR returns to LH weir for RY, completed BY and age at return.

Returns by RY					Returns by Completed BY				
	Age					Age			
RY	3	4	5	Totals	BY	3	4	5	Totals
2007	7			7	1992	9	101	17	127
2008	4	46		50	1993	3	79	25	107
2009	24	69	9	102	1994	0	32	5	37
2010	17	124	9	150					
2011	30	120	14	164	1996	5	51	15	71
2012	3	129	15	147	1997	5	34	5	44
2013	64	50	10	124					
2014	34	170	14	218	2004	7	46	9	62
					2005	4	69	9	82
					2006	24	124	14	162
					2007	17	120	15	152
					2008	30	129	10	169
					2009	3	50	14	67

Released above the LH weir

Adult returns were released above the LH weir as they swam into the trap during 2014. All but 1 of the 473 hatchery-origin (HOR) released were adults. Of the 161 NOR released, 127 were adults and the remainder jacks. There were 347 females released and 79% were HOR. The early years of the current reintroduction era saw low numbers released above the LH weir (Figure 1). These numbers increased to a high of 926 in 2012, then decreased in 2013 and 2014. HOR fish were 100% of the adults released above the LH weir in 2004-2007 and 79-90% in 2008 and 2010-2014. HOR made up 34% of the adults released in 2009. Few HOR jacks are released.

The numbers released during most years of the reintroduction eras were much lower than during the endemic era. In 1964 and 1965, the weir and trap was not operating effectively and a substantial number of returns made it past the weir without being trapped.

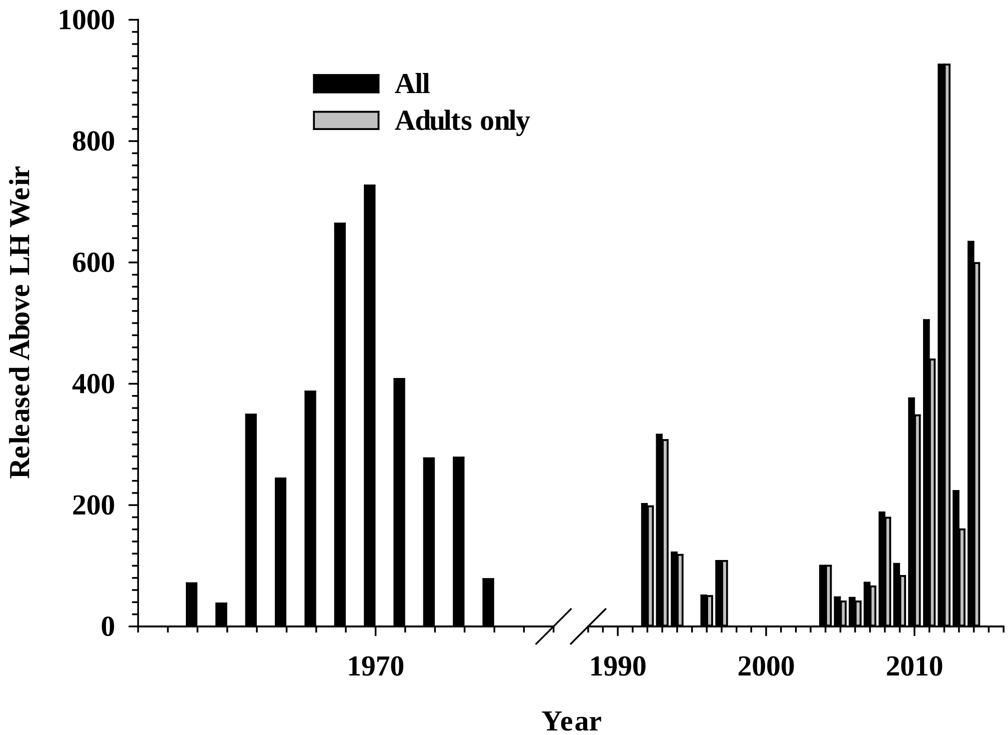

Figure 1. Spring Chinook salmon released above the LH weir to spawn in nature.

Spawning Ground Surveys

We completed 25 spawning ground surveys in Lookingglass Creek (LGC) during 12 August-19 September and observed 310 redds (Table 2). The first was observed on 12 August and the last on 18 September. There were 205 redds observed in Units 2, 3L, 3U, and 4 above the LH weir and 105 in Unit 1 below. Redds in Units 3U and 3L were the same as Unit 3 of Burck (1993), and made up 49% of the redds above the LH weir. Peak numbers of new redds above and below the weir were observed in late August. Weather and visibility conditions were generally excellent during the survey period. Spawning activity was earlier in Units 3U and 3L than Unit 1.

Table 2. New redds observed on surveys of LGC by date and unit, 2014.

	Unit				
Period	1	2	3U	3L	4
8/12-8/29	69	19	59	69	15
9/2-9/18	36	5	12	13	13
Totals	105	24	71	82	28
%	34	8	23	26	9

A high density of redds was near LH in Unit 1 (Figure 2). There were several areas with medium densities of redds in Units 2, 3L and 3U. Spawn timing and redd distribution above the LH weir were similar to the patterns observed by Burck (1993).

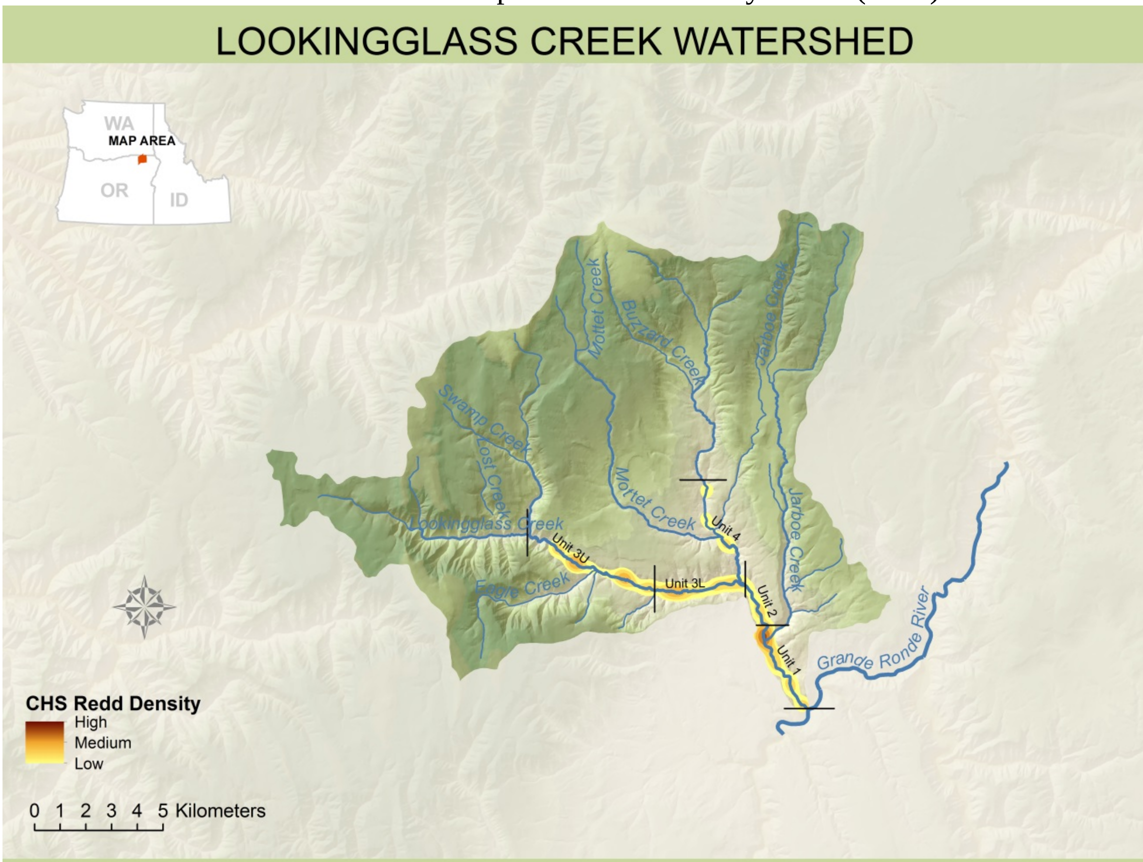

Figure 2. Distribution of spring Chinook salmon redds in LGC by unit, 2014

Burck (1993) observed about 84% of the redds above the LH weir in what we designate as Units 3U and 3L, and 13% in Unit 4 (Figure 3). The smaller numbers of redds we have observed in Unit 4 during some years may be due to releasing fish above the mouth of Little Lookingglass Creek (LLGC) at rkm 6.6.

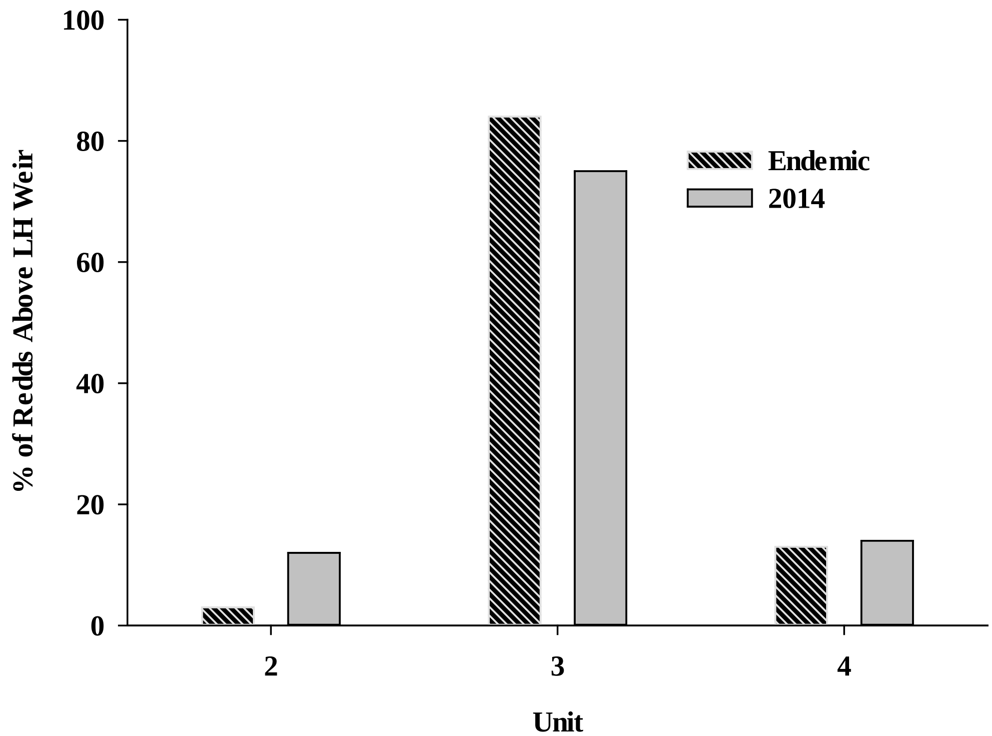

Figure 3. Percentages of spring Chinook salmon redds above the LH weir by unit for BY 1965-1969 (endemic era means) and 2014.

Redd numbers above the LH weir have varied widely during the current reintroduction era, but have usually been below those during the endemic era (Figure 4).

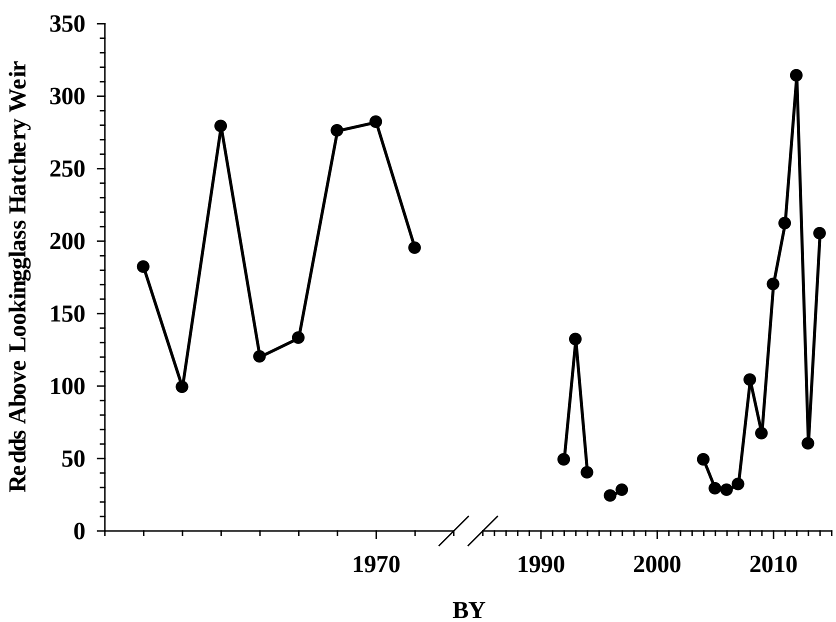

Figure 4. Spring Chinook salmon redds above the LH weir for BY 1965-1969 (endemic era), 1992-1994, 1996-1997 (Rapid River reintroduction era), and 2004-2014 (current reintroduction era).

Carcass Recoveries

There were 27 carcasses recovered above the LH weir from 25 June-11 August, prior to observation of the first redd on 12 August. All were adults and 25 were opercle-punched HOR. Of the 2 NOR recovered, 1 was opercle-punched. None of the 20 female carcasses sampled during this period had spawned.

Carcass recoveries above the LH weir on or after 12 August totaled 138. Carcass recovery efficiency for opercle-punched fish released above the LH weir was 24%. Carcasses recovered below the LH weir totaled 197. Opercle-punched carcasses recovered below the LH weir included 3 HOR and 1 NOR jacks and 6 HOR and 3 NOR adults.

The population estimate of jacks just prior to the start of regular spawning ground surveys on 12 August 2014 was 37, and the adult estimate was 583. Fish per redd were 3.02 for all fish and 2.84 for adults only (Table 3). There were 67 females sampled above the LH weir during regular spawning ground surveys and prespawning mortality was 8.96%. Prespawning mortality has varied from zero to 17.56% during the current reintroduction era. Females sampled below the weir during the regular spawning ground surveys totaled 111 and prespawning mortality was 5.40%. The higher prespawning mortality above the LH weir in some years may be due to handling at the trap. Burck (1993) reported prespawning mortality rates of 0 to 4.7%. Approximately 95% of female carcasses sampled were 100% spawned out, and 2% were 0% spawned (Burck 1993). Partially spawned females were rarely encountered.

Burck (1993) observed “sorehead” or what is now called “headburn” on some Chinook. “Sorehead” was described generally as pitted, eroded areas of skin on the top of the head, sometimes going down to the bone and accompanied by fungus growth (Burck 1993). This was a particular problem in 1969, when Burck (1993) reported 17 carcasses prior to the start of spawning and 14 of which had “sorehead”. This condition has also been also been observed occasionally during the current reintroduction era, but is usually insignificant. However, in 2014 headburn was seen on 5 of the 27 carcasses recovered during surveys above the LH weir prior to August 12. 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 we can recover them.

Table 3. Fish/redd and prespawning mortality for natural spawning spring Chinook salmon above LH weir, 2004-2014.

	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
Means	2.08	2.33	5.81

Snouts were collected from 118 carcasses above the LH weir and 85 below. Approximately half the snouts collected were misplaced and have not been processed. The majority of snouts sampled from LGC in 2014 were scanned shortly after recovery, and only those with CWT were sent to the ODFW CWT laboratory for dissection and recovery. Raw counts of CWT from 58 HOR carcasses sampled above the LH weir showed 6 codes present from BY 2010 and 2011 releases. Strays from other stocks were rarely encountered above the LH weir in 2014, possibly from passing the weir and ascending the stream before the carcass weir was installed, or possibly due to misidentification at the trap. All CWT were from LGC conventional brood stock releases except 3 from Catherine Creek (CC) and 1 from the Upper Grande Ronde River (UGR). There were 8 CWT codes from BY 2009, 2010, and 2011 releases represented in 34 HOR carcasses sampled from below the LH weir. CWT were 29 LGC conventional brood stock and 5 from UGR.

1.3.2.1 Life History

Length at Age

Mean FL at age was 71 mm greater for NOR than HOR at age 3, but 20 mm greater for HOR at age 4, using sexes combined data (Table 4). HOR data is incomplete as only some of the CWT from 2014 had been processed as of this writing. At age 4, mean FL was 30 mm greater for HOR males than females, and NOR females were 2 mm larger than males. Burck (1993) observed mean FL-at-age of NOR males and females recovered on spawning ground surveys equal at age 4 and 5 mm greater for females at age 5.

Table 4. Mean FL (mm) at age by sex and origin of LGC spring Chinook, 2014.

Origin	Sex	Age	$\bar{X}$ FL	Range	SE	N
NOR	M	3	574	572-575	2	2
NOR	M	4	744	590-810	13	22
NOR	F	4	746	605-782	5	30
NOR	Both	4	745	590-810	6	52
NOR	M	5	864	785-920	20	6
NOR	F	5	844	844-844		1
NOR	Both	5	861	785-920	17	7
HOR	M	3	503	440-560	9	17
HOR	M	4	784	630-870	8	41
HOR	F	4	754	660-850	5	68
HOR	Both	4	765	630-870	4	110

LGC NOR mean FL (mm) during the current reintroduction era has been similar to CC and both have been greater at all ages than during the endemic era (Figure 5).

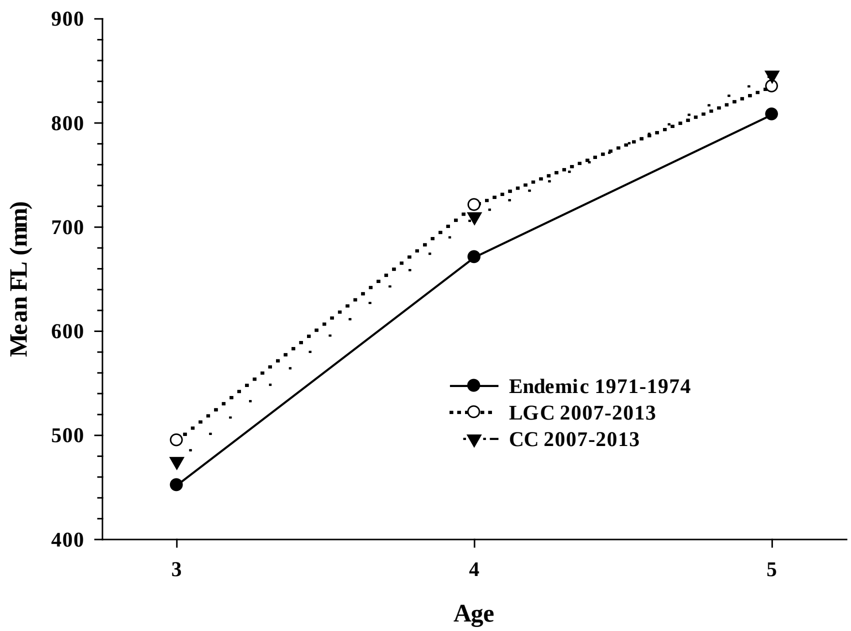

Figure 5. FL (mm) at age for LGC NOR spring Chinook salmon, 1971-1974 (endemic era) and 2007-2014 (current reintroduction era), and CC NOR determined by reading scales.

1.3.2.2 Productivity

Recruits per Spawner (R/S)

BY 2009 R/S for adults (excluding jacks) was lower than the 6 BY average of 1.5 (Table 5). R/S for BY 2001-2005 CC NOR (adults+jacks) ranged from 0.1-0.7 (Feldhaus et al. 2012[ab]) and increased to 2.2 in BY 2006 and 3.2 in BY 2007 (Feldhaus et al. 2014[ab]).

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 (Ford 2011).

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

	Population[a]		Spawners[b]		P:P	
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		
2011	500	431	470	405		
2012	937	937	772	772		
2013	210	154	210	154		
2014	620	583	564	531		

[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*

1.3.3 Juvenile Production

1.3.3.1 Abundance

Outmigrants
The rotary screw trap was fished 74% of the possible days during January-June 2013, 85% during July-December 2013, and 81% during January-June 2014.
There were 4 newly-emerged fry caught in the screw trap in January 2013 and 47 in Feburary. Totals for March, April, and May were 3,803, 4,472, and 1,553, respectively.

MY 2014 first-time captures in the screw trap from 1 July 2013-30 Jun 2014 totaled 17,978 with 0.5% mortalities. The MY 2014 outmigrant estimate was 52,415 (SE 4,569). Adding the parr estimate from 16-30 June gave 54,759. The MY 2014 outmigrant total was the highest observed during the current reintroduction era (Table 6). The mean outmigrants per redd for the endemic and Rapid River reintroduction eras were 340 and 391, respectively, higher than the mean for 9 BY of the current reintroduction era.

Table 6. LGC NOR spring Chinook salmon outmigrant summary[a].

BY	MY	Outmigrants	Redds AW[b]	Outmigrants/Redd
1965	1967	48,374	99	489
1966	1968	93,625	279	336
1967	1969	40,166	120	335
1968	1970	42,031	133	316
1969	1971	61,987	276	224
1992	1994[c]	8,713	49	178
1993	1995	65,082	132	493
1994	1996	6,707	40	168
1996	1998	14,713	24	613
1997	1999	14,140	28	505
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
Means*		19,571	112	243

[a]*PIT tags only used for estimates except MY 2012-2014*
[b]*AW=above the LH weir,* [c] *Trapping began in November 1993, *BY 2004-2012*

Outmigrants/redd and redds above the LH weir were highly variable over the endemic, Rapid River reintroduction, and current reintroduction eras, but the pattern suggested negative density-dependence (Figure 6). BY 1992 was omitted from Figure 6 since a late start to trapping likely missed a substantial part of the outmigration. Walters et al. (2013) reported strong density-dependent juvenile production for 9 Idaho spring Chinook populations

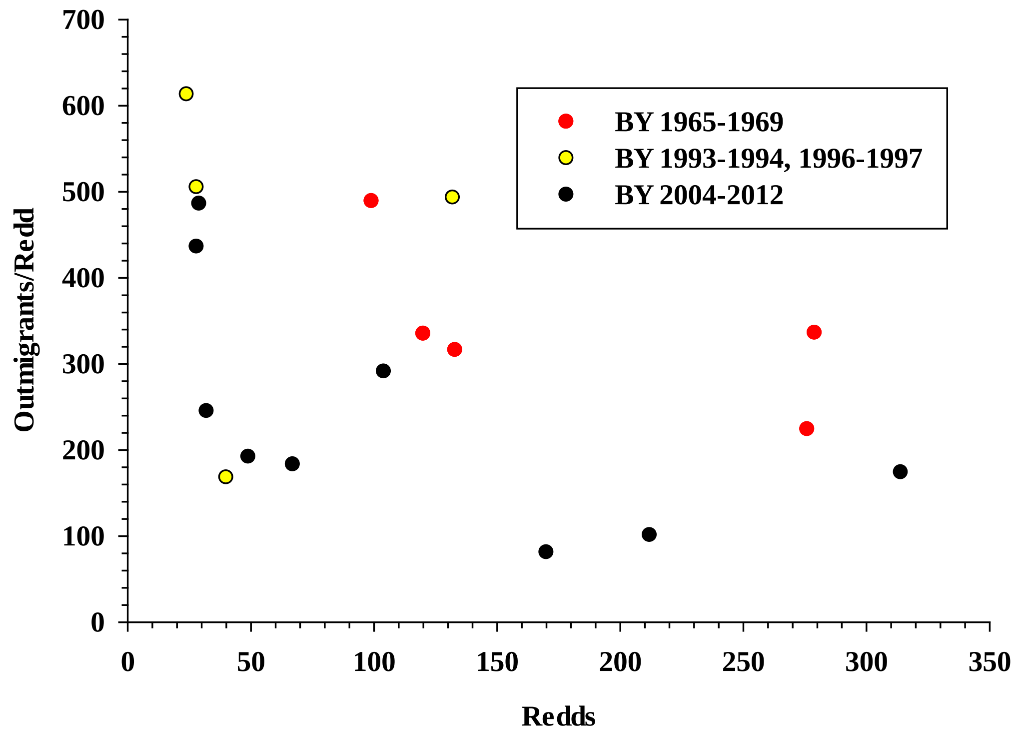

Figure 6. Scatterplot of outmigrants/redd and redds above the LH weir (AW) for BY 1965-1969 (endemic era), 1993-1994 and 1997-1998 (Rapid River reintroduction era), and 2004-2012 (current reintroduction era).

1.3.3.2 Life History

Monthly sampling

BY 2012 parr sampled totaled 200 in June, 203 in July, 221 in August and 197 in September 2013. Few parr were found at the LLGC site. Patterns seen were similar to those reported by Burck (1993). Mean FL increased in a generally linear pattern from June-September at 3 sites, and parr sampled at the most downstream site were larger for a given sampling date than upstream sites (Figure 7). Burck (1993) reported rapid growth from May-September, with differences of 10 mm between successive months at least once annually. Mean FL were lower in upstream and higher in downstream areas for a given sampling date (Burck 1993).

Mean K values decreased as the summer progressed at the rkm 0.4, 4.0, 8.9, and`10.5 km sites. Ranges were 1.38-1.15 at the rkm 0.4 site, 1.27-1.12 at rkm 4.0, 1.30-1.17 at rkm 8.9, and 1.19-1.14 at rkm 10.5. 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 2013, and the opposite pattern to that reported by Burck (1993) were surprising, particularly since the number of MY 2014 outmigrants was similar to the range reported for the endemic stock. We have no explanation for the differences in K.

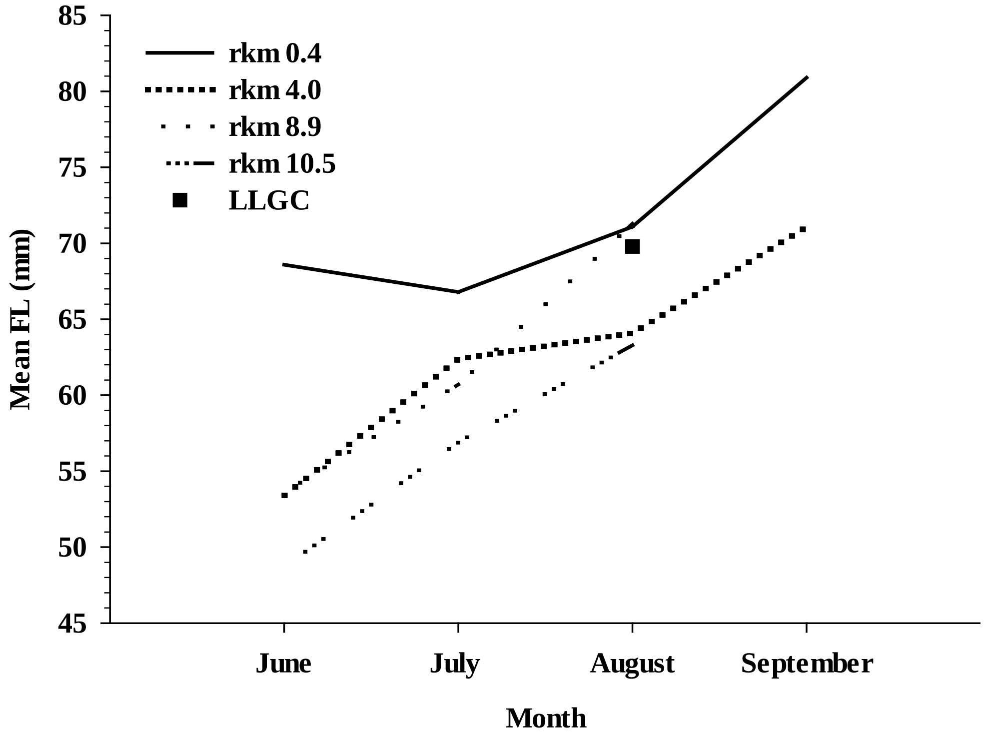

Figure 7. Mean FL (mm) of LGC BY 2012 NOR spring Chinook salmon, 2013.

Mean FL of parr sampled at the rkm 8.9 site in July was negatively related to density as represented by redds above the LH weir (Figure 8). Burck (1993) reported a similar negative relationship may have been present for early summer parr growth and density. Walters et al. (2013) also observed density-related growth of juvenile spring Chinook salmon at low abundance in several Idaho populations. Density-dependent growth of stream salmonids is a common phenomenon (Quinn 2005).

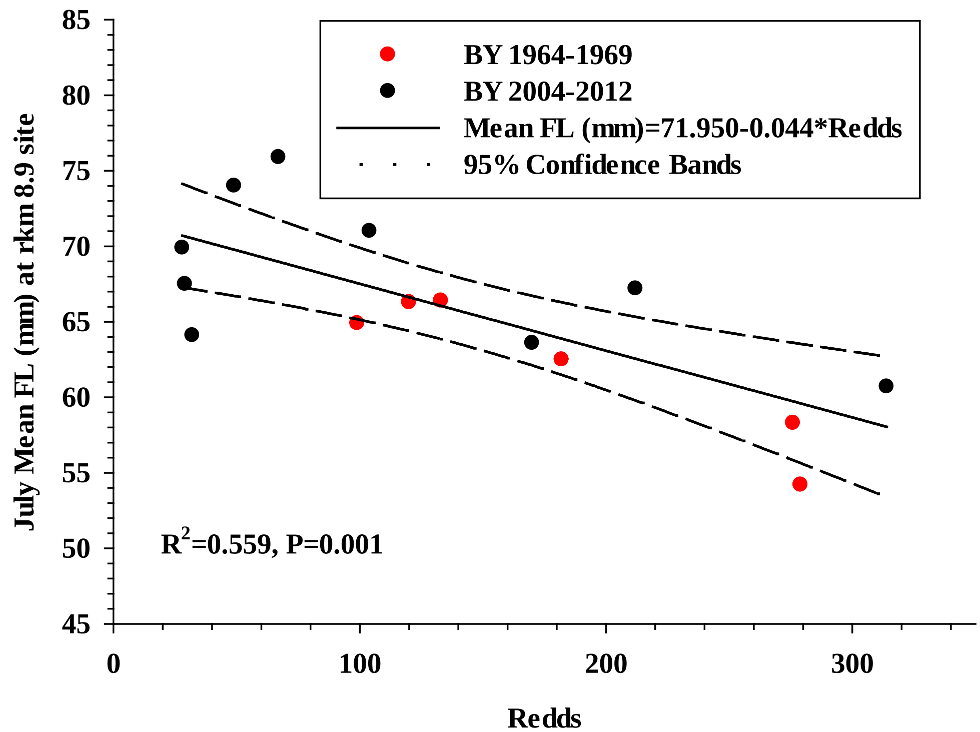

Figure 8. Regression of mean FL (mm) of LGC NOR spring Chinook salmon parr and redds above the LH weir for BY 1964-1969 (endemic era) and 2004-2012 (current reintroduction era).

Precocials

There were 33 NOR precocials caught in the screw trap from 19 July-20 September 2014 and mean FL was 141.9 mm. Burck (1993) typically caught precocials from early August through early October and recorded sizes from 77-152 mm FL. 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.

Outmigration timing

Fry began appearing in the screw trap in late January 2013, with significant numbers caught in March, April, and May. Outmigrants by season estimated from the screw trap catch were 73% for fall 2013, 24% winter 2013, and 4% spring 2014 (Table 7). The pattern observed was similar to that reported for the previous reintroduction era and Burck (1993). Burck (1993) reported fry being caught shortly after emergence and continuing for 15-17 months. Using endemic era data from June to the following June, higher percentages left during the fall season of June-September, than winter (October-December) or spring (January-June). For both reintroduction eras, higher percentages left during winter. When fall and winter were combined, the percentages were similar for the endemic and both reintroduction eras. A similar pattern of most outmigrants leaving as presmolts during July-January occurs for CC outmigrants (Anderson et al. 2011).

Table 7. Seasonal outmigration* of LGC NOR spring Chinook salmon summary.

BY	MY	Jun-Sept %	Oct-Dec %	Jan-Jun %
1965	1967	62	30	8
1966	1968	67	25	8
1967	1969	75	19	6
1968	1970	66	21	13
1969	1971	83	12	5
	Means	71	21	8
1992	1994		72	28
1993	1995	59	29	12
1994	1996	39	59	3
1996	1998	24	36	40
1997	1999	46	43	11
	Means	42	48	19
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
	Means	32	52	16

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

Obtaining an accurate estimate of January-June outmigrants is difficult because of high flow and debris during the spring and the small size of fish limiting the marking options available. Numbers leaving LGC during June, 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. The bypass trap Burck (1993) used may have been more efficient during May-August, or perhaps the pattern we have observed is more characteristic of the donor CC stock and how progeny have performed in LGC.

Burck (1993) suggested density dependent seasonal movement of outmigrants, with more leaving early as fry or small parr in BY 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. A similar pattern seems to be present during the current reintroduction era, although based only on raw counts (see comments in paragraph above). Walters et al. (2013) did not see density-dependent outmigration for 7 spring Chinook populations in Idaho however, it was evident for 2. Walters et al. (2013) suggested density-dependent migration might be occurring, but not at the scale they studied. Copeland and Venditti (2009) described 4 different outmigration phenotypes for Pahsimeroi River summer-run spring Chinook salmon, including recently-emerged fry. It is not clear from other studies whether outmigrating fry is density-dependent or an alternative life history pattern (Quinn 2005).

There were 154 recaptures of the BY 2012 summer parr group in the screw trap. Half of the recaptures were in August 2013 (Figure 9). The percentage of fall outmigrants in the screw trap was also higher than normally seen. During the current reintroduction era, recaptures of the summer parr have been variable, but show a general pattern of higher numbers in the fall. Recaptures percentages by season were 62% fall, 35% winter, and 3% spring.

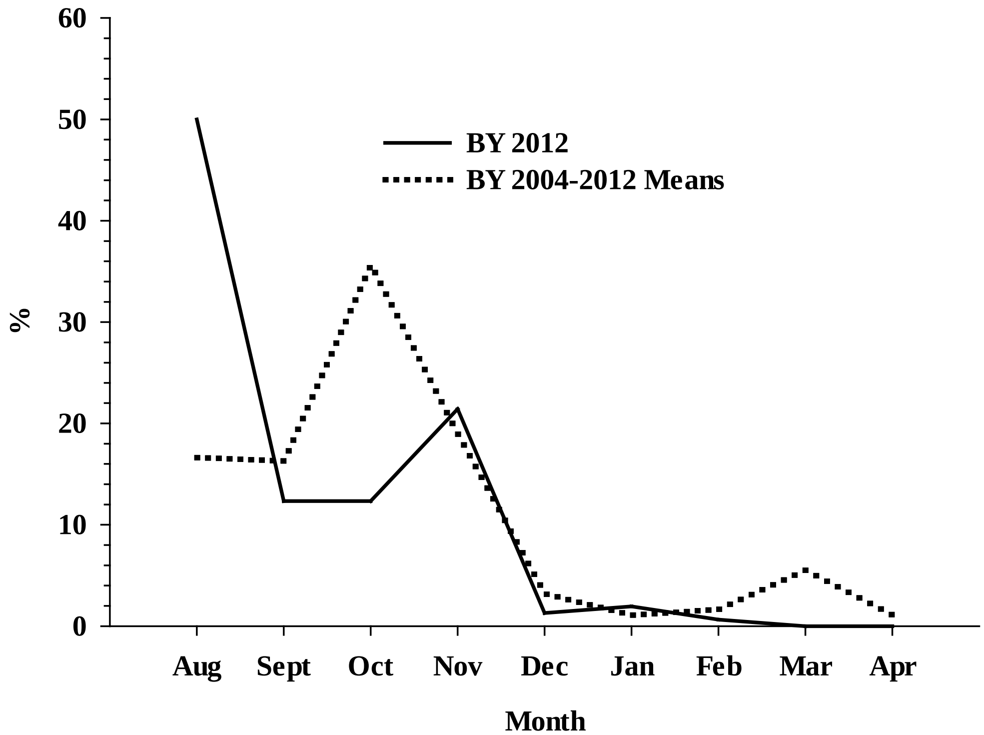

Figure 9. Percentages of recaptures in the LGC screw trap by month and MY of PIT-tagged NOR spring Chinook salmon summer.

Size of outmigrants in the screw trap catch by season

Median FL of outmigrants increased from fall 2013 to spring 2014 (Figure 10). The increase was substantial from fall 2013 to winter 2013 as smaller fish recruited to the catch from summer to fall. The difference was less so from winter 2013 to spring 2014. Burck (1993) reported outmigrants rarely exceeded 110 mm FL. Long-term data showed CC spring outmigrants larger than fall (Jonasson et al. 2014).

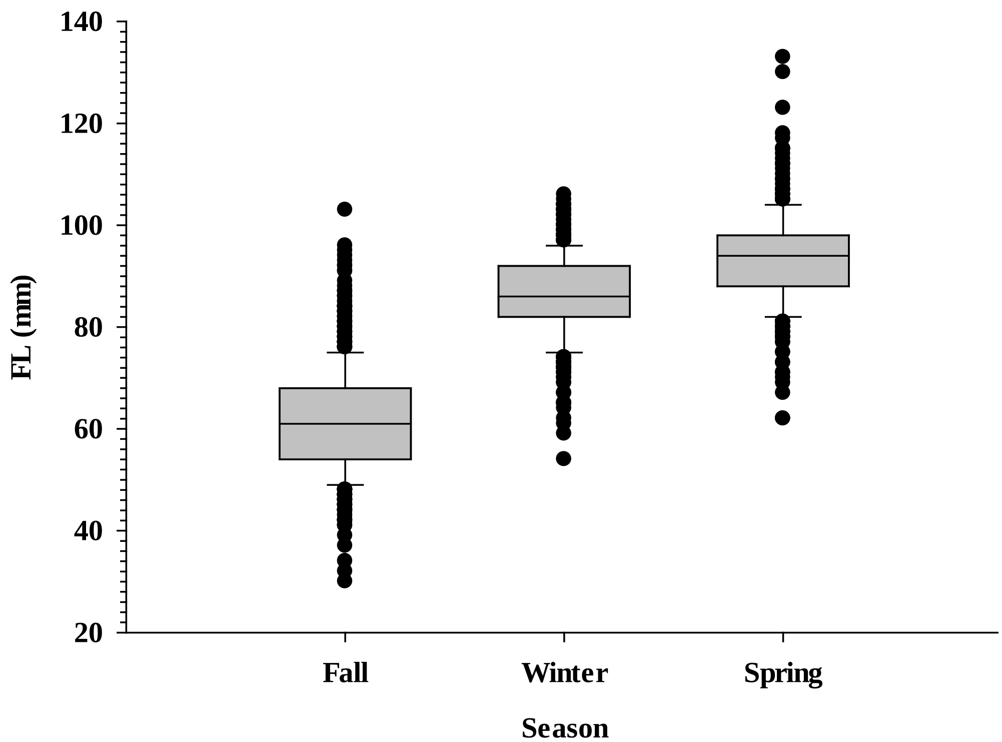

Figure 10. Box plots of FL (mm) by seasonal group for NOR BY 2010 spring Chinook outmigrants caught in the LGC screw trap, MY 2014.

PIT tagging of 2012 Brood Year

Mean FL were 66.1, 69.7, 79.4, and 82.2 mm for summer, fall, winter and spring outmigrants PIT-tagged and released. Mean weights increased from 3.1-6.5 g from summer to spring. Mean K was 1.07-1.08 for the summer and fall groups, then increased slightly to 1.10 for winter and 1.11 spring groups. Sample sizes were 944 for summer parr PIT-tagged from 5-9 August 2013 and ranged from 230-398 for fall winter, and spring groups of outmigrants couth at the screw trap. Median tagging dates were 12 August, 21 October, and 19 February, respectively.

Trends in mean FL for seasonal groups during the current reintroduction era have been consistent with mean FL (mm) smallest for the summer groups and largest for the spring groups (Figure 11). Burck (1993) found larger fish caught in the trap during October and November appeared to be disproportionate to the general population sampled by seining (Burck 1993). He suggested that may have resulted from more large fish outmigrating during that time, or that larger fish remaining upstream may have changed habitats.

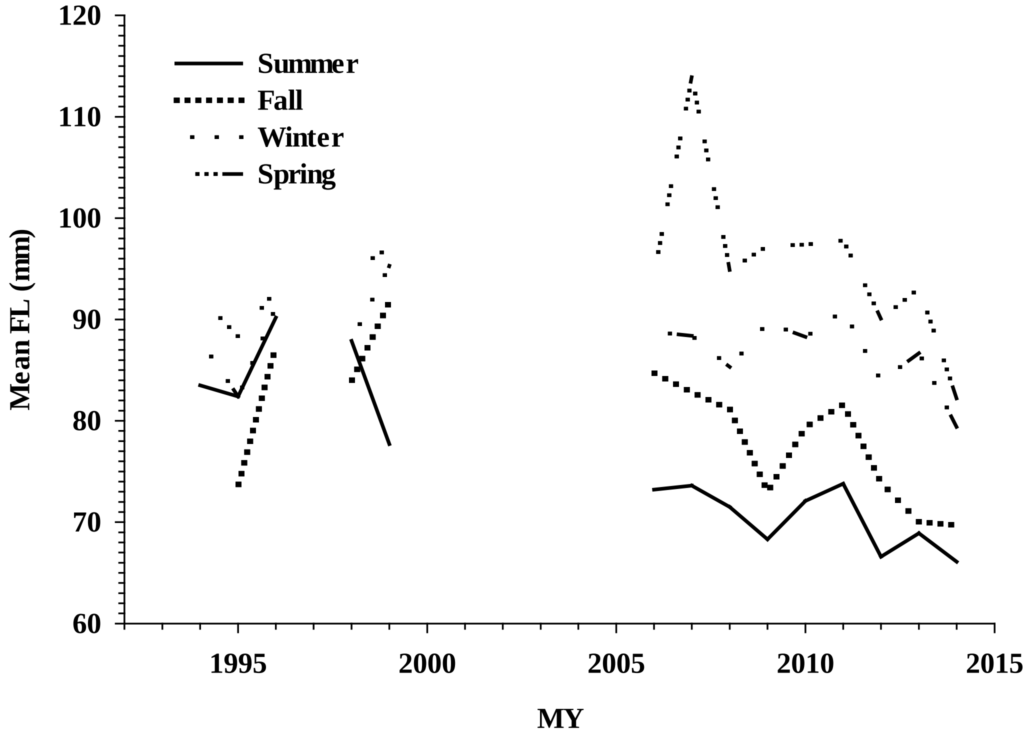

Figure 11. Size of LGC juvenile NOR spring Chinook salmon captured by snorkel-seining or screw trapping, PIT-tagged and released, MY 1994-1996, 1998-1999, and 2006-2014.

Survival probabilities (SE) to Lower Granite Dam (LGD) were 0.115 (0.012), 0.122 (0.019), 0.154 (0.035), and 0.395 (0.043) respectively for the summer, fall, winter, and spring groups of MY 2014.

Survival probabilities for summer parr of several Grande Ronde Subbasin populations showed a general decreasing pattern for MY 1993 through 2004, then increased for several years before decreasing again the last several years (Figure 12). Survival was more variable between populations for the fall/winter and spring groups, without any clear trend (Figures 13-14) or pattern over time (Figure 14). CC showed lower survivals than the other populations for both fall and spring groups. Population differences are probably the result of distances outmigrants must travel and different environmental conditions (e.g. predators, water temperatures, habitat, flow) for each population.

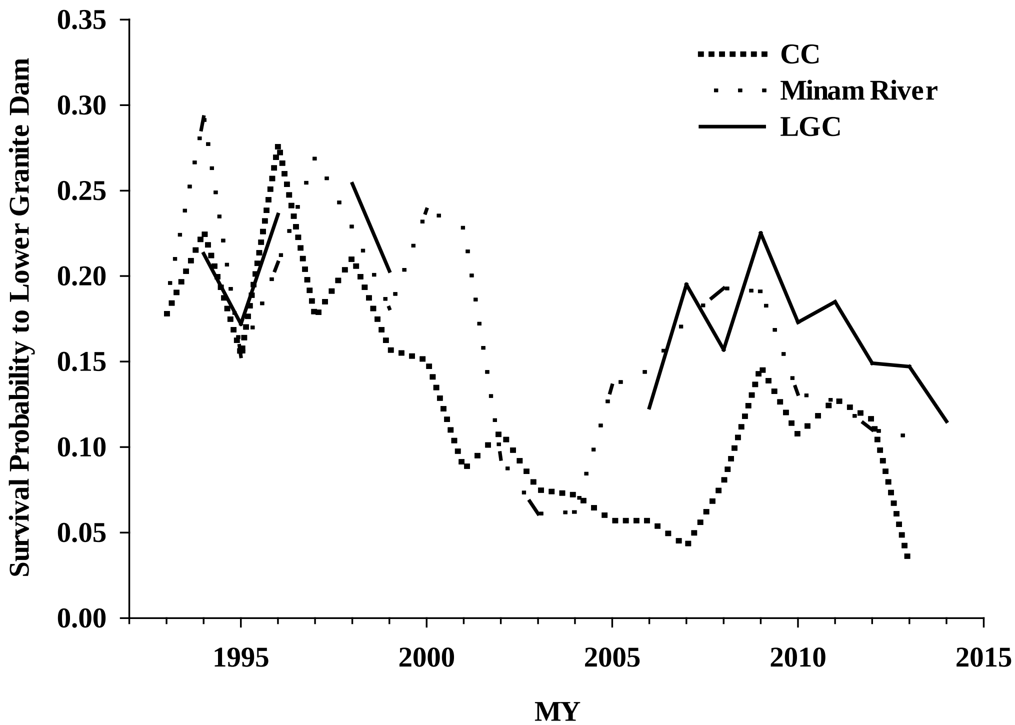

Figure 12. Survival probabilities of Grande Ronde River Subbasin NOR spring Chinook salmon summer parr spring Chinook salmon captured by snorkel-seining, MY 1993-2014.

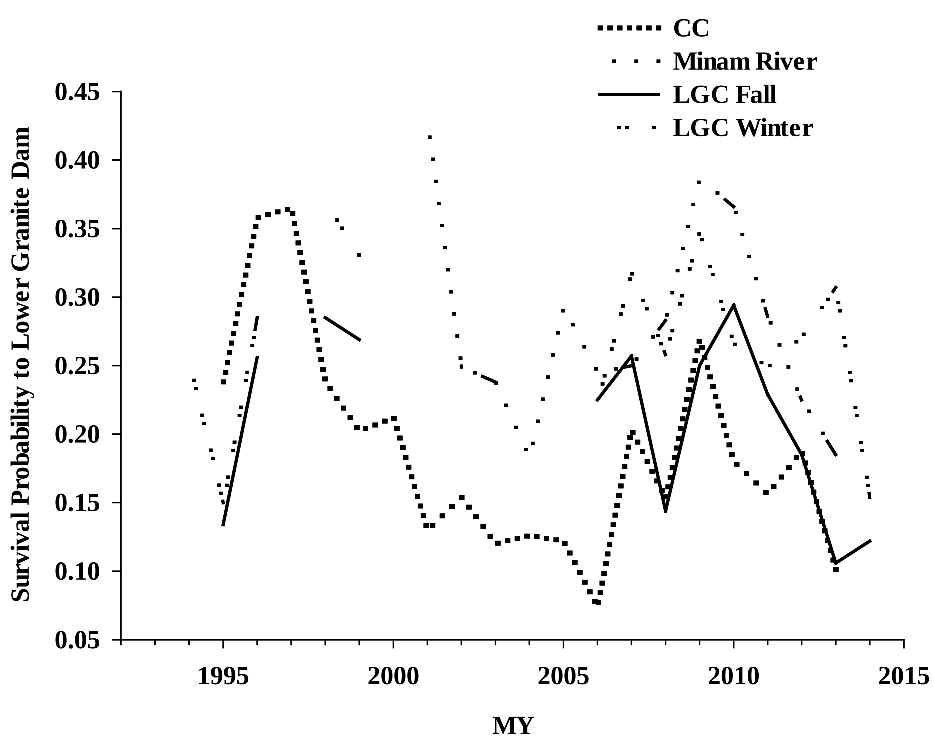

Figure 13. Survival probabilities of Grande Ronde River Subbasin NOR spring Chinook salmon fall and winter outmigrants, MY 1994-2014.

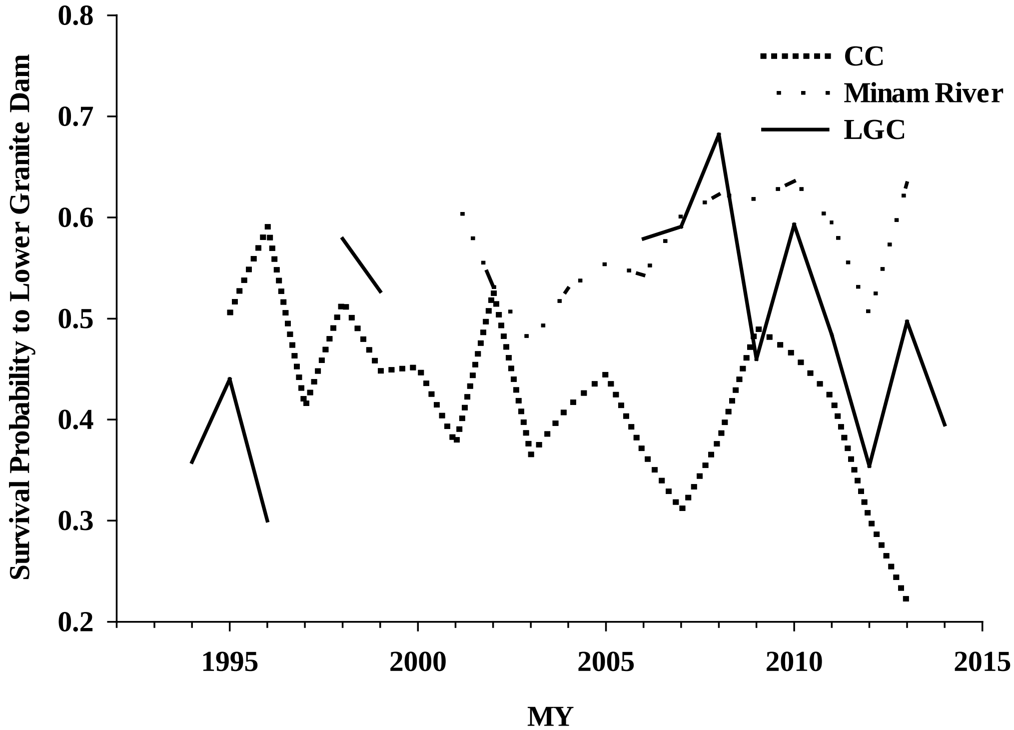

Figure 14. Survival probabilities of Grande Ronde River Subbasin NOR spring Chinook salmon spring outmigrants, MY 1994-2014.

Scatterplots failed to show any discernible pattern between redds and survival (Figure 15). Regressions of LGC redds on survival to LGD for the 4 seasonal groups failed to produce any significant relationships (P values 0.060-0.128). Burck (1993) reported a general decrease in survival from egg to outmigrant from MY 1967-1971 during the endemic era. Walters et al. (2013) reported a negative relationship between density and survival for several Chinook stocks in Idaho.

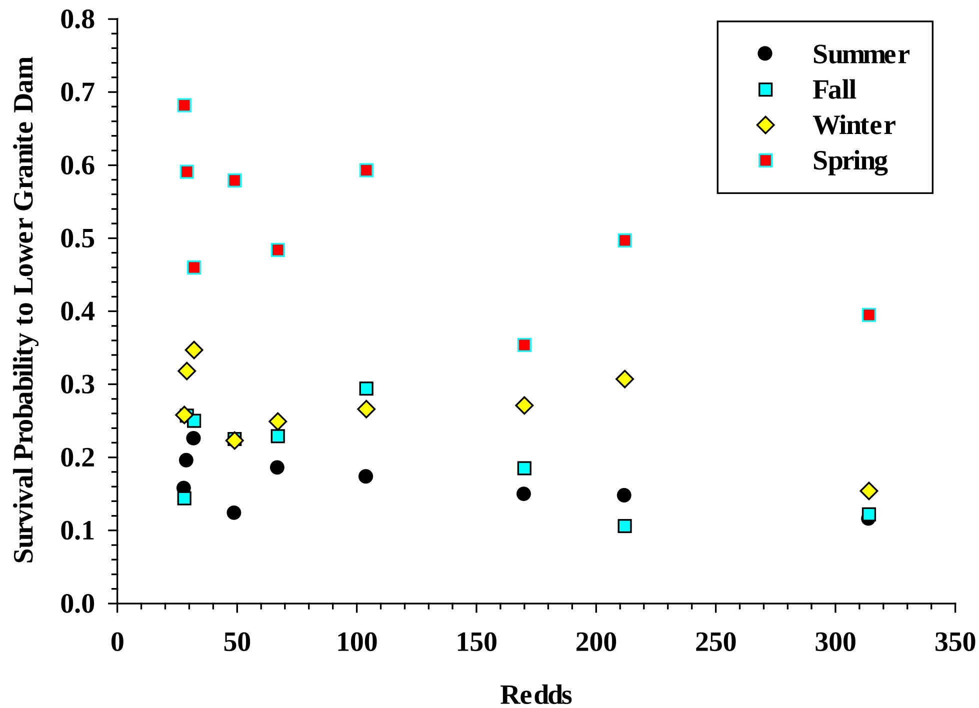

Figure 15. Scatterplot of redds above the LH weir and survival for the 4 seasonal groups of LGC spring Chinook salmon outmigrants, BY 2004-2012.

Smolt equivalent (S_{eq}) estimates (outmigrants for each group surviving to LGD) for fall 2013, winter 2013 and spring 2014 were 4,937, 1,908, and 751, respectively, for a BY 2012 total of 7,596. BY 2012 S_{eq} was nearly double the BY 2004-2012 mean, but the S_{eq}/spawner was second lowest (Table 8). S_{eq}/spawner during the current reintroduction era have been below the range of approximately 50-125 reported for CC for BY 2004-2010 (Jonasson et al. 2014). S_{eq}/spawner of 10-15 for the past 3 BY are similar to the long-term low for CC of 15 reported for BY 2011 (Jonasson et al. 2014). The scatterplot of S_{eq}/spawner and spawners for the current reintroduction era was similar to that reported for CC (Jonasson et al. 2014).

BY 2009 NOR SARs were below the BY 2004-2009 means. The BY 2004-2009 adult only mean of 2.6% is at the low of the 2-6% range and below the 4% average recovery objectives for Snake River Chinook and steelhead (NPCC 2014). SAR for NOR UGR and CC spring Chinook salmon were approximately 0.5-1% (Carmichael et al. 2010[a] and 2010[b]).

Table 8. S_{eq} to LGD and SAR for LGC NOR spring Chinook salmon.

BY	S_{eq}	S_{eq}/spawner[a]	SAR (%) All[b]	SAR (%) Adults[c]
1992	2,454		5.2	4.8
1993	11,380		0.9	0.9
1994	1,839		2.0	2.0
1996	6,371		1.1	1.0
1997	4,584		1.0	0.9
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		
2011	5,925	15		
2012	7,596	10		
Mean*	4,923*	43*	3.0**	2.6**

[a] *Adult spawners from Table 5*,

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

[c] *(Sum of BY X returns at ages 4 and 5)/S_{eq} BY X*

**BY 2004-2012, **BY 2004-2009*

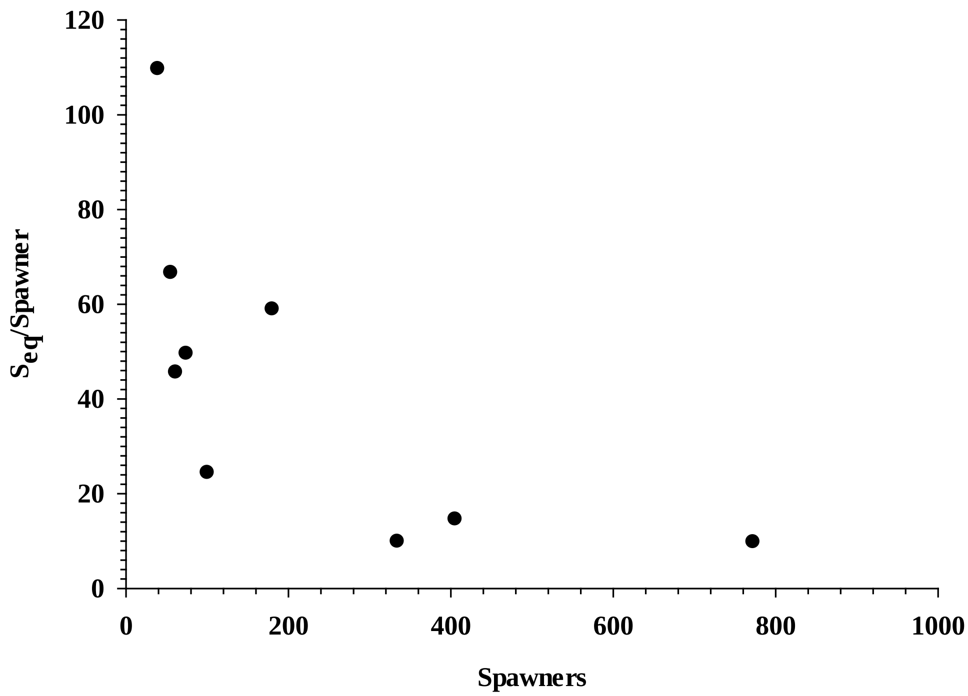

Figure 16. Scatterplot of LGC spring Chinook salmon Seq/spawner and spawners above the LH weir, BY 2004-2012.

Median arrival dates at LGD were 5 May for the summer 2013 group, 24 April for the fall 2013 group, 22 April for the winter 2013 group, and 11 May 2014 for the spring 2014 group. Expanded detections at LGD ranged from 22 for the winter 2013 group to 96 for summer 2013. Median arrival dates were in late April or early May for most BY, with spring groups usually arriving earliest and fall groups latest (Figure 17). Travel times were generally similar for MY 2004-2014 within the 4 seasonal groups (Figure 18).

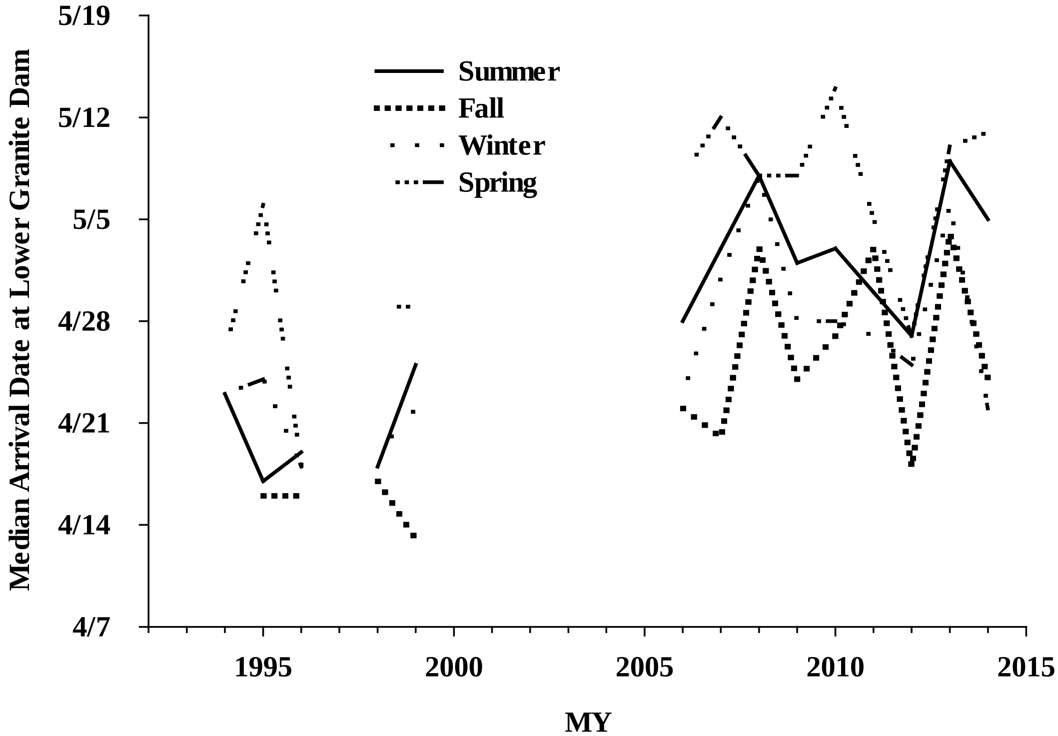

Figure 17. Median arrival dates at LGD for LGC NOR spring Chinook salmon summer parr, and fall, winter, and spring outmigrants, MY 1994-2014.

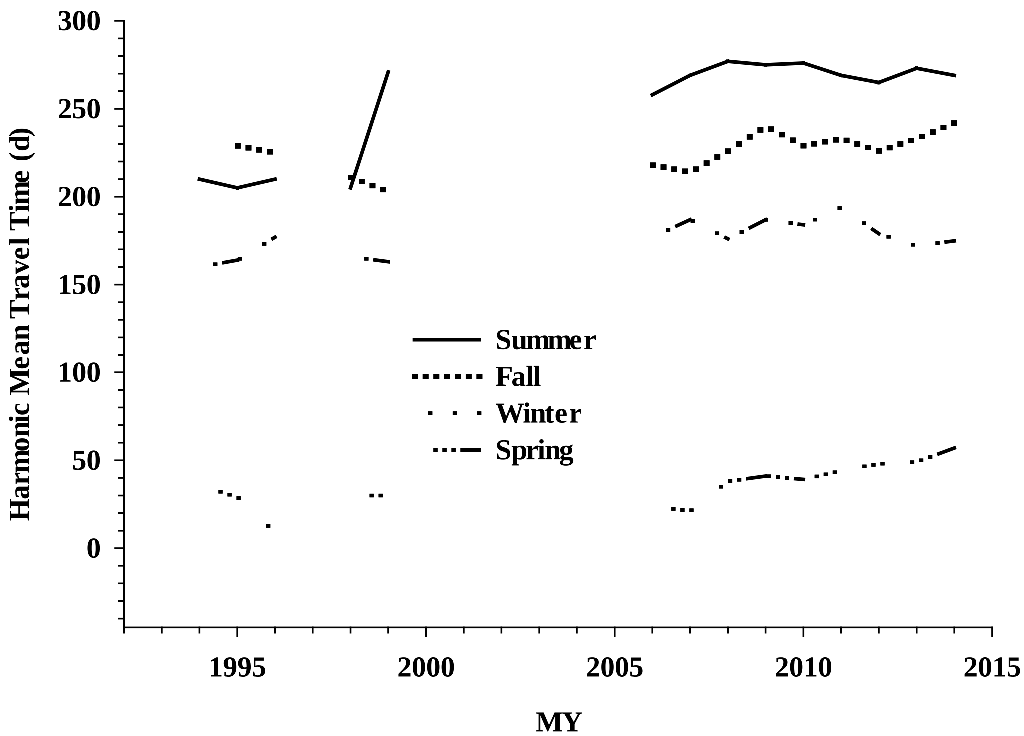

Figure 18. Harmonic mean travel time (d) to LGD for LGC NOR spring Chinook salmon summer parr, and fall, winter, and spring outmigrants, MY 1994-2014.

1.4 Summary

Life history metrics for spring Chinook salmon in the current reintroduction era were generally similar to the endemic and Rapid River reintroduction eras and also to the CC donor stock. Some differences have been seen in juvenile outmigration timing and adult FL-at-age between the LGC endemic stock and the current reintroduction era. Density-related patterns in growth of parr have been observed. Productivity expressed as recruits per spawner has been above replacement for 3 of 6 BY. A sustained improvement in productivity will be needed to rebuild and sustain a naturally-reproducing population above the LH weir.

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Note: Annual progress reports for the Lookingglass Creek Spring Chinook Reintroduction Project for all years, 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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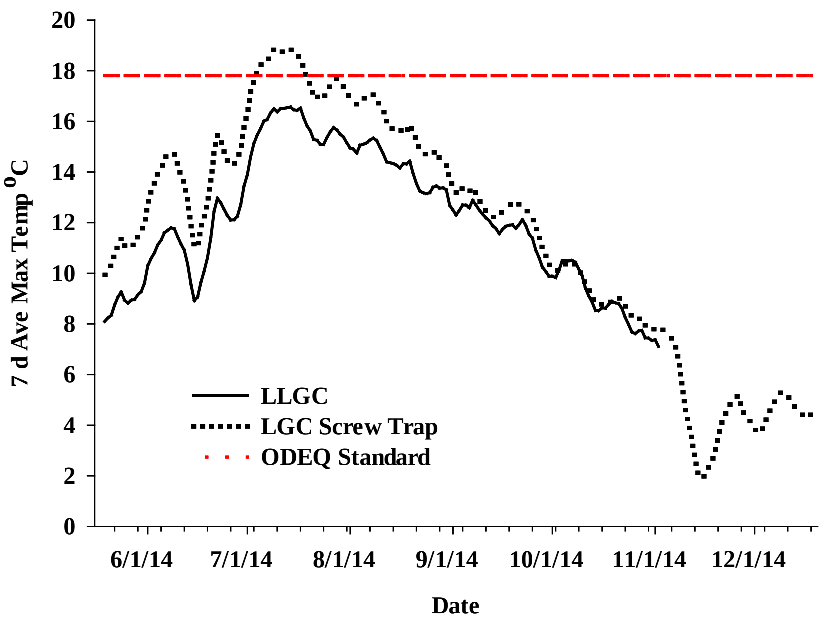
1.6 Appendix Figure 1. Water temperatures at several locations in LGC and LLGC during 2014 (7-d average maximum).



2 SECTION II 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 2014 for ongoing hatchery evaluation research. Project personnel completed spawning ground surveys for spring Chinook salmon in the Grande Ronde basin. We provided assistance in pre-release sampling of spring Chinook salmon at LH and adult spring Chinook salmon at Oregon LSRCP facilities.

We assisted Bonneville Power Administration (BPA) projects with data collection in 2014. 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.

3 ACKNOWLEDGMENTS

Thanks to Steve Yundt, Chris Starr, Margaret Anderson, Joe Krakker, and Tammy Froscher (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, and (CTUIR) provided technical and administrative support. Thanks go to members of the ODFW NE Oregon Fish Research Section for field and office assistance. Darlene Robison (Umatilla National Forest) provided water temperature data. CTUIR O&M staff and CTUIR staff from other projects assisted in various field activities. We thank the private landowners along LGC, including Hancock Properties for allowing us to access and work on their property. ODFW LH staff tended the adult trap, collected tissues and trap data, provided the use of hatchery facilities and equipment, and kept an eye on the screw trap for us. Nicole Novak and Colette Coiner (CTUIR) provided the redd density map.   Gene Shippentower (CTUIR) reviewed previous drafts of this report.