

Reintroduction of Spring Chinook Salmon in Lookingglass Creek: Analysis of Three Stocks Over Time

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Abstract

We compared natural production between an endemic spring Chinook salmon (*Oncorhynchus tshawytscha*) population that is locally extinct with two different supplementation stocks used in Lookingglass Creek, a tributary of the Grande Ronde River located in northeast Oregon. Habitat in Lookingglass Creek has been relatively unaltered over this 3-stock study period from the 1960's to present. Spring Chinook salmon were once abundant in Lookingglass Creek and supported significant tribal and sport fisheries. Intensive monitoring of natural production occurred throughout the 1960's which provided the base-case endemic stock productivity data for this study. Dam construction on the Columbia and Lower Snake Rivers was probably a major factor in the decline of the native Lookingglass stock in the late 1970's. The construction of Lookingglass Hatchery and weir in 1982 caused further stock reduction and final extirpation. From 1992 to 1999, a non-endemic Rapid River (Idaho) stock was introduced to re-establish a spring Chinook population. The weir at the hatchery and outmigrant traps allowed for precise monitoring of fish in and fish out for this comparison study. Rapid River stock showed results similar to the endemic stock across all metrics evaluated (redd distribution, spawn timing, adults per redd, outmigrants per redd, outmigration timing and survival, and parent/progeny ratios). A switch to a local Grande Ronde Basin stock (Catherine Creek captive broodstock progeny) began with juvenile releases in 2001 and returning adults placed above the weir beginning in 2004. Marked (hatchery-origin) and unmarked (natural-origin) adults have returned to Lookingglass Creek and are successfully reproducing upstream of the hatchery. As was the case with comparison of the first two stocks, the current Catherine Creek stock is also beginning to show similar or increased productivity and survival results across the same metrics. Results indicate striking potential for hatchery reintroduction/supplementation success for spring Chinook salmon. Continued work will evaluate the productivity of progeny from captive Catherine Creek broodstock that spawn naturally versus those that are subjected to another "hatchery cycle" and used for broodstock in the Lookingglass Creek reintroduction project.

Introduction

The preceding goals and objectives are consistent with the overall mission statement of the CTUIR Department of Natural Resources:

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

Similarly, the CTUIR DNR Fisheries Program mission statement is:

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

The tribal goals fit within the framework of mitigation goals established for the Lower Snake River Compensation Plan by the hatchery releases used to supplement any natural returns. Annual reports describing the historical efforts at reestablishing natural production of spring Chinook salmon in Lookingglass Creek are available at <http://www.fws.gov/lsnakecomplan/Reports/CTUIRreports.html>

The native Lookingglass Creek stock of spring Chinook salmon was extirpated within a few years after establishment of Lookingglass Hatchery (LH) in 1982. Prior to 1982, Lookingglass Creek had the second highest number of redds in the Subbasin (Figure 1). Lookingglass Creek is within the “usual and accustomed” areas of gathering for the Confederated Tribes of the Umatilla Indians (CTUIR). CTUIR, along with comanagers, began efforts in the early 1990s to reestablish natural production of spring Chinook salmon in Lookingglass Creek. Several stocks, including remnants of the endemic stock, Imnaha River, Wind River (Washington), Carson Hatchery (Washington), and Rapid River (Idaho) were used before comanagers selected Rapid River. The Rapid River (Idaho) stock was replaced with Catherine Creek stock (native to the Grande Ronde River basin) beginning in 2001. The present management goal is to reintroduce spring Chinook salmon into Lookingglass Creek using the Catherine Creek captive brood stock to support natural population restoration, tributary harvest, and maintain genetic diversity of a gene bank for the Catherine Creek stock.

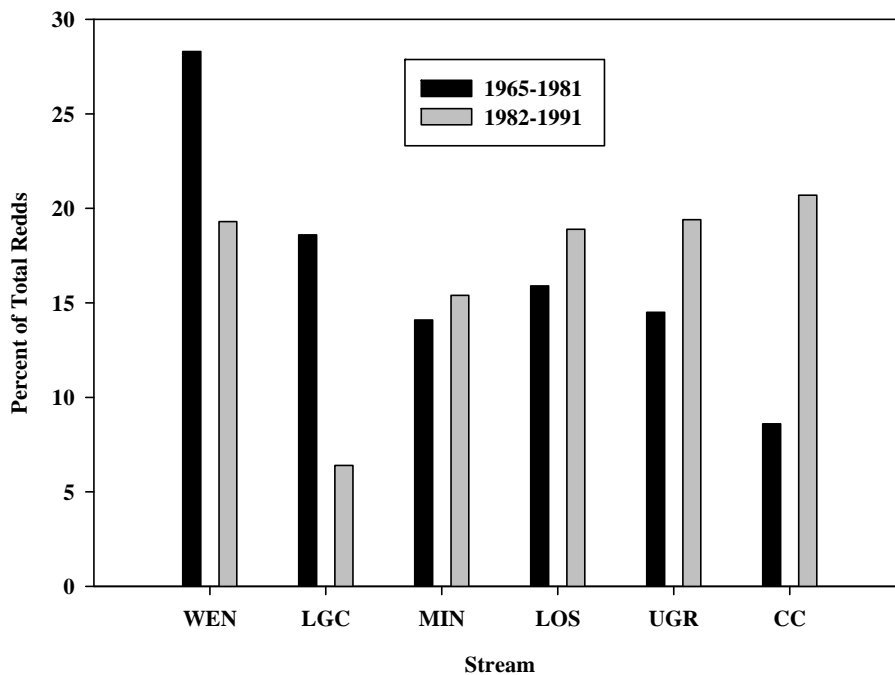


Figure 1. Percent of total redds by tributary in the Grande Ronde River Subbasin (WEN=Wenaha R., LGC=Lookingglass Creek, MIN=Minam R., LOS=Lostine R., UGR=upper Grande Ronde R., CC=Catherine Creek).

Lookingglass Creek provides a unique study opportunity for to evaluate natural production from an endemic stock vs two different supplementation treatments. The control and two treatments in this unplanned experiment occur in the same stream over

different time periods. The study takes place in a stream within a relatively healthy watershed with much less effect from human activities (e.g. grazing, water withdrawals, mining, logging) that are common to other streams in the Subbasin. The presence of a weir at Lookingglass Hatchery affords near complete control over fish that move upstream to spawn. In addition to this project on Lookingglass Creek, other supplementation projects in the Subbasin using local stocks include the upper Grande Ronde River, the Lostine River, and Catherine Creek.

Burck (1993) studied the endemic stock (control) from late 1963 through late 1974 (Study Era 1). Metrics from juvenile and adult life history and production were reported. Rapid River stock (supplementation treatment 1) were used in a reintroduction effort from 1992-2000 (Study Era 2). The Rapid River stock was used in several streams in the Subbasin. Metrics similar to Burck (1993) were contained in annual reports that can be accessed at <http://www.fws.gov/lsnakecomplan/Reports/CTUIRreports.html>. Catherine Creek captive broodstock progeny (supplementation treatment 2) have been used since 2001 (Study Era 3).

Replacement of the Rapid River stock with Catherine Creek stock occurred because Catherine Creek stock were local, had characteristics similar to the extirpated endemic stock, and surplus was available. It also afforded an opportunity to study performance of captive broodstock in the natural environment. Captive broodstock are collected in the natal stream as parr, reared in the hatchery until maturity, and spawned. Their progeny are hatchery-reared, marked, and released, usually in the spring as smolts.

Current spring Chinook salmon management (Appendix 1) for Lookingglass Creek (developed with comanagers) includes a sliding scale for disposition of hatchery- and natural-origin collected at the Lookingglass Hatchery trap and holding returns for either outplanting above the trap or use as conventional broodstock at the hatchery. Both unmarked (F_2) and marked (F_1) returns are outplanted and used as hatchery broodstock. This is unique in the Subbasin, as returning adults used for conventional broodstock from Catherine Creek and the upper Grande Ronde River exclude any marked (F_1) captive broodstock progeny due to their extended rearing time in the hatchery environment.

The supplementation sequence for Catherine Creek captive broodstock progeny into Lookingglass Creek began with the first liberation of juveniles from brood year 2000 in September 2001. The first substantial returns of Catherine Creek captive broodstock (F_1) occurred in 2004. This was the first year of Study Era #3 when adults were released above the Lookingglass Hatchery to spawn naturally. The first age 4 unmarked returns (F_2) occurred in 2008.

Our Research Goal is to conduct monitoring and evaluation studies to inform managers concerning use of a local spring Chinook salmon broodstock (Catherine Creek) for reintroduction into Lookingglass Creek. Specific objectives are to 1) compare performance across three time periods of two reintroduced stocks (Rapid River, Catherine Creek) with the extirpated endemic stock of spring Chinook salmon in Lookingglass

Creek, and 2) evaluate use of Catherine Creek F₁ captive broodstock progeny for natural spawning and hatchery production.

Methods

Standard methods for sampling fish and collecting data for evaluating performance measures (metrics) followed Burck 1993, Hesse et al. 2006 and Johnson et al. 2007. In summary, these included adult trapping, spawning ground surveys, parr collection, and outmigrant sampling with 1.5 m rotary screw trap. Metrics used to evaluate stock performance for adult life history and production included spawner abundance, percent hatchery/natural origin spawners, redd distribution, adults/redd, and prespawning mortality, smolt-to-adult ratio, and progeny per parent (recruits/spawner). Metrics used for juvenile life history and production included first-year growth, survival and migration timing to Lower Granite Dam, total outmigrants, outmigrants/redd and outmigration by season. Detailed descriptions of methods used are in annual reports accessible at <http://www.fws.gov/lsnakecomplan/Reports/CTUIRreports.html>.

Study Area

The Lookingglass Creek watershed is in the Blue Mountains of northeast Oregon with the headwaters at an elevation of 1,484 m above sea level (Figure 2). Flow is to the southeast for 25 river km (rkm) through the Umatilla National Forest then through private land before entering the Grande Ronde River at rkm 137, at an elevation of 718 m above sea level. Lookingglass Creek has five major tributaries: Lost Creek, Summer Creek, Eagle Creek, Little Lookingglass Creek, and Jarboe Creek. Lookingglass Creek and Little Lookingglass Creek are the only major areas where spring Chinook salmon spawning takes place with any regularity. Lookingglass Hatchery is located at rkm 4.0 on Lookingglass Creek.

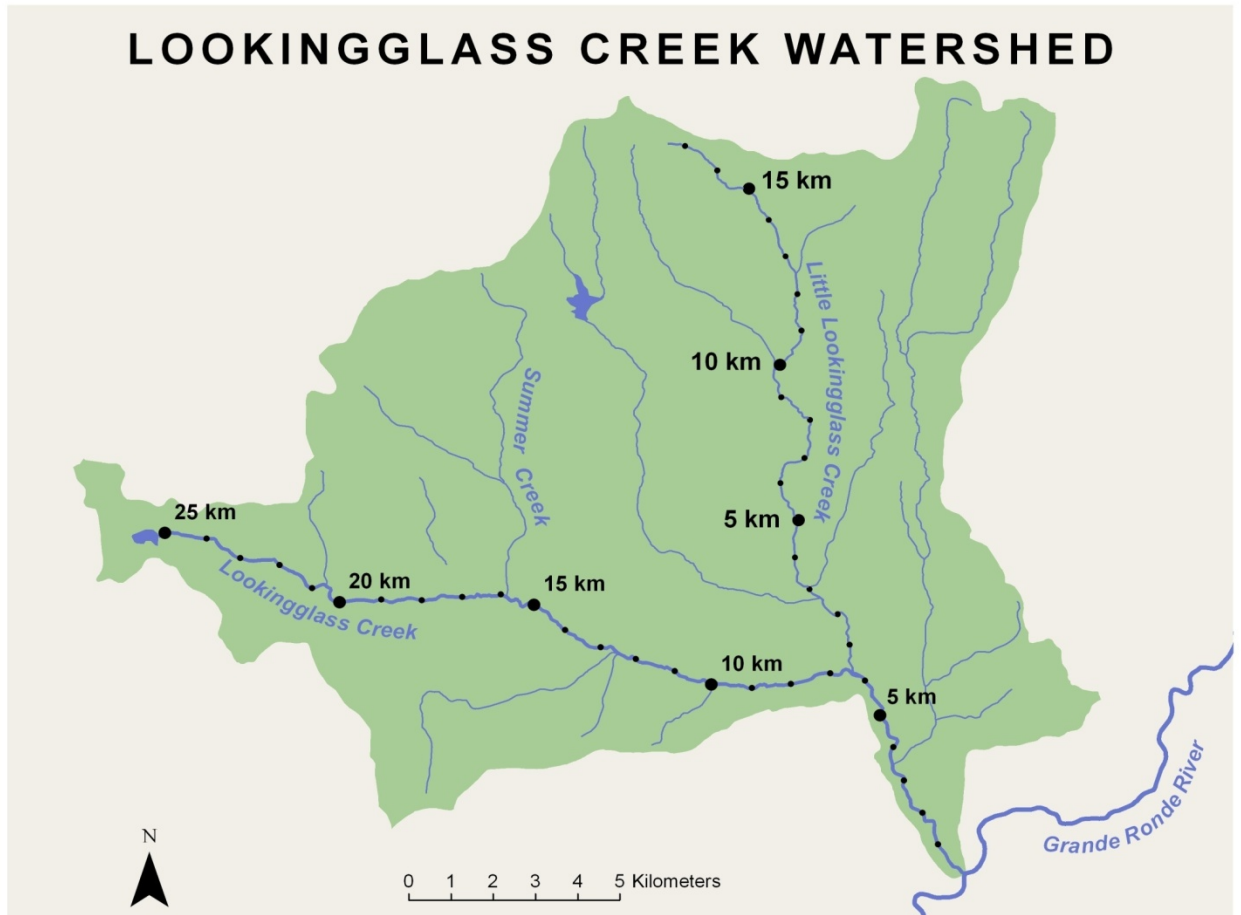


Figure 2. Lookingglass Creek watershed.

Results

Population estimates of spawners above the weir usually vary little from the number released, and indicate most fish that get upstream are handled at the trap (Figure 3). Spawners in Study Eras 2 and 3 have been much lower than the endemic era, due to the low numbers of juvenile released in most years; 2010 was the first year when spawners and redds began to approach endemic (Study Era 1) levels was 2010. For LGC-RR adults, data were separated into two time periods; early years (F_1 returns) and late years (F_2 returns). LGC-RR F_1 returns were brood year (BY) 1992-1994 and LGC F_2 returns were BY 1996-1887

Early years of reintroduction periods were entirely hatchery-origin, with some natural-origin incorporated in the later periods (56-66% hatchery-origin). Most spawning above Lookingglass Hatchery occurs in Unit 3 (Figure 4). Differences in the release time and location for upstream spawners can affect redd distribution. Average adults/redd for Study Era 3 have been less than 2, lower than Study Era 2 (approximately 3), and similar to the endemic stock (Figure 5). Average adults/redd for Study Era 3 are lower than for Catherine Creek (2.5), the upper Grande Ronde River (3), or the Lostine River (4).

Prespawning mortality was usually less than 5% for Lookingglass Creek, but may be much higher in some years if headburn is a problem on fish arriving at the trap. Prespawning mortality has been a frequent problem at the upper Grande Ronde River, due to high water temperatures, but this is rarely a problem at Lookingglass Creek. Whenever additional stock were compared in addition to the three Study Eras, we tried to include the time frame from 1992-present.

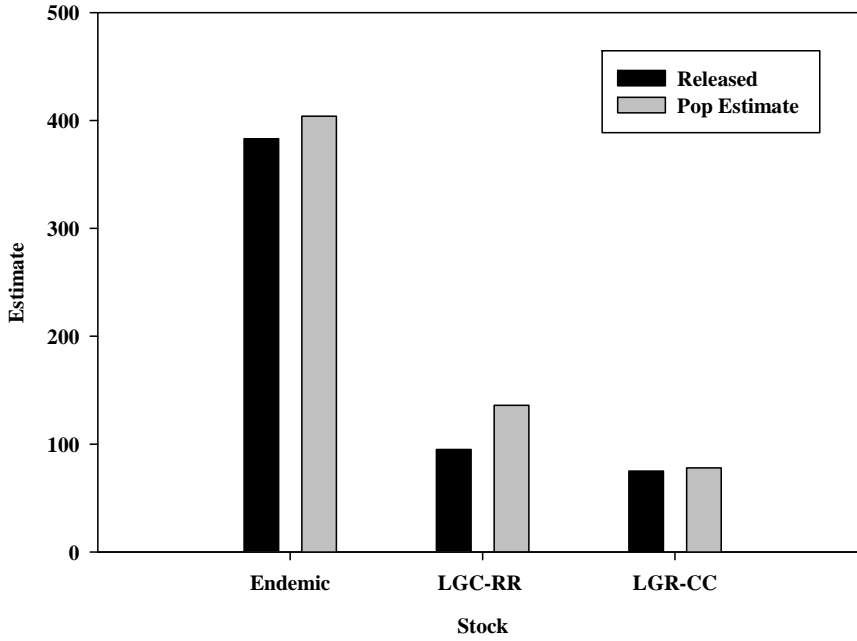


Figure 3. Adults released above the Lookingglass Hatchery weir to spawn naturally.

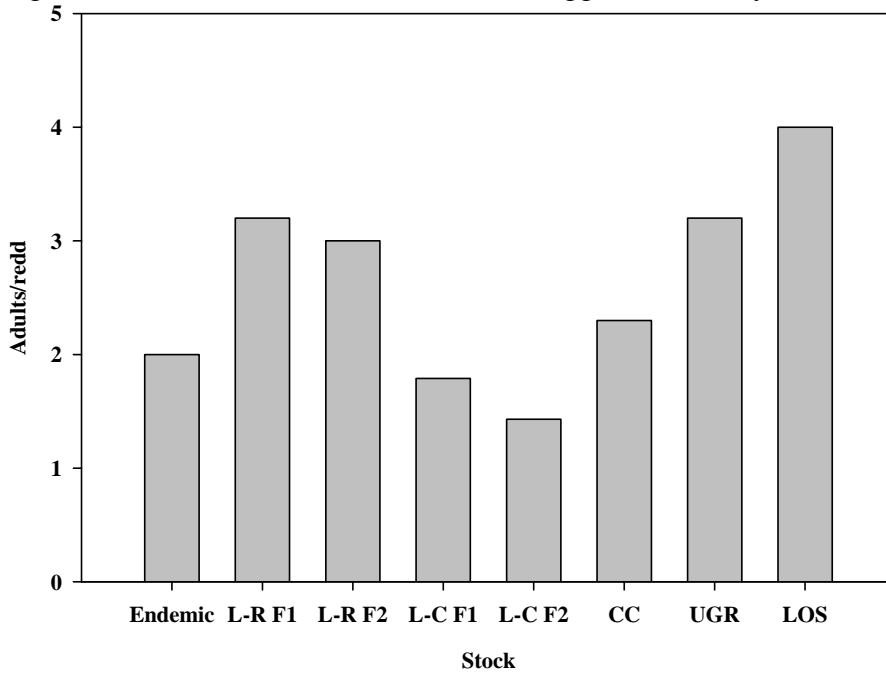


Figure 4. Average adults/redd for various stocks in the Grande Ronde Subbasin(L-R F1=Lookingglass Creek-Rapid River F₁. L-R F2=Lookingglass Creek-Rapid River F₂, L-C F1=Lookingglass Creek-Catherine Creek F₁).

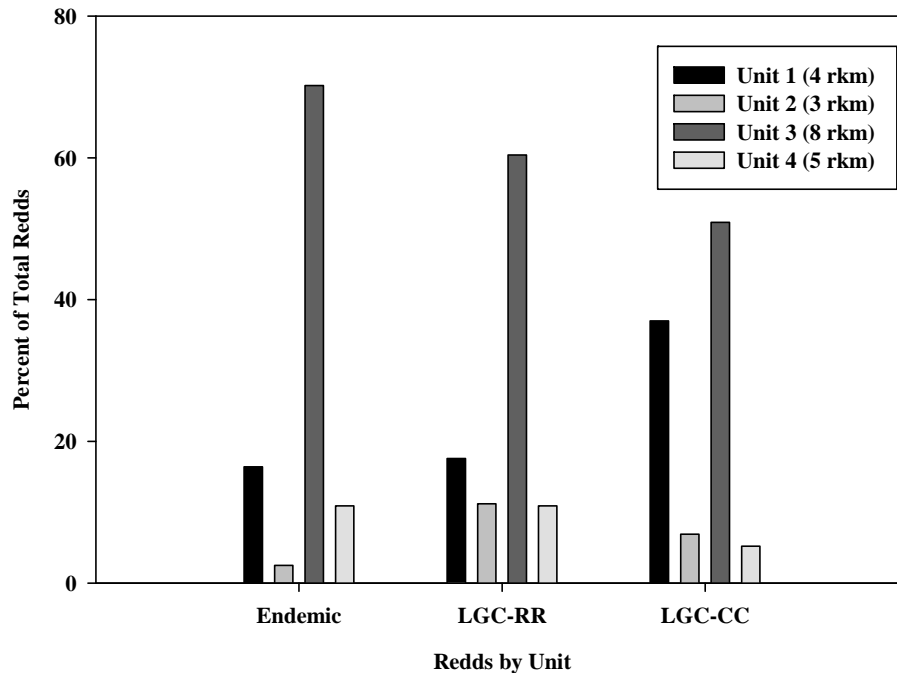


Figure 5. Lookingglass Creek redds by unit and study era.

During Study Eras 2 and 3, total outmigrant production was low, the result of low numbers of spawners above the weir compared to Study Era 1. The first year with a substantial number of adults spawning above the weir was 2008. Outmigrants per redd for Lookingglass Creek during Study Eras 2 and 3 were higher than the endemic era and also higher than those observed for other subbasin tributaries in the late 1990s and 2000s (Figure 6). Lookingglass Creek juveniles outmigrate during most of the year but fish >60 mm FL are mostly during two periods, early (fall after emergence) and late (spring the year after emergence). All three eras were similar for Lookingglass Creek (80-87% early migrants) and slightly below that of Catherine Creek (71% early migrants). Most upper Grande Ronde River outmigrants leave in the spring. Growth of juveniles sampled in the screw trap during both reintroduction eras was similar, reaching greater lengths than the endemic stock. This pattern may have been related to the higher density of juveniles during the endemic era. Summer growth of parr had two periods of rapid growth separated by a period of slower growth during Study Eras 1 and 3, but only one period of rapid growth during summer was evident for parr during Study Era 2.

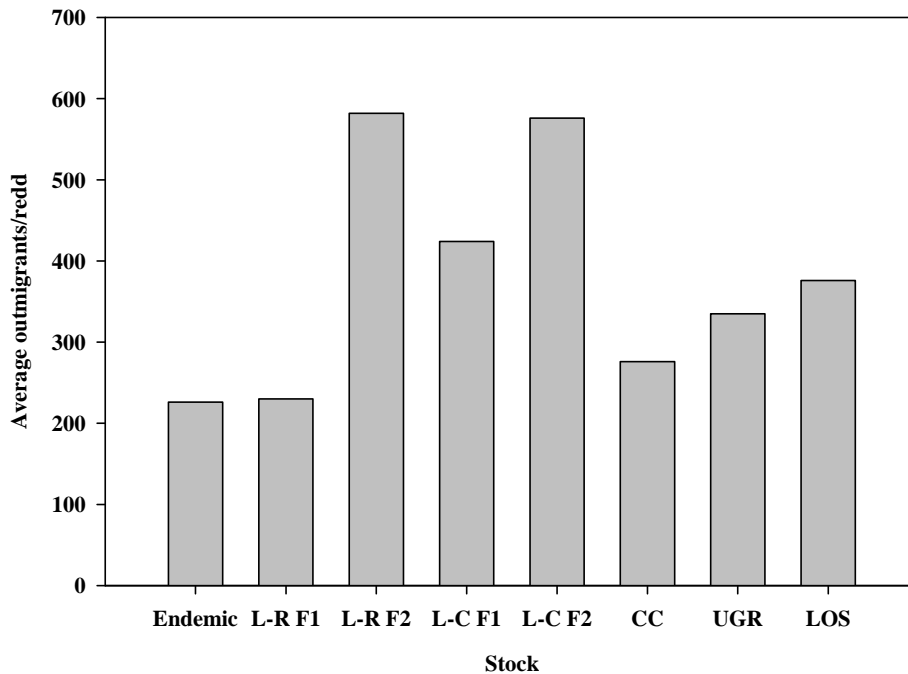


Figure 6. Average outmigrants/redd for various Grande Ronde Subbasin spring Chinook salmon stocks.

Survival probabilities for parr PIT-tagged in late July-early August in the primary nursery areas upstream of Lookingglass Hatchery were usually between 0.15-0.22 (Figure 7). Average survival probabilities for Study Eras 2 and 3 were higher than for Catherine Creek and the Lostine River, and more similar to the upper Grande Ronde River. Arrival timing at McNary Dam was compressed into a shorter time frame for Study Era 1 than either Study Eras 2 or 3. McNary Dam was used instead of Lower Granite Dam because some mark (freeze brand) data were available from the endemic era.

Progeny per parent ratios for Lookingglass Creek natural spawners typically ranged from 0.5 to 1.5 and were similar to Catherine Creek and the upper Grande Ronde River (Figure 8). Average SAR (1.7%) for two brood years (2004 and 2005) was slightly below the range expected for recovery (2-6%, Figure 9). Future work will also evaluate performance of conventional hatchery broodstock between Lookingglass Creek and Catherine Creek (Objective 2b).

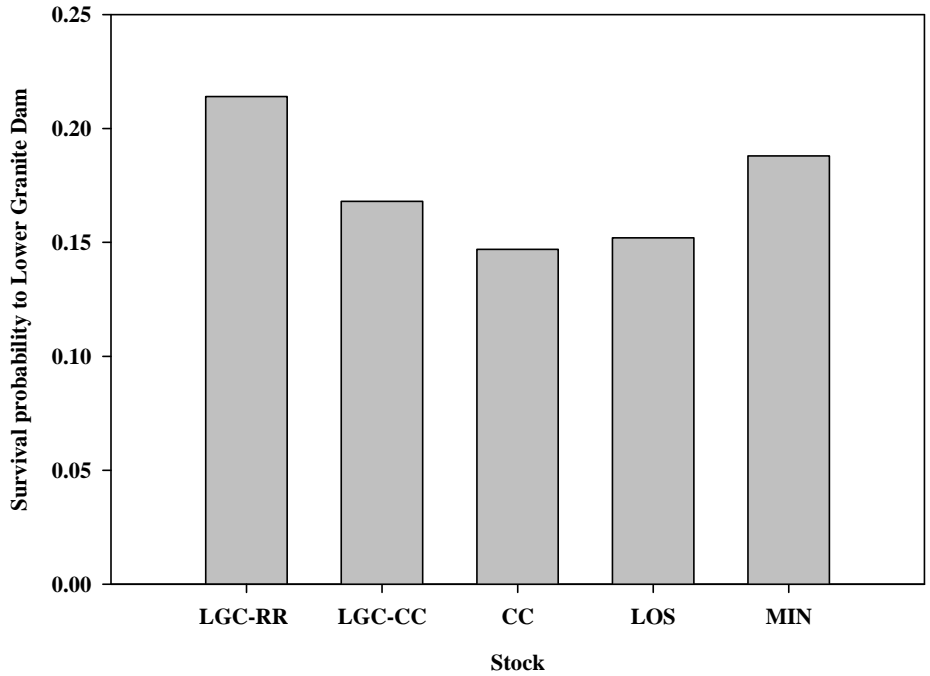


Figure 7. Survival probabilities to Lower Granite Dam.

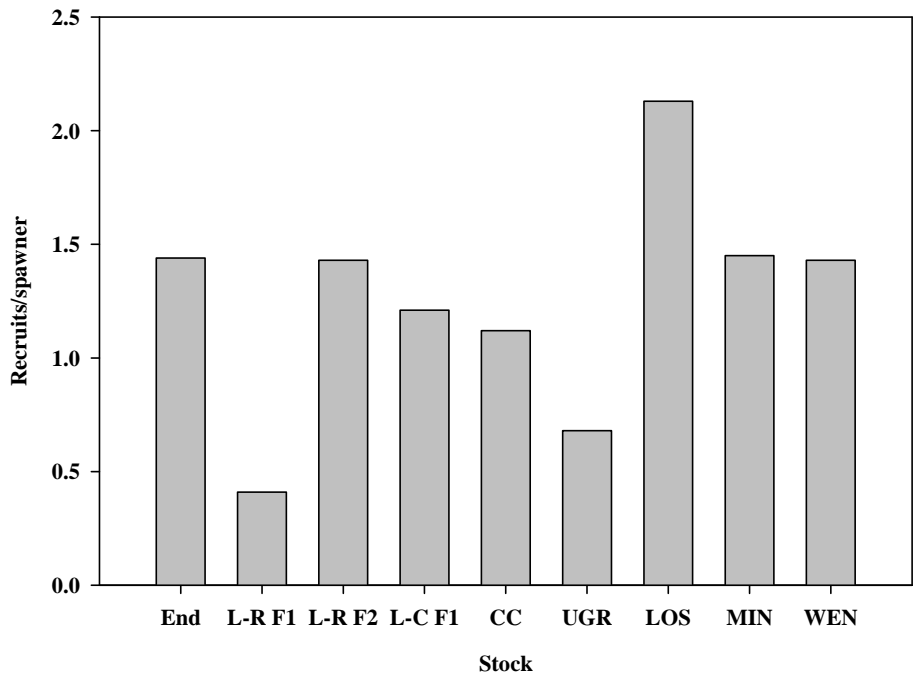


Figure 8. Recruits/spawner for various stocks and time periods (L-R F1=Lookingglass Creek-Rapid River F₁. L-R F2=Lookingglass Creek-Rapid River F₂, L-C F1=Lookingglass Creek-Catherine Creek F₁).

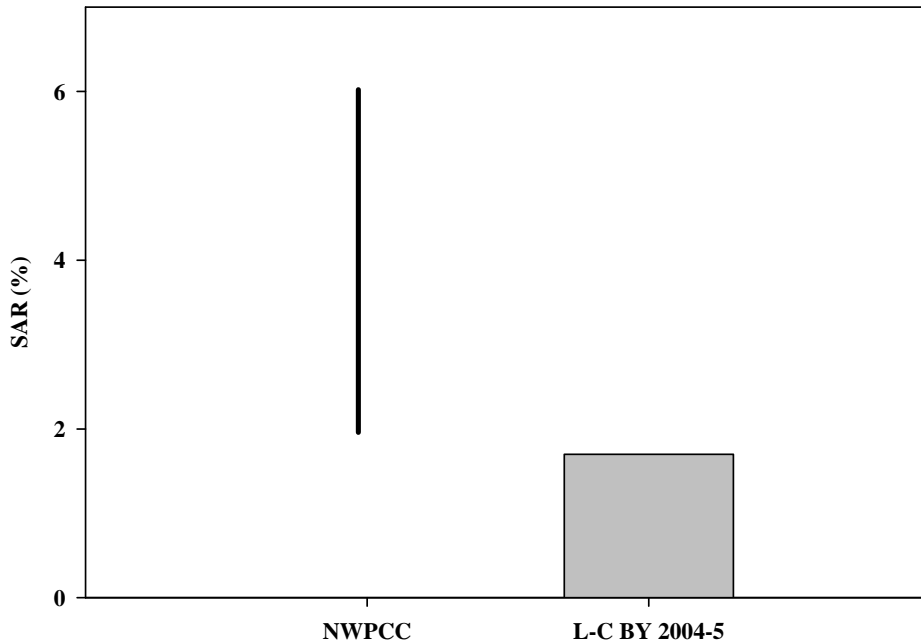


Figure 9. SAR values from NWPCC and L-C BY 2004-5.

Conclusions

Most performance measures were variable and there appeared to be differences between study eras. First year growth of both reintroduced stocks was similar and greater than the endemic stock. Outmigrants per redd were higher for the reintroduced stocks. Juvenile and adult abundance measures for the endemic stock were greater than either of the reintroduced stocks. There were minor differences in most performance measures between Lookingglass Creek natural spawners from 2004-present and Catherine Creek natural spawners for the same period, but outmigrants/redd were higher for Lookingglass Creek. With the short time series available for most data and the highly variable year-to-year results for a stock, identifying the factors which might significantly reduce survival or production becomes difficult. As more years of data are available for Study Era 3, between stock differences for the contemporary period should become more evident, as well as the factors influencing them.

These results should be viewed as preliminary. Long time series (10 years or more) are unavailable for most of the metrics during Study Era 1 and none during Study Era 2. Study Era 3 is only a little over halfway to that benchmark. Further complicating comparisons is the unplanned nature of the experiment, and the sequential aspect. Any perceived differences in life history or production may be the result not of stock differences but of environmental conditions, in the ocean, for example, during the evaluation time frame for a particular stock.

References

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Hesse, J. A., Harbeck, J. R., and R. W. Carmichael. 2006. Monitoring and evaluation plan for Northeast Oregon hatchery Imnaha and Grande Ronde Subbasin spring Chinook salmon. Prepared for Bonneville Power Administration, Portland Oregon.

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Appendix 1. Draft Lookingglass Creek Spring Chinook Salmon Management Plan (being reviewed by comanagers, October 2010)

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

Program Goal

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

Adult Return Goals

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

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

Juvenile Production and Releases

To meet the LSRCP Grande Ronde Basin adult mitigation goal, a juvenile production target of 900,000 fish at 20 fish per pound with an estimated return rate of 0.87% was originally identified. In 2002, the Grande Ronde Spring Chinook Hatchery Management Plan (GRSCHMP) was developed which outlined more specific hatchery production goals for each tributary in the basin. The GRSCHMP identified an initial production target of 150,000 yearling smolts for Lookingglass Creek and 250,000 yearling smolts for Catherine Creek. After the captive brood evaluations were completed, the release goal for Lookingglass Creek was to be increased to 250,000 with a corresponding decrease to 150,000 for Catherine Creek. These changes have occurred and current production as listed in Table B1 of the 2009-2017 *United States v. Oregon* Management Agreement is outlined in Table 1.

Table 1. Lookingglass Creek and Catherine Creek production outlined in Table B2 of 2009-2017 *US v. Oregon* Management Agreement.

Release Site	Rearing Facility	Stock	Life Stage	Target Release Number	Primary Program Purpose	Funding
LGC	LOOH/CB	CC	Smolt	250,000	Fishery/Reintroduction	LSRCP/ BPA
CC	LOOH/CB	CC	Smolt	150,000	Supplementation/Fishery	LSRCP/ BPA

*LGC=Lookingglass Creek, CC=Catherine Creek
LOOH=Lookingglass Hatchery, CB=Captive Broodstock
LSRCP=Lower Snake River Compensation Plan
BPA=Bonneville Power Administration*

The BPA captive brood program for Catherine Creek was established in response to low escapements in the mid to late 1990's. Production from this program not needed in Catherine Creek is available to meet any production shortfalls in the Lookingglass Creek program. However, this program is being phased out with brood year 2005. The last

spawn of Catherine Creek captive adults should be 2010 with the last production available in 2012. Returns from this program would be expected through 2015

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

Marking

Marking for the Lookingglass Creek program has been outlined in Attachment C of the 2009-2017 *United States v. Oregon* Management Agreement. Conventional brood releases will be 100% Ad clipped with representative coded-wire-tag (CWT) groups. Captive brood releases will be 100% AdCWT.

Weir Management

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

Table 2. Pass:Keep Disposition

Escapement Level	% Passed Above	% Keep for Brood
150	67	33
200	60	40
250	55	45
300	50	50
>300	Adjustments will be based on brood needs. If brood need has been met remainder to be released upstream.	

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

Broodstock Management

Broodstock for the program will be collected from returns to either the Lookingglass Hatchery weir or the Catherine Creek weir. Either conventional or captive hatchery adults may be used for brood. The goal for broodstock composition will be to incorporate 30% natural origin adults to maintain genetic diversity and counteract domestication selection in the program. In addition, no more than 25% of the returning natural origin adults shall be retained for brood. The broodstock collection goal will not be constrained by the 25% cap on natural adult collection. If a shortage of natural adults occurs, then additional

hatchery adults will be collected in order to meet the brood target. It is estimated that 158 adults (47 natural origin and 111 hatchery origin) will be required for brood to meet the 250,000 smolt production level.

Escapement

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

Jack Management

Hatchery jacks will be incorporated into the broodstock at a target rate of one for every 10 adult males collected (8 fish). All natural jacks will be released upriver. No hatchery jacks will be released upriver. All CWT hatchery jacks will be sacrificed for tag recovery. Other hatchery jacks will either be sacrificed with carcasses provided to the Tribes or food banks or recycled into lower Lookingglass Creek for harvest benefits.

Surplus Production

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

Fish Health

The Lookingglass Creek artificial production programs included within this management plan will follow the Integrated Hatchery Operations Team (IHOT) policies and procedures for fish health. Bacterial Kidney Disease (BKD) is of special management concern within the spring Chinook program. Eggs from individual females will be incubated separately and eggs from females with an ELISA value of 0.8 or higher will be culled from the program. If a production surplus does occur, eggs from females with an ELISA reading higher than 0.4 may be culled rather than reared.

Harvest

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