MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY:

2014 ANNUAL REPORT
February 1, 2014 through January 31, 2015

Prepared by:
Bryan R. Ishida
Richard F. Alford
Timothy J. Jeffris
Corydon M. Kamphaus
Kraig E. Mott
Gregory Wolfe

Yakama Nation
Fisheries Resource Management
P.O. Box 151
Toppenish, Washington 98948

January 2016

Prepared for

Project # 1996-040-00
Contract #56662 REL 74
U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208-3621

And

Public Utility District No. 1 of Chelan County
Wenatchee, WA 98801

And

Public Utility District No. 2 of Grant County
Ephrata, Washington 98823

TABLE OF CONTENTS

LIST OF FIGURES IV
LIST OF TABLES V
1.0 INTRODUCTION 1
2.0 BROODSTOCK COLLECTION AND SPAWNING 2
2.1 WENATCHEE RIVER BASIN 2
2.1.1 Broodstock Collection 2
2.1.2 Spawning 3
2.1.3 Incubation 5
2.2 METHOW RIVER BASIN 2014 6
2.2.1 Broodstock Collection 6
2.2.2 Spawning 7
2.2.3 Incubation 9
3.0 SPAWNING GROUND SURVEYS 10
3.1 WENATCHEE BASIN REDD COUNTS 14
3.1.1 Icicle Creek 16
3.1.2 Wenatchee River 17
3.1.4 Mission/Brender Creeks 18
3.1.8 Other Tributaries 19
3.2 METHOW BASIN REDD COUNTS 19
3.2.1 Methow River 21
3.2.2 Winthrop NFH (USFWS)/ Spring Creek and Methow FH (WDFW) Outfalls 21
3.2.3 Twisp River 22
3.2.4 Chewuch River 22
3.2.5 Gold Creek 23
3.2.6 Libby Creek 23
3.2.7 1890's Side-channel 23
3.2.8 Hancock Springs Creek and Suspension Creek 24
3.2.9 Chelan River Outfall 24
4.0 SMOLT ACCLIMATION: WENATCHEE AND METHOW 24
4.1 ACCLIMATION SITES 24
4.1.1 Leavenworth National Fish Hatchery (LNFH) 24
4.1.2 Beaver Creek Acclimation Pond 25
4.1.3 Nason Creek 25
4.1.4 Winthrop National Fish Hatchery (Winthrop NFH) 26
4.1.5 Lower Twisp Acclimation Ponds 27
4.1.6 Gold Creek Acclimation Pond 27
4.2 TRANSPORTATION AND VOLITIONAL RELEASE 28
4.2.1 Wenatchee River Basin 28
4.2.2 Methow River Basin 29
4.4 PREDATION ASSESSMENT 30
4.4.1 Estimated Mortality-Predator Consumption Model versus PIT tag Detection 30

5.0 SURVIVAL RATES 35
5.1 SMOLT SURVIVAL RATES – RELEASE TO MCNARY DAM 35
5.1.1 2014 Methow and Wenatchee Smolt Survival 35
5.2 SMOLT-TO-ADULT SURVIVAL RATES (SAR) FOR BROOD YEAR 2011 36
6.0 SUMMARY 39
7.0 ACKNOWLEDGEMENTS 41
8.0 LITERATURE CITED 42
APPENDIX A: 2014 NASON CREEK SMOLT TRAP REPORT 43
APPENDIX B: SPAWNING GROUND SURVEY RECORDS FOR THE WENATCHEE AND METHOW RIVERS, 2014 105
APPENDIX C: WENATCHEE AND METHOW BASIN COHO RELEASE NUMBERS AND MARK GROUPS, BY2012. 116

LIST OF FIGURES

Figure 1. Number of coho spawned at Leavenworth National Fish Hatchery, 2014......... 4
Figure 2. Temporal spawning distribution: brood years 2000-2013 and 2014 at Leavenworth NFH. 5
Figure 3 Number of coho spawned at Winthrop National Fish Hatchery, 2014. 8
Figure 4. Temporal spawning distribution: brood years 2004-2013 and 2014 at Winthrop NFH.. 9
Figure 5. Weekly redd counts conducted in Icicle Creek from September 25 through December 15, 2014. 17
Figure 6. Known and estimated mortality at all acclimation sites in the Methow and Wenatchee river basins, 2014. 32
Figure 7. Comparison of in-pond mortality estimation methods; PIT tag versus a predator consumption model, 2014.. 34

LIST OF TABLES

Table 1. Coho salmon and incidentals handled during trapping, 2014. 3
Table 2. Summary of coded-wire-tag and scale analysis from coho spawned at Leavenworth National Fish Hatchery in 2014. 4
Table 3. Spawn dates, number of eggs collected, and eye-up rate at LNFH and the PIF, 2014. 6
Table 4. Summary of Methow program coho broodstock collections, 2014. 7
Table 5. Broodstock composition and collection locations for fish spawned at Winthrop NFH, 2014. 9
Table 6. Spawn dates, number of eggs collected, and eye-up rate at Winthrop NFH, 2014. 10
Table 7. Spawning ground survey reaches for the Wenatchee and Methow river sub-basins in 2014. 12
Table 8. Summary of Wenatchee River coho redd counts, distribution and carcass recovery in 2014. 14
Table 9. Summary of carcass distribution and origin throughout the Wenatchee River and its tributaries, 2014. 15
Table 10. Origin of carcasses without CWTs recovered in the Wenatchee River Basin, 2014. 16
Table 11. Summary of Methow River coho redd counts, distribution and carcass recovery in 2014. 19
Table 12. Summary of carcass distribution and origin throughout the Methow River and its tributaries, 2014. 20
Table 13. Origin of carcasses without CWTs recovered in the Methow River Basin, 2014. 20
Table 14. Mid-Columbia coho smolt release summary, 2014. 29
Table 15. PIT estimates of in-pond survival and tag detection efficiency, 2014. 33
Table 16. PIT tag release numbers and locations, 2014. 36
Table 17. Estimated coho run size to the Wenatchee River, 2014. 37
Table 18. Estimated coho run size to the Methow River, 2014. 37
Table 19. Wenatchee River brood year 2011 SARs by release site, brood origin, and rearing facility. 37
Table 20. Methow River brood year 2011 SARs by release site, brood origin, and rearing facility. 38
Table 21. Hatchery comparison of smolt-to-smolt and smolt-to-adult survival rates, brood years 1997-2014. 38

1.0 INTRODUCTION

Wild stocks of coho salmon (*Oncorhynchus kisutch*) were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). Since the early 1900s, native stocks of coho had been extirpated from several Columbia River tributaries (Wenatchee, Entiat and Methow rivers; Mullan 1983). Efforts to restore coho within these areas will rely heavily on hatchery coho releases. Feasibility of re-establishing coho within mid-Columbia tributaries initially depended upon resolution of two central issues; (1) adaptability of domesticated, lower Columbia coho stocks used in the re-introduction efforts measured through their associated survival rates and (2) ecological risk to other species of concern, such as ESA listed spring Chinook (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*). Both of these key issues have been resolved in a positive sense (i.e. – insignificant interspecific interactions), therefore allowing the project to continue forward while attempting to achieve its ultimate goal of coho restoration through implementation of the Mid-Columbia Coho Reintroduction Plan (MCCRP).

If coho re-introduction efforts in mid-Columbia tributaries are to succeed, parent stocks must possess sufficient genetic variability to allow for phenotypic plasticity in response to ever changing, selective pressures to environmental conditions between lower Columbia River and mid-Columbia tributaries. Both the Mid-Columbia Coho Hatchery and Genetic Management Plan (HGMP 2002) and Master Plan for Coho Restoration (YN FRM 2009) describe strategies that will be implemented to facilitate the local adaptation process.

We are optimistic that the project will continue to observe positive trends in hatchery coho survival now that the transition has been made from exclusively using lower Columbia River hatchery coho to the sole use of in-basin, locally adapted broodstock. Therefore, it is important to measure hatchery fish performance, not only as an indicator of project performance, but to track potential short and long-term program benefits from the outlined strategies.

If re-introduction efforts are to be successful long-term, adult returns must be adequate to meet replacement levels without adversely affecting other fish populations. Additionally, minimizing hydro impacts, compensating for habitat loss and providing additional harvest opportunities will ultimately play a role in the coho re-introduction program.

This report documents coho restoration activities and results for the performance period of February 2014 through January 2015, to include acclimation, broodstock collection, spawning, egg incubation and transportation, spawning ground surveys and survival (both juvenile and adult). In addition, the Yakama Nation (YN) operated a 5-foot rotary smolt trap to estimate the number of naturally produced coho emigrating from Nason Creek in 2014-2015. This trap is operated with joint funding from Grant County Public Utility District (GCPUD, #430-2365) and BPA coho (#1996-040-00); therefore detailed population and productivity estimates are not included in the body of this report but included as a supplemental document (Ishida et al. 2015; Appendix A).

2.0 BROODSTOCK COLLECTION AND SPAWNING

2.1 WENATCHEE RIVER BASIN

2.1.1 Broodstock Collection

Broodstock collections occurred at Dryden and Tumwater dams. Although Dryden Dam has been the primary source of past brood collections, Tumwater Dam has become increasingly significant as program collections shift toward incorporating more upper basin returning adults, which have successfully ascended Tumwater Canyon. The emphasis on collecting coho salmon at Tumwater Dam is described in the Mid-Columbia Coho Restoration Master Plan (Broodstock Development Phase II; YN FRM 2009).

Coho collected in the Wenatchee Basin in 2014 were comprised entirely of brood year (BY) 2011 adults. Acting as MCCRP Wenatchee program Broodstock, these fish were all 4^{th} generation, Mid-Columbia River (MCR) returns. There were no BY2012 jacks incorporated into the 2014 hatchery efforts.

Dryden Dam fish traps were passively operated up to five days per week, 24-hours per day, from September 1 through November 12. Due to the large adult return, operation of the trap five days per week was generally unwarranted. On Saturdays and Sundays, both facilities were opened, allowing unimpeded upstream passage for target and non-target species. Coho trapping at Dryden Dam occurred concurrently with the Washington Department of Fish and Wildlife's (WDFW) summer steelhead and Chinook stock assessment

Coho broodstock was collected concurrently at Tumwater Dam up to five days per week, 8 hours per day, between September 1 and November 12. All coho encountered at Tumwater Dam were assessed for condition, and if deemed suitable, incorporated into the broodstock. Adult coho considered unsuitable for collection consisted of any fish with signs of significant abrasions or wounds, fungus, and/or were overripe (factors that would decrease the likelihood of an individual to survive to spawning). Coho collected at Tumwater Dam were externally marked with a green floy tag in the left dorsal sinus and given a left-side opercule punch for later identification during spawning and post-spawn data collection. The opercule punch served as a secondary mark in the event that a floy tag became dislodged during holding. A small proportion (n = 15) of coho collected at Tumwater Dam had been previously floy tagged at Dryden Dam as a part of an ongoing YN mark-recapture study.

The differential marking schemes at multiple trap locations provided the necessary evaluation tools to parse out supplemental collections when evaluating smolt-to-adult survivals rates, as well as when determining migratory success. Approximately 55.9% and 44.1% of the total broodstock were collected at Tumwater and Dryden dams, respectively.

A summary of broodstock collection and fish handled at all trapping sites can be found in Table 1. All coho broodstock were transported to LNFH and held until spawning.

Table 1. Coho salmon and incidentals handled during trapping, 2014.

Location	Coho (*broodstock*)	Steelhead	Sockeye	Summer Chinook	Bull Trout
Dryden Dam	2,519* (556)	132	14	108	1
Tumwater Dam	1,493* (438)	N/A	N/A	N/A	N/A

**Actual number of coho handled during trapping at Dryden and Tumwater Dams during broodstock collection efforts for 2014.*

2.1.2 Spawning

A total of 994 coho were initially collected for broodstock; 509 females and 485 males. The rate of pre-spawn mortality at LNFH was 19.9% (198 fish; 89 females and 109 males).

Spawning occurred between October 14 and November 12 totaling 796 adults; 420 females and 376 males. Peak spawn occurred on November 12 with 153 females (Figure 1). YN broodstock protocols used a variety of estimators to determine collection numbers for both programs. Two of the largest values that impacted production were fecundity and pre-spawn mortality. Based on a five year mean of the previous broodstocks (2007-2012), an estimated fecundity of 2,992 eggs per female and a pre-spawn mortality rate of 3.0% were established.

Protocols at both LNFH and PIF facilities had eggs from each female being fertilized with one primary and one back-up male. During fertilization, a 1.0% saline solution was used to increase sperm motility. Eggs were held for a minimum of 2-3 minutes allowing for maximum fertilization success. After fertilization, excess milt, ovarian fluid and other organics were decanted and eggs soaked in 75 parts per million (ppm) of PVP iodine for disinfection purposes. The treatment occurred for 30 minutes and was immediately followed by a freshwater rinse and eggs being placed into the incubation vessel.

Coded-wire tag (CWT) analysis showed that 491 of the fish collected were LNFH origin returns from 2013 (BY2011) releases, while 397 were acclimated and released from upper Wenatchee River basin ponds (Table 2). An additional 14 tags were lost during extraction but are known to be of hatchery origin. Scale analysis revealed the remaining 92 fish consisted of 56 hatchery origin fish with unknown release locations, 33 natural origin, and 3 unknown origin (analyses were inconclusive due to scale regeneration).

Table 2. Summary of coded-wire-tag and scale analysis from coho spawned at Leavenworth National Fish Hatchery in 2014.

Juvenile Release Location		BY2011 Adults	BY2012 Jacks	Percentage of Brood by Release Site
Leavenworth National Fish Hatchery	*Small Foster-Lucas Ponds*	292	0	36.68%
	Large Foster-Lucas Ponds	113	0	14.19%
Upper Wenatchee River Basin	*Coulter Pond*	26	0	3.26%
	Beaver Creek Pond	67	0	8.41%
	Rohlfing's Pond	105	0	13.19%
	Nason Creek Wetlands	101	0	12.68%
Unknown Hatchery Origin		60	0	7.53%
Unknown Origin		2	0	0.25%
Natural Origin		30	0	3.76%
Totals		**796**	**0**	

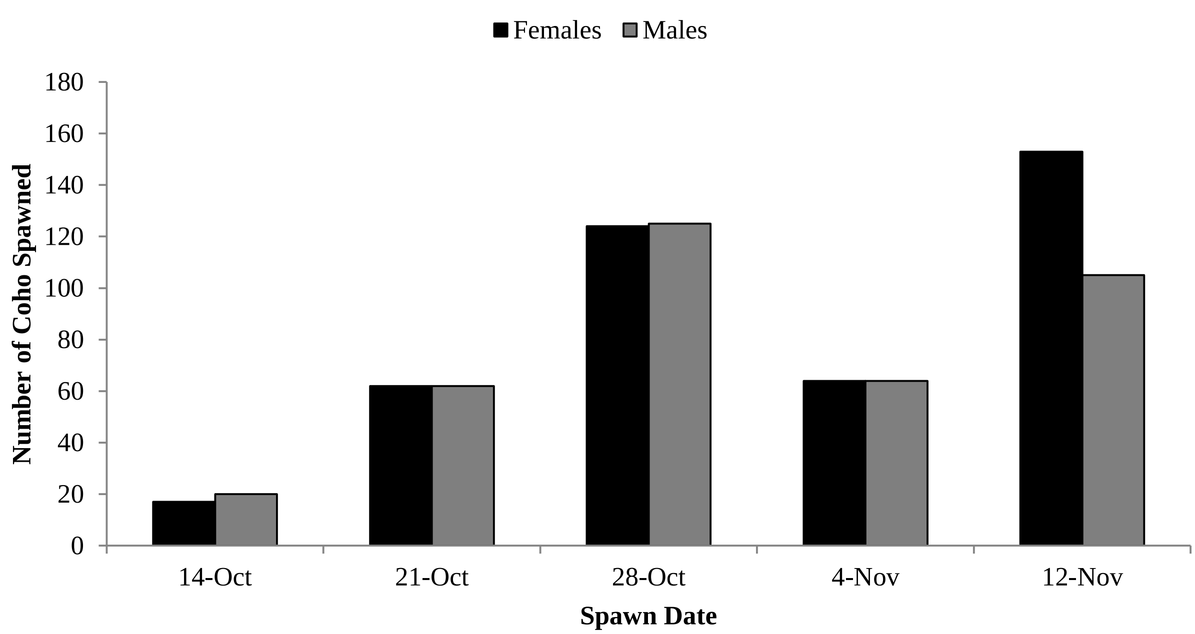


Figure 1. Number of coho spawned at Leavenworth National Fish Hatchery, 2014.

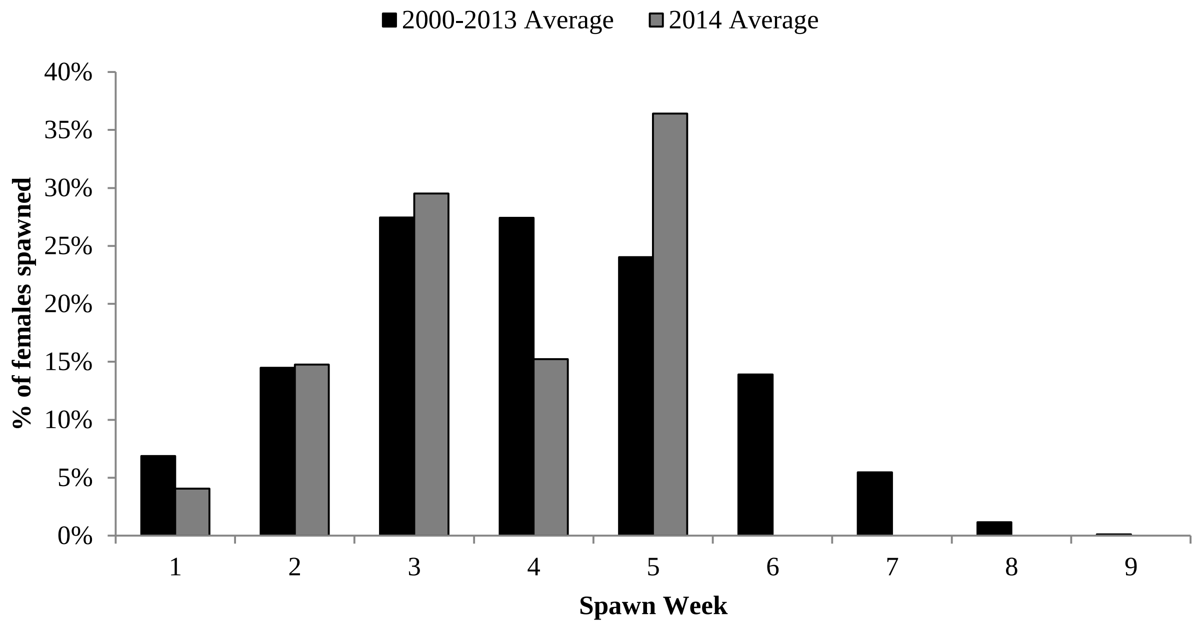


Figure 2. Temporal spawning distribution: brood years 2000-2013 and 2014 at Leavenworth NFH.

2.1.3 Incubation

A total of 1,058,610 green eggs were collected from the 2014 coho broodstock; 588,456 were incubated at LNFH while the remaining 470,154 were transported to a YN operated Peshastin Incubation Facility (PIF). Vertical stacks were used to incubate coho eggs at LNFH while coho eggs at PIF were bulk incubated in deep troughs. This bulk incubation system has been efficient for coho since it allows for a relatively large number of eggs to be successfully incubated in a cost-effective manner while using low volumes of water as compared to the more traditional vertical stack method (5 gpm vs 20 gpm). Chilled water, supplied at 4-5 gpm at 44° F and 41° F was provided to coho eggs at PIF and LNFH, respectively. Water source at the two facilities was 100% groundwater and non-chlorinated city water with a groundwater backup at LNFH and PIF.

Eyed-egg totals for LNFH and PIF were 452,233 and 168,266 respectively. Combined total average eye-up rate for the 2014 brood was 58.6%. The reduction in eye-up was possibly attributed to poor quality gametes obtained from a very large number of adult brood fish afflicted by *Ichthyophthirius multifilis* (Ich). The 2014 brood coho eyed-eggs from both incubation facilities were transported to Willard NFH between early December and early January for long-term rearing until they reach the pre-smolt stage. A summary of spawn dates, number of green eggs collected, eye-up rate at LNFH and PIF and transport to the rearing facility can be found in Table 3. Transportation from the incubation facilities to the rearing facilities occurred between 550 and 600 temperature units (°F).

Table 3. Spawn dates, number of eggs collected, and eye-up rate at LNFH and the PIF, 2014.

Incubation Location	Spawn Date	Trans. Date	Number of Viable Females	Total green eggs	Number dead eggs	Number eyed eggs	Avg. Eggs per female	Avg. Eyed eggs per female	Avg. % Eye-up	Receiving/ rearing hatcher
LNFH	14-Oct	12-Dec	17	44,461	6,776	37,685	2,615	2,217	85%	Cascade
LNFH	21-Oct	19-Dec	62	152,454	59,202	93,252	2,459	1,504	61%	Cascade
LNFH	28-Oct	31-Dec	124	304,485	48,457	256,028	2,456	2,065	84%	Cascade
PIF	4-Nov	22-Dec	64	153,411	53,134	100,277	2,397	1,567	65%	Willard & Casca
PIF	12-Nov	6-Jan	153	403,799	270,542	133,257	2,639	871	33%	Willard & Casca
Total			**420**	**1,058,610**	**438,111**	**620,499**	**2,513**	**1,645**	**66%**	

2.2 METHOW RIVER BASIN 2014

2.2.1 Broodstock Collection

Coho broodstock were collected from Douglas County Public Utility District's (DCPUD) Wells Hydroelectric Project fish ladders, and Winthrop National Fish Hatchery (Winthrop NFH) between September 23 and November 19. Wells Dam east and west fish-ladders were utilized as primary collection facilities to ensure representative hatchery and natural origin fish were obtained from throughout the basin. Supplemental collections at Winthrop NFH relied on volitional swim-ins and an adult collection weir located adjacent to the fish ladder (Spring Creek). Collections at Wells Dam occurred concurrently with Wells Fish Hatchery (FH) steelhead and summer Chinook broodstock collections between September 23 and November 9. Both ladder traps were actively operated by YN and/or Wells FH staff no more than three days per week until September 26, after which, collection efforts increased to five days a week between September 27 and October 9, and seven days per week between October 10 and conclusion of the trapping season. This was a new trapping schedule for 2014 and authorized under the programs' ESA Section 7 BiOp.

A total of 621 adults were collected for brood; 572 (290 females and 282 males) were intercepted at Wells Dam and 49 (17 F and 32 M) were collected at Winthrop NFH sites (Table 4). Adults collected at Wells Dam were tagged in the dorsal sinus with sequentially numbered floy tags and given a left side opercule punch prior to transport to Winthrop NFH. Marks were used to differentiate fish collected at Columbia River collection points versus swim-ins during spawning and post-spawn data collection.

Adults collected from Wells Dam facilities and Winthrop NFH adult weir were transported to the Winthrop NFH holding pond on a daily basis. Sodium chloride, Poly

Aqua® and MS-222 were used to decrease stress during transport from Wells Dam to Winthrop NFH. There were no mortalities incurred during transport. Handling of coho during the broodstock-collection process as well as non-target species (summer Chinook and summer steelhead) is documented in Table 4.

Table 4. Summary of Methow program coho broodstock collections, 2014.

Location	Coho (*broodstock*)	Steelhead (*Wells FH broodstock*)	Summer Chinook *(Wells FH broodstock*)	Bull Trout
Winthrop NFH adult holding pond/collection weir	147 (*49*)	N/A	N/A	0
Wells Dam West/East Ladders	644 (*572*)	176 (*80*)[a]	250(*3*)[a]	0

[a] - Total numbers of adult steelhead and summer Chinook diverted into the west ladder holding pond for Wells FH broodstock

2.2.2 Spawning

Coho broodstock were spawned at Winthrop NFH. Spawning activities occurred on a weekly basis beginning October 22 and continued through November 19. Handling procedures during spawning activities included utilization of CO^2 to reduce potential stress incurred during assessment for ripeness as well as segregating adults by maturation level to decrease handling. Formalin treatments were initiated three times per week as a preventative measure to inhibit pathogens from spreading within the holding pond.

Peak spawn occurred on November 5 with 103 viable females, one week earlier than the BY2004-BY2013 average (Figs 3 & 4). Difference in spawn timing is likely due to an earlier peak return (n = 17 days) observed over Wells Dam, when compared the historical mean; resulting in a higher proportion of ripe females during the third week when compared to previous years.

Spawning protocols involved eggs from each female being mated with one primary and one back-up male. Females were “bled out” by severing gill arches prior to gamete extraction. Bleeding out females reduced the amount of excess organic matter which could potentially cause an obstruction to the egg’s micropyle, prohibiting successful fertilization. During fertilization, gametes were mixed within one gallon buckets along with a 1.0% saline solution to increase sperm motility. Buckets containing fertilized eggs were then placed into transport coolers and allowed to stand until cooler capacity was met (approximately 5 buckets per cooler), or a minimum of 10-15 minutes. Coolers were then transported from the spawning shed to the incubating room located inside the main building. After fertilization, excess milt, ovarian fluid and other organics were decanted and eggs laid into trays with 75ppm PVP iodine solution for disinfection purposes (*see 2.1.3 Incubation*). The treatment occurred for 30 minutes and was immediately followed by a freshwater rinse with 100% groundwater at 39° F.

Of the total 621 coho adults initially retained as brood stock, 433 (215 females and 218 males) viable adult coho were successfully spawned. Contributions to the total brood by Wells Dam and Winthrop NFH collection sites were 416 and 17 adults, respectively. Pre-spawn mortality at Winthrop NFH was 9.3% (58 fish; 34 females and 24 males); an increase over a 4.3% mortality experienced in 2013. Exact causes for the increase in pre-spawn mortality is unknown, however decreased fitness, resulting from environmental constraints experienced during upstream migration, may have been a factor. As a precautionary measure, fifty moribund adults were culled from the brood in an attempt to inhibit pathogen transfer within the adult holding pond. An additional nine adults were deemed non-viable (possessing gametes that were underdeveloped or in unsuitable condition for fertilization) at the time of spawning. Once spawning goals were fulfilled, 71 (50 females and 21 males) excess adults were released back into locations on both the Methow River (rkm 64.6) and Spring Creek to spawn naturally.

CWT analysis revealed that the majority of adults spawned originated from 2013 Winthrop NFH releases (134 females and 122 males). Thirty-one adults (19 females and 12 males) were not identifiable by the presence of a CWT; scale analysis was conducted and revealed twenty-six were of unknown hatchery origin and five were natural origin adults. For a complete summary of broodstock composition and collection locations, please refer to Table 5.

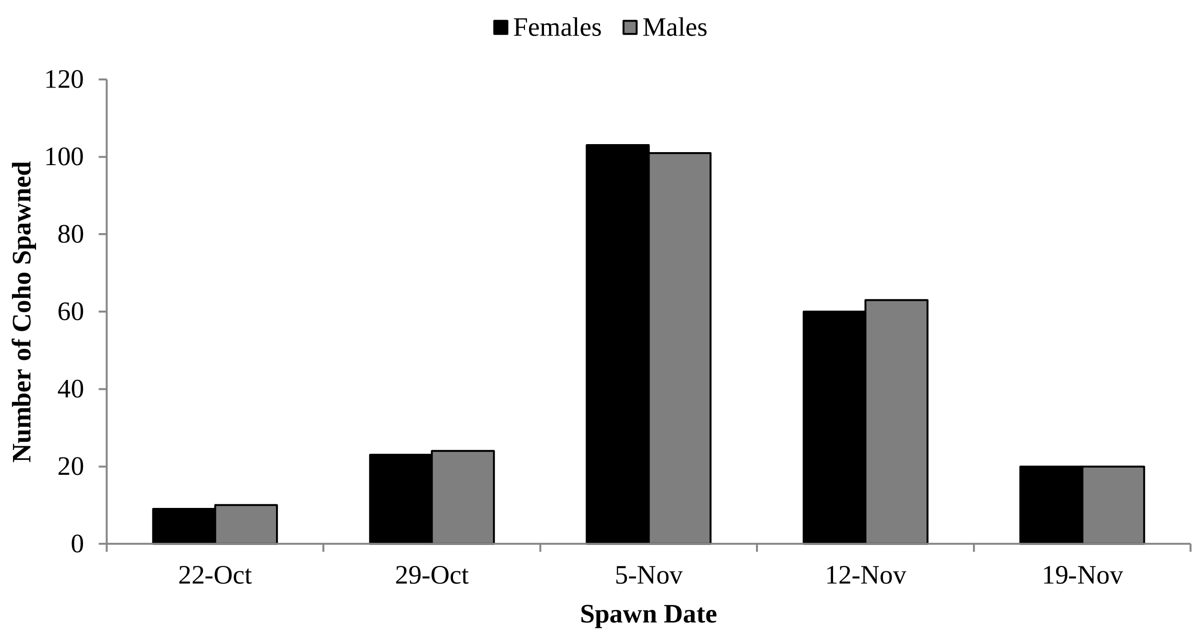


Figure 3 Number of coho spawned at Winthrop National Fish Hatchery, 2014.

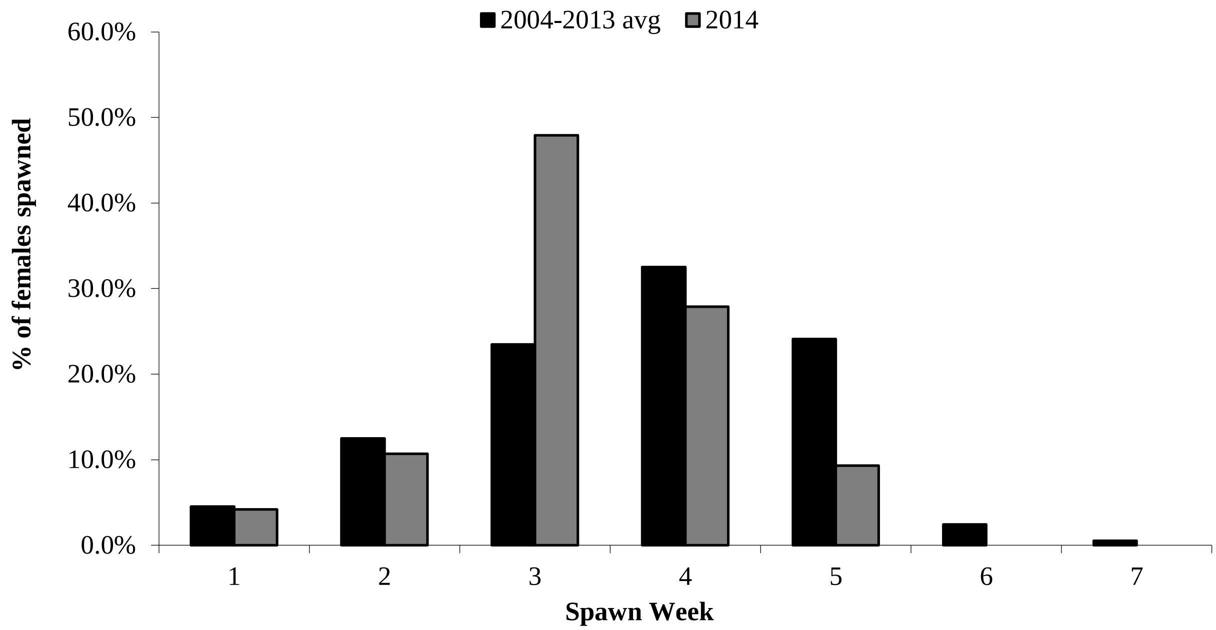


Figure 4. Temporal spawning distribution: brood years 2004-2013 and 2014 at Winthrop NFH.

Table 5. Broodstock composition and collection locations for fish spawned at Winthrop NFH, 2014.

Juvenile Release Location	BY2011 Adults	Percentage of Brood by Release Site
Winthrop NFH On-station	225	51.96%
Winthrop NFH Back Channel	47	10.85%
Lower Twisp Ponds	29	6.70%
Gold Creek Ponds	11	2.54%
Wolf Creek Pond	21	4.85%
Beaver Creek (Wenatchee Basin)	1	0.23%
Coulter Creek (Wenatchee Basin)	1	0.23%
Wells FH On-station	67	15.47%
Unknown Hatchery	26	6.00%
Natural Origin	5	1.15%
Totals	**433**	**100%**

2.2.3 Incubation

A total of 584,579 green eggs were collected from the 2014 Methow broodstock. Eyed eggs totaled 440,173; 364,161 remained on-station at Winthrop NFH while 76,012 were transported to Cascade FH for rearing. Eyed eggs remaining at Winthrop NFH will comprise the on-station, Gold and Wolf Creek release groups, and eggs transferred to Cascade FH were allocated for the Lower Twisp Ponds release group in 2016. Average eye-up was 75.3%; a decrease of 7.4% over the previous years' brood. Transportation of these eyed eggs occurred at approximately 600 temperature units (°F). A summary of spawn dates, number of eggs collected, fecundity and the eye-up rate at Winthrop NFH can be found in Table 6.

Table 6. Spawn dates, number of eggs collected, and eye-up rate at Winthrop NFH, 2014.

Incubation Location	Spawn Date	Trans. Date	Number of Viable Females	Total green eggs	Number dead eggs	Number eyed eggs	Avg. Eggs per Female	Avg. Eyed eggs per Female	Avg. Eye-up (%)	Receiving/ rearing hatchery
Cascade FH	22-Oct	19-Dec	9	24,660	6,609	18,051 [b]	2,740	2,006	73.2	Cascade FH
Cascade FH	29-Oct	19-Dec	21.5 [a]	67,146	24,387	42,759 [b]	3,123	1,989	63.7	Cascade FH
WNFH/CFH	5-Nov	19-Dec	101	275,740	78,611	197,129	2,730	1,952	71.5	WNFH/CFH
Winthrop NFH	12-Nov	NA	59.5 [a]	168,526	27,610	140,916	2,832	2,368	83.6	Winthrop NFH
Winthrop NFH	19-Nov	NA	19.5 [a]	48,507	7,189	41,318	2,488	2,119	85.2	Winthrop NFH
Totals			**210.5**	**584,579**	**144,406**	**440,173**	**2,777**	**2,091**	**75.3**	

[a] - *Females observed to be only partially fecund during spawning activities were enumerated as 0.5 in an attempt to more accurately quantify the individual's contribution to the brood.*
[b] - *Approximately 76,012 eyed eggs were transported to Cascade FH on Dec 19 from spawning activities between October 22 and November 5, while the remaining 364,161 eyed eggs were incubated and reared to full term at Winthrop NFH.*

3.0 SPAWNING GROUND SURVEYS

In 2014, coho salmon spawning ground surveys were conducted on the mainstem Wenatchee River from its origin at Lake Wenatchee to its confluence with the Columbia River in the city of Wenatchee. Portions of Beaver Creek, Chiwawa River, Chiwaukum Creek, Chumstick Creek, Icicle Creek, Mission/Brender Creek, Nason Creek, Peshastin Creek, and Roaring Creek were also surveyed. Survey efforts focused on tributaries where current juvenile releases occur (e.g. Beaver, Nason & Icicle creeks) as well as areas in proximity to release sites (e.g., middle reaches of the Wenatchee River). Individual surveys were conducted mainly on a weekly basis with reaches historically know to produce little coho spawning activity being covered less frequently.

Methow basin surveys were prioritized based on historical spawner densities/distribution observed and typically occurred on a weekly basis (e.g. - Methow River, Twisp and Chewuch rivers, Spring Creek and Methow FH outfall). Survey frequency ranged from weekly to multiple times per season dependent on redd abundance. Periodic surveys, typically at or near peak spawning, were conducted in tributaries where historical redd data demonstrated low counts (historical avg. <5 redds) or had not been surveyed in previous years. These reaches included Libby, Gold, Hancock Springs, and Suspension creeks, and the 1890's side-channel. There were no surveys conducted in Wolf and Beaver creeks due to persistent, high turbidity followed by ice in early November. Out-of-basin surveys were not conducted due to increased staffing needs for brood collections and surveys in the Methow Basin; historically, these surveys were prioritized secondarily to in-basin surveys to assess spawner escapement. Complete survey records for both basins can be found in Appendix B.

Surveys in both basins were conducted either by foot, raft or pontoon boat depending on size of stream and flow conditions. Foot surveys were conducted by two staff members. Raft surveys were performed by three people; one person rowing while a second person surveyed, and a third staff member via a pontoon boat which served as a satellite spotter. Data recorded for each individual survey included number of new redds, live and dead fish, redd coordinates, survey duration, and stream temperature. Individual redds were either recorded on a map or flagged in the field by tying surveyor's tape to nearby riparian vegetation. Each marker listed the date, redd location, redd number, agency and the surveyor's initials. Global positioning (GPS) was used to record the exact location of individual redds on all surveys.

Fork length (FL) and post-orbital-hypural lengths (POH) measured to the nearest centimeter were recorded on all carcasses collected during surveys. Measurements of POH were generally more reliable than those of FL since many recovered carcasses were found with substantially worn snouts and/or caudal fins. For the purpose of accurate comparisons, measurements of POH, rather than FL are described. Snouts were removed from all carcasses for subsequent CWT analysis. Sex of each carcass was recorded, if discernible at the time of sampling. In-tact females (i.e. - no tears within the abdomen wall) were checked for egg retention by counting number of eggs present in the body cavity. Egg voidance was calculated by subtracting known number of eggs remaining in an individual female from the average fecundity recorded during that seasons' coho broodstock from their respective basins and expressed as a percentage. To prevent re-sampling, the caudal fin was removed at the peduncle before discarding the carcass along the stream bank.

Spawning ground survey objectives were to:

1) Determine spatial and temporal distribution of naturally spawning coho salmon.

2) Collect biological data from the carcasses of naturally spawning coho to determine return composition (hatchery vs natural origin) and carcass recovery rate.

3) Estimate spawning escapement and subsequent seeding level (total egg deposition) of naturally spawning adults within the Methow and Wenatchee rivers and their tributaries.

Data generated from these efforts are used to monitor progress and development of the recently reintroduced coho population and inform hatchery production through annual abundance estimates, stray rates and adult age composition. These surveys are comprehensive and will remain so until established spawner distribution patterns have been documented as a result of Natural Production Phases (YN FRM 2010). At that point in time, index reaches (shorter and representative) could be used to estimate spawner escapement. Current survey reaches were determined by length and duration of time necessary to complete them in a single day and derived from established agency protocols in the Upper Columbia for a variety of other species surveys (spring Chinook, summer Chinook and steelhead; Table 7).

Table 7. Spawning ground survey reaches for the Wenatchee and Methow river sub-basins in 2014.

Reach Designation	Reach Description	Reach Location (RK)
	Wenatchee River Basin	
	Icicle Creek	
I1	Mouth to Hatchery	0.0 - 4.5
I2	Hatchery to Head Gate	4.5 – 6.2
I3	Headgate to LNFH intake	6.2 – 8.0
	Nason Creek	
N1	Mouth to Coles Corner	0.0 - 7.0
N2	Coles Corner to Butcher Pond	7.0 - 14.3
N3	Butcher Pond to Rayrock	14.3 – 20.0
N4	Rayrock to Whitepine Creek	20.0 – 22.0
	Wenatchee River	
W1	Mouth to Cashmere Park	0.0 – 13.4
W2	Cashmere to Dryden Dam	13.4 – 28.0
W3	Dryden Dam to Boat Ramp	28.0 – 38.0
W4	Boat Ramp to Leavenworth Bridge	38.0 – 41.7
W5	Leavenworth Br. to Tumwater Bridge	41.7 – 56.2
W6	Tumwater Bridge to Plain Bridge	56.2 – 69.2
W7	Plain to Lake Wenatchee	69.2 – 86.0
	Beaver Creek (WEN)	
BV1	Mouth to Acclimation Pond	0.0-2.4
	Brender Creek	
BR1	Mouth to Mill Road	0.0 - 0.3

	Chiwaukum Creek	
CW1	Mouth to Hwy 2 Bridge	0.0 – 1.0
	Chiwawa River	
CH1	Mouth to Weir	0.0 – 1.0
	Chumstick Creek	
CM1	Mouth to North Road	0.0 – 0.5
	Mission Creek	
M1	Mouth to Residential Area	0.0 – 1.0
	Peshastin Creek	
P1	Mouth to YN Office	0.0 – 3.5
P2	YN Office to Mountain Home Road	3.5 – 8.0
P3	Mountain Home Rd. to Valley High Bridge	8.0 – 13.3
	Roaring Creek	
R1	Mouth to split channel	0.0 – 0.5
	Methow River Basin	
	Methow River	
M1	Mouth to Steel Br.	0.0 –7.2
M2	Steel Br. to Lower Burma Br.	7.2 – 14.9
M3	Lower Burma Br. to Upper Burma Br.	14.9 – 23.8
M4	Upper Burma Br. to Lower Gold Creek Br.	23.8 – 33.7
M5	Lower Gold Creek Br. to Carlton	33.7 – 46.9
M6	Carlton to Holterman's Hole	46.9 – 64.6
M7	Holterman's Hole to MVID dam	64.6 – 74.6
M8	MVID dam to Red barn	74.6 – 83.7
M9	Red Barn to Wolf Creek	83.7 – 88.1
M10	Wolf Creek to Rip Rap	88.1 – 92.7
M11	Rip Rap to Weeman Br.	92.7 – 98.6
	Chewuch River	
C1	Mouth to Co. HWY 1613	0.0 – 4.0
C2	Co. Hwy 1613 to East County Junction	4.0 –15.3
C3	East County Junction to Eight Mile Ranch	15.3 – 20.2
	Twisp River	
TR1	Mouth to Lower Poorman Br.	0.0 – 2.9
TR2	Lower Poorman Br. to Upper Poorman Br.	2.9 – 7.8
TR3	Upper Poorman Br. to Twisp River Weir	7.8 – 11.4
TR4	Twisp River Weir to Newby Br.	11.4 –13.2
TR5	Newby Br. to Buttermilk BR.	13.2 – 21.1
TR6	Buttermilk Br. to War Creek	21.1 – 28.5
	Spring Creek	

SP1	Mouth to Winthrop NFH	0.0 – 0.4
	WDFW/ Methow FH Outfall	
MFH1	Mouth to hatchery adult weir	0.0 – 0.5
	Hancock Spring Creek	
HS1	Mouth to Source	0.0 – 1.5
	Suspension Creek	
SUS1	Mouth to first log jam	0.0 – .25
	Libby Creek	
L1	Mouth to Hwy 153 Br.	0.0 – 0.5
	Gold Creek	
G1	Private land to South Fork Br.	1.7 – 2.1
G2	Confluence with South Fork Creek to acclimation ponds on SF Gold Creek	0.0 – .33
	1890's Side-channel	
1890's	Mouth with Methow to source	0.0 – 1.3

3.1 WENATCHEE BASIN REDD COUNTS

In 2014, YN identified a total of 1,495 redds and collected 804 adult coho carcasses throughout the Wenatchee River subbasin for an overall sample rate of 23.4%. The majority of redds (n = 1,477) were located in the lower Wenatchee River and tributaries at/or downstream of Leavenworth. A total of 18 redds were found upstream of Leavenworth with most of these occurring in Nason Creek (n = 16). Successful passage of adult coho above Tumwater Dam remained low throughout the fall due to increased broodstock collection efforts. For a spawning ground summary for the Wenatchee basin, please see Table 8.

Table 8. Summary of Wenatchee River coho redd counts, distribution and carcass recovery in 2014.

Stream	Redd Count				Live Fish Count				Recovered Carcasses				Sample Rate[a]
	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	FINAL
Beaver	0	0	—	0	0	0	—	0	0	0	—	0	**0.0%**
Chiwaukum	0	0	0	0	0	1	0	1	0	0	0	0	**0.0%**
Chiwawa	0	0	0	0	4	0	0	4	0	0	0	0	**0.0%**
Chumstick	12	38	2	52	56	112	14	182	2	57	21	80	**66.9%**
Icicle	618	287	8	913	4,206	2,130	103	6,439	108	252	27	387	**18.4%**
M/B	18	23	2	43	44	40	6	90	11	17	6	34	**34.4%**
Nason	11	5	—	16	56	24	—	80	2	2	—	4	**10.9%**
Peshastin	29	27	2	58	43	18	0	61	5	2	0	7	**5.2%**

Roaring	0	0	0	0	0	0	0	0	0	0	0	0	**0.0%**
Wenatchee	173	233	7	413	838	421	22	1,281	66	197	29	292	**30.6%**
Total	**861**	**613**	**21**	**1,495**	5,247	2,746	145	**8,138**	194	527	83	**804**	**23.4%**

[a] – sample rate was based on Fish Per Redd (fpr) derived from calculated sex ratios form the run-at-large (1.3M: 1F)
Note* Limited September surveys conducted on lower-basin reaches not represented due to a lack of coho activity

Carcasses recovered in the mid to lower drainage represented 99.5% (*n* = 800) of the basin total. Analysis of 631 recovered CWTs revealed that 531 fish originated from LNFH juvenile releases while 96 were released from several upper Wenatchee River acclimation ponds (Table 9). Four carcasses recovered in the lower basin were released as juveniles from Methow River sites (WNFH and Biddle Pond). Origins of fish unidentifiable via CWT analysis are noted in Table 10. The proportion of natural origin returns in the Wenatchee Basin was 2.4%.

Table 9. Summary of carcass distribution and origin throughout the Wenatchee River and its tributaries, 2014.

Juvenile Coho Release Location/Origin through CWT analysis		Adult Recovery Location										
		Lower Wenatchee					Upper Wenatchee					
		Mission	Peshastin	Chumstick	Icicle	Wenatchee 1-4	Chiwaukum	Chiwawa	Beaver	Nason	Wenatchee 5-7	TOTAL
Lower Wenatchee	LNFH LFL 1 & 2	4	1	9	73	50	—	—	—	—	—	137
	LNFH SFL 1 & 2	1	—	—	12	10	—	—	—	—	—	23
	LNFH SFL 8, 9, 19-21	2	—	9	78	23	—	—	—	—	—	112
	LNFH SFL 10-12, 16-18	6	1	10	99	53	—	—	—	—	—	169
	LNFH SFL 22-24	3	2	1	39	38	—	—	—	—	—	83
	LNFH SFL 25	—	—		5	2	—	—	—	—	—	7
Upper Wenatchee	Beaver Creek Acc. Pond	1	—	—	1	8	—	—	—	—	—	10

	Rolfing's Acc. Pond	3	1	5	15	20	—	—	—	1	—	45
	Butcher Creek Acc. Pond	—	—	—	—	—	—	—	—	—	—	0
	Coulter Creek Acc. Pond	1	—	1	3	5	—	—	—	—	—	10
	Nason Creek Wetlands	2	—	4	9	14	—	—	—	2	—	31
Methow River Basin	**Biddle Pond**					1						1
	Winthrop NFH	1	—	—	—	2	—	—	—	—	—	3
TOTAL		**24**	**5**	**39**	**334**	**226**	**0**	**0**	**0**	**3**	**0**	**631**

Table 10. Origin of carcasses without CWTs recovered in the Wenatchee River Basin, 2014.

Carcass Recovery Location	Origin[a]		
	Unknown Hatchery	Natural Origin	Unknown[b]
Chumstick Creek	37	3	1
Icicle Creek	45	5	3
Mission/Brender Creek	7	3	—
Nason Creek	1	—	—
Peshastin Creek	1	—	1
Wenatchee River	57	8	1
Total = 173	**148**	**19**	**6**

[a] Origin determined through scale analysis
[b] Scales too deteriorated/damaged to read

3.1.1 Icicle Creek

YN conducted 13 weekly spawning ground surveys in the main channel (I1) and restored side channel (I2) of Icicle Creek between September 25 and December 15 (Figure 5). Two surveys were conducted above Dam 2 (I3) during periods of peak spawning. Unseasonably high discharge levels (often in excess of 1,000cfs) throughout much of the survey period limited visual coverage of spawning aggregates. An additional two surveys with the sole purpose of carcass recovery were conducted during periods of high discharge and turbidity. YN recorded 696 redds in the main channel, 215 redds in the restored channel, and 2 redds above Dam 2 (Icicle Creek total = 913). Redds recorded in Icicle Creek represented 61.1% of the total number of redds found in the Wenatchee River basin (Table 8).

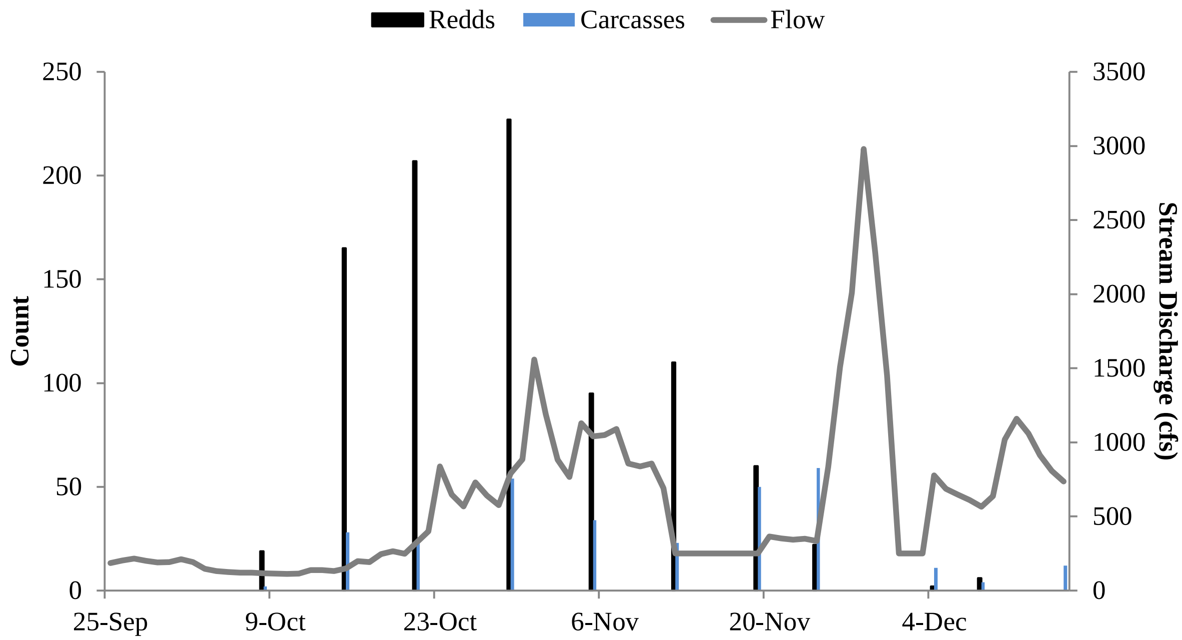


Figure 5. Weekly redd counts conducted in Icicle Creek from September 25 through December 15, 2014.

YN recovered 387 coho carcasses (260 females, 126 males and 1 unknown) from Icicle Creek for a sample rate of 18.4%. Mean POH lengths for female and male carcasses were 53.4cm (*n* = 250; *SD* = 3.2*)* and 50.6cm (*n* =121; *SD* = 4.9), respectively. All females with intact body cavities were examined for egg presence. Among female carcasses that were intact and appeared to have died from natural causes (e.g.-not predation), mean egg voidance was 59.0% (*n* = 209; *SD* = 0.4).

3.1.2 Wenatchee River

A total of 413 redds were recorded on the mainstem Wenatchee River, from Lake Wenatchee to the Columbia River confluence (reaches 1-7), between September 25 and December 17 (Table 8). Weekly surveys were conducted on the lower Wenatchee River reaches from Leavenworth to the mouth (W1 – W4). Upper Wenatchee River reaches (W5 – W7) were surveyed bi-monthly. The majority of redds were counted in the lower Wenatchee River (*n* = 411; 99.5%) with only two redds being located in the upper reaches. Redds located on the mainstem accounted for 27.6% of the total in the Wenatchee River basin. YN recovered 292 mainstem Wenatchee River carcasses for a sample rate of 30.7%. Mean POH lengths for female and male carcasses were 53.1cm (*n* = 158; *SD*= 4.1) and 51.2cm (*n* = 108; *SD* = 5.7), respectively. Mean egg voidance was 50.7% (*n* = 116; *SD* = 0.4).

Adults returning to the upper Wenatchee migrate through the Tumwater Canyon where fish can be passed or collected at Tumwater Dam. A total of 1,932 adult coho were counted at this facility in 2014; 1,493 were allowed to pass upstream while 439 were collected as broodstock. Despite strong efforts made to locate spawning coho in Wenatchee reaches 6 and 7, challenging river conditions (e.g. - poor visibility, high water levels) limited observations. Additionally, adult sex ratio observed at Tumwater Dam was heavily make-skewed in 2014 (9.6M:1F). The low proportion of females above Tumwater dam likely resulted in low spawning activity relative to total escapement.

3.1.3 Nason Creek

Weekly surveys of Nason Creek were conducted between October 10 and November 21 (Table 8). A total of 16 redds documented represented 1.1% of the coho redds identified in the Wenatchee River basin. Challenging survey conditions brought on by high discharge levels occurring throughout the survey period prevented comprehensive coverage. YN recovered four carcasses for a sample rate of 10.9 %. Mean POH length for males was 52.0cm (*n* = 2; *SD* = 7.1). POH measurements could not be taken from the two female coho collected due to non-intact carcasses at the time of discovery. Because both females recovered on Nason Creek possessed open abdominal cavities upon recovery, a mean egg voidance for the tributary could not be determined.

3.1.4 Mission/Brender Creeks

Weekly surveys of Mission/Brender creeks were conducted between September 24 and December 16. A total of 43 redds were recorded which represented 2.9% of the total coho redds in the Wenatchee River basin (Table 8). YN recovered 34 carcasses for a sample rate of 32.4%. Mean POH lengths for females and males were 53.7cm (*n* = 19; *SD* = 4.9) and 49.5 cm (*n* = 10; *SD* = 5.6), respectively. Mean egg voidance was 44.6% (*n* = 15; *SD* = 0.4).

3.1.5 Peshastin Creek

Seven surveys were conducted on Peshastin Creek between September 30 and November 4 (Table 8). A total of 58 redds were located in Peshastin Creek representing 3.9% of those recorded in the basin. High flows prevented comprehensive coverage during the survey period. A total of seven carcasses were recovered for a sample rate of 5.2%. Mean POH lengths for females and males were 55.7cm (*n* = 3; *SD* = 2.5) and 46.3cm (*n* = 3; *SD* = 5.5), respectively. All recovered females were identified as pre-spawn mortalities through the presence of firm, intact skeins.

3.1.6 Chiwawa River

Six surveys of the lower Chiwawa river were conducted between October 13 and November 15. High flows and elevated turbidity levels prevented comprehensive coverage during the survey period. Although live coho were observed, there were no redds documented or carcasses recovered in 2014.

3.1.7 Chumstick Creek

Weekly surveys of Chumstick Creek were performed between October 2 and December 16. A total of 52 redds were identified, representing 3.5% of the coho redds identified in the Wenatchee River basin. During the survey period, 80 carcasses were recovered for a sample rate of 66.9%. Mean POH lengths for females and males were 50.8cm (*n* = 40; *SD* = 3.8) and 50.1cm (*n* = 25; *SD* = 3.3), respectively. Mean egg voidance was 81.6% (*n* = 12; *SD* = 0.4).

3.1.8 Other Tributaries

Surveys were also conducted on Beaver Creek, Chiwaukum Creek, and Roaring Creek. Beaver Creek was surveyed weekly between October 13 and November 17 with no live coho, carcasses, or redds observed. Chiwaukum was surveyed five times between October 13 and December 1 with only one live coho observed. Roaring Creek was surveyed four times between October 13 and December 12 with no live coho, carcasses, or redds observed.

3.2 METHOW BASIN REDD COUNTS

In 2014, YN identified a total of 718 redds and collected 422 adult coho carcasses throughout the Methow River basin for an overall sample rate of 29.0%. The majority of redds were located in the mainstem Methow River (*n* = 293) and associated outfalls of Winthrop NFH and Methow FH (*n* = 279). For a spawning ground summary for the Methow Basin, please see Table 11.

Carcasses found on the mainstem Methow River accounted for 43.8 % (*n* = 185) of the total recovered in the basin. CWT analysis of 398 recovered tags revealed that 268 originated from Winthrop NFH on-station releases while the remaining 130 were released from acclimation ponds (Table 12). Origin of carcasses unidentifiable by CWT is documented in Table 13.

Additional data from the Chelan River outfall was collected by BioAnalyst staff during summer Chinook surveys. Out- of - basin surveys were not conducted in 2014 due to increased staff time allocated for broodstock collections and spawning ground surveys in the Methow Basin.

Table 11. Summary of Methow River coho redd counts, distribution and carcass recovery in 2014.

Stream	Redd Count				Live Fish Count				Recovered Carcasses				Sample Rate[a]
	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	FINAL
Methow	128	164	1	293	641	395	2	1,038	97	87	1	185	**31.1%**
Twisp	72	19	1	92	137	31	0	168	18	20	1	39	**20.1%**
Chewuch	10	12	0	22	15	15	0	30	3	2	0	5	**11.2%**
Libby Creek	1	0	1	2	6	0	0	6	0	0	0	0	**—**

1890’s Side - channel	—	19	—	19	—	64	—	64	—	22	—	22	**57.0%**
Gold Creek	6	5	0	11	55	8	1	64	0	4	0	4	**17.9%**
Winthrop NFH Outfall/Spring Creek	140	86	0	226	1,000	2,000	0	3,000	73	69	0	142	**31.0%**
WDFW/Methow FH outfall	11	41	1	53	41	151	3	195	2	23	0	25	**23.20%**
Hancock Springs	—	0	0	0	—	1	0	1	—	0	0	0	**—**
Total	368	346	4	**718**	1,895	2,665	6	**4,566**	205	231	2	**422**	**29.00%**

[a] *– Sample rate is based on a sex ratio of 1.03M: 1.0F observed at Wells Dam facilities. Sample rate was*

Table 12. Summary of carcass distribution and origin throughout the Methow River and its tributaries, 2014.

Juvenile Coho Release Location/Origin through CWT analysis		**Adult Recovery Location**										
		Methow River									**Out of Basin**	
		Methow 1-4	**Methow 5-8**	**Methow 9-11**	**Twisp River**	**Chewuch River**	**Spring Creek**	**Methow FH outfall**	**Gold Creek**	**1890’s Side Channel**	**Chelan River outfall**	**TOTAL**
Methow River Basin	**Winthrop NFH**	3	107	4	7	—	116	19	1	9	2	268
	Winthrop NFH Back Channel	—	8	1	—	—	11	2	—	8	—	30
	Lower Twisp Ponds	—	6	—	25	1	1	—	2	1	—	36
	Gold Creek	1	3	1	4	1	—	—	1	—	—	11
	Wolf Creek	1	23	5	1	3	5	3	—	2	1	44
Out of Basin	**Wells Fish Hatchery**	—	2	—	—	—	2	—	—	—	5	9
TOTAL		**5**	**149**	**11**	**37**	**5**	**135**	**24**	**4**	**20**	**8**	**398**

Table 13. Origin of carcasses without CWTs recovered in the Methow River Basin, 2014.

Carcass Recovery Location	**Origin[1]**	
	Unknown Hatchery	**Natural Origin**

Methow River Basin	Methow River	17	3
	Twisp River	—	2
	1890's Side Channel	2	—
	Methow FH outfall	1	—
	Spring Creek	7	—
Out of Basin	Chelan River outfall	8	—
Total = 40		**35**	**5**

[1] – Origin was determined through scale analysis

3.2.1 Methow River

Methow River redd surveys were conducted every seven to ten days between October 1and December 15. Surveys included eleven reaches (M1-M11) on the Methow River extending from Weeman Bridge (RK 98.6) to confluence with the Columbia River (RK 0.0). Surveys on the lower Methow River (RK 46.9 – 0.0) were temporarily suspended between October 21 and November 1 due to increased turbidity. Poor visibility was a result of heavy rains on the recent wildfire and mudslide areas. A total of 293 coho redds were identified on the mainstem; 19 redds in lower reaches M1-M4 (RK 0.0-33.7), 243 redds in middle reaches M5-M8 (RK 33.7-83.7), and the remaining 31 redds in upper reaches M9-M11 (RK 83.7-98.6). Redds the mainstem Methow River accounted for 40.8% of all redds documented in the Methow basin in 2014. A total of 185 carcasses were identified during surveys. Mean POH lengths for females and males were 51.9cm (n = 108; SD = 7.2) and 52.3cm (n = 77; SD = 4.4), respectively. All females with intact body cavities were examined for the presence of eggs. Mean egg voidance for females recovered was 78.5% (n = 107). Twelve of these females possessed intact egg skeins and were determined to be pre-spawn mortalities. Carcass recovery rate for the mainstem Methow River was 31.1% (Table 11).

The high proportion of redds identified within the middle reaches continues to demonstrate a shift in spawning distribution when compared to previous years; historically, the highest proportion of redds were observed within the lower four reaches of the mainstem (M1-M4; RK 0.0-33.9). This may be attributed to an increasing number of returning adults demonstrating sufficient energetic levels to return to preferred habitat in proximity to their release point when compared to previous years.

3.2.2 Winthrop NFH (USFWS)/ Spring Creek and Methow FH (WDFW) Outfalls

Spring Creek and the Methow FH outfall were surveyed weekly between October 16 and December 6. The Winthrop NFH complex (on-station raceways and back- channel pond) was the primary release location within the Methow River basin in 2013, resulting in unnaturally high spawning densities surrounding the hatchery outfall. High spawning densities were observed around the outfall to the Methow FH due to a common point source for both hatchery facilities' surface water diversions.

A total of 226 redds were located within Spring Creek between mid-October through mid-December. These redds accounted for 31.5% of all coho redds identified within the Methow Basin (Table 11). Mean POH lengths for females and males were 51.9cm (*n* = 69; *SD* = 3.7) and 50.3cm (*n* = 73; *SD* = 4.5), respectively. Fourteen of these females possessed intact egg skeins and were determined to be pre-spawn mortalities. Mean egg voidance was 72.3% (*n* = 65). Carcass sample rate was 31.0%.

A total of 53 redds were identified within the Methow FH outfall between mid-October through late-December. These redds accounted for 7.4% of all coho redds identified within the Methow basin (Table 11). Mean POH lengths for females and males were 53.9cm (*n* = 15; *SD* = 2.8) and 51.6cm (*n* = 10; *SD* = 4.5), respectively. Mean egg voidance was 91.9% (*n* = 15). Carcass sample rate was 23.2%.

3.2.3 Twisp River

Twisp River surveys were conducted between October 23 and December 9. Surveys included six reaches extending from War Creek Bridge (RK 28.5) to the confluence with the Methow River (RK 0.0). Survey reaches TR 1- 4 (RK 0.0 – 13.2) were prioritized and surveyed twice weekly between October 8 and December 11. The increased frequency of surveys within these reaches is due an observed increase in spawning densities proximal to Lower Twisp Ponds release location (RK 1.6) as well as overall expansion of surveys since acclimated releases from this tributary began in 2009. Three surveys were conducted in TR 5 (RK 13.2 – 21.1); during pre, peak, and post- peak spawn, between October 30 and November 11. A post-peak survey was conducted in TR 6 (RK 21.1 – 28.5) on December 13, with no redds or carcasses observed.

A total of 92 redds were located, of which, 64 were located upstream from the Twisp Ponds acclimation site. Two redds were observed in survey reach TR 5 above the Little Bridge Creek confluence (RK 15.2), which constituted the furthest observed coho distribution in the Twisp River basin in 2014. Spawning activity in the Twisp River accounted for 12.8% of all redds in the Methow basin. The number of redds identified in 2014 was the highest recorded since programs' inception. Redds observed upstream of the acclimation site may demonstrate an increased, energetic fitness allowing adults to migrate and locate suitable spawning habitat beyond their point of release. Mean POH lengths for females and males were 50.1cm (*n* = 24; *SD* = 4.3) and 47.9cm (*n* = 15; *SD* = 4.5), respectively. Mean egg voidance was 87.7% (*n* = 24) and the carcass sample rate was 20.1% for the Twisp River (Table 11).

3.2.4 Chewuch River

Chewuch River surveys were conducted between October 9 and November 29 and included three survey reaches, extending from Eight Mile Creek to the confluence with the Methow River (CR1-CR3; RK 20.2- 0.0). Twenty-two redds were identified (highest recorded since programs' inception), with the majority (*n* = 13) located between RK 4.2 - 8.7. Redds on the Chewuch River accounted for 3.1% of all documented spawning activity in the Methow Basin. Previous surveys of Chewuch River reaches proximal to the town of Winthrop showed little to no spawning activity (n ≦ 2). This expansion was likely a result of adults selecting to avoid competition by migrating to preferred habitat upstream of mainstem, Methow River reaches proximal to the Winthrop NFH outfall. One male with a POH of 40cm, and four females with a mean POH of 53.0m (*n* = 4; *SD* = 3.7) were sampled. Mean egg voidance was 93.7% (*n* = 4) and the carcass sample rate was 11.2% for the Chewuch River.

3.2.5 Gold Creek

Gold Creek surveys were conducted between October 15 and December 15. Surveys in 2014 were expanded to include a reach of South Fork Gold Creek, adjacent to the Gold Creek acclimation ponds to the confluence with Gold Creek (G2; RK .33 – 0.0). Similar to previous years, GC 1 extended from State Boundary markers to private land downstream (RK 2.1 – 1.7). This addition was to account for returning adults from releases at Gold Creek Ponds in 2013. YN staff will continue to work with landowners to further expand surveys within this tributary. A total of eleven redds and four carcasses were identified (Table 11). Redds in Gold Creek accounted for 1.5% of all documented spawning activity in the Methow Basin. All four recovered carcasses were female with a mean POH of 54.0cm (*n* = 4; *SD* = 1.4). Mean egg voidance was 59.4% (*n* = 4) and the carcass sample rate was 17.9%.

3.2.6 Libby Creek

Libby Creek surveys were conducted every 14 days between October 7 and December 14. Surveys were conducted as one reach from Hwy 153 to the confluence with the Methow River (RK .33 – 0.0). Two redds were identified and no carcasses were collected. Redds in Libby Creek accounted for 0.3% of all documented spawning activity in the Methow Basin.

3.2.7 1890's Side-channel

The 1890's side-channel project is a restored, ground-water fed channel at RK 68.1 on the Methow River. The project was completed by YN Habitat branch in the fall of 2014, and created approximately 4,200 linear feet of new perennial flow spring creek within what was the main Methow River channel in the early 1890's. Two surveys were conducted; during peak and post peak spawn between November 6 and 15. A total of nineteen redds were observed and twenty-two carcasses collected. Redds in the 1890's Side Channel accounted for 2.6% of all documented spawning activity in the Methow Basin. Mean POH lengths for females and males were 49.6 (*n* = 12; *SD* = 3.9) and 44.9cm (*n* = 10; *SD* = 5.0), respectively. Mean egg voidance was 96.5% (*n* = 12) and carcass sample rate was 57.0%.

3.2.8 Hancock Springs Creek and Suspension Creek

Two surveys; during peak and post-peak spawning were conducted on Hancock Springs Creek between November 7 and December 3. Surveys were conducted as one reach extending from the confluence with the Methow River to approximately 1.5 kilometers upstream to the water source; a natural spring. One live male was identified, however no redds or carcasses were observed. Two surveys were conducted on Suspension Creek after peak spawn between November 21 and December 3. The survey was conducted as one reach (SUS1) extending from the confluence with the Methow River upstream approximately 250 meters. There were no redds, live fish observed, or carcasses recovered.

3.2.9 Chelan River Outfall

There were no surveys conducted in areas proximal to Wells Dam on the Columbia River in 2014, due to increased staff needs for broodstock collections and surveys in the Methow Basin. Coho carcass data was collected by BioAnalyst staff between October 17 and November 21 in the Chelan River outfall during summer Chinook surveys. Redd data was not recorded. A total of 16 carcasses were recovered. Mean POH lengths for females and males were 54.9cm (n = 12; SD = 5.9) and 51.5 (n = 4; SD = 3.9), respectively. Of these, ten of the females were found with intact egg skeins and considered pre-spawn mortalities. Mean egg voidance was 15.5% (n = 12).

4.0 SMOLT ACCLIMATION: WENATCHEE AND METHOW

4.1 ACCLIMATION SITES

In 2014, within the Wenatchee River basin, YN acclimated coho pre-smolts at LNFH, Beaver Creek, and three sites on Nason Creek. For the Methow River broodstock development program, YN acclimated coho pre-smolts at Winthrop NFH, Winthrop NFH back-channel pond, the Twisp Ponds Complex (Twisp ponds), Wolf Creek, and Gold Creek acclimation ponds.

4.1.1 Leavenworth National Fish Hatchery (LNFH)

LNFH is located at river kilometer (RK) 4.5 on Icicle Creek. Coho smolts were acclimated in refurbished raceways, also known as small and large Foster-Lucas (SFL & LFL) ponds. Originally, these Foster-Lucas ponds were designed for rearing steelhead, sockeye, and spring Chinook. The intent for the oval-shape design was to create a low-maintenance raceway. These ponds were discontinued by USFWS staff due to insufficient turnover rates and maintenance difficulties in favor of more widely used 8x100 and 10x100-foot raceways. Both SFL’s and LFL’s were partially refurbished by

Yakama Nation Fisheries and supplied with re-use water for coho acclimation. The water source for the LFL's originates from the hatchery's 10'x100' juvenile spring Chinook raceway effluent. Re-use water supplied to the SFL's was pumped from a sump below the adult holding ponds, which doubles as a rearing/acclimation pond for juvenile spring Chinook until release in late-April. Water to each Foster-Lucas pond was manually adjusted to achieve flow requirements needed for coho densities on-hand. In 2014, acclimation for both coho and spring Chinook continued until mid-April. Upon release from marked ponds, four passive integrated transponder (PIT) tag detection systems were installed to monitor the release and provide emigration timing, determine residence time, calculate in-pond survival and provide accurate release numbers for a smolt-to-smolt survival analysis (Section 4.4 and 5.0).

4.1.2 Beaver Creek Acclimation Pond

The Beaver Creek acclimation pond is located at RK 2.4 on Beaver Creek. The Beaver Creek drainage enters into the Wenatchee River near Plain, Washington at RK 74.4. The acclimation pond was constructed in the mid-1980s and located behind Mountain Springs Lodge. Originally, the property owner stocked the pond with Kamloops rainbow trout for aesthetic purposes. River otter predation on these year-round resident trout became too problematic and the stocking was discontinued in the early 1990s. After the stocking ceased, Beaver Creek pond had been void of salmonids until YN began using the site in 2002 to acclimate coho salmon prior to release. Pre-acclimation activities included installing containment structures at the pond's inlet and outlet. The expectation was that returning adults from the Beaver Creek release would either spawn in Beaver Creek or the upper Wenatchee River watershed. The resulting natural production would continue to build the ongoing broodstock development process. Two PIT tag detection systems were installed to monitor the release and provide emigration timing, determine residence time, calculate in-pond survival, and provide accurate release numbers for a smolt-to-smolt survival analysis (Section 4.4 and 5.0).

4.1.3 Nason Creek

In 2014, acclimated coho pre-smolts were reared and released from three sites on Nason Creek; Coulter Creek, Butcher Creek and Rohlfing's Pond. All acclimation sites in Nason Creek are natural or semi-natural earthen ponds. Natural and earthen ponds may have advantages over conventional, hatchery raceways by providing lower rearing densities, access to a variety of invertebrates for diet supplementation, and other improved environmental conditions (e.g. natural temperature and flow regimes, increased water quality, volitional pond migration, etc.) that should produce a juvenile with adequate imprinting capabilities and persist during springtime rearing and subsequent downstream migration.

4.1.3.1 Rohlfing's Acclimation Pond

Rohlfing's Pond acclimation site is located on an unnamed, seasonal creek which connects to the lower end of Mahar Creek before reaching Nason Creek at RK 20.3. This earthen pond was constructed and developed by the property owner. In 2003, to create a more suitable acclimation environment, YN enlarged the pond and planted native riparian vegetation. Again in 2010, the pond was enlarged and native riparian vegetation planted. This expansion was largely to facilitate a multi-species acclimation opportunity with ESA listed steelhead as a part of the YN's Expanded and Multispecies Acclimation project (BPA Project #-2009-001-00). In 2012, a well was installed to provide a reliable year round water source. Pre-acclimation activities included installing a seine net secured to the banks with cable. The seine was installed in a way that allowed unimpeded upstream migration of native fish and maximum rearing space for juvenile coho.

4.1.3.2 Coulter Creek Acclimation Pond

The Coulter Pond acclimation site is located at RK 1.6 on Coulter Creek. Fish released from Coulter Pond immigrate through the Nason Creek Wetlands at the easternmost point of the complex just prior to entering Nason Creek at RK 13.7. This natural beaver pond contains multiple braided channels which coalesce into one, large, widened waterway. In 2014, a barrier net was used to encircle the majority of the channel to contain the coho during the acclimation period. The release was closely monitored to ensure fish could pass through multiple beaver dams into Nason Creek. Two PIT tag detection systems were installed to monitor the release and provide emigration timing, determine residence time, calculate in-pond survival and provide accurate release numbers for a smolt-to-smolt survival analysis (Section 4.4 and 5.0).

4.1.3.3 Butcher Creek Acclimation Pond

The Butcher Creek acclimation site is located at RK 13.2 on Nason Creek. This site, which was once the original channel of Nason Creek, is now a beaver pond at the mouth of Butcher Creek. Coho smolts were volitionally released directly into Nason Creek from the pond. Prior to transportation, a net was placed upstream of the beaver's natural barrier to contain coho during acclimation. Floating and submerged structures were installed to provide protection from predators and reduce in-pond stress.

4.1.4 Winthrop National Fish Hatchery (Winthrop NFH)

Coho smolts released into the Methow River from Winthrop NFH, located at RK 80.6, were acclimated from the fingerling stage to release within five, on-station raceways as well as the Winthrop NFH back-channel pond. The back-channel pond is located on Spring Creek (Winthrop NFH outfall) and functions as a semi-natural acclimation site. Prior to acclimation, a one piece, net canopy was installed over the back-channel acclimation pond and floating covers were installed to enhance the rearing environment by providing cover and shade. A juvenile fish- bypass system was also integrated so that wild juveniles migrating from upstream of the acclimation pond could travel unimpeded through the pond area to the Methow River. YN staff installed one Allflex detection system at the pond's outlet to augment the USFWS Multi-plex array. The purpose of the added system was to increase detection probabilities; large numbers of PIT tagged juveniles occur between various hatchery programs at this location (> 35,000 to include coho, summer steelhead and spring Chinook). All detection systems functioned to monitor juvenile escapement until release as well as in-pond and release-to-McNary survivals.

4.1.5 Lower Twisp Acclimation Ponds

The Lower Twisp Ponds site, located at RK 1.6 on the Twisp River, functions as a semi-natural acclimation facility that is owned and operated by the Methow Salmon Recovery Foundation (MSRF). The site was constructed in 2002 and consists of a series of five ponds. The pond complex receives surface water from the Twisp River at an inlet, located at RK 2.5, just upstream of the first pond. A ground water pump system is also available for use if the water supply from the Twisp River is impeded (e.g. ice, woody debris) or insufficient for acclimation due to low river flows. Coho acclimation occurs in the furthest downstream pond. The pond is approximately 42.0 meters in length and includes a small outlet back to the Twisp River. Coho acclimation at this location is intended to help reach phased goals (YN FRM 2012) by increasing in-basin production. Prior to fish arrival, additional large woody debris (LWD) and shade covers were placed within the ponds to enhance rearing conditions and minimize predation. YN staff also installed three, pass-through PIT tag detection systems, in series, within the outlet of the pond to monitor juvenile escapement and assess in-pond and smolt-to-smolt survival. Acclimation at this location in 2014 marked the sixth consecutive year these ponds were used by the MCCRP.

4.1.6 Gold Creek Acclimation Pond

The acclimation site is comprised of a series of four, man-made ponds on private property adjacent to South Fork Gold Creek, located at RK 1.0 from the confluence with Gold Creek. The site is intended to provide an additional release location in-basin, prior to the initiation of the Natural Production Implementation Phase (NPIP) of the program in 2017. Pre-transfer, individual seine nets within each pond were moved, shore outward and installed to segregate incoming hatchery pre-smolts from potential interactions with naturally produced juveniles inhabiting the same pond complex while providing migratory access. Once the net was in-place, staff members conducted a snorkel survey and confirmed absence of fish within the contained area. Additional surveys were conducted throughout the acclimation period to ensure the acclimation net was secure, as well as determine if use, primarily outside of the contained area, occurs by different species during the acclimation time period. Three PIT tag detection systems were installed, in series, below the pond's outfall to monitor escapees as well as providing outmigration success and survival.

4.1.7 Wolf Creek Acclimation Pond

Coho acclimation at this location is intended to provide an additional release location, similar to Gold Creek Ponds, to increase the proportion of in-basin program releases. Seine net installation and snorkel surveys followed the same protocols as identified above "***Gold Creek Acclimation Pond (4.1.6)"***. Juveniles at this location were not PIT tagged due to the site's proximity to Winthrop NFH (< 2.0 RK) when looking at Methow River residence time as well as sufficient years' worth of historical site data to provide estimate in-pond survivals.

4.2 TRANSPORTATION AND VOLITIONAL RELEASE

4.2.1 Wenatchee River Basin

Mid-Columbia coho pre-smolts (BY2012) were transported to the Wenatchee River basin from rearing facilities at Willard NFH and Cascade FH between December 3, 2013 and April 4, 2014. Coho were acclimated between 4 and 19 weeks at five acclimation sites.

All coho smolts acclimated at LNFH were force-released from April 16-18. Volitional releases began at Coulter Creek Pond, Rohlfing's Pond, and Beaver Creek Pond between May 1 and May 6. All acclimation facilities were deemed empty by June 24.

Coho released in 2014 were CWT-tagged with a 98.8% retention rate. In addition to CWTs, all upper Wenatchee basin released coho had a secondary, blank wire tag inserted into the adipose region with 99.2% retention. This secondary mark provided the means to implement Broodstock Development Phase II (YN FRM 2009) by selectively passing returning adult coho destined for the upper basin at the Dryden Dam broodstock collection facility (lowermost brood collection point) for potential recapture at Tumwater Dam (uppermost brood collection point). By demonstrating that a sufficient proportion of adults (# of trappable adults to achieve 50% of broodstock needs) can navigate above Tumwater Dam, whether collected into broodstock or passed upstream, is critical in achieving specific management goals designed within YN's phased approach for reintroduction, and would continue the broodstock development and adaptation towards the upper watershed.

In 2014, 29,881 coho juveniles were marked with PIT tags. These PIT tagged fish were used to measure survival from release point to McNary Dam and determine in-pond survival at select release sites (see Section 4.4). A minimum two PIT tag detection systems were installed in series at each of the upper basin acclimation sites (Beaver and Coulter) to ensure maximum detection efficiency.

A total of 971,645 hatchery produced coho smolts were released from the Wenatchee River basin in 2014. Release numbers, size-at-release, release locations and PIT tag numbers can be found in Table 14. For detailed mark and release information, see Appendix C.

4.2.2 Methow River Basin

Juvenile coho were transported from Cascade FH by Oregon Department of Fish and Wildlife (ODFW) personnel to the Winthrop NFH back-channel, Gold Creek, Lower Twisp, and Wolf Creek ponds for acclimation on March 7 and 28, and April 4 and 7, respectively. All juveniles acclimated and released were 100%, 3rd generation MCR progeny from the Methow program.

Volitional releases were initiated at all in-basin release sites and occurred between April 18 and May 14. A follow-up forced release was initiated on May 9 at Winthrop NFH to allow sufficient time for staff to conduct routine raceway maintenance prior to transferring BY2013 juveniles out of the nursery tanks. Emigrations from all acclimation ponds were visually deemed complete by June 17. CWT retentions from juveniles acclimating on-station at Winthrop NFH and within the Winthrop NFH back-channel were 99.2% and 94.6%, respectfully. Juveniles acclimated at the Lower Twisp, Gold, and Wolf Creek ponds were 97.2%, 99.9%, and 90.6%, respectively. Data collected from PIT tagged juveniles will be used to evaluate metrics measuring release to McNary Dam survival, in-pond survival, and downstream migration timing (see section 4.4 and 5.0). Release summary information is provided in Table 14.

A total of 512,992 coho juveniles were released for the Methow program (Table 14). For detailed mark information, see Appendix C. Juvenile releases in 2014 marked the seventh consecutive year that 100% of the smolts were progeny of locally returning adults to the Methow basin. The development of a local broodstock is critical for achieving program goals within the Methow River basin (YN FRM 2010).

Table 14. Mid-Columbia coho smolt release summary, 2014.

Location	Release Date	Release Number	Size @ release (FPP)	No. PIT Tags
Beaver Creek	1-May	101,442	17.1	5,337
Coulter Creek	1-May	58,965	16.1	5,500
Rohlfing's Pond	6-May	85,824	16.4	0
Butcher Creek	6-May	108,453	17	0
Leavenworth NFH LFL's (large Foster-Lucas Ponds)	16&17-Apr	258,419	20.5	5,694
Leavenworth NFH SFL's (small Foster-Lucas Ponds)	18-Apr	358,541	20.6	11,509
Wenatchee Total		**971,644**		**28,040**
Winthrop NFH (on-station)	18-Apr	276,739	18	5,911

Winthrop NFH (back-channel pond)	22-Apr	47,797	15.2	5,681
Lower Twisp Ponds	12-May	81,107	14.8	5,311
Gold Creek	2-May	48,724	15.6	5,737
Wolf Creek	14-May	58,625	18.3	—
Methow Total		**512,992**		**22,640**
Wenatchee/Methow Totals		**1,484,636**		**50,680**

4.4 PREDATION ASSESSMENT

As standard practice of good fish husbandry and fish health, moribund and deceased coho were recovered daily from all sites until the end of release to determine known mortality during this rearing period. The number of observed mortalities is typically low (avg. < 2%), however we assume that the majority of loss occurs through predation and precludes enumeration. This unaccounted for loss can have a significant impact on acclimation rearing, not only directly but also indirectly through elevated and continual stress. Unusually, high densities of hatchery fish can create an optimal situation for predation while consistent stress events can negatively affect coho survival (e.g.- delayed fight vs. flight stimuli response, disrupted Na-K and ATPase activity, reduced overall condition and delayed downstream migration). YN used both a predator consumption model and PIT tag detection (where applicable) to estimate in-pond predation.

4.4.1 Estimated Mortality-Predator Consumption Model versus PIT tag Detection

4.4.1.1 Predation Model

Primary predators observed during the acclimation period were the North American river otter (*Lutra canadensis*) and the common merganser (*Mergus merganser*). Adult river otters can consume as much as 20% of their body weight in the natural environment (Beckel 1982) and may be an underestimate considering the environment that acclimation sites provide. Average body weights for male and female river otters used in this model, derived from multiple sources of documentation, were 25 and 19 pounds, respectively. Common mergansers can consume upwards of one pound of fish per day and can congregate in large numbers (Stephenson 2004). In addition to these key predators, mink, belted kingfishers, great blue herons, and hooded mergansers have all been documented throughout the basin and observed in small numbers at some of the sites. Mallards and other “dabbler” types of ducks have recently also been identified as opportunistic, piscivorous predators if ideal conditions are present. Although these opportunistic bird species persist, literature determining their consumption rate is difficult to attain. Based on limited observations by USFWS and YN staff, an estimated consumption rate for dabblers has been estimated to be approximately one-third that of the common merganser. Since both species are similar in body weight, the dabbler-type ducks likelihood of success assumes that they are only 1/3 as likely to successfully prey on juvenile coho and that these fish have a higher probability of avoiding such predatory attempts. In the past couple of years, estimated predation numbers have decreased in part to the extended hazing efforts conducted by YN personnel during this period. Staff was stationed at these sites from dawn until dusk, seven days a week, focusing on the early morning and late evening periods. This tactic was particularly effective against sight-feeding avian predators such as mergansers and mallards. Once hazing pressure was applied, mammalian feeders, primarily North American river otter, shifted towards a nocturnal feeding schedule. This behavior limited the effectiveness of hazing efforts by YN staff. Although hazing efforts were very beneficial, predation still occurred at these locations. To try and determine the final numbers of juvenile coho released from natural acclimation ponds, daily documentation of predator abundance was used to estimate predation mortality using the following equation.

$$C_e = C_t * FPP * N_i * D_p$$

C_e= Estimated consumption for an individual predator

C_t= Consumption total per day (kg) for an individual predator

FPP= Fish per pound

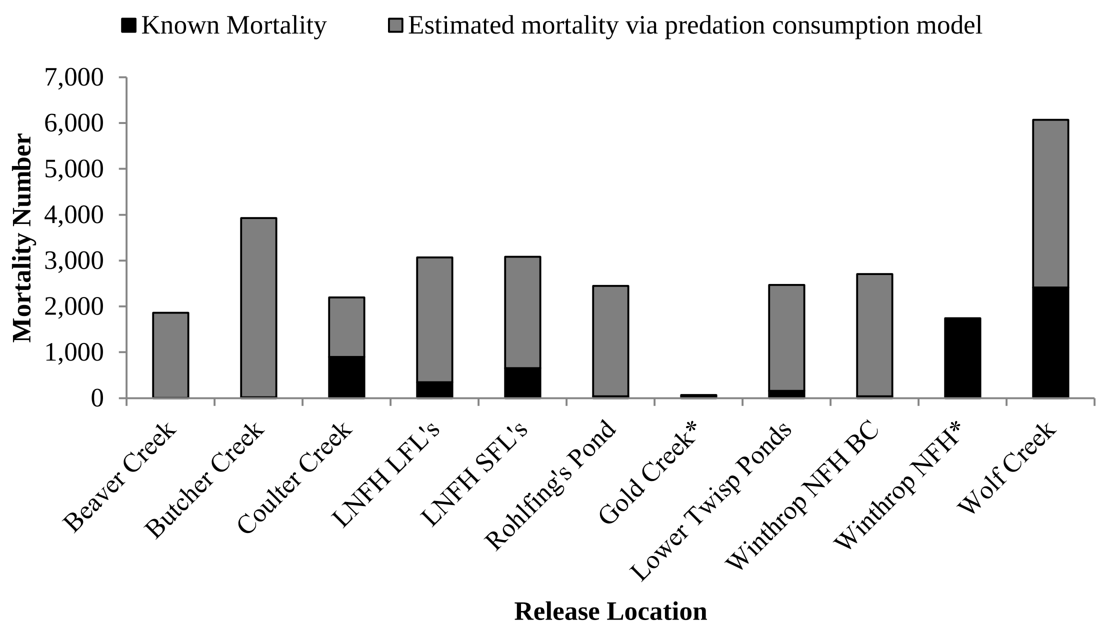
N_i= Number of same species predators observed during time interval i

D_p= Duration of same species predators observed

The estimated predator consumption varied between acclimation ponds (Figure 6). Pond shape, pond size, numbers of coho, geographic location, cumulative riparian area, and aquatic vegetation all affect the predator abundance and predation mortality.

In the Wenatchee Basin, various predators were observed at all of the upper basin acclimation locations. Piscivorous avian and mammalian predators at Beaver Pond included blue herons, mallards, mink, and North American river otters. All of the piscivorous predators observed at Beaver Pond were also observed at Coulter Pond. Although the mallard piscivorous dietary intake is relatively unknown, these opportunistic individuals have been observed occasionally feeding on coho pre-smolts. Predator sightings at Rohlfing's pond included mink and otter.

In the Methow basin, species of piscivorous avian and mammalian predators observed at acclimation locations included both common and hooded mergansers, belted kingfishers, blue herons, mallards, mink, and otter. Predator sightings were highest at the Twisp ponds, primarily common mergansers, belted kingfishers, and blue herons. This location is a preferred nesting habitat for a variety of avian species. At Winthrop NFH, there were no documented sightings of predators in or proximal to the juvenile coho raceways during acclimation, although predators were observed at this facility and predation is assumed to occur. The numerous juvenile raceways used at this facility facilitate multiple options for predators; further impeding the estimate for predation loss. Predation observed at the Winthrop NFH back-channel pond continues to be significantly less than in years prior and may be attributed to the protection provided by custom, predation netting. At Wolf Creek pond, both common and hooded mergansers, mallards, and belted kingfisher were observed. Presence of predator species was not documented throughout the season at Gold Creek ponds; however low levels of predation was presumed to occur nocturnally and/or when YN staff was not present.



*Direct predation not observed, mortality due to consumption not represented

Figure 6. Known and estimated mortality at all acclimation sites in the Methow and Wenatchee river basins, 2014.

4.4.1.2 PIT tag Detection

In addition to predator enumeration and mortality estimation, select locations had an in-pond survival estimate determined with the use of PIT tags. Each selected group that was tagged varied in the proportion of PIT tagged fish, but a minimum of 6,000 tags were designated for target acclimation ponds to provide for both estimates of in-pond survival and release-to-McNary Dam survival. If detection efficiencies at Rocky Reach Dam continue to be high, YN may consider decreasing numbers of tags assigned to individual ponds as downstream detections are more than sufficient to perform release-to-McNary survival estimates.

Prior to the 2014 acclimation, YN installed PIT tag antenna arrays at Coulter Pond, Beaver Pond, Winthrop NFH back-channel pond (USFWS Multi-plex system), Gold Creek, and Lower Twisp Ponds to detect any possible escapees immediately after transport. Additional units were added prior to initiating releases. Only sites with maintained outlet detection systems and employing a volitional release strategy (high tag collisions during forced releases) could be used for measuring in-pond survival and comparing methods for measuring in-pond survival (PIT tag vs. predation model).

In-pond survival was estimated by the following formula:

$$S_{ip} = \frac{(D_{outlet} / E_{detection})}{PIT_{total}}$$

Where S_{ip} = in-pond survival, D_{outlet} = unique detections at the pond outlet, $E_{detection}$ = estimated PIT detection efficiency at the outlet, and PIT_{total} = the total number of PIT tagged fish released into the pond.

We estimated the efficiency of the PIT tag arrays installed at the outlets with the following formula.

$$E_{detection} = \frac{\text{\# unique outlet detections that were also detected downstream}}{\text{Total number of downstream detections}}$$

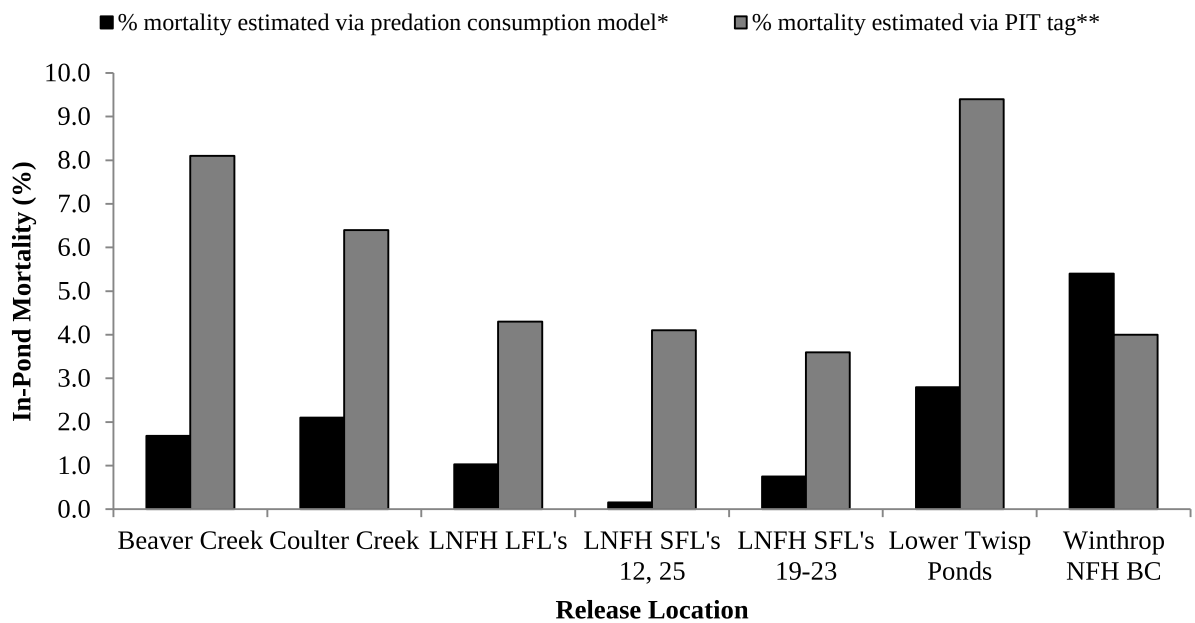
By querying the PTAGIS database for downstream PIT tag detections for fish released from a given acclimation pond, we are able to estimate the efficiency of our antennas by determining the proportion of the fish detected downstream that were also detected exiting the pond. Estimates of detection efficiency and in-pond survival for each site with PIT tag arrays can be found in Table 15.

Table 15. PIT estimates of in-pond survival and tag detection efficiency, 2014.

	Wenatchee Basin				Methow Basin			
	Beaver Pond	Coulter Creek	LNFH LFLs	LNFH SFLs	Gold Creek	Twisp Ponds	Winthrop NFH back-channel	Winthrop NFH on-station
Total PITs	5,807	5,878	11,926	5,997	5,811	5,973	5,921	5,986
Unique Outlet Detections	5,286	5,456	10,850	5,670	5,410	4,672	5,655	5,612
Unique Downstream Detections	630	751	2,377	1,261	4,706	2,818	2,389	2,376
Downstream and Outlet Detections	624	745	2,256	1,237	4,438	2,479	2,378	2,256
Detection Efficiency	99.0%	99.2%	94.9%	98.1%	94.3%	88.0%	99.5%	94.9%
PITs released	5,337	5,500	11,422	5,780	5,737	5,311	5,681	5,911

In-Pond Survival	91.9%	93.6%	95.9%	96.4%	98.7%	88.9%	95.9%	98.7%

A comparison of in-pond mortality estimates based upon PIT tags and predator consumption model expansions can be found in Figure 7. Typically, the predator consumption model underestimates the in-pond mortality rate as compared with PIT tags. However, estimates generated via PIT tags may overestimate loss since they encompass cumulative, unobserved loss at both the lower river facilities and acclimation site. Beginning in 2012, pre-transport PIT tag detection monitoring was implemented to better estimate the number of tags entering each site.



** Gold Creek and Winthrop NFH estimates not made - lack of observed direct predation.*
*** Butcher Creek, Wolf Creek, and various LNFH SFLs estimates not made - lack of PIT tags*

Figure 7. Comparison of in-pond mortality estimation methods; PIT tag versus a predator consumption model, 2014.

5.0 SURVIVAL RATES

5.1 Smolt Survival Rates – Release to McNary Dam

5.1.1 2014 Methow and Wenatchee Smolt Survival

To obtain a McNary passage index of PIT-tagged fish released into the Wenatchee and Methow basins, the number of McNary Dam PIT tag detections were expanded by dividing by an estimate of the McNary detection-rate (efficiency). McNary detection rate is the proportion of total PIT-tagged fish passing the dam that are detected by the dam's PIT tag detectors. McNary passage is stratified into sequential days having similar detection rates. The McNary detection rate was calculated by summing the number of PIT-tagged fish detected at McNary and at a downstream dam and dividing by the total number detected at the downstream dam. An index of survival to McNary Dam is the estimated total passage divided by the number of fish detected either leaving the acclimation pond (release-to-McNary) or from original tagging files (tagging-to-McNary). Release numbers were used whenever possible and were only substituted with original tagging numbers if a) outlet detection efficiencies were poor or b) outlet detection capabilities were not present at the location. Data suggests that coho juveniles reared full-term at Cascade FH appear to have an increased release-to-McNary survival when compared to the other primary, full-term rearing facility (Willard NFH) at both upper and lower basin release locations. A summary of release-to-McNary survival rates for the 2012 releases can be found in Table 16.

Table 16. PIT tag release numbers and locations, 2014.

Basin	Release Tributary	Release Location	Rearing Facility	Brood Origin	*n*	McNary survival % (SD)
Methow	Spring Creek	WNFH Back-channel	CascadeFH	MCR	5,681	51.7 (7.6)
		WNFH On-station	Winthrop NFH	MCR	5,911	51.8 (7.5)
	Twisp River	Lower Twisp Ponds	Cascade FH	MCR	5,311	63.6 (8.3)
	Gold Creek	Gold Creek Ponds	Cascade FH	MCR	5,737	55.4 (7.6)
Wenatchee	Beaver Creek	Beaver Cr.	Willard NFH	MCR	5,337	42.2 (6.8)
	Nason Creek	Coulter Creek Pond	Willard NFH	MCR	5,500	41.5 (6.8)
	Icicle Creek	SFL	Willard NFH	MCR	5,729	40.6 (5.9)
			Willard NFH (overwinter group)	MCR	5,780	52.7 (9.8)
		LFL	Cascade FH	MCR	2,835	53.3 (9.5)
			Willard NFH	MCR	2,859	29.8 (6.2)

5.2 Smolt-to-Adult Survival Rates (SAR) for Brood Year 2011

For coho returning to the Wenatchee River, we calculated the number of coho returning to the basin using four methods:

1) Dryden Dam counts expanded by linear regression for non-trapping days, plus redd counts downstream from Dryden Dam
2) Broodstock collected at Dryden Dam plus all redd counts
3) Broodstock collected at Dryden Dam, Tumwater Dam counts, and redds counted downstream of Tumwater Dam
4) Mainstem dam counts (Rock Island Dam – Rocky Reach Dam).

Method one may underestimate the total number of coho returning to the basin if the trapping efficiency of Dryden Dam is low (due to fall freshets) or may overestimate the number of coho returning if fallback rates of fish not collected in the broodstock are high. Method two and three may also underestimate the number of coho to return to the Wenatchee River because it does not take pre-spawn mortalities or unidentified coho redds into account. Method four is likely an overestimate, as it assumes no fallbacks or drop-outs occurred between Rock Island and Rocky Reach dams. SARs calculated using methods one, two, and three for total escapement have been consistent in previous years.

In the Methow River, the number of coho returning to the basin was calculated using two methods:

1) Redd counts plus broodstock collected

2) Wells Dam counts plus broodstock collected at Wells Dam.

Estimated run size for the Wenatchee and Methow basins in 2014, using the aforementioned methods, can be found in Tables 17 and 18. Smolt-to-adult survival rates for the Wenatchee and Methow basins are summarized in Tables 19 and 20.

Table 17. Estimated coho run size to the Wenatchee River, 2014.

Method	Est. Run Size
1) Dryden Dam counts expanded for non-trapping days plus redds located below Dryden Dam[1]	8,817 (8,721 adults & 96 jacks)
2) Redd counts plus broodstock collected[1]	4,666 (4,590 adults & 76 jacks)
3)Tumwater Dam counts, redds below Tumwater Dam, and broodstock collected[1]	4,897 (4,820 adults & 77 jacks)
4) Mainstem Dam Counts[2]	34,448 (34,244 adults & 204 jacks)

[1]Each redd count was expanded by 2.3 fish per redd based on the sex ratio of coho observed at Dryden Dam, 1.3M:1F.
[2]Mainstem dam counts represent the difference in adult passage observed between Rock Island Dam and Rocky Reach Dam.

Table 18. Estimated coho run size to the Methow River, 2014.

Method	Est. Run Size
1) Redd counts plus broodstock collected [1]	2,068 (2,067 adults & 1 jacks)
2) Wells Dam Counts plus Wells Dam broodstock collected[2]	9,730 (9,721 adults & 9 jack)

[1] Each redd count was expanded by 2.03 fish per redd based on the sex ratio of coho observed at Wells Dam facilities, 1.03M:1.F
[2] Coho collected for broodstock at Wells Dam were not incorporated into daily fish passage counts for 2014. Broodstock collected only reflects the proportion of fish taken at Wells Dam and not volunteer swim-ins at Winthrop NFH.

Estimation of SARs for hatchery fish were based on CWT recovery, which allows for a comparison of survival between brood origins, rearing hatchery, and release sites (Table 20 and 21). In both the Wenatchee and Methow River basins, we used scale analysis to verify the origin of any coho without CWTs. SARs for naturally produced coho were based on an estimate of the number of natural origin adults returning to the basin and an estimate of smolt emigration from the basin for the same brood year. The natural origin smolt emigration estimate was provided by WDFW from data collected via rotary smolt traps operated on both rivers.

Table 19. Wenatchee River brood year 2011 SARs by release site, brood origin, and rearing facility.

Release Site	Minimum Acclimation Duration[a]	Brood Origin	Rearing Facility	*n*(Adult and Jack Returns)	*n*(CWT Release Number)	SARs[b]
Beaver Cr. Pond	6 Weeks	MCR-Wenatchee	Willard NFH	281	95,589	0.29%

Coulter Cr. Pond	5.5 Weeks	MCR-Wenatchee	Willard NFH	116	53,786	0.22%
Nason Cr. Wetlands	< 1 Week	MCR-Wenatchee	Cascade FH	436	128,082	0.34%
Rohlfing's Pond	7 Weeks	MCR-Wenatchee	Cascade FH	300	64,138	0.47%
	7 Weeks	MCR-Wenatchee	Willard NFH	156	59,189	0.26%
LNFH: LFL Ponds	7 Weeks	MCR-Wenatchee	Cascade FH	808	128,791	0.63%
	7 Weeks	MCR-Wenatchee	Willard NFH	235	72,726	0.32%
LNFH: SFL Ponds 10-12, 16-18	20.5 Weeks	MCR-Wenatchee	Cascade FH	959	127,735	0.75%
LNFH: SFL Ponds 22-24	10 Weeks	MCR-Wenatchee	Cascade FH	662	63,698	1.04%
LNFH: SFL Ponds 8-9, 19-21	20.5 Weeks	MCR-Wenatchee	Cascade FH	757	97,475	0.78%
LNFH: SFL Pond 25	12 Weeks	MCR-Wenatchee	Willard NFH	62	29,526	0.21%
Total	**—**	**—**	**—**	**4,772**	**920,735**	**0.48%**
Naturally Produced Coho[c]	**N/A**	**N/A**	**N/A**	**154**	**30,342**	**0.51%**

[a] Minimum acclimation duration is based on transport to release dates and does not account time required for all volitionally released fish to leave the acclimation pond.
[b] An estimated return to the basin of 4,897 fish (method 3) was used in the calculation of BY2011 SARs.
[c] Naturally produced coho were positively identified through scale analysis.

Table 20. Methow River brood year 2011 SARs by release site, brood origin, and rearing facility.

Release Site	Minimum Acclimation Duration[a]	Brood Origin	Rearing Facility	N Adult Return	N Released	SARs[b]
WNFH on-station	N/A[c]	MCR-Methow	Winthrop NFH	1,080	247,834	0.44%
WNFH Back Channel	6 weeks	MCR-Methow	Cascade FH	235	39,156	0.60%
Twisp Ponds	5 weeks	MCR-Methow	Cascade FH	160	63,641	0.25%
Gold Creek Ponds	6weeks	MCR-Methow	Cascade FH	71	34,535	0.21%
Wolf Creek	6 weeks	MCR-Methow	Cascade FH	109	62,974	0.17%
Wells FH	8 weeks	MCR-Methow	Cascade FH	382	95,068	0.40%
Coulter Pond	5.5 Weeks	MCR-Wenatchee	Willard NFH	4	50,212	0.01%
Beaver Creek	6 Weeks	MCR-Wenatchee	Willard NFH	8	17,371	0.05%
Total	**—**	**—**	**—**	**2,051**	**543,208**	**0.38%**
Naturally Produced Coho	**N/A**	**N/A**	**N/A**	**17**	**3,147**	**0.53%**

[a] Minimum acclimation duration is based on transport to release dates and does not account time required for all volitionally released fish to leave the acclimation pond.
[b] An estimated return to the basin of 2,068 fish (method 1), to include natural origin adults, was used in the calculation of BY2011 SARs for returns to the target watershed (Methow basin).
[c] Fish released directly from on-station rearing facility.

A comparison of smolt-smolt survival and smolt-to-adult survival across years (1997-2011 brood years) can be found in Table 21.

Table 21. Hatchery comparison of smolt-to-smolt and smolt-to-adult survival rates, brood years 1997-2014.

Brood Year	Release Year	Methow R. Smolt Survival	Icicle Cr. Smolt Survival	Upper Wen. Smolt Survival	Return Year	Methow R. Smolt-Adult Survival	Wenatchee R. Smolt-Adult Survival
1997	1999	N/A	53.9%	N/A	2000	N/A	0.21% -0.38%
1998	2000	33.30%	63.0%	N/A	2001	0.17%-0.27%	0.17%-0.86%
1999	2001	9.90%	21.6%	N/A	2002	0.03%	0.03%-0.13%
2000	2002	N/A	87.4%-78.5%	39.30%	2003	0.15%	0.32%-0.51%
2001	2003	N/A	62.8%	37.20%	2004	0.16%	0.33%-0.55%
2002	2004	26.1%-29.5%	56.3%-60.8%	30.5%-36.2%	2005	0.19%	0.29%-0.47%
2003	2005	N/A	34%-44%	16%-18%	2006	0.18%	0.15%-0.37%
2004	2006	N/A	37%-51%	16.0%-47%	2007	0.13%-0.47%	0.11%-0.74%
2005	2007	N/A	39.4%-86.7%	45.0%-53.5%	2008	0.13%-0.38%	0.03%-0.33%
2006	2008	28.30%	40.5%-63.4%	46.3%-71.2%	2009	0.16%-0.47%	0.12%-0.60%
2007	2009	40.5%-49.1%	43.8%-50.5%	34.2%-60.2%	2010	0.11%-0.21%	0.02%-0.44%
2008	2010	65.5%-79.9%	49.9%-77.0%	37.4%-84.1%	2011	0.13%-0.41%	0.32%-1.15%
2009	2011	35.6%-43.4%	28.6%-53.6%	24.6%-48.8%	2012	0.26%-0.37%	0.09%-0.47%
2010	2012	33.4%-45.0%	27.5%-42.4%	25.6%-54.3%	2013	0.03%-0.13%	0.03%-0.23%
2011	2013	51.4%-63.0%	53.9%-65.4%	36.2%-55.4%	2014	0.17%-0.60%	0.21%-1.04%
2012	2014	51.7%-63.6%	29.8%-53.3%	41.5%-42.2%	2015	N/A	N/A

6.0 SUMMARY

The long-term vision for the mid-Columbia coho reintroduction project is to re-establish naturally reproducing coho salmon populations in mid-Columbia river basins at biologically sustainable levels which will provide opportunities for harvest for tribal and non-tribal fishers.

We are optimistic that the project will continue to observe positive trends in hatchery coho survival as developing local broodstock continues to adapt to conditions in mid-Columbia tributaries. Therefore it is important to measure hatchery fish performance not only to use as an indicator of project performance but to track potential short-and long-term program benefits. This document reports the coho restoration activities completed in 2014; results are briefly summarized below.

- Between September 1 and November 12, YN collected 994 coho at Dryden and Tumwater Dams on the Wenatchee River. At Winthrop NFH, Methow FH adult weir and Wells Dam, 621 coho were collected for the Methow River program between September 24 and November 14. Excess coho for the Methow program were returned to the river to naturally spawn. Broodstock goals for both basins were to collect enough females to fulfill future acclimation release needs of 500,000 juveniles in the Methow River and 1,000,000 juveniles in the Wenatchee River.

- YN spawned 796 coho at Leavenworth NFH and 433 at Winthrop NFH. An eye-up rate of 58.6% was calculated for the Wenatchee program and 75.3% for the Methow program.

- During spawning ground surveys in the Wenatchee Basin for 2014, YN found a total of 1,495 coho redds. Of which, 61.1% (*n* = 913) were found on Icicle Creek, 27.6% (*n* = 413) were found on the Wenatchee River, 1.1% (*n* = 16) were found on Nason Creek, and the remaining 10.2% (*n* = 153) were located on other tributaries i.e., Beaver Creek, Brender Creek, Chiwaukum Creek, Chiwawa River, Chumstick Creek, Mission Creek, Peshastin Creek, and Roaring Creek.

- During spawning ground surveys in the Methow Basin for 2014, YN found a total of 718 coho redds. Of which, 40.8% (*n* = 293) were on the Methow River, 12.8% (*n* = 92) in the Twisp River, 3.1% (*n* = 22) in the Chewuch River, and the remaining 43.3% (*n* = 311) within tributaries (i.e. Winthrop NFH and Methow FH outfalls, Gold and Libby creeks, and 1890's side-channel).

- Acclimating pre-smolts on local waters is an essential component to the restoration program. Smolt release numbers for the Wenatchee and Methow rivers in 2014 were 971,645 and 512,992 fish, respectively (Appendix C). Coho released in the Methow Basin achieved a mean, estimated in-pond survival of 95.6%. In the Wenatchee basin, mean in-pond survival was 94.4%.

- YN estimated that the Wenatchee River in-basin SAR for BY2011 hatchery coho smolts was 0.48% (based on estimated return of 4,897 adults). SAR rates between individual release groups ranged from 0.21% to 1.04%. Using scale analysis to verify origin, we estimated that 154 coho of natural-origin returned to the Wenatchee River basin. An estimate of smolt abundance from the lower Wenatchee River smolt trap was used to determine a natural-origin SAR of 0.51% for the 2014 adult return.

- In the Methow River, we estimated that the overall SAR for BY2011 hatchery coho was 0.38% (based on estimated return of 2,067 adults and 1 jack). SAR rates of the individual release groups ranged from 0.01% to 0.60. Using scale analysis to verify origin, we estimated that 17 adults returning to the Methow River to spawn originated from natural production. An estimate of smolt abundance from the Methow River smolt trap was used to determine a natural-origin SAR of 0.53% for the 2014 adult return.

7.0 ACKNOWLEDGEMENTS

We are thankful to the many people involved in the coho reintroduction feasibility study. Bonneville Power Administration funded the study. Roy Beaty administered funding and contracting. Tom Scribner, project manager, provided program oversight and direction for the Mid-Columbia Coho Project. Jamie Hallman, Kevin Swager, Matthew Clubb, Clendon Allen, Kenneth Allen, Arlene Heemsah, Michael Whitefoot, Barry Hodges, Kenneth Allen, Edward Gutzweiler, Paul Edwards, Shekinah Saluskin, Jason Hickman, Andrew Carr, Conner Parrish, Leonard Blake, Casey Heemsah, Kory Kuhn, Brady Miller assisted with field data collection. Debbie Azure, Loverne George, Monica Clark and Louiza Umtuch provided much needed administrative support for this program. Doug Neeley (International Statistical Training and Technical Services) provided statistical consultation for survival estimates of PIT-tagged fish. Several employees at WDFW provided assistance throughout the year, including the Eastbank FH crew during broodstock collection; JB Walter and Charlie Snow provided the population estimates of naturally produced coho emigrating from the Wenatchee and Methow rivers as well as adult coho carcass information.

8.0 LITERATURE CITED

Busack, C., B. Watson, T. Pearsons, C. Knudsen, S. Phelps, M. Johnston. 1997. Yakima fisheries project spring Chinook supplementation monitoring plan. Unpublished Yakima/Klickitat Fisheries Project internal report, Toppenish, Washington.

Chapman, D. W. 1986. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Transaction of the American Fisheries Society 115:662-670.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin-past and present. United States Fish and Wildlife Service. Special scientific report-Fisheries Number 618. Washington D.C.

HGMP. 2002. Hatchery and genetics management plan: Mid-Columbia coho reintroduction program. Yakama Nation, Washington Department of Fish and Wildlife, Bonneville Power Administration.

Mullan J.W. 1983. Overview of Artificial and Natural Propagation of Coho Salmon (*Oncorhynchus kisutch*) on the mid-Columbia River. Fisheries Assistance Office, U.S. Fish and Wildlife Service, Leavenworth, Washington. December 1983.

Murdoch, K.G. and M.G. Collins. 2008. Integrated status and effectiveness monitoring program – Expansion of existing smolt trapping program in Nason Creek. *Prepared for*: Bonneville Power Administration project #2003-017-00. Portland OR.

Murdoch, K.G., S.A. Prevatte, and C.M. Kamphaus. 2006. Mid-Columbia coho reintroduction feasibility study: 2005 Monitoring and Evaluation Report, February 1, 2004 through January 31, 2005. *Prepared for:* Bonneville Power Administration, project #1996-040-00. Portland, OR.

Yakama Nation Fisheries Resource Management (YN FRM) 2008. Mid-Columbia Coho Restoration Master Plan. *Prepared for*: Northwest Power and Conservation Council.

Neeley, D. Release-to-McNary survival indices of 2007 releases into the Wenatchee and Methow Rivers. *Prepared for:* Yakama Nation Fisheries Resource Management. Toppenish WA.

Stephenson, A., D. Fast. 2004. Yakima/Klickitat Fisheries Project; Monitoring and Evaluation of Avian Predation on Juvenile Salmonids on the Yakima River, Washington", 2003-2004 Annual Report, Project No. 199506325, 42 electronic pages, (BPA Report DOE/BP-00013769-2)

Williams, J.E. 1951. Manual of Fisheries Service Methods II, Chapter 13. *Revised by Schneider, J.C.* 2000.

APPENDIX A: 2014 NASON CREEK SMOLT TRAP REPORT

Population Estimates for Juvenile Salmonids in Nason Creek, WA

2014 Annual Report

Prepared by:
Bryan Ishida
Cory Kamphaus
Keely Murdoch

YAKAMA NATION
FISHERIES RESOURCE MANAGEMENT
Toppenish, WA 98948

Prepared for:

Public Utility District No. 2 of Grant County
Ephrata, Washington 98823

and

U.S Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
Portland OR, 97208-3621

Project No. 1996-040-00

ABSTRACT

In 2014, Yakama Nation Fisheries Resource Management (YN FRM) monitored emigration of naturally spawned juvenile coho salmon as well as Endangered Species Act (ESA) listed Upper Columbia River (UCR) spring Chinook salmon and summer steelhead in Nason Creek. This report summarizes juvenile abundance and freshwater survival estimates for each of these species. Fish were captured using a 1.5m rotary smolt trap between March 1 and November 30, 2014. We collected 2,693 spring Chinook salmon, 1,266 summer steelhead, 4 bull trout, and 24 coho; all of natural origin and varying age classes. Daily fish abundances for spring Chinook, steelhead, and coho were expanded by stream discharge-to-trap efficiency regression. All estimates were made with a 95% confidence interval (CI) with total emigration estimates for BY2012 spring Chinook juveniles and coho juveniles of 32,671 (± 4,863) and 479 (± 237), respectively. We estimated the total BY2011 summer steelhead emigration at the trap to be 13,605 (± 3,525). Egg-to-emigrant survival rates for BY2012 Chinook and BY2012 coho were 1.9% and 0.8%, respectively. The egg-to-emigrant survival rate for BY2011 summer steelhead was 0.9%. Productivity, as measured by emigrants-per-redd, for spring Chinook, summer steelhead, and coho was 79, 58 and 23, respectively.

CONTENTS

CONTENTS xlvi
LIST OF FIGURES xlviii
LIST OF TABLES l
ACKNOWLEDGEMENTS lii
1.0 INTRODUCTION 53
1.1 Watershed Description 53
2.1 Trapping Equipment and Operation 56
2.2 Biological Sampling 57
2.3 PIT Tagging 57
2.4 Mark-Recapture Trials 58
2.5 Data Analysis 58
2.5.1 Estimate of Abundance 58
2.5.2 Emigration During The Non-Trapping Period 61
2.5.3 Production and Survival 61
3.0 RESULTS 62
3.1 Dates of Operation 62
3.2 Daily Captures and Biological Sampling 62
3.2.1 Spring Chinook Yearlings (BY2012) 62
3.2.2 Spring Chinook Subyearlings (BY2013) 63
3.2.3 Summer Steelhead 64
3.2.4 Hatchery Steelhead Smolts 65
3.2.5 Bull Trout 66
3.2.6 Coho Yearlings (BY2012) 67
3.2.7 Coho Subyearlings (BY2013) 68
3.2.8 Hatchery Coho Smolts (BY2012) 68
3.3 Remote Parr Tagging (BY2013 Spring Chinook) 69
3.4 Trap Efficiency Calibration and Population Estimates 70
3.4.1 Spring Chinook Yearlings (BY2012) 70
3.4.2 Spring Chinook Subyearlings (BY2013) 72
3.4.3 Summer Steelhead 73

3.4.4 Coho Yearlings (BY2012) 76
3.4.5 Coho Subyearlings (BY2013) 78
3.5 PIT Tagging 78
3.6 Incidental Species 79
3.7 ESA Compliance 79
4.0 DISCUSSION 81
5.0 LITERATURE CITED 86
APPENDIX A. Daily Stream Discharge and Stream Temperature 87
APPENDIX B. Daily Trap Operation 92
APPENDIX C. Regression Models 96
APPENDIX D. Historical Morphometric Data 101

LIST OF FIGURES

Figure 1. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location. 54

Figure 2. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2014. 55

Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station in 2014. 55

Figure 4. Daily catch of BY2012 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014. 63

Figure 5. Daily catch of BY2013 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2014. 64

Figure 6. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to November 30, 2014. Estimates of fish passage during trap interruptions are not depicted. 65

Figure 7. Daily catch of hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014. 66

Figure 8. Daily catch of BY2012 naturally produced coho yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014. 67

Figure 9. Daily catch of BY2013 naturally produced coho subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2014. 68

Figure 10. Daily catch of BY2012 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014. 69

Figure 11. Daily detections of remote-tagged BY2013 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2014 and March 2015. 70

Figure 12. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2012. 72

Figure 13. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2011. 76

Figure 14. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek naturally-produced coho, BY 2004 to 2012... 78

Figure 15. Comparison of wild spring Chinook abundance estimates (BY2007-2012) made at the White River, Nason Creek, and Chiwawa River smolt traps.. 82

Figure 16. Comparison of egg-to-emigrant survival (BY 2007-2012) and egg deposition for Nason Creek, Chiwawa River, and White River spring Chinook... 83

LIST OF TABLES

Table 1. Summary of Nason Creek rotary trap operation. 62

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap. 63

Table 3. Summary of length, weight and condition factor by age class of wild summer steelhead emigrants and hatchery steelhead captured at the Nason Creek rotary trap. 65

Table 4. Summary of length, weight and condition factor for bull trout captured at the Nason Creek rotary trap. 66

Table 5. Summary of length and weight sampling of juvenile coho salmon captured at the Nason Creek rotary trap in 2014. 67

Table 6. Trap efficiency trials conducted with BY2012 wild spring Chinook yearlings. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial*. 70

Table 7. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek spring Chinook salmon. 71

Table 8. Trap efficiency trials conducted with BY2013 wild spring Chinook subyearlings. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial*. 73

Table 9. Efficiency trials conducted with wild summer steelhead juveniles. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial*. 74

Table 10. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead. 74

Table 11. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek coho salmon. 76

Table 12. Number of PIT tagged coho, Chinook, and steelhead with shed rates at the Nason Creek rotary trap in 2014. 78

Table 13. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2014. 79

Table 14. Summary of ESA species and coho salmon mortality at the Nason Creek rotary trap. 79

ACKNOWLEDGEMENTS

This project is part of a basin wide monitoring program requiring close coordination between multiple agencies and contractors. We greatly appreciate the hard work of the YN FRM crew members including Matthew Clubb, Jamie Hallman, Arlene Heemsah, Barry Hodges, Tim Jeffris, and Kevin Swager who maintained and operated the trap during all hours including nights/weekends and through challenging weather conditions. We would like to also thank the Wenatchee River Ranger District (U.S. Forest Service) and Mr. Duane Bolser for providing use of the trapping site and accommodating the needs of this project as well as to Peter Graf (Grant County PUD) for administering contracting and funding. Finally, thank you to Mike Hughes, Andrew Murdoch, Ben Truscott, and J.B. Walters (Washington Department of Fish and Wildlife), and Tracy Hillman (Bio Analysts, Inc.) for shared data and smolt trap methodologies.

1.0 INTRODUCTION

Beginning in the fall of 2004, YN began operating a rotary smolt trap in Nason Creek for nine months per year. Prior to 2004, the smolt trap was operated on a limited basis solely for hatchery coho predation studies. This project is a cost share between the YN's Mid-Columbia Coho Reintroduction and Grant County PUD's Hatchery Monitoring Plan. Trap operations were conducted in compliance with ESA consultation specifically to address abundance and productivity of spring Chinook, steelhead trout, and coho salmon in Nason Creek.

Within this document we will report:

> 1) Juvenile abundance and productivity of spring Chinook salmon (tkwínat) *Oncorhynchus tshawytscha*, steelhead trout (shúshaynsh) *Oncorhynchus mykiss* and coho salmon (súnx) *Oncorhynchus kisutch* in Nason Creek.
>
> 2) Emigration timing of spring Chinook salmon, steelhead trout and coho salmon emigrating from Nason Creek.

The data presented will be directly used to address Objective 2 in the Monitoring and Evaluation Plan for PUD Hatchery Programs (Hillman et al. 2013) on a 5-year analytic cycle:

> **Objective 2: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity of supplemented stocks (Hillman et al. 2013).**

1.1 Watershed Description

The Nason Creek watershed drains 65,600 acres of alpine glaciated landscape where high precipitation and moderate rain on snow recurrence controls the hydrology and aquatic communities. Nason Creek originates near the Cascade crest at Stevens Pass and flows east for approximately 37 river kilometers (rkm) until joining the Wenatchee River at rkm 86.3 just below Lake Wenatchee. Both smolt trap locations employed in 2014 (see section 2.1 Trapping Equipment and Operations) were downstream from the majority of spring Chinook and steelhead spawning grounds (Figure 1). There are 26.4 rkm along the mainstem accessible to anadromous fish in Nason Creek. Private land ownership comprises 52,300 acres (79.7%) of the watershed while 12,800 acres (19.5%) are federal and 480 acres (0.1%) are state owned (USFS et al. 1996).

The channel morphology of the lower 25 kilometers of Nason Creek has been impacted by development of highways, railroads, power lines, and residential development resulting in channel confinement and reduced side-channel habitat. The present condition is a low gradient (< 1.1%), low sinuosity (1:2 to 2:0 channel-to-valley length ratio) and depositional channel (USFS et al. 1996). Peak runoff typically occurs in May and June with occasional high water produced by rain on snow events in October and November.

In 2014, mean daily discharge for Nason Creek was 452 cfs with mean daily stream temperatures ranging from 0.0°C to 18.6°C (Figure 2 & 3). Spring and fall freshets included multiple high-water events exceeding 12-year mean discharge levels. Most significant of these was a late November rain-on-snow event that pushed discharge levels to nearly 3,000 cfs. Water temperatures in Nason Creek were well below the 12-year mean values in the spring of 2014. Conversely, fall water temperatures were unseasonably high.

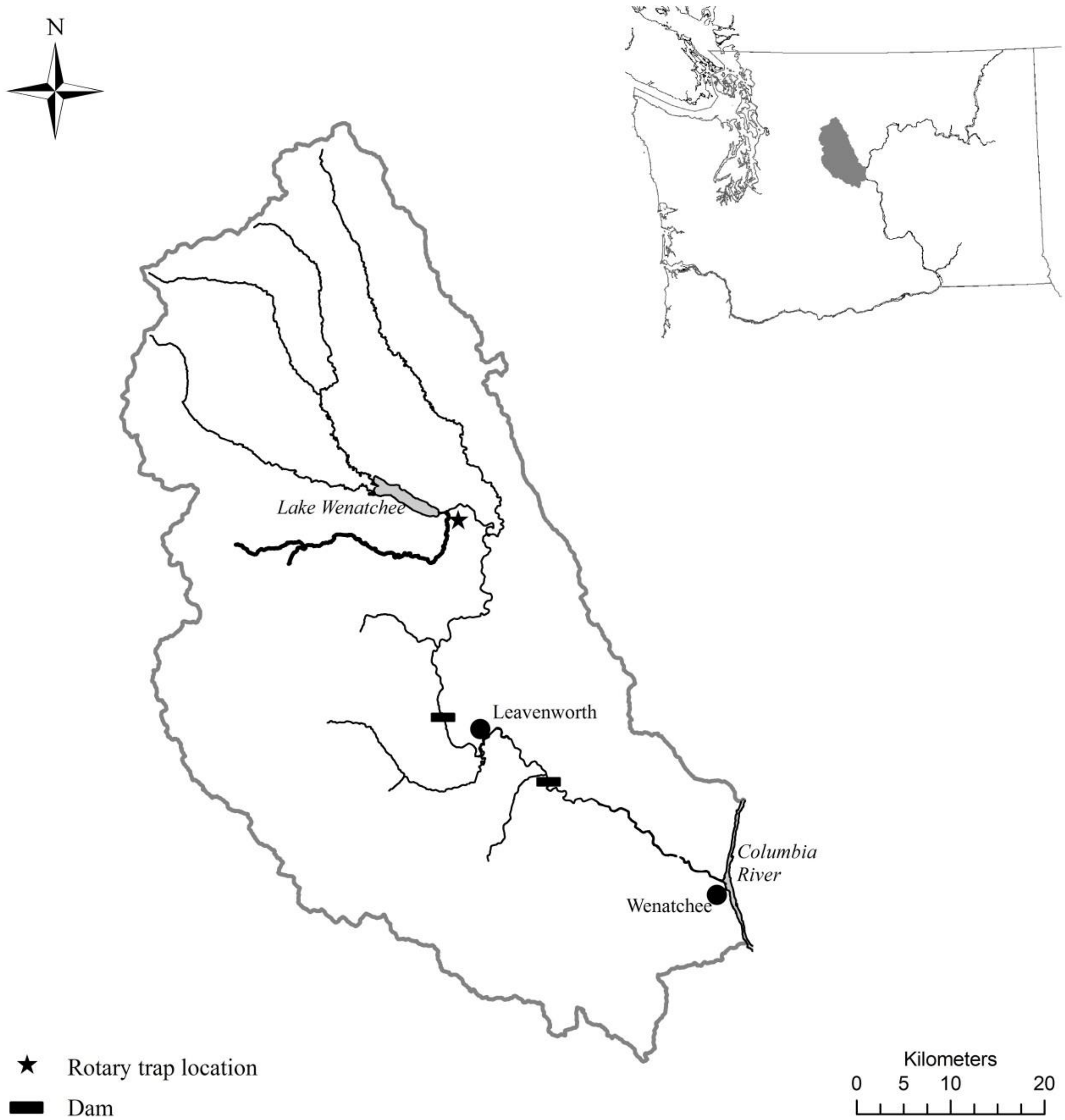


Figure 8. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location.

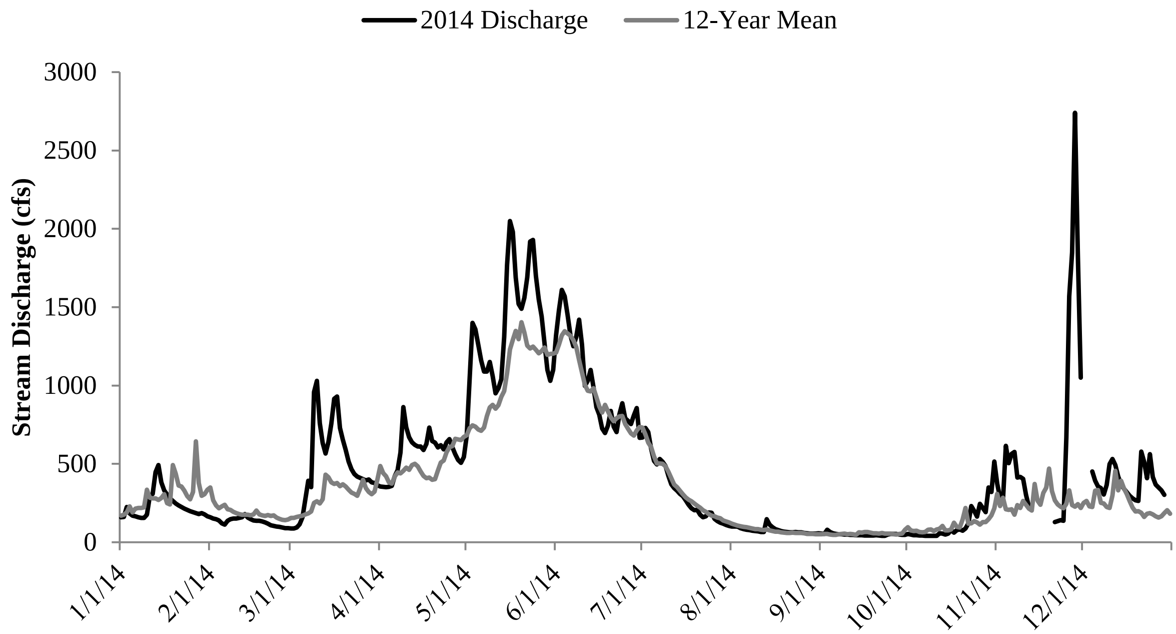


Figure 9. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2014.

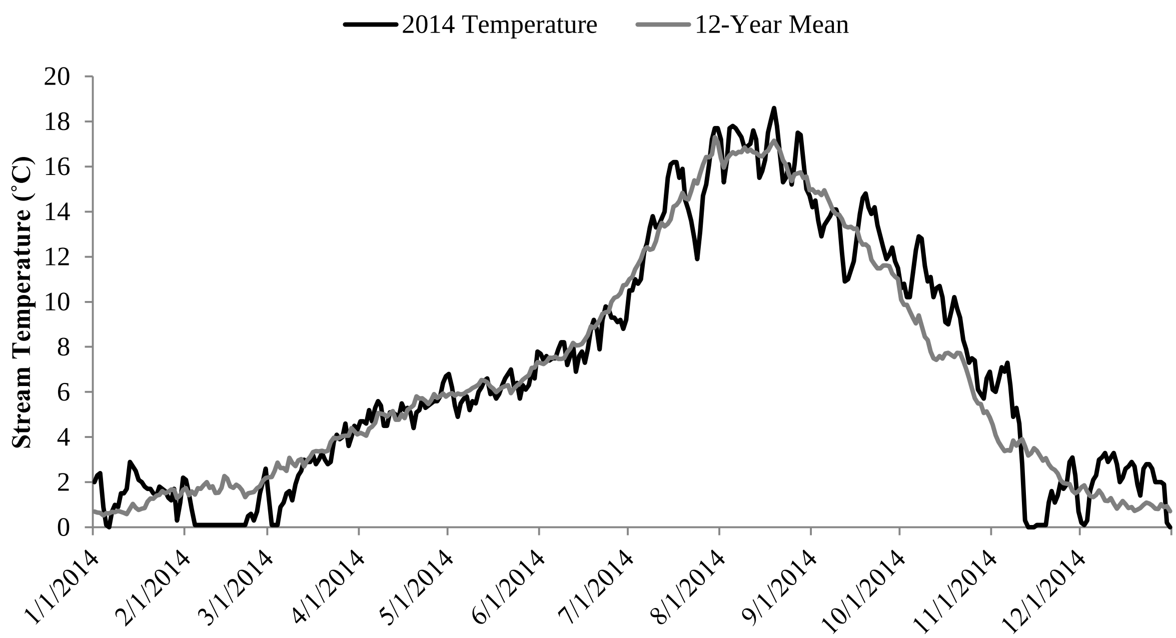


Figure 10. Mean daily water temperature at the Nason Creek DOE stream monitoring station in 2014.

2.0 METHODS

2.1 Trapping Equipment and Operation

In 2014, two different trap locations were employed; the originally used location herein referred to as “campground” (rkm 0.9), and new location herein referred to as “Bolser” (rkm 0.3). Initial trap operations began on March 1 at campground and extended until June 25. The trap was then relocated to Bosler, where it was operated from July 1 to November 30. Equipment at both sites included the same 1.5m rotary smolt trap and wire rope suspension system of rigging. Whereas campground required seasonal changes in the anchoring of the trap to accommodate campground traffic, cable configuration at Bolser remained static throughout operations. The move to Bolser is intended as a permanent relocation with campground no longer being utilized.

At both locations, the smolt trap was operated continually 24 hours per day, 7 days per week for the majority of their respective seasons. During spring snowmelt, operations at campground occurred only during hours of darkness in order to minimize trap damage and capture mortality, while retaining the ability to sample during periods of peak fish movement. Without the threat of vandalism posed during periods of peak use at the campground, summer operations at Bolser were not modified (daytime suspension) as required at the previous site.

On a daily basis, fish were removed from the primary collection box and retained in separate shore-anchored holding boxes until removed for efficiencies trials (up to 72 hours; Section 7 permit 2011/05645). A rotating drum-screen constantly removed small debris from the live box to avoid fish injury. All changes/modifications to the trap as well as periods of stoppage were noted. During periods when the trap was not operating (e.g. high discharge, high debris or mechanical malfunction), the number of target species captured was estimated. The estimated number of fish captured was calculated using the average number of fish captured three days prior and three days after the break in operation. This estimate of daily capture was incorporated into the overall emigration estimate.

2.2 Biological Sampling

Trap operating procedures and techniques followed a standardized basin-wide monitoring plan developed by the Upper Columbia Regional Technical Team (RTT) for the Upper Columbia Salmon Recovery Board (UCSRB; Hillman 2004), which was adapted from Murdoch and Petersen (2000).

All fish were enumerated by species and size class. Fish to be sampled were anesthetized in a solution of MS-222, weighed with an electronic scale and measured in a wetted trough-type measuring board. Anesthetized fish received oxygen through aquarium bubblers and were allowed to fully recover before being either released downstream of the trap or used in efficiency trials. Fork length (FL) and weight were recorded for all fish except when large numbers of fry or non-target species were collected; a sub-sample of 25 fish were measured and weighed while the remaining fish were tallied. Weight was measured to the nearest 0.1 gram and FL to the nearest millimeter. We used these data to calculate a Fulton-type condition factor (K-factor) using the formula:

$$K = (W/L^3) \times 100{,}000$$

Where K = Fulton-type condition metric, W = weight in grams, L = fork length in millimeters and 100,000 is a scaling constant.

Scale samples were collected from steelhead measuring ≥ 60 mm FL so that age and brood year could be assigned. Samples were collected according to the needs and protocols set by Washington Department of Fish and Wildlife (WDFW), who conducted the analysis and provided YN with results. Tissue samples were collected from spring Chinook and steelhead for DNA analysis. Samples from spring Chinook and steelhead were retained for reproductive success analyses conducted by WDFW and National Marine Fisheries Service (NMFS). All target salmonids were classified as either natural or hatchery origin by physical appearance, presence/absence of coded wire tags (CWTs), or post-orbital elastomer tags. Developmental stages were visually classified as fry, parr, transitional, or smolt. Fry were defined as newly emerged fish with or without a visible yolk sac and a FL measuring < 50 mm. Age-0 coho and spring Chinook salmon captured before July 1 were considered 'fry' and were excluded from subyearling population estimates because of the uncertainity that these fish were actively migrating (UCRTT, 2001).

2.3 PIT Tagging

All natural origin Chinook, steelhead and coho measuring ≥ 60mm were PIT tagged. Once anesthetized, each fish was examined for external wounds or descaling, then scanned for the presence of a previously implanted PIT tag. If a tag was not detected, a pre-loaded 12mm Digital Angel 134.2 kHz type TX 1411ST PIT tag was inserted into the body cavity using a Biomark MK-25 Rapid Implant Gun. Each unique tag code was electronically recorded along with date of tag implantation, date of fish release, tagging personnel, FL, weight, and anesthetic bath temperature. Data were entered using P3 software and submitted to the PIT Tag Information System (PTAGIS). PIT tagging methods were consistent with methodologies described in the PIT Tag Marking Procedures Manual (CBFWA 1999) as well as in 2008 ISEMP protocols (Tussing 2008).

After marking and sampling, fish were held for a minimum of 24-hours in holding boxes at the trap to; a) ensure complete recovery, b) assess tagging mortality, and c) determine a PIT tag shed rate. Fish that were not used in mark-recapture trials were released downstream from the trap. Fish used in mark-recapture trials at campground were then transported in 5-gallon buckets 1.0 rkm upstream and released at nautical twilight from an automated release box. Mark groups released during operation at Bolser were released by hand 0.8 rkm above the trap at nautical twilight. Fish released by hand were distributed evenly along apposing banks in pools and other protected areas.

2.4 Mark-Recapture Trials

Groups of marked juveniles were released during a range of stream discharges in order to determine the trapping efficiency. PIT tags were the only method of marking used in 2014. These releases followed the protocols described in Hillman (2004), in which the author suggests a minimum sample size of 100 fish for each mark-recapture trial. Although 100 fish/trial represented the ideal mark group, low abundance of fish often required mark-recapture trials be completed with smaller sample sizes. To achieve the largest marked group possible, we combined catch over a maximum of 72 hours. Fish being held for mark-recapture trials were kept in auxiliary live boxes attached to the end of each pontoon or floating holding boxed anchored to the stream bank. A pre-season, minimum mark group size for each species/life stage was initially determined based on past regression models. In light of high abundance, minimum trial sizes could be raised to a more robust mark group with the intention of strengthening existing regression models.

Each mark-recapture trial was conducted over a three-day (72 hour) period to allow time for passage or capture. Completed trials were only considered invalid if an interruption to trapping occurred or proper pre-release procedures were not followed. Trials resulting in zero recaptures were included in the efficiency regression (if determined valid once vetted through release/recapture protocols) as allowed by the new method of observed trap efficiency calculation. The model used (Bailey) employs use of recaptures +1 in the calculation of efficiency as a mode of bias correction. As a result, even trials yeilding no recaptures can be included in regression modeling (See equation 3 in **2.5.1 Estimate of Abundance**).

2.5 Data Analysis

2.5.1 Estimate of Abundance

A recent WDFW review of smolt monitoring programs in the Wenatchee basin suggested that changes in the calculations for estimating abundance and its associated variance were necessary. Calculation of daily and seasonal smolt abundance changed only slightly. More significant changes were made to the variance estimator making the calculations more complex. The following describes the revised calculation of the point estimate, variance, and standard error of seasonal smolt abundances based on regression relationships.

Seasonal juvenile migration, N, was estimated as the sum of daily migrations, N_i, i.e., $N = \sum_i N_i$, and daily migration was calculated from catch and efficiency:

$$\hat{N}_i = \frac{C_i}{\hat{e}_i}, \quad \textbf{(1)}$$

where C_i = number of fish caught in period *I*;

$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2(b_0 + b_1 flow_i)$,

where b_0 is estimated intercept and b_1 is the estimated slope of the regression.

The regression parameters b_0 and b_1 are estimated using linear regression for the model:

$$\arcsin\left(\sqrt{e_k^{obs}}\right) = \beta_0 + \beta_1 flow_k + \varepsilon, \quad \textbf{(2)}$$

where e_k^{obs} = observed trap efficiency of Eq. 2 for trapping period *k*;

β_0 = intercept of the regression model;

β_1 = slope parameter;

ε = error with mean 0 and variance σ^2.

In Equation 2, the observed trap efficiency, e_k^{obs}, is calculated as follows,

$$e_k^{obs} = \frac{r_k + 1}{m}. \quad \textbf{(3)}$$

The estimated variance of seasonal migration is calculated from daily estimates as:

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var(N_i)}_{Part\,A} + \underbrace{\sum_i \sum_j Cov(N_i, N_j)}_{Part\,B},$$

or,

$$Var\left(\sum_{i=1}^{n} \hat{N}_i\right) = \underbrace{\sum_i Var\left(\frac{(C_i + 1)}{\hat{e}_i}\right)}_{Part\,A} + \underbrace{\sum_i \sum_j Cov\left(\frac{(C_i + 1)}{\hat{e}_i}, \frac{(C_j + 1)}{\hat{e}_j}\right)}_{Part\,B}. \quad \textbf{(4)}$$

Part A of equation 4 is the variance of daily estimates. Part B is the between-day covariance. Note that the between-day covariance exists only for days that use the same trap efficiency model. If, for example, day 1 is estimated with one trap efficiency model, and day 2 estimated from a different model, then there is no covariance between day 1 and day 2. The full expression for the estimated variance:

$$\hat{Var}\left(\sum_{i=1}^{n}\hat{N}_i\right) = \underbrace{\sum_i \hat{N}_i^2\left(\frac{N_i\hat{e}_i(1-\hat{e}_i)}{(C_i+1)^2} + \frac{4(1-\hat{e}_i)}{\hat{e}_i}\hat{Var}(b_0 + b_1 flow_i)\right)}_{PartA} +$$

$$\underbrace{\sum_i\sum_j 4\left(\hat{N}_i(1-\hat{e}_i)\right)\left(\hat{N}_j(1-\hat{e}_j)\right)\cdot\left[\hat{Var}(b_0) + flow_i\, flow_j \hat{Var}(b_1)\right]}_{PartB}$$

where $\hat{Var}(b_0 + b_1 flow_i) = M\hat{S}E\left(1 + \frac{1}{n} + \frac{\left(flow_i - \overline{flow}\right)^2}{(n-1)s_{flow}^2}\right)$, and $\hat{Var}(b_0)$ and $\hat{Var}(b_1)$ are

obtained from regression results. In Excel, the standard error (SE) of the coefficients is provided. The variance is calculated as the square of the standard error, SE^2.

In cases when there was no significant flow-efficiency relationship (i.e., low correlation), then a pooled, or average trap efficiency will suffice for the stratum. The estimator is calculated as follows:

$$\hat{\hat{e}} = \frac{\sum_{j=1}^{k} r_j}{\sum_{j=1}^{k} m_j}$$

where $\hat{\hat{e}}$ = the average or pooled trap efficiency for the stratum;

m_j = the number of smolts marked and released in efficiency trial j for the stratum;

r_j = the number of smolts recaptured out of m_j marked fish in efficiency trial j.

Abundance for a trapping period is estimated as:

$$\hat{N}_i^{pooled} = \frac{C_i}{\hat{\hat{e}}},$$

,and total stratum abundance is:

$$N^{pooled} = \sum_i \hat{N}_i^{pooled}.$$

The variance of seasonal abundance takes into account the variability in catch numbers that are a result of binomial sampling (Part A), the pooled variance of trap efficiency, $\hat{\hat{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

$$\hat{Var}\left(\sum_{i=1}^{n}\hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i\left(1-\hat{\hat{e}}\right)}{\hat{\hat{e}}}\right)}_{PartA} + \underbrace{\frac{Var\left(\hat{\hat{e}}\right)}{\hat{\hat{e}}^2}\sum_i \hat{N}_i^2}_{PartB} + \underbrace{\frac{Var\left(\hat{\hat{e}}\right)}{\hat{\hat{e}}^2}\sum_i\sum_j \hat{N}_i\hat{N}_j}_{PartC}.$$

The Part B and Part C terms are combined in the calculation as a new Part B:

$$\hat{Var}\left(\sum_{i=1}^{n}\hat{N}_i^{pooled}\right) = \underbrace{\left(\sum_i \frac{\hat{N}_i\left(1-\hat{\hat{e}}\right)}{\hat{\hat{e}}}\right)}_{PartA} + \underbrace{\frac{Var\left(\hat{\hat{e}}\right)}{\hat{\hat{e}}^2}\left[\sum_i \hat{N}_i^2 + \sum_i\sum_j \hat{N}_i\hat{N}_j\right]}_{PartB}.$$

The variance of $\hat{\hat{e}}$ is calculated as:

$$\hat{Var}\left(\hat{\hat{e}}\right) = \hat{Var}\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\hat{e}}_k m_k\right)^2}{\overline{m}^2 n(n-1)}$$

where $\overline{m}$ is the average release size across all efficiency trial, $\frac{\sum_{k=1}^{n} m_k}{n}$.

Confidence intervals were calculated using the following formulas:

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

The single M-R estimator of abundance carries a set of well documented assumptions (Everhart and Youngs 1981; Seber 1982),

1. The population is closed to mortality.
2. The probability of capturing a marked or unmarked fish is equal.
3. Marked fish were randomly dispersed in the population prior to recapture.
4. Marking does not affect probabilities of capture.
5. Marks were not lost between the time of release and recapture.
6. All marks are reported upon recapture.
7. The number of fish in the trap, C, is fully enumerated and known without error.

2.5.2 Emigration During The Non-Trapping Period

An estimate of spring chinook emmigration during the non-trapping period (December 1 through February 28) was calculated using remote-tagged spring chinook parr and the lower Nason Creek PIT tag array (NAL). A flow-detection efficiency regression was developed using mark-groups previously released to test the efficiency of the smolt trap. Daily spring Chinook detections at NAL and the developed regression were then applied to the Bailey estimator, as was peformed with daily trap abundance data(See section **2.5.1 Estimate of Abundance**).

2.5.3 Production and Survival

Production estimates by age class were summed to produce a total emigration estimate. For spring Chinook and coho, estimates of fall migrant parr were added to subsequent spring smolt estimates to generate a single brood year estimate. For steelhead, a single brood year may require up to three years for emigration from Nason Creek to occur. Pending scale analysis, steelhead captured in 2014 were aged via an age-length histogram built upon previously analyzed scale samples. For all three species, egg-to-emigrant estimates were calculated by dividing estimated emigrants by approximated egg deposition during a spawning brood (average fecundity used to determine egg deposition derived from WDFW Chiwawa broodstock spawning). The number of emigrants-per-redd for each brood year was calculated by dividing the total emigrant estimate by the number of redds counted during spawning ground surveys.

3.0 RESULTS

3.1 Dates of Operation

The Nason Creek trap was installed at campground on February 26, 2014 (started on March 1) and removed on June 25 for relocation to Bolser. Installation at Bolser occurred on June 26 and operations began on July 1. Removal of the trap occurred on December 2 (operations concluded November 30). The trap was operated continuously 24 hours a day, 7 days per week including periods of extreme high flows (>2,000cfs) associated with spring snowmelt. Interruptions to trapping at campground were mainly caused by ice formation in the cone at the onset of the season and relocation of the trap in late June (Table 1). Interruptions at Bolser were more frequent and caused primarily by debris and low discharge levels (Table 1).

Table 22. Summary of Nason Creek rotary trap operation.

Date of Trap Operations	Trap Status	Description	Days
March 1 to June 30 (Campground)	Operating	Continuous data collection.	113
	Interrupted	Interrupted by debris, ice and/or low flows.	2
	Pulled	Intentionally pulled to prevent harm to fish or protect the trap during high flows.	7
July 1 to November 30 (Bolser)	Operating	Continuous data collection.	114
	Interrupted	Interrupted by debris and/or low flows.	27
	Pulled	Intentionally pulled due to low discharge levels or ice formation	12

3.2 Daily Captures and Biological Sampling

3.2.1 Spring Chinook Yearlings (BY2012)

Between March 1 and June 30, a total of 464 wild Chinook yearlings were captured at the trap (Figure 4). The majority of these fish were collected prior to the onset of major spring snowmelt, with peak catch occuring on March 25. Following a significant increase in stream discharge, capture numbers dropped substantially with the last emigrating Chinook yearling captured on May 21. Daily catch estimates during the initial trap stoppage in March (March 1-4) were not made due to a lack of pre-stoppage data and influence of coinciding drastically changing flows. Mean FL and weight for Chinook yearlings was 89.5mm (n = 464; SD = 6.9) and 7.5g (*n* = 464; *SD* = 1.8; Table 2), respectively. Tissue sample were collected from 456 fish for an ongoing, parental-based DNA analysis by WDFW. There were no yearling Chinook mortalitites.

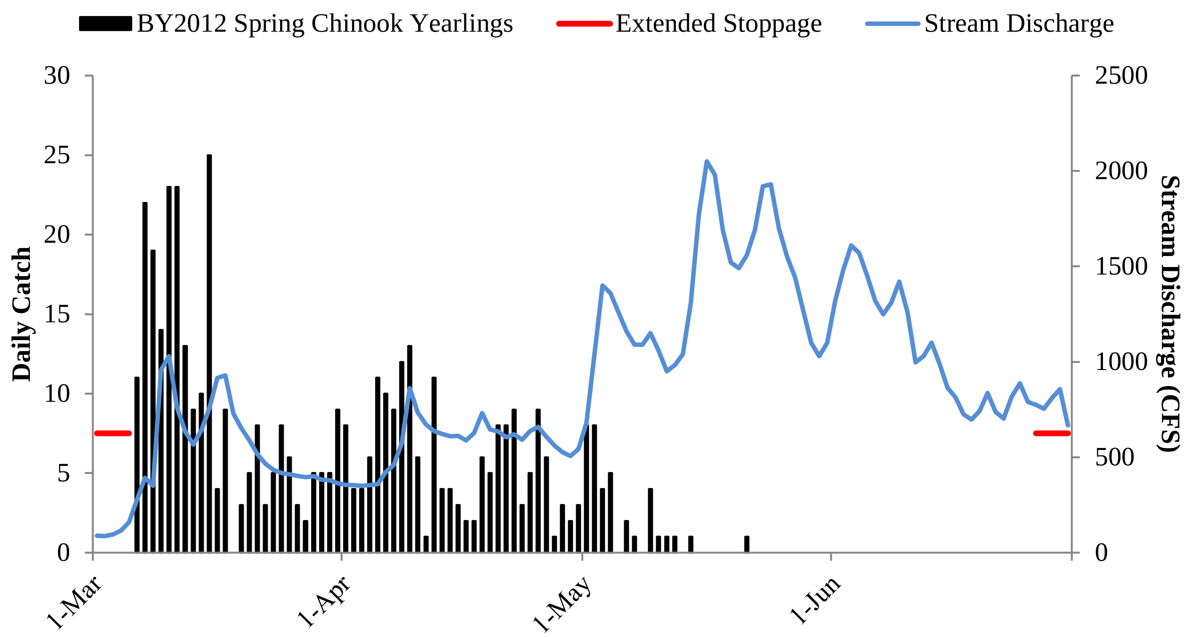


Figure 11. Daily catch of BY2012 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014.

Table 23. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2012	Wild Chinook Yearling Smolt	89.5	464	6.9	7.5	464	1.8	1.0
2013	Wild Chinook Subyearling Fry	40.1	677	5.2	0.9	221	0.5	1.4
2013	Wild Chinook Subyearling Parr	69.1	1,549	12.3	3.8	1,547	2.3	1.2

3.2.2 Spring Chinook Subyearlings (BY2013)

A total of 1,550 wild spring Chinook subyearling parr were captured between July 1 and November 30, with an additional 679 subyearling fry captured prior to July 1 (Figure 5). A peak daily capture of 93 subyearling Chinook parr occurred in July as snowmelt-driven high water subsided. The initial peak in subyearling parr catch decreased accordingly with discharge levels. A second major peak in parr catch occurred in late October at the onset of the first fall freshets. Mean FL and weight among fall subyearling parr was 69.1mm (*n* = 1,549; *SD* = 12.3) and 3.8g (*n* = 1,547; *SD* = 2.3), respectively. We estimate that an additional 349 Chinook subyearling parr would have been captured if the trap had been operated without interuption during this period: 200 Chinook during short discreet stoppages (≤3days in duration) and 149 chinook during prolonged suspension due to low flow or ice accumulation. A total of 11 subyearling Chinook (3 fry and 8 parr) mortalities occurred in 2014. Causes of death included trapping mortality, tagging/handing mortality, and pre-existing fungal infection/poor condition.

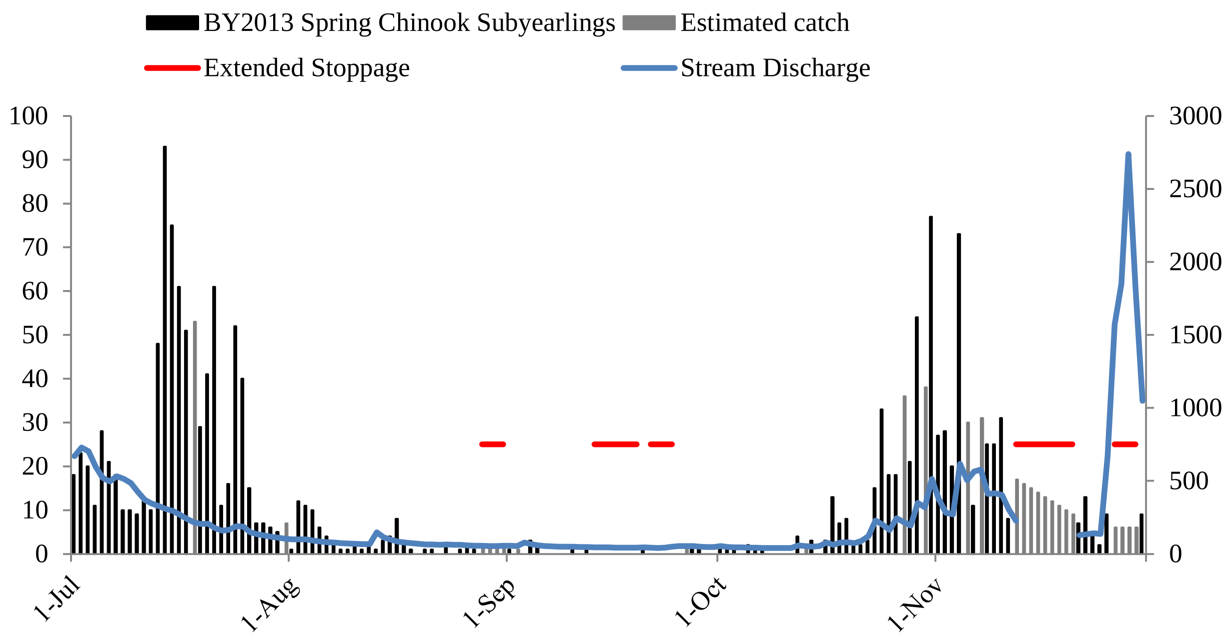


Figure 12. Daily catch of BY2013 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2014.

3.2.3 Summer Steelhead

A total of 1,267 wild summer steelhead juveniles were captured throughout the season from March 1 to November 30 with a peak catch of 40 fry on September 14 (Figure 6). We estimated that an additional 35 age-1 juveniles would have been captured if there had been no interruptions to trapping during the migratory period (Mar 1 to July 31). Histogram analysis of known steelhead ages sampled from 2005 to 2012 allowed us to estimate ages of fish captured in 2014 using FL. We estimate that of the total steelhead captured, 491 were young-of-the-year, 745 were age-1, and 30 were age-2. One steelhead did not have FL measurements taken and could not be aged. Subyearling steelhead had a mean FL of 50mm (n = 490; SD = 12.8), and a mean weight of 1.7(n = 389; SD = 1.1). The majority of steelhead juveniles captured were age-1 parr emigrating past the trap in spring. Mean FL and weight of age-1 fish was 82mm (n = 745; SD = 13.6; Table 3) and 6.3g (n = 745; SD = 3.5), respectively. Age-2 steelhead were caught primarily in the spring, with only one fish being captured after July 31. Mean FL and weight of age-2 fish was 145mm (n = 30; SD = 16.5) and 33.0g (n = 30; SD = 13.4), respectively. Tissue samples were not taken from wild-origin in 2014 as per the request WDFW personnel. Scales were taken from a sub-sample (n = 852) to be used for future age analyses. There was one steelhead fry trapping mortality (See **3.6 ESA Compliance**).

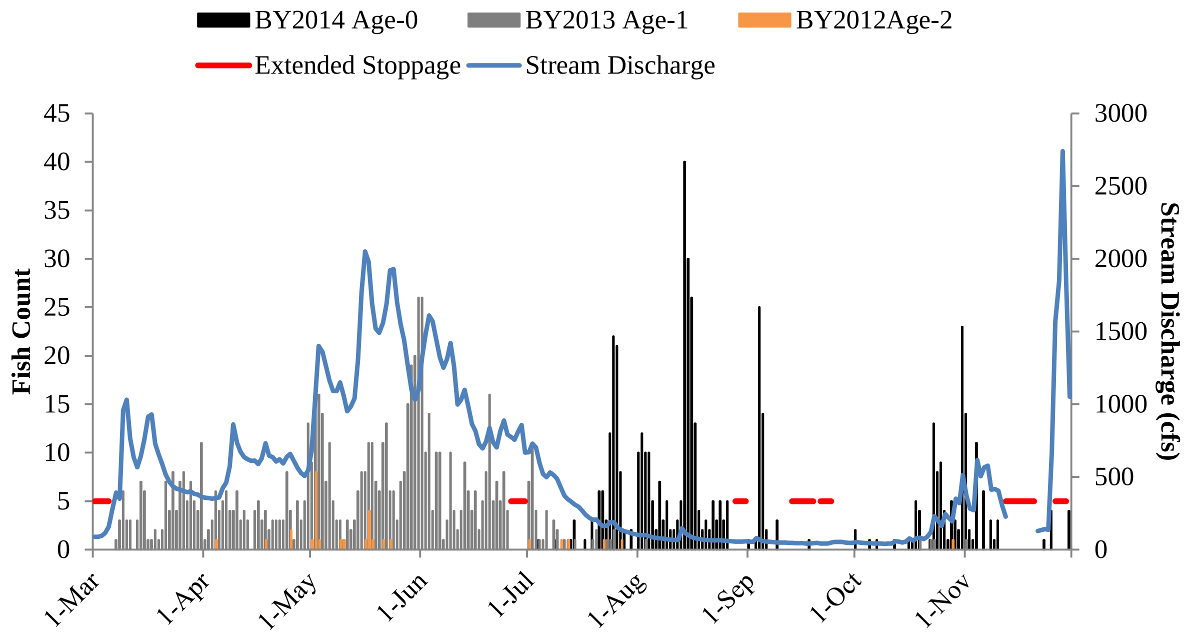


Figure 13. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to November 30, 2014. Estimates of fish passage during trap interruptions are not depicted.

Table 24. Summary of length, weight and condition factor by age class of wild summer steelhead emigrants and hatchery steelhead captured at the Nason Creek rotary trap.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2014	Wild Summer Steelhead (Age-0)	49.6	490	12.8	1.7	389	1.1	1.4
2013	Wild Summer Steelhead (Age-1)	82.2	745	13.6	6.3	745	3.5	1.1
2012	Wild Summer Steelhead (Age-2)	145.1	30	16.5	33	30	13.4	1.1
2011	Wild Summer Steelhead (Age-3)	—	—	—	—	—	—	—
2013	Hatch. Summer Steelhead Smolt	173.4	632	18.7	52.6	633	15.9	1.0

3.2.4 Hatchery Steelhead Smolts

During the months of April and May, WDFW released a total of 90,090 hatchery steelhead smolts into Nason Creek. Subsequently, a total of 1,571 hatchery steelhead were captured at the smolt trap with a mean FL and weight of 173mm (*n* =632; *SD* = 18.7) and 52.6g (*n* = 633; *SD* = 15.9), respectively (Figure 7). The presence of hatchery-origin steelhead at the trap was limited one to two months after initial release, and did not continue into the summer. Hatchery origin was determined by the presence of coded wire tags (CWT). There were no hatchery steelhead mortalities.

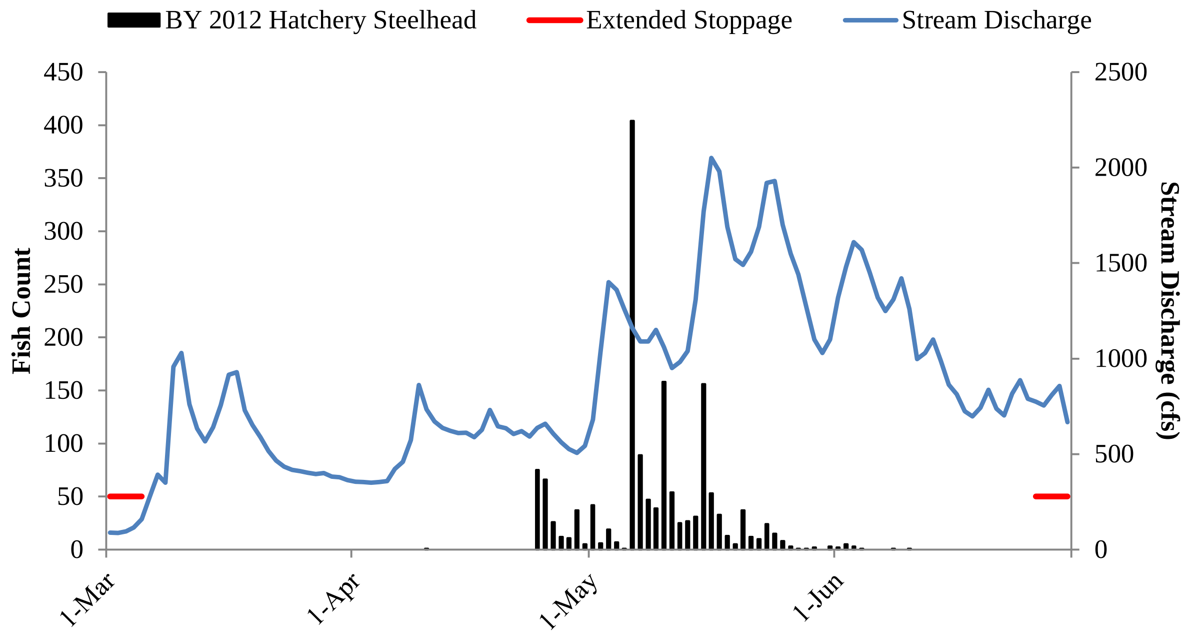


Figure 14. Daily catch of hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014.

3.2.5 Bull Trout

A total of four bull trout were captured with a mean fork length of 150mm (*n* = 4; *SD* = 12.8; Table 4). There were no mortalities incurred.

Table 25. Summary of length, weight and condition factor for bull trout captured at the Nason Creek rotary trap.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
Unknown	Wild Bull Trout	150.3	4	12.8	33.4	4.9	9.8	1.0

3.2.6 Coho Yearlings (BY2012)

A total of 20 naturally produced coho yearlings were captured during spring emigration between March 1 and June 30 (Figure 8). Peak catch of three yearling smolts occurred on May 16 and 19 following an increase in flow associated with spring snowmelt. Mean FL and weight were 96mm (*n* = 20; *SD* = 9.8) and 9.9g (*n* = 20; *SD* = 3.0), respectively (Table 5). There were no coho yearling mortalities. Scale samples were collected from 19 fish to continue developing a baseline of freshwater growth patterns for naturally produced coho from Nason Creek. A subsample of 13 coho yearlings also had tissue samples taken from them for parental-based DNA analysis.

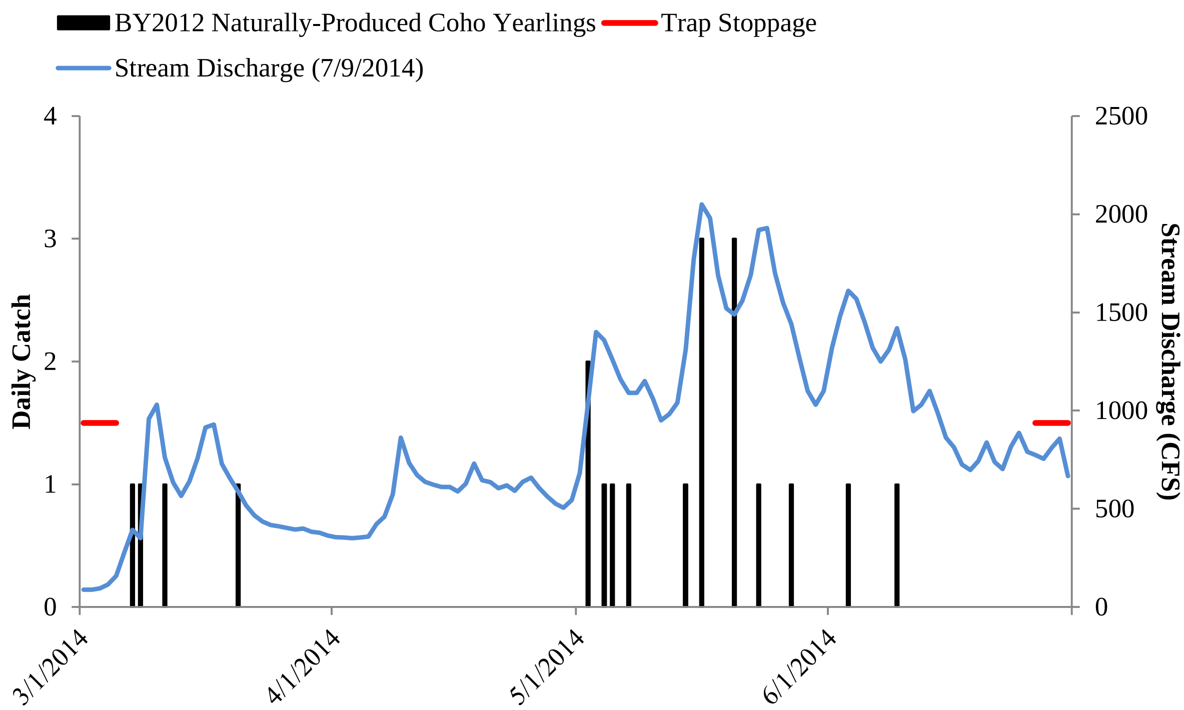


Figure 15. Daily catch of BY2012 naturally produced coho yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014.

Table 26. Summary of length and weight sampling of juvenile coho salmon captured at the Nason Creek rotary trap in 2014.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2012	Naturally Produced Coho Yearling Smolt	96.3	20	9.8	9.9	20	3.0	1.1
2013	Naturally Produced Coho Subyearling Fry	36.0	1	—	—	—	—	—
2013	Naturally Produced Coho Subyearling Parr	73.0	3	22.5	5.9	3	4.7	1.5
2012	Hatchery Coho Yearling Smolt	127.0	1,203	9.7	21.7	1,201	5.0	1.1

3.2.7 Coho Subyearlings (BY2013)

A total of three naturally produced coho subyearling parr were captured during between July 1 and November 30 (Figure 9). Mean FL and weight were 73mm (*n* = 3; *SD* = 22.5) and 5.9g (*n* = 3; *SD* = 4.7), respectively. One additional subyearling coho fry was also captured with a mean FL of 47mm. Scale samples were taken from two coho parr. Collected scale samples will continue to develop a freshwater aging baseline mentioned previously. There was one parr mortality attributed to unknown causes (no signs of external injury).

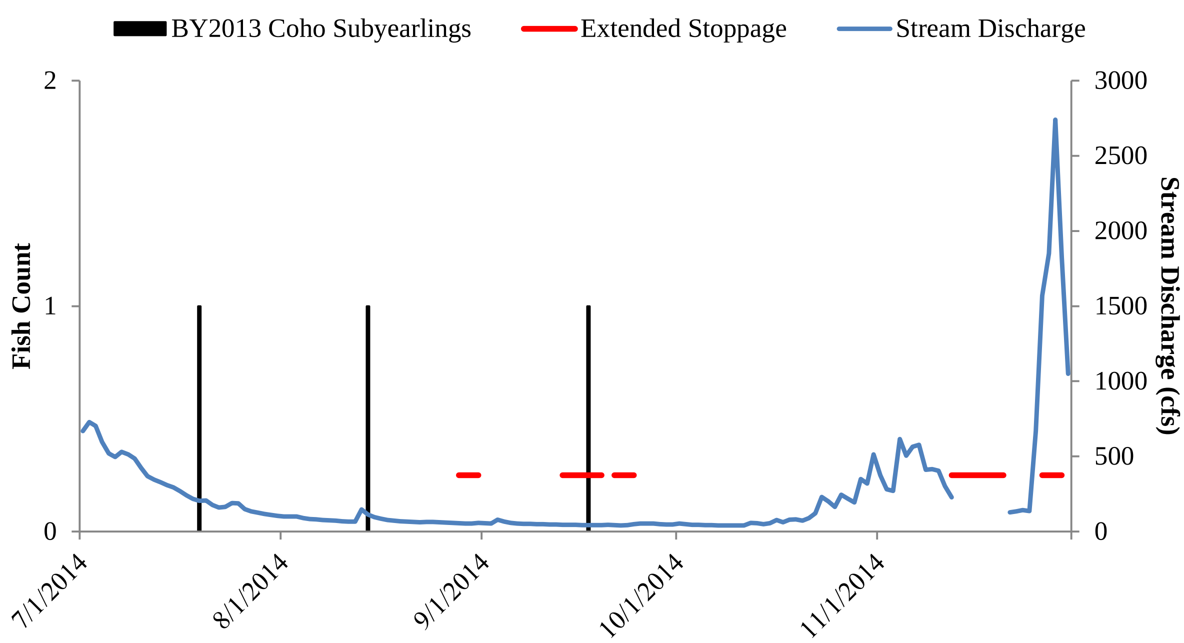


Figure 16. Daily catch of BY2013 naturally produced coho subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2014.

3.2.8 Hatchery Coho Smolts (BY2012)

A total of 253,343 hatchery coho were released into Nason Creek above the trap in spring of 2014. All hatchery coho released were acclimated in natural ponds adjacent to Nason Creek and reared to smolt stage prior to volitional release. Between March 1 and June 30, a total of 4,410 hatchery coho were captured at the trap (Figure 10). Mean FL was 127mm (*n* = 1,203; *SD* = 9.7) and mean weight was 21.7g (*n* = 1,201; *SD* = 5.0; Table 2). Peak daily catch occurred on May 16 (*n* = 411) following volitional release into Nason Creek. There were no hatchery coho smolt mortalities incurred during the 2014 trapping season. Hatchery coho emigration data at the Nason Creek trap assists MCCRP by providing size-at-emigration, emigration timing and duration of residence in Nason Creek.

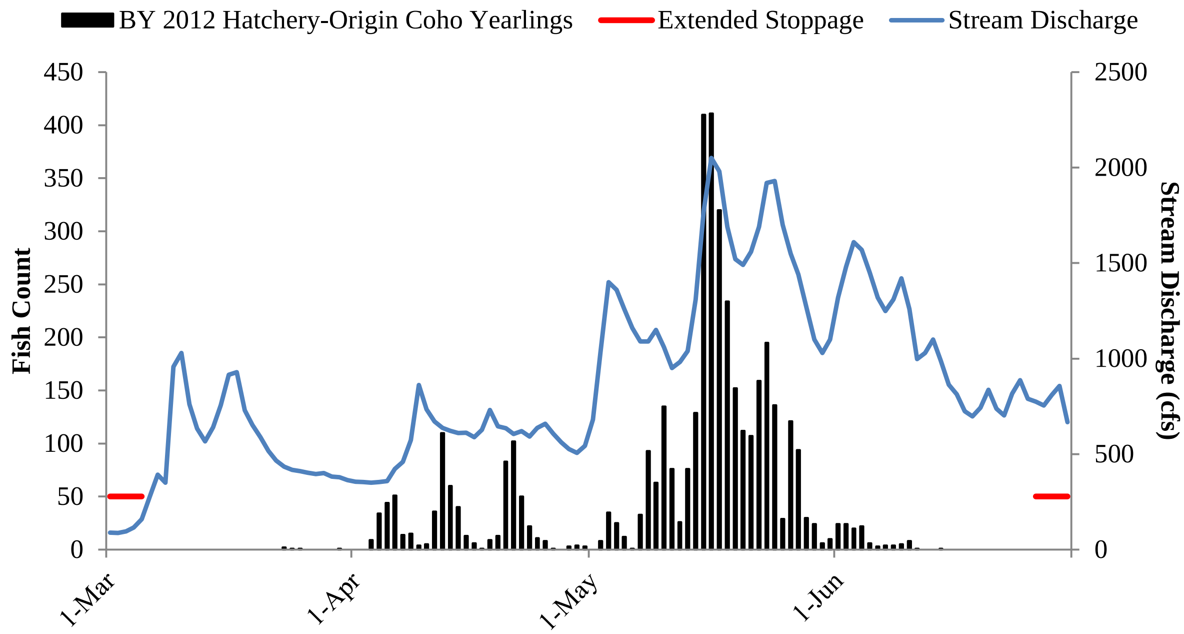


Figure 17. Daily catch of BY2012 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2014.

3.3 Remote Parr Tagging (BY2013 Spring Chinook)

YNF and WDFW personnel PIT tagged and released a total of 1,821 BY2013 spring Chinook parr between September 22 and October 24. The total surveyed area included Nason Creek from rkm 0.78 to rkm 26.12. All collections were performed via backpack electrofisher.

Between October 1 and March 30, a total of 311 re-sights of the remote tagged Chinook were documented at NAL (Figure 11). Of these detections, only 13 were during the winter non-trapping period. PTAGIS event logs for NAL indicated that it operated continuously for the duration of this time with no alterations to the array.

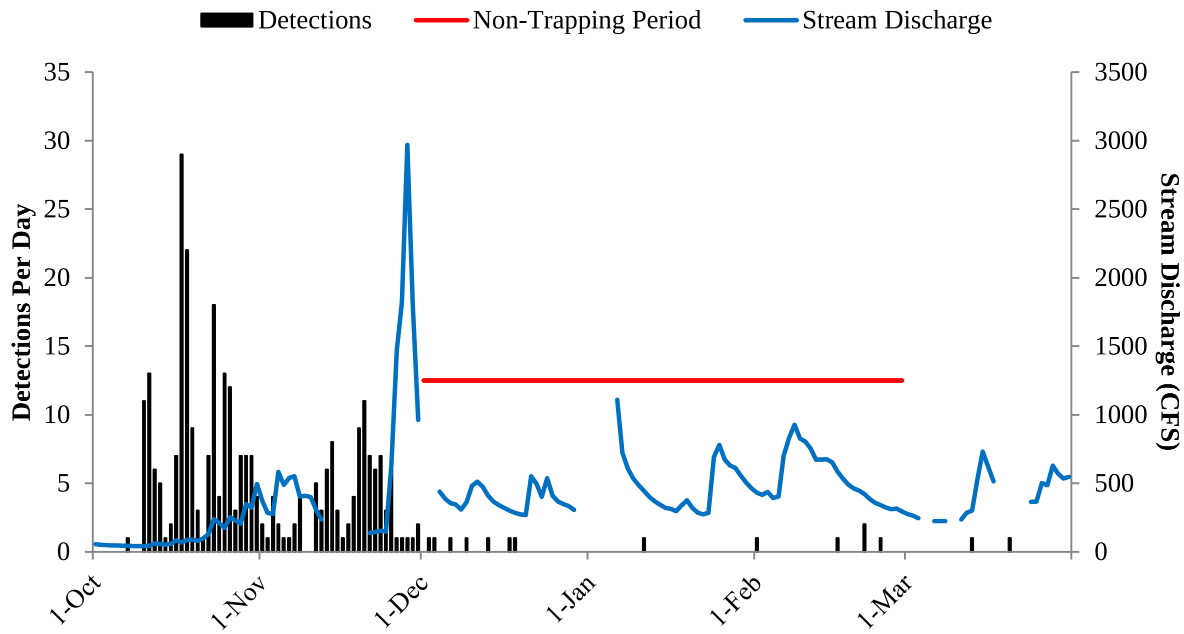


Figure 18. Daily detections of remote-tagged BY2013 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2014 and March 2015.

3.4 Trap Efficiency Calibration and Population Estimates

3.4.1 Spring Chinook Yearlings (BY2012)

Low abundance of yearling Chinook allowed us to only conduct two efficiency trials in 2014 (Minimum mark group size = 40 smolts; Table 6). The multi-year, weighted flow-efficiency regression was statistically significant ($r^2 = 0.15$, $p = 0.03$; *See Appendix C*). We estimated a total of 4,561 (± 1,540; 95% CI) BY2012 Chinook yearlings emigrated in spring of 2014 (Table 7). Combined with a recalculated BY2012 subyearling estimate of 28,110 (± 4,611; 95% CI), we estimated that a total of 32,671 (± 4,863; 95% CI) BY2012 spring Chinook juveniles emigrated from Nason Creek during the period of trap operation.

Table 27. Trap efficiency trials conducted with BY2012 wild spring Chinook yearlings. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial*.

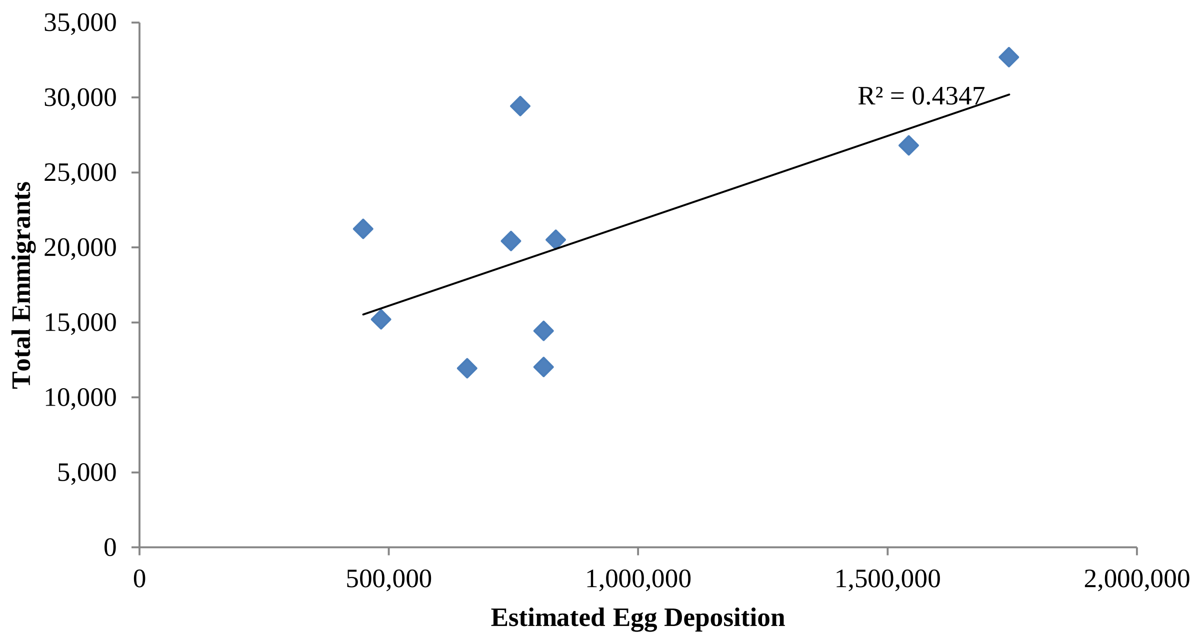
Origin/Species/Stage	Age	Date	Trap Position	Marked	Recaptured	Trap Efficiency	Discharge (cfs)
Wild Chinook Yearlings	1+	3/9/2014	Back	65	4	7.69%	958
Wild Chinook Yearlings	1+	3/13/2014	Back	67	9	14.93%	566

*See equation 3 in **2.5.1 Estimate of Abundance**

Table 28. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek spring Chinook salmon.

Brood Year	No. of Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				Age-0[b]	Non Trap[d]	Age-1	Total ± 95% CI		
2002	294	4,654	1,368,276	DNOT		4,683	—	—	—
2003	83	5,844	485,052	8,829		6,358	15,187 ± 1,605	3.10%	183
2004	169	4,799	811,031	11,822		2,597	14,419 ± 2,766	1.80%	85
2005	193	4,327	835,111	11,814		8,696	20,510 ± 5,018	2.50%	106
2006	152	4,324	657,248	4,144		7,798	11,942 ± 1,744	1.80%	79
2007	101	4,441	448,541	15,556		5,679	21,235 ± 2,864	4.70%	210
2008	336	4,592	1,542,912	23,182		3,611	26,793 ± 6,756	1.70%	80
2009	167	4,573	763,691	27,720		1,705	29,425 ± 12,777	3.90%	176
2010	188	4,314	811,032	8,491		3,535	12,026 ± 1,954	1.50%	64
2011	170	4,385	745,450	17,991		2,422	20,413 ± 3,889	2.70%	120
2012	413	4,223	1,744,099	28,110		4,561	32,671 ± 4,863	1.90%	79
2013	212	4,716	999,792	29,784	223	—	—	—	—
Avg.[c]	197	4,582	884,417	15,766	—	4,696	20,502	2.60%	118

[a] Data provided by Hillman et al. 2014.
[b] Does not include subyearling fry prior to July 1.
[c] 10-year average of complete brood data, BY2003-2012.
[d] Estimated emigration during the winter non-trapping period (December 1 – February 28).



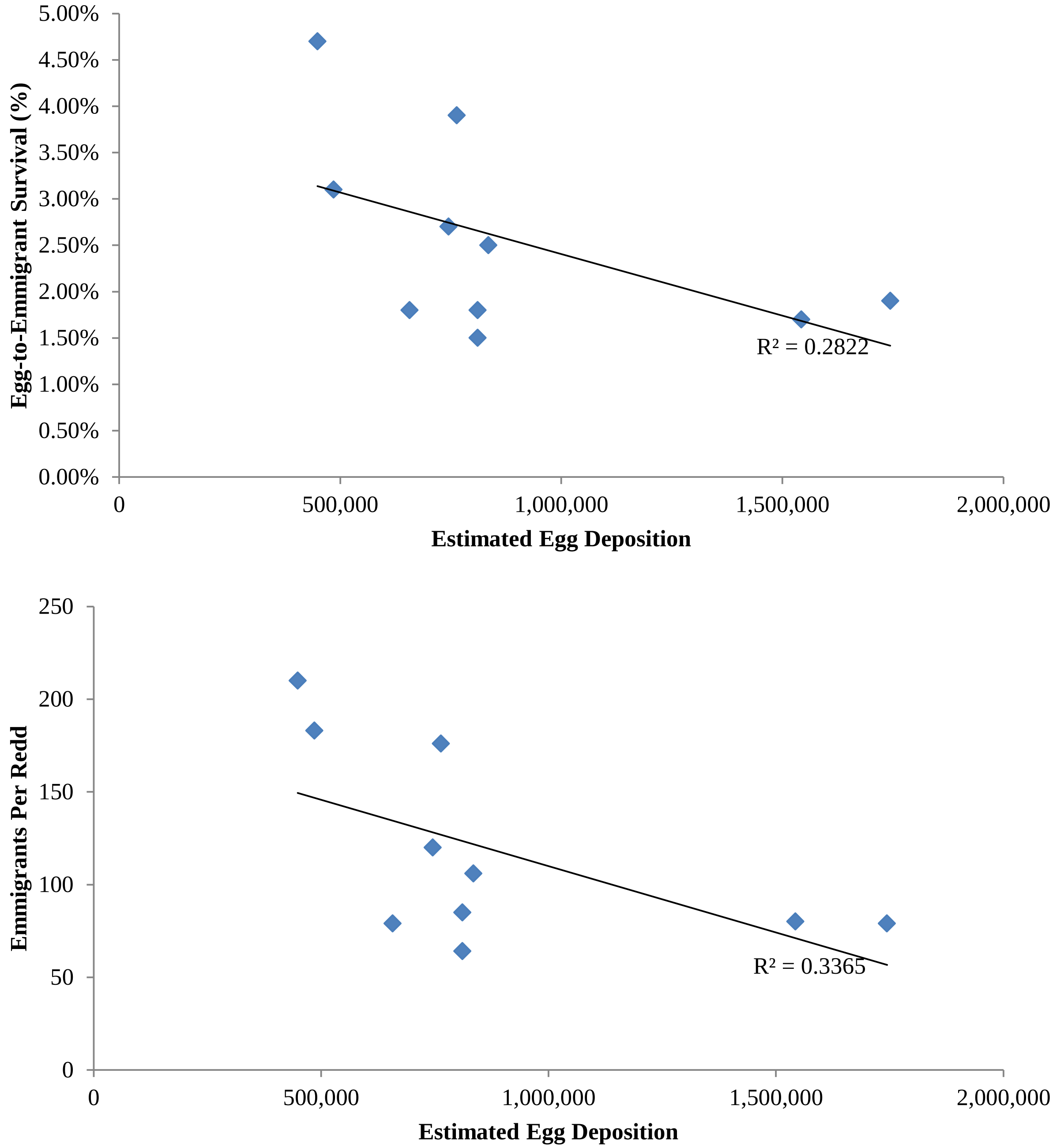


Figure 19. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2012.

3.4.2 Spring Chinook Subyearlings (BY2013)

Initially, attempts to create a flow-efficiency regression were made at Bolser (Table 8). Due to limited parr abundance at higher flows and trap stoppages due to debris and ice, a viable model could not be developed. Instead, a pooled efficiency using mark groups released at the new trapping site was used to calculate parr emigrant abundance (Minimum mark group size = 50 parr; Table 8). Using this model we estimated that a total of 29,784 (± 32,081; 95% CI) BY2013 spring Chinook emigrated past the trap in the Fall of 2013 (Table 7). Use of this pooled efficiency is seen as only a temporary method of expansion in leiu of the regression model. Continued efforts will be made in 2015 to develop a regression model; at which time recalculation of the BY2013 parr estimate will be made.

Table 29. Trap efficiency trials conducted with BY2013 wild spring Chinook subyearlings. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial*.

Origin/Species/Stage	Age	Date	Trap Position	Marked	Recaptured	Trap Efficiency	Discharge (cfs)
Wild Chinook Subyearlings	0	7/14/2014	Back	89	7	8.99%	309
Wild Chinook Subyearlings	0	7/21/2014	Back	74	4	6.76%	176
Wild Chinook Subyearlings	0	7/27/2014	Back	72	4	6.94%	135
Wild Chinook Subyearlings	0	10/27/2014	Back	71	3	5.63%	219
Wild Chinook Subyearlings	0	10/30/2014	Back	70	5	8.57%	320
Wild Chinook Subyearlings	0	11/1/2014	Back	96	6	7.29%	374

*See equation 3 in **2.5.1 Estimate of Abundance**

Utilizing mark groups previously used to test the efficiency of the smolt trap, a viable flow-antenna efficiency regression was developed for NAL. In order to best describe emigration patterns during this period of no previous efficieny trials, mark-groups included in this regression were limited to those performed one month before and after (November and March) the winter non-trapping period. In March 2010, the NAL array was converted from a floating antenna system to its current flat plate configuration. Because of this change to the array's configuration, all trials performed prior to 2010 were also excluded from the model. The resulting regression showed statistical significance (r^2 = 0.64; p = 0.0004) and covered a discharge range of 127cfs to 880cfs (see **Appendix C: Regression Models).** Using the Baily Model, we estimate that a total of 233 (± 253; 95% CI) BY2013 emigrants passed the antenna during the non-trapping period. This estimate of winter migratory movement will be included in the total BY2013 emigrant estimate made at the Nason Creek smolt trap.

3.4.3 Summer Steelhead

Summer steelhead efficiency trials were conducted on three separate occasions between March 1 and July 31 (Minimum mark group size = 50 parr/smolt; Table 9). Although an in-year model could not be achieved, M-R data from 2014 was used to strengthen our multi-year steelhead regression. The modified regression was used to produce estimates of abundance for 2014 summer steelhead emigrants as well as recalculations of previous estimates. We utilized a single steelhead model specific to the back position to estimate age 1+ smolt/parr abundance throughout the entire trapping period. Estimates of age-0 fry and parr were not made due to insufficient evidence that active migration is occurring at this young age. Previous attempts to build a model based on YOY steelhead parr in the fall have yielded weak flow-efficiency relationships; further suggesting that age-0 parr catch is the result of displacement rather than active migration. We estimated that 11,837 (± 3,611; 95% CI) BY2013 age-1 and 813 (± 731; 95% CI) BY2012 age-2 steelhead emigrated past the trap in 2014 (Table 10). There were no age-3 steelhead identified through age estimation (histogram). We estimate that total (age 1-3) BY2011 emigration to be 13,605 (± 3,525; 95% CI).

Table 30. Efficiency trials conducted with wild summer steelhead juveniles. Note: trap efficiency is reported as the percentage of recaptures + 1 divided by the number of marked fish in the trial[*].

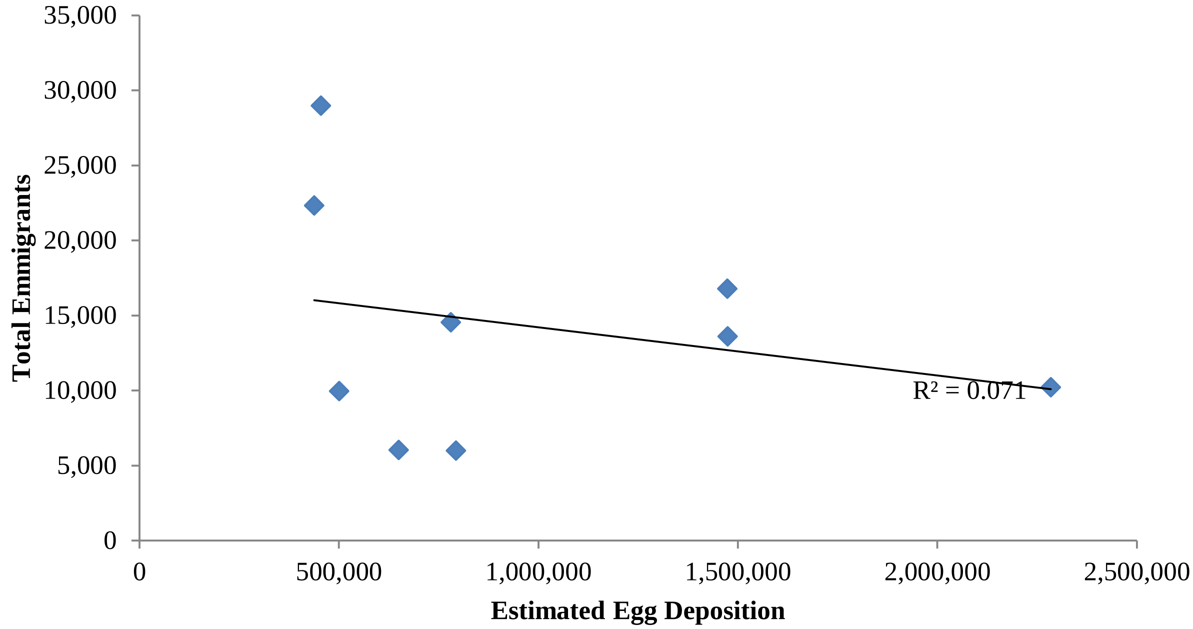
Origin/Species/Stage	Date	Trap Position	Marked	Recaptured	Trap Efficiency	Discharge (cfs)
Wild Steelhead Parr/Smolt	5/3/2014	Back	50	2	6.00%	1400
Wild Steelhead Parr/Smolt	5/30/2014	Back	57	0	1.75%	1030
Wild Steelhead Parr/Smolt	6/3/2014	Back	75	1	2.67%	1610

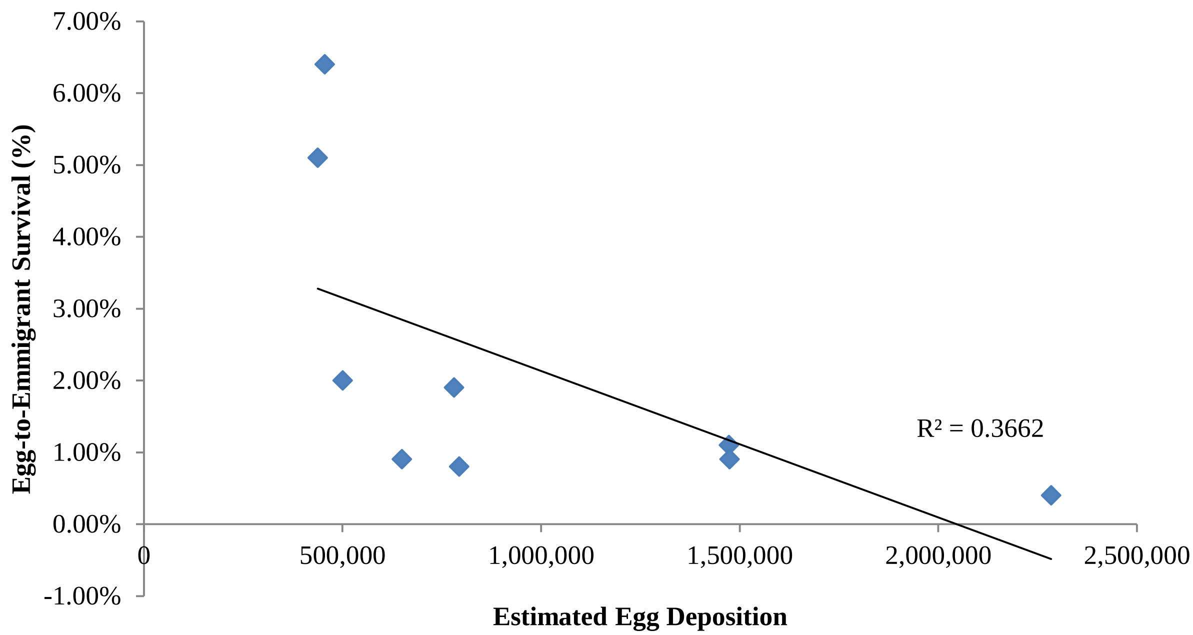
[*]See equation 3 in **2.5.1 Estimate of Abundance**

Table 31. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead.

Brood Year	No. of Redds	Fecundity[a]	Est. Egg Deposition	No. of Emigrants				Egg-to-Emigrant	Emigrants per Redd
				1+	2+	3+	Total ± 95%CI		
2001	27	5,951	160,677	DNOT	DNOT	846	—	—	—
2002	80	5,776	462,080	DNOT	2,475	0	—	—	—
2003	121	6,561	793,881	4,906	1,054	27	5,987 ± 1,193	0.8%	49
2004	127	5,118	649,986	5,107	906	22	6,035 ± 885	0.9%	48
2005	412	5,545	2,284,540	7,416	2,502	298	10,216 ± 2,147	0.4%	25
2006	77	5,688	437,976	19,609	2,673	37	22,319 ± 5,722	5.1%	290
2007	78	5,840	455,520	26,518	2,325	117	28,960 ± 7,739	6.4%	371
2008	88	5,693	500,984	8,782	1,164	0	9,946 ± 2,382	2.0%	113
2009	126	6,199	781,074	13,606	608	312	14,526 ± 2,868	1.9%	115
2010	270	5,458	1,473,660	12,767	3,999	0	16,776 ± 3,885	1.1%	62
2011	235	6,276	1,474,860	13,109	482	0	13,605 ± 3,525	0.9%	58
2012	212	5,309	1,125,508	26,637	813	—	—	—	—
2013	135	5,761	777,735	11,837	—	—	—	—	—
Avg[b]	170	5,820	983,609	12,424	1,747	90	14,262	0	126

[a] Data provided by Hillman et al. 2014.
[b] 8-year average of complete brood estimates, BY2003-2011.


35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Total Emmigrants
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Estimated Egg Deposition
R² = 0.071


7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
-1.00%
Egg-to-Emmigrant Survival (%)
0
500,000
1,000,000
1,500,000
2,000,000
2,500,000
Estimated Egg Deposition
R² = 0.3662

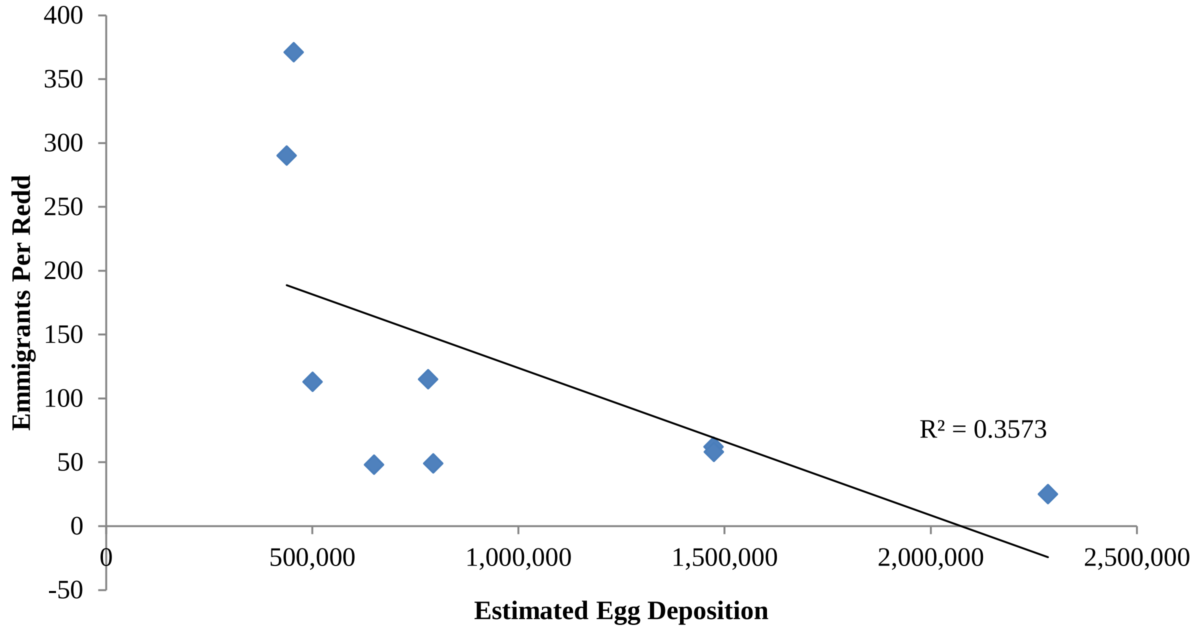


Figure 20. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2011.

3.4.4 Coho Yearlings (BY2012)

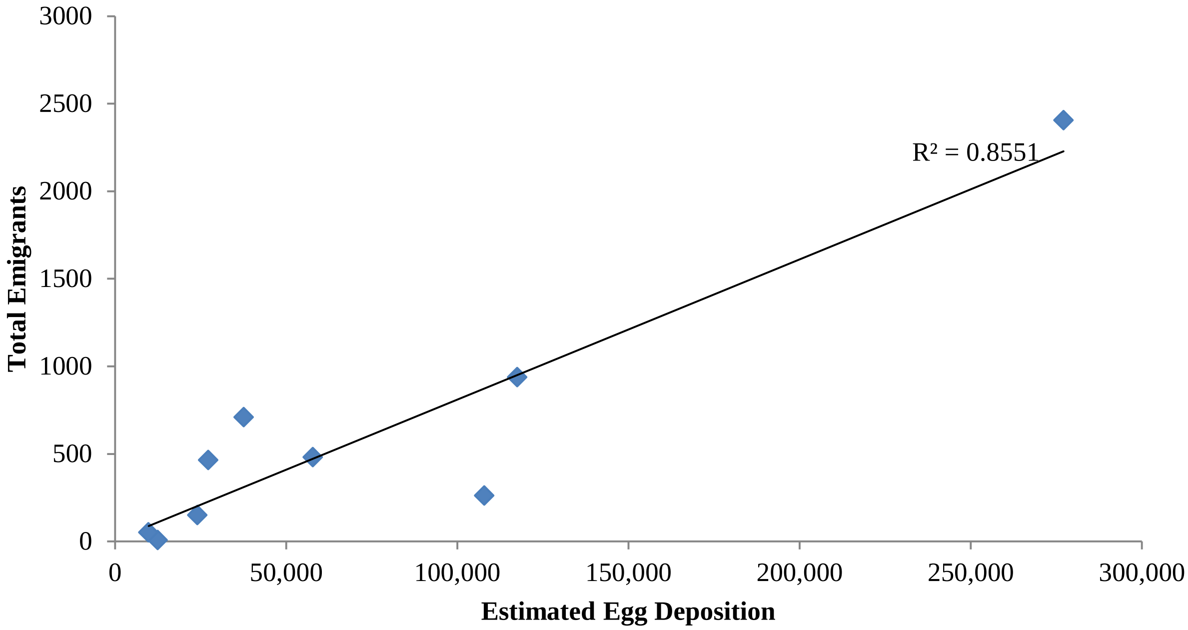
Limited abundance of BY2012 coho yearlings did not provide any opportunities to perform any efficiency trials in the spring of 2014. As in previous years, a wild spring Chinook yearling model was applied to coho to provide a smolt estimate (r^2 = 0.15, p = 0.03; *See Appendix C*). In the spring of 2014, we estimated that 434 (± 235; 95% CI) emigrated past the trap (Table 11). This gave us a total BY2012 emigrant estimate of 479 (± 237; 95% CI).

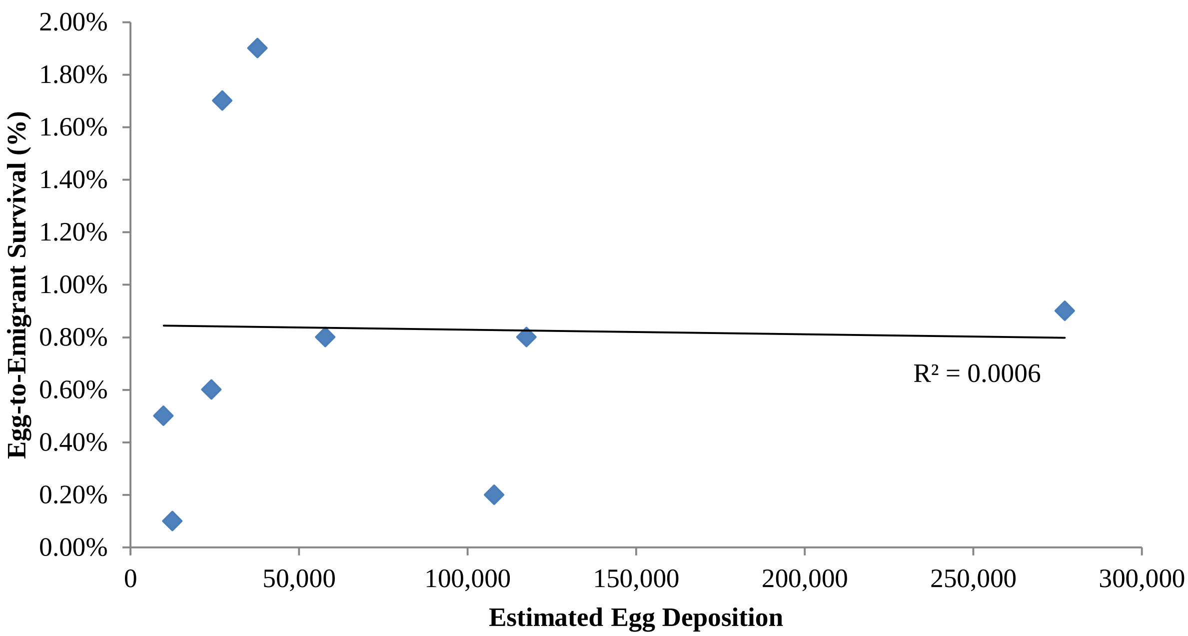
Table 32. Estimated egg-to-emigrant survival and smolts-per-redd production for Nason Creek coho salmon.

Brood Year	No. of Redds	Fecundity	Est. Egg Deposition	No. of Emigrants			Egg-to-Emigrant	Emigrants per Redd
				Age-0[a]	Age-1	Total ± 95% CI		
2003	6	2,458	14,748	DNOT	394	—	—	—
2004	35	3,084	107,940	204	56	260 ± 155	0.2%	7
2005	41	2,866	117,506	27	910	937 ± 347	0.8%	23
2006	4	3,126	12,504	7	0	7 ± 10	0.1%	2
2007	10	2,406	24,060	14	136	150 ± 104	0.6%	15
2008	3	3,275	9,825	50	0	50 ± 57	0.5%	17
2009	14	2,691	37,674	471	237	708 ± 478	1.9%	51
2010	8	3,411	27,288	27	437	464 ± 231	1.7%	58
2011	89	3,114	277,146	1,018	1,387	2,405 ± 612	0.9%	27
2012	21	2,752	57,792	46	434	480 ± 237	0.8%	23
2013	0	—	—	49	—	—	—	—

Avg.[b]	25	2,969	74,637	207	400	607	0.8%	25

[a] Does not include subyearling fry prior to July 1.
[b] 9-year average of complete brood data, BY2004-2012.





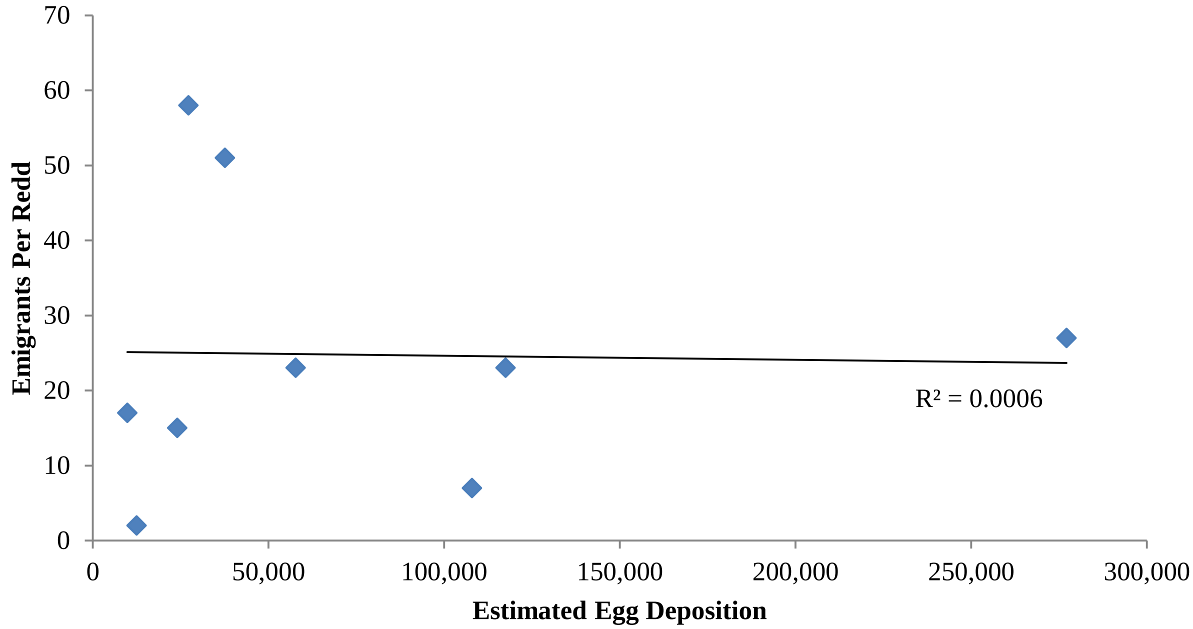


Figure 21. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek naturally-produced coho, BY 2004 to 2012.

3.4.5 Coho Subyearlings (BY2013)

A total of only three coho subyearling parr did not allow us to make any attempts to build an species/age specific a regression model at the new trap location. Because these subyearling emigrants were captured at the DB site prior to establishment of a viable flow-efficiency regression, a pooled estimate based on subyearling Chinook parr efficiency trials performed in the summer/fall of 2014 was used. Using the pooled efficiency, we estimated that 49 (± 82 ; 95% CI) emigrated past the trap in the fall of 2014 (Table 11).

3.5 PIT Tagging

During the 2014 trapping season, we PIT tagged 1,578 wild spring Chinook, 838 steelhead, and 22 naturally produced coho (Table 12). All tagging files were submitted to the PTAGIS database. There were no shed PIT tags were recovered in holding boxes where fish had been held for 24-72 hours after tagging.

Table 33. Number of PIT tagged coho, Chinook, and steelhead with shed rates at the Nason Creek rotary trap in 2014.

Species/Stage	Year-to-date Catch	Year-to-date PIT Tagged	No. of Shed Tags	Percent Shed Tags
Chinook Yearling Smolt	464	456	0	0.00%
Chinook Subyearling Parr (Mar 1 to June 30)	62	4	0	0.00%
Chinook Subyearling Parr (July 1 to Nov 30)	1,502	1,109	0	0.00%

Steelhead Parr	991	820	0	0.00%
Steelhead Smolt	18	18	0	0.00%
Coho Yearling Smolt	20	20	0	0.00%
Coho Subyearling Parr	3	2	0	0.00%

* Counts do not include fish with FL<50mm (fry).

During remote tagging efforts in the fall of 2014, 1,893 spring Chinook were PIT tagged by YN and WDFW personnel. Of the total tagged, 78% were held overnight to determine tag retention. Shed rate for this tagging effort was 0.07%.

3.6 Incidental Species

Along with wild spring Chinook, wild steelhead/rainbow trout, and naturally produced coho, other resident fish species captured at the Nason Creek rotary trap and included in Table 13 are: bull trout *Salvelinus* confluentus, cutthroat trout *Oncorhynchus clarki*, flathead minnow *Pimephales promelas*, longnose dace *Rhinichthys cataractae*, northern pikeminnow *Ptychocheilus oregonensis*, redside shiner *Richardsonius balteatus*, sculpin *Cottus sp.*, sucker *Catostomus sp.*, and mountain whitefish *Prosopium williamsoni*.

Table 34. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2014.

Species	Total Count	Length (mm)			Weight (g)		
		Mean	N	SD	Mean	N	SD
Bull Trout	4	150.2	4	12.8	33.4	4	9.8
Cutthroat Trout	2	272.0	2	5.7	200.3	2	4.9
Fathead Minnow	26	58.6	26	5.3	2.5	26	0.7
Longnose Dace	144	63.9	144	29.0	6.7	114	6.8
Northern Pikeminnow	12	150.2	11	98.0	100.0	8	116.5
Redside Shiner	7	60.6	7	11.8	2.9	6	1.9
Sculpin	70	72.4	70	38.6	12.3	57	17.4
Sucker	24	116.8	24	90.6	18.3	21	28.1
Whitefish Fry	27	37.0	27	5.4	—	—	—
Whitefish Parr	42	79.6	42	47.7	9.8	41	33.0

3.7 ESA Compliance

The Nason Creek smolt trap was operated under consultation with NMFS and USFWS. Total numbers of UCR spring Chinook and UCR summer steelhead that were captured or handled (indirect take) at the trap were less than the maximum permitted (20%) for each species. Lethal take was well below the allowable level of 2% for spring Chinook (0.41%), summer steelhead (0.08%), and bull trout (0.0%; Table 14). Stream temperatures did not exceeded 18˚C at any time in which fish were being handled.

Table 35. Summary of ESA species and coho salmon mortality at the Nason Creek rotary trap.

Species/Stage/Brood Year	Total Collected	Total Mortality	% Mortality

Spring Chinook Yearling (BY2012)	464	0	0.00%
Spring Chinook Subyearling (BY 2013)	2,229	11	0.49%
Total Wild Spring Chinook	**2,693**	**11**	**0.41%**
Steelhead Age-0 (BY2014)	491	1	0.20%
Steelhead Age-1 (BY2013)	745	0	0.00%
Steelhead Age-2 (BY2012)	30	0	0.00%
Total Wild Summer Steelhead	**1,266**	**1**	**0.08%**
Total Hatchery Summer Steelhead	**4,140**	**0**	**0.00%**
Total Bull Trout	**4**	**0**	0.00%
Coho Yearling (BY2012)	20	0	0.00%
Coho Subyearling (BY2013)	4	0	0.00%
Total Coho	**24**	**0**	**0.00%**

4.0 DISCUSSION

Operation of the Nason Creek smolt trap at campground endured several chronic problems during the past eleven trapping seasons. Most notable of these included both shifting channel morphology and the seasonal threat of vandalism. Thalweg positioning at campground varied drastically with changing discharge levels. This posed a significant problem in that our flow-efficiency models are assigned temporally to a static trap position/configuration. Because the trap could therefore not be moved readily within a specific migratory period without confounding the associated model, we periodically found ourselves trapping well outside the thalweg's bounds as flows fluctuated. We believe these problems warranted the relocation of the smolt trap. The alternate location (Bolser property) at ~rkm 0.3 was chosen for its ease of access, remote setting (to dissuade vandalism), and favorable channel morphology. Relocation of the trap offered the opportunity to improve our estimates while minimizing the threat to both fish and public safety.

In order to ensure that the move coincided with the onset of the subyearling spring Chinook (BY2013) migratory period (July 1), relocation occurred in late June of 2014. In doing so, we prevented splitting collections of the BY2012 brood between the two trap locations. The trap was positioned on the river-right bank of a slight bend in the river where the thalweg was pushed to the outer-edge of the channel. Once the position of the trap was established, an anchoring system was created that ensured a static location throughout the hydrograph. We intend to operate the smolt trap in this configuration for the duration of its lifetime at this location.

Initial trap operations at Bolser in the summer and fall of 2014 presented no significant challenges. The trap ran successfully until approximately 45cfs, at which time water velocity could no long rotate the cone consistently. This is an improvement over campground, which could only be operated until approximately 60 cfs. We surmise that the low cone speeds experienced at extreme base flow is due in part to an unbalanced cone. A replacement cone will be installed in 2015, which we expect will allow us to operate the smolt trap at even lower discharge levels. There were no signs of tampering with the smolt trap or suspected intentional stoppages by the public at large.

Spring Chinook

Returning adult spring Chinook in 2012 produced a record 413 redds in Nason Creek. Despite the relatively low average fecundity of these adults, high spawner recruitment in 2012 yielded an estimated egg deposition twice that of the ten-year average. Reflecting the spawner escapement, our BY2012 estimate of 32,671 spring Chinook was the largest that we have estimated since the trap was established. Historical brood estimates (2003-2012) indicate that an average of 76.9% of the brood leave prior to overwintering. The observed migratory timing of BY2012 spring Chinook juveniles was typical of Nason Creek with the majority (86.0%) of the cohort moving out of the system as subyearling parr. Our pooled BY2013 subyearling spring Chinook parr of 29,784 emigrants should be considered provisional until a viable regression model can be built. The pooled efficiency used to calculate this estimate was admittedly skewed toward the few efficiency trials that could be performed at lower flows. The resulting estimate would therefore inherently overestimate abundance. Combined with the non-trapping period estimate of 223 emmigrants, we estimate that a total of 30,007 BY2013spring Chinook emigrated out of Nason Creek by March 2015.

Comparison of spring Chinook estimates to those of other upper-Wenatchee tributary smolt traps suggests that egg-to-emigrant survival in Nason Creek is relatively low (Figure 15). With the exception of BY2009, Nason Creek egg-to-emigrant survival has consistently fallen below those of the Chiwawa River and White River, which is not suprising giving the extent of development and associated habitat impacts in Nason Creek. Comparison with the other Wenatchee Basin tributaries also indicates that BY2012's low rate of egg-to-emigrant survival despite high spawner escapement is not a tributary-specific phenomenon (Figure 16). Strong 2012 adult returns to both the Chiwawa River and White River also produced low in-stream survival rates.

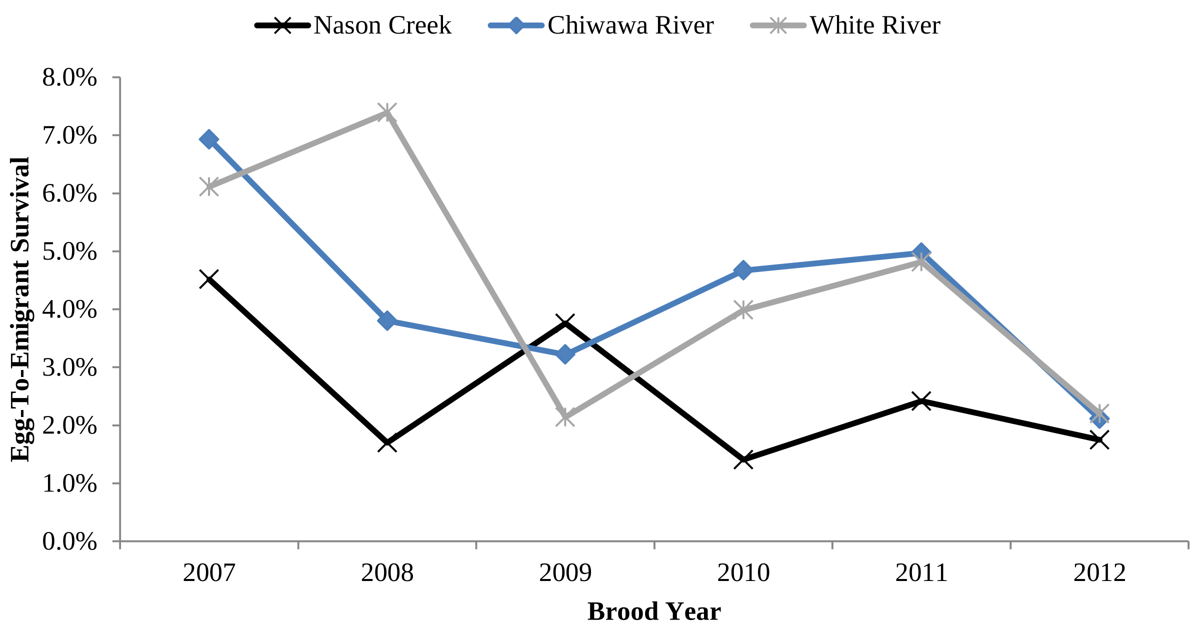


Figure 22. Comparison of wild spring Chinook abundance estimates (BY2007-2012) made at the White River, Nason Creek, and Chiwawa River smolt traps.

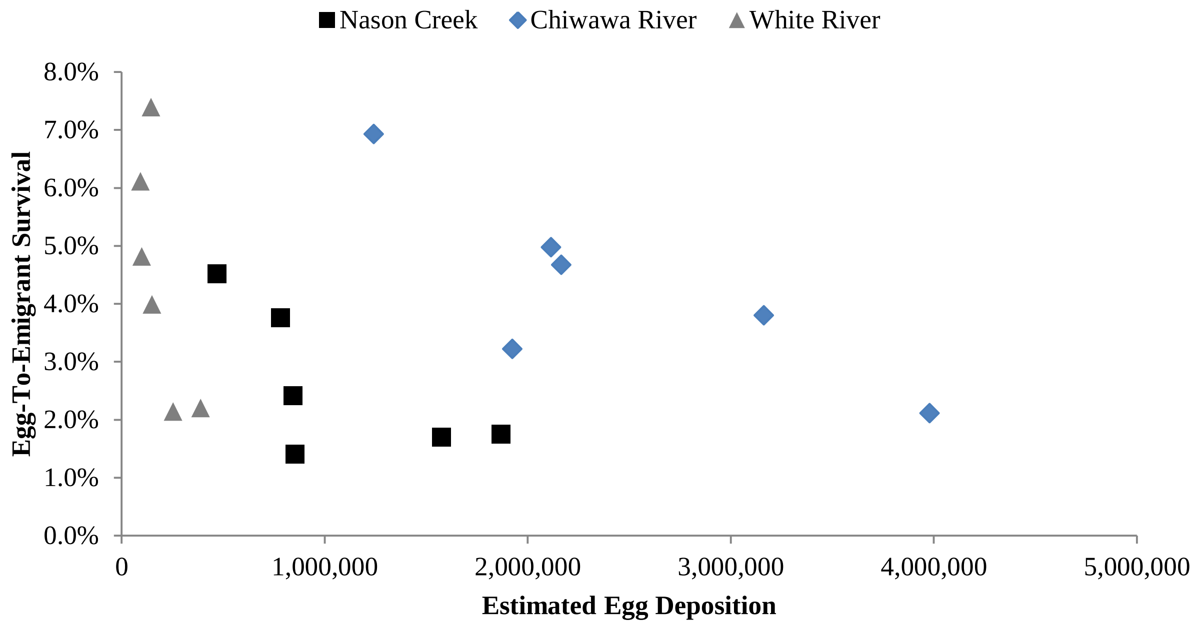


Figure 23. Comparison of egg-to-emigrant survival (BY 2007-2012) and egg deposition for Nason Creek, Chiwawa River, and White River spring Chinook. *Chiwawa BY2012 spring Chinook data provided by WDFW and to be considered provisional until peer review

Summer Steelhead

Unable to produce an in-year regression model as we did in 2013, estimates produced in 2014 were based on a multi-year flow-efficiency regression. All age 1+ steelhead captured between March 1 and June 30 were considered migratory, and subsequently included in the model. Steelhead catch numbers at Bolser (July1-November 30) were not expanded because a viable regression or alternate method of estimation could not be developed in the first year of operation. The impact of this exclusion was ultimately minimal as the overwhelming majority (98.5%) of steelhead captured in the summer/fall are age-0 young-of-the-year, and therefore excluded from all estimation. Age 1+ steelhead presence at Bolser was minimal throughout the duration of trapping (*n* =6). Expansions of daily age 1+ steelhead catch at the new trap location will be made and added to their respective brood years as soon as the necessary regression can be developed.

Steelhead estimates produced in 2014 concluded our final BY2011 emigrant estimate (age 1-3) with a total of 13,605 parr/smolt. Because there were no age-3 steelhead captured in 2014, the temporary inability to expand steelhead daily abundance at Bolser did not affect the validity of this brood estimate. Although total emigrants estimated was near the nine-year mean, BY2011 egg-to-emigrant survival was well below the running average. Consideration of the relatively strong 2011 spawner success suggests desity dependent mortality may be a limiting factor. However, the ongoing (age 1-2) BY2012 estimate (*n* = 25,450) demonstrates that a relatively large return can produce a brood with a high relative rate of survival. The initial BY2013 age-1 steelhead estimate of 11,837 emigrants fall close to the nine-year average, as does the number of redds observed in 2013.

The general migratory timing of the different steelhead brood years caught in 2014 was typical of Nason Creek. The overwhelming majority of migratory steelhead encountered at the trap were captured during spring run-off. During this exodus, age-1 parr represented approximately 85% of the total steelhead caught while only 3% of the steelhead captured were age-2 fish of the previous brood. Age-3 steelhead are infrequently captureed in Nason Creek and completely absent at the smolt trap in 2014. As flows subsided, age-0 fry became the predominant age class. Age 1+ steelhead catch in the summer and fall is infrequent, suggesting that most steelhead rarely spend more than a year rearing in Nason Creek.

Coho

The BY2012 naturally-produced coho estimate of 480 emigrants falls below the nine-year average of 607 emigrants. While the yearling component of this emigrant estimate fell close to the nine-year smolt mean (n = 434), subyearling representation appears lower than expected (n = 46). A poor adult coho return in 2013 led to exhaustive measures by YN FRM to collect the necessary broodstock to supply its hatchery-supplementation efforts. Included in these measures was the retention of 100% of all coho collected at tumwater dam until late in the run. A total of only 32 adult coho were allowed to pass above the dam, none of which were observed spawning in Nason creek. Despite no observed redds in 2013, 49 subyearlings were estimated to have passed the trap in 2014.

Juvenile coho in Nason Creek primarily emigrate as yearling smolts. Exceptions to this pattern do exist however, with a greater proportion of subyearling emigrats in BY2004, BY2006, BY2008, and BY2009. Comparison of average egg-to-emigrant survival rates of coho to those of spring Chinook suggest that coho are surviviving at lower rates than spring Chinook (0.8% vs 2.6%), this could be in part due to the coho stock used in the reintroduction program not being considered ‘locally adapted’. Reported egg- to emigrant survival rates are also affected by the proportion of fish that leave in the fall as sub-yearlings (77% for spring Chinook compared to 34% for coho) since overwinter mortality would not be included in the estimate. While subsequent monitoring efforts (e.g. - remote PIT tagging, reliable trap estimates, etc.) have not been possible due to low adult escapements over most years, a future programmatic shift towards maximizing natural production in key tributaries (Natural Production Phases; YN Master Plan) should help alleviate uncertianities regarding migration timing and survival.

2015 Trap Operations at Nason Creek

Trap operations in 2015 will be performed entirely at Bolser. At the onset of the 2015 season, our main priority will be the development of our flow efficiency regressions. Part of this process is the adherence to a strict set of trap operation and fish-handling protocols. Steps have been taken to ensure that all efficiency trials are both necessary and adequately robust prior to release. We ultimately intend to produce year-specific flow-efficiency regressions annually for each species and age class estimated. Multi-year regressions will be continually improved as a failsafe in the event that low abundance prevents in-year modeling.

The additional PIT-tagging effort in the fall of 2013 allowed for an estimate of subyearling migration during the winter non-trapped period. Using the NAL PIT-array model, an estimated

233 out of 30,007 subyearlings (7.4%) migrated during the winter non-trapping period. These results support the assumption that the migration of juvenile spring Chinook during the winter period is minimal. Future Nason Creek spring Chinook winter migration will continue to be monitored by additional remote parr tagging. A joint effort by GCPUD, WDFW, and YN FRM has targeted up to 3,000 spring Chinook parr that will be systematically tagged throughout Nason Creek in the fall of 2015. Successful development of a viable regression and estimate of winter migrants in this report marks the first time in which Chinook movement in the non-trapping period could be quantified at Nason Creek. This tool contributes to our ability to test assumptions inherent in screw trap based estimates of migrant abundance.

5.0 LITERATURE CITED

CBFWA (Columbia Basin Fish and Wildlife Authority). 1999. PIT tag marking procedures manual, version 2.0. Columbia Basin Fish and Wildlife Authority, Portland OR.

Everhart, W.H. and W.D. Youngs. 1981. Principles of Fishery Science, second edition. Comstock Publishing Associates, *a division of* Cornell University Press, Ithica and London.

Hillman, T.W. 2004. Monitoring strategy for the Upper Columbia Basin: Draft report February 1, 2004. *Prepared for* Upper Columbia Regional Technical Team, Wenatchee, Washington.

Hillman, T.M., T. Kahler, G. Mackey, J. Murauskas, A. Murdoch, K. Murdoch, T. Pearsons, and M. Tonseth. 2013. Monitoring and Evaluation Plan for PUD Hatchery Programs: 2013 Update. *Prepared for:* HCP and PRCC Hatchery Committees.

Murdoch, A. T. Miller, B. L. Truscott, C. Snow, C. Frady, K. Ryding, J. Arteburn and D. Hathaway. 2012. Upper Columbia Spring Chinook Salmon and Steelhead Juvenile and Adult Abundance, Productivity and Spatial Structure Monitoring. BPA Project 2010-034-00.

Murdoch, A., and K. Petersen. 2000. Freshwater Production and Emigration of Juvenile Spring Chinook from the Chiwawa River in 2000. Washington State Department of Fish and Wildlife

PTAGIS (Columbia Basin PIT Tag Information System). 2014. Interrogation Site Metadata: http://www.ptagis.org/sites/interrogation-site-metadata?IntSiteCode=NAL

Seber, G.A.F. 1982. The Estimation of Animal Abundance and Related Parameters, 2nd edition. Edward Arnold: London

Tussing, S.P. 2008. A Field Manual of Scientific Protocols for Downstream Migrant Trapping within the Upper Columbia Monitoring Strategy: 2008 Working Version 1.0. Prepared for Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program.

UCRTT (Upper Columbia Regional Technical Team). 2001. A Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region, a Discussion Draft Report. Upper Columbia Salmon Recovery Board.

USFS (United States Forest Service). 1996. Nason Creek Stream Survey Report.

WDOE (Washington State Department of Ecology). 2013. River and Stream Flow Monitoring: https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45J070

YNFRM (Yakama Nation Fisheries Resource Management). 2010. Mid-Columbia Coho Restoration Master Plan. *Prepared for:* Northwest Power and Conservation Council, Portland OR.

APPENDIX A. Daily Stream Discharge and Stream Temperature

Date	Stream Discharge (CFS)	Water Temperature (˚C)
1/1/2014	159	2
1/2/2014	161	2.3
1/3/2014	225	2.4
1/4/2014	183	0.9
1/5/2014	170	0.1
1/6/2014	166	0
1/7/2014	159	0.7
1/8/2014	155	1
1/9/2014	155	0.9
1/10/2014	176	1.5
1/11/2014	295	1.5
1/12/2014	309	1.7
1/13/2014	447	2.9
1/14/2014	493	2.7
1/15/2014	382	2.5
1/16/2014	332	2.1
1/17/2014	304	2
1/18/2014	280	1.8
1/19/2014	263	1.7
1/20/2014	247	1.7
1/21/2014	235	1.5
1/22/2014	225	1.4
1/23/2014	215	1.8
1/24/2014	206	1.7
1/25/2014	198	1.6
1/26/2014	192	1.3
1/27/2014	185	1.2
1/28/2014	179	1.7
1/29/2014	185	0.3
1/30/2014	177	1.1
1/31/2014	166	2.2
2/1/2014	159	2.1
2/2/2014	152	1.5
2/3/2014	148	0.8
2/4/2014	138	0.1
2/5/2014	120	0.1
2/6/2014	112	0.1
2/7/2014	137	0.1
2/8/2014	148	0.1
2/9/2014	151	0.1
2/10/2014	151	0.1
2/11/2014	156	0.1
2/12/2014	159	0.1
2/13/2014	179	0.1
2/14/2014	157	0.1
2/15/2014	148	0.1
2/16/2014	139	0.1
2/17/2014	137	0.1
2/18/2014	137	0.1
2/19/2014	132	0.1
2/20/2014	127	0.1
2/21/2014	119	0.1
2/22/2014	108	0.5
2/23/2014	104	0.6
2/24/2014	101	0.3
2/25/2014	97.5	0.7
2/26/2014	93	1.5
2/27/2014	90.8	2
2/28/2014	90.1	2.6
3/1/2014	88.4	1.4
3/2/2014	87.6	0.1
3/3/2014	94.9	0.1
3/4/2014	115	0.1
3/5/2014	159	0.9
3/6/2014	276	1.1
3/7/2014	393	1.5
3/8/2014	351	1.6
3/9/2014	958	1.2
3/10/2014	1030	1.9
3/11/2014	761	2.3
3/12/2014	634	2.5
3/13/2014	566	3
3/14/2014	640	2.9
3/15/2014	756	2.9
3/16/2014	915	3.2
3/17/2014	929	2.8
3/18/2014	729	3
3/19/2014	653	3.3
3/20/2014	588	3

3/21/2014	516	2.8	5/3/2014	1400	5.4
3/22/2014	466	2.9	5/4/2014	1360	4.9
3/23/2014	435	3.8	5/5/2014	1260	5.5
3/24/2014	418	4.1	5/6/2014	1160	5.7
3/25/2014	411	3.9	5/7/2014	1090	5.8
3/26/2014	403	4	5/8/2014	1090	5.2
3/27/2014	395	4.6	5/9/2014	1150	5.6
3/28/2014	400	3.6	5/10/2014	1060	5.5
3/29/2014	383	4	5/11/2014	951	6
3/30/2014	379	4.5	5/12/2014	982	6.2
3/31/2014	364	4.3	5/13/2014	1040	6.5
4/1/2014	356	4.7	5/14/2014	1310	6.6
4/2/2014	354	4.7	5/15/2014	1770	5.9
4/3/2014	351	4.6	5/16/2014	2050	6
4/4/2014	354	5.2	5/17/2014	1980	5.7
4/5/2014	359	4.7	5/18/2014	1690	5.9
4/6/2014	422	5.3	5/19/2014	1520	6.3
4/7/2014	460	5.6	5/20/2014	1490	6.6
4/8/2014	573	5.4	5/21/2014	1560	6.8
4/9/2014	862	4.5	5/22/2014	1690	7
4/10/2014	734	4.5	5/23/2014	1920	6.2
4/11/2014	671	5.1	5/24/2014	1930	6.4
4/12/2014	637	5.1	5/25/2014	1700	5.7
4/13/2014	622	5	5/26/2014	1550	6.3
4/14/2014	611	4.9	5/27/2014	1440	6.1
4/15/2014	612	5.5	5/28/2014	1270	6.3
4/16/2014	589	5.2	5/29/2014	1100	6.9
4/17/2014	627	5.3	5/30/2014	1030	6.6
4/18/2014	731	5.1	5/31/2014	1100	7.8
4/19/2014	645	4.4	6/1/2014	1320	7.7
4/20/2014	636	5.1	6/2/2014	1480	7.4
4/21/2014	605	5.2	6/3/2014	1610	7.6
4/22/2014	620	5.7	6/4/2014	1570	7.4
4/23/2014	592	5.3	6/5/2014	1450	7.5
4/24/2014	637	5.4	6/6/2014	1320	7.5
4/25/2014	659	5.5	6/7/2014	1250	7.9
4/26/2014	607	5.6	6/8/2014	1310	8.2
4/27/2014	562	5.6	6/9/2014	1420	8.2
4/28/2014	526	5.8	6/10/2014	1260	7.2
4/29/2014	506	6.4	6/11/2014	998	7.6
4/30/2014	544	6.7	6/12/2014	1030	8.1
5/1/2014	681	6.8	6/13/2014	1100	6.9
5/2/2014	1040	6.2	6/14/2014	990	7.6

6/15/2014	863	7.8	7/28/2014	125	16.1
6/16/2014	814	7.3	7/29/2014	118	17.2
6/17/2014	725	7.9	7/30/2014	111	17.7
6/18/2014	697	8.8	7/31/2014	105	17.7
6/19/2014	743	9.2	8/1/2014	99.2	17.2
6/20/2014	837	8.8	8/2/2014	99.9	15.3
6/21/2014	738	7.9	8/3/2014	99.6	16.2
6/22/2014	702	9.2	8/4/2014	90.1	17.7
6/23/2014	817	9.8	8/5/2014	83.9	17.8
6/24/2014	887	9.7	8/6/2014	80	17.7
6/25/2014	790	9.3	8/7/2014	77.5	17.5
6/26/2014	775	9.3	8/8/2014	74.1	17.3
6/27/2014	755	9.1	8/9/2014	71.5	16.8
6/28/2014	810	9.2	8/10/2014	68.5	16.9
6/29/2014	857	8.8	8/11/2014	66.1	17
6/30/2014	667	9.2	8/12/2014	66.2	17.6
7/1/2014	669	10.5	8/13/2014	147	17.2
7/2/2014	729	10.5	8/14/2014	112	15.5
7/3/2014	702	11	8/15/2014	96.8	15.8
7/4/2014	597	10.8	8/16/2014	84.3	16.3
7/5/2014	520	11	8/17/2014	77.4	17.5
7/6/2014	497	12.2	8/18/2014	72.5	18.1
7/7/2014	531	12.6	8/19/2014	68	18.6
7/8/2014	513	13.3	8/20/2014	65.3	17.8
7/9/2014	486	13.8	8/21/2014	63.7	16.6
7/10/2014	424	13.3	8/22/2014	62.8	15.3
7/11/2014	369	13.4	8/23/2014	64.5	15.5
7/12/2014	345	13.7	8/24/2014	63.1	16.1
7/13/2014	328	14	8/25/2014	62.7	15.2
7/14/2014	309	15.5	8/26/2014	59	16.1
7/15/2014	294	16.1	8/27/2014	56.9	17.5
7/16/2014	268	16.2	8/28/2014	55.3	17.4
7/17/2014	240	16.2	8/29/2014	54.3	16.2
7/18/2014	217	15.5	8/30/2014	54.2	15
7/19/2014	204	15.9	8/31/2014	56.9	14.7
7/20/2014	207	14.5	9/1/2014	55.4	14.2
7/21/2014	176	14.1	9/2/2014	53.6	14.5
7/22/2014	160	13.6	9/3/2014	78.8	13.6
7/23/2014	165	12.8	9/4/2014	66.2	12.9
7/24/2014	190	11.9	9/5/2014	57.7	13.4
7/25/2014	187	13.1	9/6/2014	54	13.6
7/26/2014	149	14.7	9/7/2014	51.8	13.8
7/27/2014	135	15.2	9/8/2014	50.2	14.1

9/9/2014	49.1	14.1	10/22/2014	121	8.3
9/10/2014	49.5	13.7	10/23/2014	230	7.9
9/11/2014	47.7	12.2	10/24/2014	201	7.3
9/12/2014	46.5	10.9	10/25/2014	164	7.5
9/13/2014	45.7	11	10/26/2014	245	7.4
9/14/2014	45.1	11.4	10/27/2014	219	6.1
9/15/2014	44.3	11.8	10/28/2014	193	5.9
9/16/2014	43.4	12.8	10/29/2014	350	5.7
9/17/2014	42.8	13.9	10/30/2014	320	6.6
9/18/2014	42.1	14.6	10/31/2014	514	6.9
9/19/2014	43.5	14.8	11/1/2014	374	6.1
9/20/2014	45.5	14.2	11/2/2014	281	6
9/21/2014	42.6	13.9	11/3/2014	270	6.5
9/22/2014	41.5	14.2	11/4/2014	616	7.1
9/23/2014	41.8	13.4	11/5/2014	505	6.9
9/24/2014	48.9	12.9	11/6/2014	565	7.3
9/25/2014	53.8	12.4	11/7/2014	577	6.3
9/26/2014	53.8	11.9	11/8/2014	412	4.9
9/27/2014	53.7	12.1	11/9/2014	416	5.3
9/28/2014	48.8	12.4	11/10/2014	405	4.6
9/29/2014	46.3	11.8	11/11/2014	302	2.8
9/30/2014	46.6	11.5	11/12/2014	227	0.3
10/1/2014	52.8	10.6	11/13/2014		0
10/2/2014	48.2	10.8	11/14/2014		0
10/3/2014	45.4	10.2	11/15/2014		0
10/4/2014	44.3	10.2	11/16/2014		0.1
10/5/2014	43.5	11.3	11/17/2014		0.1
10/6/2014	42.1	12.3	11/18/2014		0.1
10/7/2014	41.4	12.9	11/19/2014		0.1
10/8/2014	40.9	12.8	11/20/2014		1.1
10/9/2014	40.6	11.6	11/21/2014	128	1.6
10/10/2014	40.9	10.9	11/22/2014	135	1.1
10/11/2014	41.4	11.1	11/23/2014	142	1.4
10/12/2014	57.1	10.2	11/24/2014	137	2
10/13/2014	54.8	10.6	11/25/2014	669	1.7
10/14/2014	48.9	10.7	11/26/2014	1570	1.9
10/15/2014	54.5	10.2	11/27/2014	1850	2.9
10/16/2014	77.2	9.1	11/28/2014	2740	3.1
10/17/2014	62.2	9	11/29/2014	1830	2.3
10/18/2014	78.3	9.6	11/30/2014	1050	0.7
10/19/2014	80.8	10.2	12/1/2014		0.2
10/20/2014	72.7	9.7	12/2/2014		0.1
10/21/2014	88.8	9.3	12/3/2014		0.3

12/4/2014	451	1.6
12/5/2014	392	2.1
12/6/2014	355	2.3
12/7/2014	345	3
12/8/2014	305	3.1
12/9/2014	365	3.3
12/10/2014	498	2.9
12/11/2014	531	3.1
12/12/2014	493	3.3
12/13/2014	418	2.8
12/14/2014	369	2
12/15/2014	341	2.2
12/16/2014	318	2.6
12/17/2014	297	2.7
12/18/2014	280	2.9
12/19/2014	268	2.7
12/20/2014	263	1.9
12/21/2014	579	1.4
12/22/2014	513	2.6
12/23/2014	408	2.8
12/24/2014	561	2.8
12/25/2014	417	2.6
12/26/2014	368	2
12/27/2014	349	2
12/28/2014	332	2
12/29/2014	303	1.9
12/30/2014		0.2
12/31/2014		0

APPENDIX B. Daily Trap Operation

Date	Trap Staus	Comments
3/1/2014	Op.	
3/2/2014	No Op.	Stopped - ice
3/3/2014	No Op.	Pulled - ice
3/4/2014	No Op.	Pulled - ice
3/5/2014	Op.	
3/6/2014	Op.	
3/7/2014	Op.	
3/8/2014	Op.	
3/9/2014	Op.	
3/10/2014	Op.	
3/11/2014	Op.	
3/12/2014	Op.	
3/13/2014	Op.	
3/14/2014	Op.	
3/15/2014	Op.	
3/16/2014	Op.	
3/17/2014	Op.	
3/18/2014	Op.	
3/19/2014	Op.	
3/20/2014	Op.	
3/21/2014	Op.	
3/22/2014	Op.	
3/23/2014	Op.	
3/24/2014	Op.	
3/25/2014	Op.	
3/26/2014	Op.	
3/27/2014	Op.	
3/28/2014	Op.	
3/29/2014	Op.	
3/30/2014	Op.	
3/31/2014	Op.	
4/1/2014	Op.	
4/2/2014	Op.	
4/3/2014	Op.	
4/4/2014	Op.	
4/5/2014	Op.	
4/6/2014	Op.	
4/7/2014	Op.	
4/8/2014	Op.	
4/9/2014	Op.	
4/10/2014	Op.	
4/11/2014	Op.	
4/12/2014	Op.	
4/13/2014	Op.	
4/14/2014	Op.	
4/15/2014	Op.	
4/16/2014	Op.	
4/17/2014	Op.	
4/18/2014	Op.	
4/19/2014	Op.	
4/20/2014	Op.	
4/21/2014	Op.	
4/22/2014	Op.	
4/23/2014	Op.	
4/24/2014	Op.	
4/25/2014	Op.	
4/26/2014	Op.	
4/27/2014	Op.	
4/28/2014	Op.	
4/29/2014	Op.	
4/30/2014	Op.	
5/1/2014	Op.	
5/2/2014	Op.	
5/3/2014	Op.	
5/4/2014	Op.	
5/5/2014	Op.	
5/6/2014	Op.	
5/7/2014	Op.	
5/8/2014	Op.	
5/9/2014	Op.	
5/10/2014	Op.	
5/11/2014	Op.	
5/12/2014	Op.	
5/13/2014	Op.	
5/14/2014	Op.	
5/15/2014	Op.	
5/16/2014	No Op.	Stopped - woody debris
5/17/2014	Op.	

5/18/2014	Op.		6/30/2014	No Op.	Trap set at new site
5/19/2014	Op.		7/1/2014	Op.	
5/20/2014	Op.		7/2/2014	Op.	
5/21/2014	Op.		7/3/2014	Op.	
5/22/2014	Op.		7/4/2014	Op.	
5/23/2014	Op.		7/5/2014	Op.	
5/24/2014	Op.		7/6/2014	Op.	
5/25/2014	Op.		7/7/2014	Op.	
5/26/2014	Op.		7/8/2014	Op.	
5/27/2014	Op.		7/9/2014	Op.	
5/28/2014	Op.		7/10/2014	Op.	
5/29/2014	Op.		7/11/2014	Op.	
5/30/2014	Op.		7/12/2014	Op.	
5/31/2014	Op.		7/13/2014	Op.	
6/1/2014	Op.		7/14/2014	Op.	
6/2/2014	Op.		7/15/2014	Op.	
6/3/2014	Op.		7/16/2014	Op.	
6/4/2014	Op.		7/17/2014	Op.	
6/5/2014	Op.		7/18/2014	No Op.	Pulled - fire activity
6/6/2014	Op.		7/19/2014	Op.	
6/7/2014	Op.		7/20/2014	Op.	
6/8/2014	Op.		7/21/2014	Op.	
6/9/2014	Op.		7/22/2014	Op.	
6/10/2014	Op.		7/23/2014	Op.	
6/11/2014	Op.		7/24/2014	Op.	
6/12/2014	Op.		7/25/2014	Op.	
6/13/2014	Op.		7/26/2014	Op.	
6/14/2014	Op.		7/27/2014	Op.	
6/15/2014	Op.		7/28/2014	Op.	
6/16/2014	Op.		7/29/2014	Op.	
6/17/2014	Op.		7/30/2014	Op.	
6/18/2014	Op.		7/31/2014	No Op.	Stopped - low water
6/19/2014	Op.		8/1/2014	Op.	
6/20/2014	Op.		8/2/2014	Op.	
6/21/2014	Op.		8/3/2014	Op.	
6/22/2014	Op.		8/4/2014	Op.	
6/23/2014	Op.		8/5/2014	Op.	
6/24/2014	Op.		8/6/2014	Op.	
6/25/2014	Op.		8/7/2014	Op.	
6/26/2014	No Op.	Pulled - relocation	8/8/2014	Op.	
6/27/2014	No Op.	Pulled	8/9/2014	Op.	
6/28/2014	No Op.	Pulled	8/10/2014	Op.	
6/29/2014	No Op.	Pulled	8/11/2014	Op.	

8/12/2014	Op.		9/24/2014	No Op.	Stopped - low water
8/13/2014	Op.		9/25/2014	Op.	
8/14/2014	Op.		9/26/2014	No Op.	Stopped - low water
8/15/2014	Op.		9/27/2014	Op.	
8/16/2014	Op.		9/28/2014	Op.	
8/17/2014	Op.		9/29/2014	Op.	
8/18/2014	Op.		9/30/2014	Op.	
8/19/2014	Op.		10/1/2014	Op.	
8/20/2014	Op.		10/2/2014	Op.	
8/21/2014	Op.		10/3/2014	Op.	
8/22/2014	Op.		10/4/2014	Op.	
8/23/2014	Op.		10/5/2014	Op.	
8/24/2014	Op.		10/6/2014	Op.	
8/25/2014	Op.		10/7/2014	Op.	
8/26/2014	Op.		10/8/2014	Op.	
8/27/2014	Op.		10/9/2014	No Op.	Stopped - low water
8/28/2014	No Op.	Stopped - low water	10/10/2014	Op.	
8/29/2014	No Op.	Stopped - low water	10/11/2014	Op.	
8/30/2014	No Op.	Stopped - low water	10/12/2014	Op.	
8/31/2014	No Op.	Stopped - low water	10/13/2014	No Op.	Stopped - woody debris
9/1/2014	Op.		10/14/2014	Op.	
9/2/2014	No Op.	Stopped - low water	10/15/2014	Op.	
9/3/2014	Op.		10/16/2014	Op.	
9/4/2014	Op.		10/17/2014	Op.	
9/5/2014	Op.		10/18/2014	Op.	
9/6/2014	Op.		10/19/2014	Op.	
9/7/2014	No Op.	Stopped - low water	10/20/2014	Op.	
9/8/2014	Op.		10/21/2014	Op.	
9/9/2014	Op.		10/22/2014	Op.	
9/10/2014	Op.		10/23/2014	Op.	
9/11/2014	Op.		10/24/2014	Op.	
9/12/2014	Op.		10/25/2014	Op.	
9/13/2014	No Op.	Stopped - low water	10/26/2014	Op.	
9/14/2014	No Op.	Stopped - low water	10/27/2014	No Op.	Stopped - woody debris
9/15/2014	No Op.	Stopped - low water	10/28/2014	Op.	
9/16/2014	No Op.	Stopped - low water	10/29/2014	Op.	
9/17/2014	No Op.	Stopped - low water	10/30/2014	No Op.	Stopped - woody debris
9/18/2014	No Op.	Stopped - low water	10/31/2014	Op.	
9/19/2014	No Op.	Stopped - low water	11/1/2014	Op.	
9/20/2014	Op.		11/2/2014	Op.	
9/21/2014	No Op.	Stopped - low water	11/3/2014	Op.	
9/22/2014	No Op.	Stopped - low water	11/4/2014	Op.	
9/23/2014	No Op.	Stopped - low water	11/5/2014	No Op.	Stopped - woody debris

11/6/2014	Op.	
11/7/2014	No Op.	Stopped - woody debris
11/8/2014	Op.	
11/9/2014	Op.	
11/10/2014	Op.	
11/11/2014	Op.	
11/12/2014	No Op.	Stopped - ice
11/13/2014	No Op.	Pulled - ice
11/14/2014	No Op.	Pulled - ice
11/15/2014	No Op.	Pulled - ice
11/16/2014	No Op.	Pulled - ice
11/17/2014	No Op.	Pulled - ice
11/18/2014	No Op.	Pulled - ice
11/19/2014	No Op.	Pulled - ice
11/20/2014	No Op.	Pulled - ice
11/21/2014	Op.	
11/22/2014	Op.	
11/23/2014	Op.	
11/24/2014	Op.	
11/25/2014	Op.	
11/26/2014	No Op.	Stopped - ice
11/27/2014	No Op.	Pulled - ice
11/28/2014	No Op.	Pulled - ice
11/29/2014	No Op.	Pulled - ice
11/30/2014	Op.	Last day of trapping

APPENDIX C. Regression Models

Model: Chinook Yearlings (Spring '06-'14) Back Position, (r^2 = 0.15; p = 0.03)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	869
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	264
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	173
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	250
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	656
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	434
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	966
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	732
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	358
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	443
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.158	0.409	210
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.034	0.187	1380
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.068	0.263	368
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.136	0.377	876
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.125	0.361	936
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.045	0.213	330
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.194	0.457	274
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.136	0.377	188
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.154	0.403	1230
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.167	0.421	315
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.157	0.408	271
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.476	327
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.077	0.281	958
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.149	0.397	566

Model: Chinook Subyearling (Fall '06-'13) Back Position, (r^2 = 0.55; p = 0.001)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Parr	0	10/26/2006	Back	183	50	0.28	0.56	51
Wild Chinook Parr	0	10/30/2006	Back	168	52	0.32	0.60	63
Wild Chinook Parr	0	11/1/2010	Back	254	42	0.17	0.42	198
Wild Chinook Parr	0	11/4/2010	Back	287	49	0.17	0.43	215
Wild Chinook Parr	0	11/7/2010	Back	168	32	0.20	0.46	241
Wild Chinook Parr	0	11/13/2010	Back	185	35	0.19	0.46	131
Wild Chinook Parr	0	11/3/2012	Back	201	25	0.13	0.37	402

Wild Chinook Parr	0	11/7/2012	Back	233	27	0.12	0.35	394
Wild Chinook Parr	0	11/11/2012	Back	328	87	0.27	0.54	217
Wild Chinook Parr	0	11/15/2012	Back	195	34	0.18	0.44	213
Wild Chinook Parr	0	9/30/2013	Back	171	12	0.08	0.28	542
Wild Chinook Parr	0	10/2/2013	Back	213	43	0.21	0.47	328
Wild Chinook Parr	0	10/3/2013	Back	181	41	0.23	0.50	296
Wild Chinook Parr	0	10/7/2013	Back	242	31	0.13	0.37	233
Wild Chinook Parr	0	10/9/2013	Back	203	40	0.20	0.47	303
Wild Chinook Parr	0	11/27/2013	Back	241	55	0.23	0.50	182

Model: Chinook Subyearling (Fall ’06-’13) Forward Position, (r^2 = 0.16; p = 0.02)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Parr	0	7/13/2006	Back	52	8	0.17	0.43	171
Wild Chinook Parr	0	7/17/2006	Back	138	15	0.12	0.35	129
Wild Chinook Parr	0	7/20/2006	Back	74	5	0.08	0.29	113
Wild Chinook Parr	0	7/28/2006	Back	54	5	0.11	0.34	91
Wild Chinook Parr	0	7/31/2006	Back	99	7	0.08	0.29	79
Wild Chinook Parr	0	9/18/2006	Back	55	10	0.20	0.46	46
Wild Chinook Parr	0	7/31/2008	Back	60	15	0.27	0.54	121
Wild Chinook Parr	0	8/12/2008	Back	103	2	0.03	0.17	85.6
Wild Chinook Parr	0	8/22/2008	Back	75	11	0.16	0.41	97
Wild Chinook Parr	0	8/28/2008	Back	72	7	0.11	0.34	81.9
Wild Chinook Parr	0	10/9/2008	Back	110	22	0.21	0.48	63.5
Wild Chinook Parr	0	10/27/2008	Back	51	12	0.26	0.53	56.1
Wild Chinook Parr	0	10/30/2008	Back	84	15	0.19	0.45	53
Wild Chinook Parr	0	11/6/2008	Back	78	8	0.12	0.35	77.7
Wild Chinook Parr	0	11/10/2008	Back	88	0	0.01	0.11	309
Wild Chinook Parr	0	7/14/2009	Back	86	2	0.04	0.19	193
Wild Chinook Parr	0	7/15/2009	Back	105	4	0.05	0.22	179
Wild Chinook Parr	0	7/17/2009	Back	122	8	0.07	0.28	157
Wild Chinook Parr	0	7/20/2009	Back	89	2	0.03	0.19	135
Wild Chinook Parr	0	8/17/2009	Back	73	1	0.03	0.17	58
Wild Chinook Parr	0	9/10/2009	Back	56	7	0.14	0.39	60
Wild Chinook Parr	0	8/8/2010	Back	58	1	0.03	0.19	85
Wild Chinook Parr	0	8/11/2010	Back	114	8	0.08	0.29	77
Wild Chinook Parr	0	9/11/2010	Back	68	9	0.15	0.39	75
Wild Chinook Parr	0	10/12/2010	Back	216	42	0.20	0.46	126
Wild Chinook Parr	0	10/15/2010	Back	192	37	0.20	0.46	95
Wild Chinook Parr	0	10/18/2010	Back	193	36	0.19	0.45	81
Wild Chinook Parr	0	10/22/2010	Back	92	18	0.21	0.47	69
Wild Chinook Parr	0	10/25/2010	Back	60	7	0.13	0.37	78
Wild Chinook Parr	0	10/29/2010	Back	127	0	0.01	0.09	95.1
Wild Chinook Parr	0	8/19/2011	Back	106	5	0.06	0.24	123

Model: Summer Steelhead Back Position ('07-'14), (r^2 = 0.35; p = 2.90E-05)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Steelhead Parr/Smolt	1+	3/20/2007	Back	55	1	0.04	0.19	1230
Wild Steelhead Parr/Smolt	1+	3/31/2007	Back	56	4	0.09	0.30	869
Wild Steelhead Parr/Smolt	1+	4/10/2007	Back	60	8	0.15	0.40	966
Wild Steelhead Parr/Smolt	1+	5/1/2007	Back	52	2	0.06	0.24	783
Wild Steelhead Parr/Smolt	1+	6/9/2007	Back	71	9	0.14	0.38	842
Wild Steelhead Parr/Smolt	1+	6/12/2007	Back	65	8	0.14	0.38	704
Wild Steelhead Parr/Smolt	1+	6/14/2007	Back	61	5	0.10	0.32	687
Wild Steelhead Parr/Smolt	1+	6/21/2007	Back	67	4	0.07	0.28	751
Wild Steelhead Parr/Smolt	1+	4/14/2008	Back	149	46	0.32	0.60	327
Wild Steelhead Parr/Smolt	1+	4/17/2008	Back	75	3	0.05	0.23	274
Wild Steelhead Parr/Smolt	1+	4/28/2008	Back	74	11	0.16	0.41	271
Wild Steelhead Parr/Smolt	1+	5/1/2008	Back	176	29	0.17	0.43	315
Wild Steelhead Parr/Smolt	1+	5/12/2008	Back	55	8	0.16	0.42	663
Wild Steelhead Parr/Smolt	1+	5/15/2008	Back	57	1	0.04	0.19	1390
Wild Steelhead Parr/Smolt	1+	6/9/2008	Back	142	20	0.15	0.39	938
Wild Steelhead Parr/Smolt	1+	6/12/2008	Back	83	10	0.13	0.37	823
Wild Steelhead Parr/Smolt	1+	6/16/2008	Back	81	8	0.11	0.34	1140
Wild Steelhead Parr/Smolt	1+	4/20/2010	Back	121	11	0.10	0.32	675
Wild Steelhead Parr/Smolt	1+	4/22/2010	Back	121	10	0.09	0.31	726
Wild Steelhead Parr/Smolt	1+	6/20/2010	Back	128	11	0.09	0.31	926
Wild Steelhead Parr/Smolt	1+	4/5/2011	Back	52	1	0.04	0.20	761
Wild Steelhead Parr/Smolt	1+	5/22/2011	Back	84	3	0.05	0.22	1540
Wild Steelhead Parr/Smolt	1+	6/12/2012	Back	69	5	0.09	0.30	1170
Wild Steelhead Parr/Smolt	1+	7/26/2012	Back	63	4	0.08	0.29	278
Wild Steelhead Parr/Smolt	1+	4/22/2013	Back	66	6	0.11	0.33	520
Wild Steelhead Parr/Smolt	1+	4/26/2013	Back	50	2	0.06	0.25	642
Wild Steelhead Parr/Smolt	1+	4/30/2013	Back	54	2	0.06	0.24	778
Wild Steelhead Parr/Smolt	1+	5/8/2013	Back	62	0	0.02	0.13	2170
Wild Steelhead Parr/Smolt	1+	5/19/2013	Back	122	15	0.13	0.37	1130
Wild Steelhead Parr/Smolt	1+	5/22/2013	Back	58	4	0.09	0.30	1080
Wild Steelhead Parr/Smolt	1+	5/26/2013	Back	79	3	0.05	0.23	724
Wild Steelhead Parr/Smolt	1+	5/30/2013	Back	92	7	0.09	0.30	849
Wild Steelhead Parr/Smolt	1+	6/3/2013	Back	71	6	0.10	0.32	962
Wild Steelhead Parr/Smolt	1+	6/7/2013	Back	94	4	0.05	0.23	1420
Wild Steelhead Parr/Smolt	1+	6/13/2013	Back	64	2	0.05	0.22	745
Wild Steelhead Parr/Smolt	1+	6/17/2013	Back	115	5	0.05	0.23	883
Wild Steelhead Parr/Smolt	1+	6/29/2013	Back	60	12	0.22	0.48	730
Wild Steelhead Parr/Smolt	1+	7/7/2013	Back	75	9	0.13	0.37	325
Wild Steelhead Parr/Smolt	1+	5/5/2014	Back	55	3	0.07	0.27	1260
Wild Steelhead Parr/Smolt	1+	5/20/2014	Back	57	0	0.02	0.13	1490

Wild Steelhead Parr/Smolt	1+	6/3/2014	Back	75	1	0.03	0.16	1610

Model: 2013 Summer Steelhead Back Position (In-yr.), (r^2 = 0.15; p = 0.05)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Smolt	1+	3/31/2007	Back	40	2	0.08	0.28	869
Wild Chinook Smolt	1+	4/6/2006	Back	42	9	0.24	0.51	264
Wild Chinook Smolt	1+	4/14/2010	Back	42	4	0.12	0.35	173
Wild Chinook Smolt	1+	3/31/2012	Back	43	5	0.14	0.38	250
Wild Chinook Smolt	1+	4/3/2007	Back	46	1	0.04	0.21	656
Wild Chinook Smolt	1+	4/19/2012	Back	48	7	0.17	0.42	434
Wild Chinook Smolt	1+	4/10/2007	Back	53	4	0.09	0.31	966
Wild Chinook Smolt	1+	4/21/2009	Back	53	0	0.02	0.14	732
Wild Chinook Smolt	1+	4/13/2012	Back	53	4	0.09	0.31	358
Wild Chinook Smolt	1+	4/16/2012	Back	53	7	0.15	0.40	443
Wild Chinook Smolt	1+	4/24/2008	Back	57	8	0.158	0.409	210
Wild Chinook Smolt	1+	4/23/2012	Back	58	1	0.034	0.187	1380
Wild Chinook Smolt	1+	4/24/2006	Back	59	3	0.068	0.263	368
Wild Chinook Smolt	1+	3/23/2007	Back	59	7	0.136	0.377	876
Wild Chinook Smolt	1+	3/17/2007	Back	64	7	0.125	0.361	936
Wild Chinook Smolt	1+	4/18/2010	Back	67	2	0.045	0.213	330
Wild Chinook Smolt	1+	4/17/2008	Back	72	13	0.194	0.457	274
Wild Chinook Smolt	1+	4/3/2006	Back	81	10	0.136	0.377	188
Wild Chinook Smolt	1+	3/20/2007	Back	91	13	0.154	0.403	1230
Wild Chinook Smolt	1+	5/1/2008	Back	102	16	0.167	0.421	315
Wild Chinook Smolt	1+	4/28/2008	Back	127	19	0.157	0.408	271
Wild Chinook Smolt	1+	4/14/2008	Back	195	40	0.21	0.476	327
Wild Chinook Smolt	1+	3/9/2014	Back	65	4	0.077	0.281	958
Wild Chinook Smolt	1+	3/13/2014	Back	67	9	0.149	0.397	566

Model: Spring Chinook 2010-2014 Non-Trapping Period Array (NAL) Efficiency, (r^2 = 0.64; p = 0.0004)

Origin/Species/Stage	Age	Date	Mark	Detections	Trap Efficiency (R+1) / M	ASIN Transform	Discharge
Wild Chinook Parr	0	11/4/2010	254	95	0.38	0.66	224
Wild Chinook Parr	0	11/7/2010	287	70	0.25	0.52	248
Wild Chinook Parr	0	11/10/2010	168	74	0.45	0.73	169
Wild Chinook Parr	0	11/18/2010	185	22	0.12	0.36	278
Wild Chinook Parr	0	11/3/2012	201	21	0.11	0.34	384

Wild Chinook Parr	0	11/7/2012	233	31	0.14	0.38	394
Wild Chinook Parr	0	11/11/2012	328	66	0.20	0.47	378
Wild Chinook Parr	0	11/15/2012	195	68	0.35	0.64	219
Wild Chinook Parr	0	11/4/2013	130	51	0.40	0.68	127
Wild Chinook Parr	0	11/8/2013	106	39	0.38	0.66	146
Wild Chinook Parr	0	11/4/2014	114	5	0.05	0.23	583
Wild Chinook Parr	0	3/9/2014	65	4	0.08	0.28	880
Wild Chinook Parr	0	3/13/2014	67	5	0.09	0.30	541
Wild Chinook Parr	0	11/13/2010	74	41	0.57	0.85	140

APPENDIX D. Historical Morphometric Data

Spring Chinook (2004-2014)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Wild Chinook Yearling Smolt	93.4	336	12.4	9.0	337	5.0	1.1
2004	2003	Wild Chinook Subyearling Fry	39.5	82	5.1	0.6	79	0.3	1.0
2004	2003	Wild Chinook Subyearling Parr	82.4	792	7.9	6.1	702	2.7	1.1
2005	2003	Wild Chinook Yearling Smolt	93.6	278	7.9	8.7	276	2.1	1.1
2005	2004	Wild Chinook Subyearling Fry	42.1	107	5.6	0.7	102	0.4	0.9
2005	2004	Wild Chinook Subyearling Parr	75.9	924	9.6	4.9	890	3.8	1.1
2006	2004	Wild Chinook Yearling Smolt	91.2	363	7.1	7.5	362	1.8	1.0
2006	2005	Wild Chinook Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Wild Chinook Subyearling Parr	72.9	1,428	9.6	3.9	1,428	2.3	1.0
2007	2005	Wild Chinook Yearling Smolt	89.0	676	8.2	8.0	675	6.1	1.1
2007	2006	Wild Chinook Subyearling Fry	39.0	24	3.7	0.6	24	0.5	1.0
2007	2006	Wild Chinook Subyearling Parr	79.5	686	13.8	6.1	685	2.6	1.2
2008	2006	Wild Chinook Yearling Smolt	96.1	904	6.6	9.5	904	2.1	1.1
2008	2007	Wild Chinook Subyearling Fry	42.8	127	4.6	0.8	127	0.4	1.0
2008	2007	Wild Chinook Subyearling Parr	75.8	2,049	12.5	5.2	2,049	2.4	1.2
2009	2007	Wild Chinook Yearling Smolt	94.4	198	8.9	9.2	198	2.5	1.1
2009	2008	Wild Chinook Subyearling Fry	44.8	82	4.8	0.9	82	0.6	1.0
2009	2008	Wild Chinook Subyearling Parr	70.1	2,333	12.0	4.2	2,333	2.0	1.2
2010	2008	Wild Chinook Yearling Smolt	96.9	366	7.3	10.2	366	2.3	1.1
2010	2009	Wild Chinook Subyearling Fry	41.8	30	5.0	1.3	8	0.2	1.8
2010	2009	Wild Chinook Subyearling Parr	80.7	3,021	10.7	6.2	3,021	2.3	1.2
2011	2009	Wild Chinook Yearling Smolt	89.1	152	9.9	7.7	152	1.8	1.1
2011	2010	Wild Chinook Subyearling Fry	39.8	217	6.6	0.6	217	0.5	1.0
2011	2010	Wild Chinook Subyearling Parr	73.4	1,046	13.1	4.9	1,046	2.5	1.2
2012	2010	Wild Chinook Yearling Smolt	93.3	368	7.0	9.2	368	2.2	1.1
2012	2011	Wild Chinook Subyearling Fry	42.7	48	9.1	0.9	48	0.6	1.2
2012	2011	Wild Chinook Subyearling Parr	77.9	2,160	10.7	5.3	2,160	1.9	1.1
2013	2011	Wild Chinook Yearling Smolt	90.6	239	75.0	7.9	239	2.1	1.1
2013	2012	Wild Chinook Subyearling Fry	45.6	1,824	6.8	1.0	1,803	0.6	1.1
2013	2012	Wild Chinook Subyearling Parr	70.0	4,422	11.4	3.8	4,409	1.7	1.1
2014	2012	Wild Chinook Yearling Smolt	89.5	464	6.9	7.5	464	1.8	1.0
2014	2013	Wild Chinook Subyearling Fry	40.1	677	5.2	0.9	221	0.5	1.4
2014	2013	Wild Chinook Subyearling Parr	69.1	1,549	12.3	3.8	1,547	2.3	1.2

Summer Steelhead (2004-2014)

Trap Year	Brood Year	Age	Origin/Species	Fork Length (mm)			Weight (g)			K-factor
				Mean	n	SD	Mean	n	SD	
2004	2004	0	Wild Summer Steelhead	67.0	358	10.0	3.5	279	1.5	1.2
2004	2003	1	Wild Summer Steelhead	101.7	394	23.2	13.2	366	27.3	1.3
2004	2002	2	Wild Summer Steelhead	161.6	146	19.8	43.4	141	15.5	1.0
2004	2001	3	Wild Summer Steelhead	201.6	43	11.2	76.0	43	21.2	0.9
2004	2003	1	Hat. Summer Steelhead	182.8	523	22.4	62.1	497	21.2	1.0
2005	2005	0	Wild Summer Steelhead	54.1	649	15.7	2.2	616	3.2	1.4
2005	2004	1	Wild Summer Steelhead	93.6	585	25.6	10.8	575	10.1	1.3
2005	2003	2	Wild Summer Steelhead	153.5	103	21.2	38.1	102	16.4	1.1
2005	2002	3	Wild Summer Steelhead	144	1	—	43.2	1	—	1.4
2005	2004	1	Hat. Summer Steelhead	188.2	343	21.2	66.0	343	24.0	1.0
2006	2006	0	Wild Summer Steelhead	66.3	180	5.8	2.5	180	1.0	0.9
2006	2005	1	Wild Summer Steelhead	85.2	877	18.7	6.7	877	6.6	1.1
2006	2004	2	Wild Summer Steelhead	155.9	106	26.8	36.1	105	13.5	1.0
2006	2003	3	Wild Summer Steelhead	197	2	—	73.5	2	—	1.0
2006	2005	1	Hat. Summer Steelhead	—	—	—	—	—	—	—
2007	2007	0	Wild Summer Steelhead	54.2	329	11.7	2.0	328	1.4	1.3
2007	2006	1	Wild Summer Steelhead	82.7	1,330	16.8	7.2	1,329	6.3	1.3
2007	2005	2	Wild Summer Steelhead	143.8	102	20.6	31.4	102	11.9	1.1
2007	2004	3	Wild Summer Steelhead	143	1	—	26.8	1	—	0.9
2007	2006	1	Hat. Summer Steelhead	149.3	3	47	33.1	3	29.1	1.0
2008	2008	0	Wild Summer Steelhead	52.9	930	11.1	1.7	930	1.2	1.1
2008	2007	1	Wild Summer Steelhead	84.5	1,876	17.1	7.4	1,874	6.6	1.2
2008	2006	2	Wild Summer Steelhead	149.9	122	22.9	36.0	122	15.5	1.1
2008	2005	3	Wild Summer Steelhead	180.3	13	18.9	57.4	13	16.4	1.0
2008	2007	1	Hat. Summer Steelhead	179.4	389	16.5	55.9	388	14.8	1.0
2009	2009	0	Wild Summer Steelhead	55.6	843	10.5	2.2	688	1.1	1.3
2009	2008	1	Wild Summer Steelhead	82.6	452	18.6	7.1	447	5.5	1.3
2009	2007	2	Wild Summer Steelhead	156.9	72	22.0	40.9	72	15.5	1.1
2009	2006	3	Wild Summer Steelhead	195.0	3	5.0	73.0	3	6.7	1.0
2009	2008	1	Hat. Summer Steelhead	183.1	280	16.7	60.8	280	18.2	1.0
2010	2010	0	Wild Summer Steelhead	55.0	1,287	11.1	2.5	917	1.3	1.5
2010	2009	1	Wild Summer Steelhead	89.8	1,079	19.1	9.0	1,072	7.1	1.2
2010	2008	2	Wild Summer Steelhead	144.9	87	25.1	35.0	87	17.4	1.2
2010	2007	3	Wild Summer Steelhead	184.0	8	12.2	61.9	8	10.2	1.0
2010	2009	1	Hat. Summer Steelhead	183.5	531	19.5	61.3	526	19.6	1.0
2011	2011	0	Wild Summer Steelhead	43.5	1,093	10.1	1.1	783	0.9	1.3
2011	2010	1	Wild Summer Steelhead	75.7	818	18.5	5.5	811	5.7	1.3
2011	2009	2	Wild Summer Steelhead	144.8	27	41.3	42.1	27	62.1	1.4
2011	2008	3	Wild Summer Steelhead	—	—	—	—	—	—	—

2011	2010	1	Hat. Summer Steelhead	180.7	464	17.0	59.1	464	17.6	1.0
2012	2012	0	Wild Summer Steelhead	55.1	589	14.2	2.6	402	1.2	1.6
2012	2011	1	Wild Summer Steelhead	84.7	747	17.4	7.6	741	5.7	1.3
2012	2010	2	Wild Summer Steelhead	127.1	132	27.0	23.7	132	14.5	1.2
2012	2009	3	Wild Summer Steelhead	161.0	4.0	32.0	40.5	4.0	15.6	1.0
2012	2011	1	Hat. Summer Steelhead	154.8	318	20.9	37.7	318	14.0	1.0
2013	2013	0	Wild Summer Steelhead	56.1	878	11.3	2.1	777	1.1	1.2
2013	2012	1	Wild Summer Steelhead	44.5	1,777	14.7	5.4	1,772	4.2	1.2
2013	2011	2	Wild Summer Steelhead	144.7	21	15.7	36.1	21	10.2	1.0
2013	2010	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2013	2012	1	Hat. Summer Steelhead	166.2	365	21.4	49.2	363	18.2	1.1
2014	2014	0	Wild Summer Steelhead	49.6	490	12.8	1.7	389	1.1	1.4
2014	2013	1	Wild Summer Steelhead	82.2	745	13.6	6.3	745	3.5	1.1
2014	2012	2	Wild Summer Steelhead	145.1	30	16.5	33.0	30	13.4	1.1
2014	2011	3	Wild Summer Steelhead	—	—	—	—	—	—	—
2014	2013	1	Hat. Summer Steelhead	173.4	632	18.7	52.6	633	15.9	1.0

Coho (2007-2014)

Trap Year	Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-factor
			Mean	n	SD	Mean	n	SD	
2004	2002	Nat. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2004	2003	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2004	2003	Nat. Orig. Coho Subyearling Parr	—	—	—	—	—	—	—
2004	2002	Hatchery Coho Yearling Smolt	136.6	847	12.8	27.4	820	7.5	1.1
2005	2003	Nat. Orig. Coho Yearling Smolt	114.4	17	8.8	16.2	17	3.6	1.1
2005	2004	Nat. Orig. Coho Subyearling Fry	49.1	9	10.4	1.3	9	0.8	1.1
2005	2004	Nat. Orig. Coho Subyearling Parr	76.7	9	12.8	4.9	9	2.7	1.1
2005	2003	Hatchery Coho Yearling Smolt	137.3	689	11.3	28.6	690	7.2	1.1
2006	2004	Nat. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2006	2005	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2006	2005	Nat. Orig. Coho Subyearling Parr	71.0	4	13.6	3.8	4	2.9	1.1
2006	2004	Hatchery Coho Yearling Smolt	—	—	—	—	—	—	—
2007	2005	Nat. Orig. Coho Yearling Smolt	92.9	36	12.5	8.7	36	4.0	1.1
2007	2006	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2007	2006	Nat. Orig. Coho Subyearling Parr	83.0	1	—	6.2	1	—	1.1
2007	2005	Hatchery Coho Yearling Smolt	116.0	2	—	16.8	2	—	1.1
2008	2006	Nat. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2008	2007	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2008	2007	Nat. Orig. Coho Subyearling Parr	87.0	1	—	6.4	1	—	1.0
2008	2006	Hatchery Coho Yearling Smolt	130.2	843	10.4	23.6	843	6.2	1.1

2009	2007	Nat. Orig. Coho Yearling Smolt	103.0	4	9.7	11.7	4	3.4	1.1
2009	2008	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2009	2008	Nat. Orig. Coho Subyearling Parr	79.6	5	20.1	6.6	5	4.8	1.3
2009	2007	Hatchery Coho Yearling Smolt	135.3	625	8.9	26.2	579	5.2	1.1
2010	2008	Nat. Orig. Coho Yearling Smolt	—	—	—	—	—	—	—
2010	2009	Nat. Orig. Coho Subyearling Fry	48.0	2	—	1.3	2	—	1.2
2010	2009	Nat. Orig. Coho Subyearling Parr	83.6	27	8.6	6.7	27	2.4	1.1
2010	2008	Hatchery Coho Yearling Smolt	130.0	1,051	10.1	23.8	1,049	5.3	1.1
2011	2009	Nat. Orig. Coho Yearling Smolt	100.2	14	12.7	11.3	14	3.9	1.1
2011	2010	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2011	2010	Nat. Orig. Coho Subyearling Parr	64.7	3	10.8	3.0	3	1.5	1.1
2011	2009	Hatchery Coho Yearling Smolt	124.6	969	8.6	21.0	969	4.8	1.1
2012	2010	Nat. Orig. Coho Yearling Smolt	102.1	17	9.1	11.9	17	3.0	1.1
2012	2011	Nat. Orig. Coho Subyearling Fry	36.0	1	—	—	—	—	—
2012	2011	Nat. Orig. Coho Subyearling Parr	78.4	84	9.3	5.0	84	2.1	1.0
2012	2010	Hatchery Coho Yearling Smolt	126.2	1,684	7.6	21.5	1,684	5.5	1.1
2013	2011	Nat. Orig. Coho Yearling Smolt	97.0	81	10.0	10.0	81	3.1	1.1
2013	2012	Nat. Orig. Coho Subyearling Fry	47.3	3	1.0	1.0	3	1.0	0.9
2013	2012	Nat. Orig. Coho Subyearling Parr	87.8	4	3.8	6.6	4	1.0	1.0
2013	2011	Hatchery Coho Yearling Smolt	130.1	982	8.5	23.3	977	4.9	1.1
2014	2012	Nat. Orig. Coho Yearling Smolt	96.3	20	9.8	9.9	20	3.0	1.1
2014	2013	Nat. Orig. Coho Subyearling Fry	36.0	1	—	—	—	—	—
2014	2013	Nat. Orig. Coho Subyearling Parr	73.0	3	22.5	5.9	3	4.7	1.5
2014	2012	Hatchery Coho Yearling Smolt	127.0	1,203	9.7	21.7	1,207	5.0	1.1

APPENDIX B: SPAWNING GROUND SURVEY RECORDS FOR THE WENATCHEE AND METHOW RIVERS, 2014

Stream	Reach	Date	New Redds	Live Fish	Dead Fish
Beaver Creek	1	10/13/2014	0	0	0
		10/20/2014	0	0	0
		10/27/2014	0	0	0
		11/3/2014	0	0	0
		11/10/2014	0	0	0
		11/17/2014	0	0	0
		Beaver Cr. Total	**0**	**0**	**0**
Chiwaukum Creek	1	10/13/2014	0	0	0
		10/27/2014	0	0	0
		11/3/2014	0	1	0
		11/17/2014	0	0	0
		12/1/2014	0	0	0
		Chiwaukum Cr. Total	**0**	**1**	**0**
Chiwawa River	1	10/13/2014	0	0	0
		10/18/2014	0	2	0
		10/20/2014	0	2	0
		10/27/2014	0	0	0
		11/3/2014	0	0	0
		11/15/2014	0	0	0
		Chiwawa R. Total	**0**	**4**	**0**
Chumstick Creek	1	10/2/2014	0	0	0
		10/9/2014	0	0	0
		10/13/2014	1	3	0
		10/20/2014	6	15	1
		10/27/2014	5	38	1
		11/3/2014	25	49	4
		11/10/2014	11	30	20
		11/17/2014	2	20	24
		11/25/2014	0	13	9
		12/1/2014	1	5	15
		12/8/2014	1	8	6
		12/16/2014	0	1	0
		Chumstick Cr. Total	**52**	**182**	**80**
Icicle Creek	1	9/25/2014	0	0	0
		10/1/2014	0	32	0
		10/8/2014	11	90	1
		10/15/2014	72	400	24
		10/21/2014	146	435	23
		10/29/2014	205	800	53
		11/2/2014	0	0	33

		11/5/2014	91	273	34
		11/9/2014	0	0	34
		11/12/2014	104	651	40
		11/19/2014	39	100	44
		11/24/2014	22	225	58
		12/4/2014	0	15	11
		12/8/2014	6	37	4
		12/15/2014	0	18	12
Icicle Creek	2	9/25/2014	0	0	0
		10/1/2014	0	37	0
		10/8/2014	8	319	1
		10/15/2014	91	651	4
		10/21/2014	61	742	1
		10/29/2014	22	690	1
		11/5/2014	4	448	0
		11/12/2014	6	240	3
		11/19/2014	21	193	6
		12/4/2014	2	33	0
		12/15/2014	0	0	0
Icicle Creek	3	10/15/2014	2	7	0
		10/29/2014	0	3	0
		Icicle Cr. Total	**913**	**6,439**	**387**
Mission/Brender Creek	1	9/24/2014	0	0	0
		10/2/2014	0	0	0
		10/9/2014	1	0	0
		10/16/2014	4	8	1
		10/23/2014	2	6	1
		10/30/2014	11	30	9
		11/6/2014	22	24	1
		11/13/2014	0	6	1
		11/21/2014	1	8	13
		11/25/2014	0	2	0
		12/1/2014	2	5	1
		12/9/2014	0	1	5
		12/16/2014	0	0	0
		M/B Cr. Total	**43**	**90**	**32**
Nason Creek	1	10/10/2014	0	0	0
		10/14/2014	0	0	0
		10/22/2014	5	32	2
		11/4/2014	**0**	**0**	**0**
		11/15/2014	2	0	0
		11/18/2014	0	0	0

	2	10/10/2014	0	0	0
		10/17/2014	0	0	0
		10/24/2014	4	10	0
		11/1/2014	2	13	0
		11/14/2014	0	0	1
		11/21/2014	1	0	0
	3	10/17/2014	1	2	0
		10/24/2014	1	8	0
		11/1/2014	0	4	1
		11/7/2014	0	2	0
		11/14/2014	0	1	0
		11/21/2014	0	0	0
	4	10/13/2014	0	0	0
		10/20/2014	0	4	0
		10/27/2014	0	0	0
		11/3/2014	0	4	0
		11/10/2014	0	0	0
		11/17/2014	0	0	0
		Nason Cr. Total	**16**	**80**	**4**
Peshastin Creek	1	9/30/2014	0	0	0
		10/6/2014	1	2	0
		10/15/2014	5	11	2
		10/22/2014	11	20	2
		11/6/2014	0	0	0
		11/10/2014	23	18	2
		11/19/2014	0	0	0
		12/4/2014	2	0	0
	2	10/15/2014	1	2	0
		10/22/2014	11	8	1
		11/6/2014	0	0	0
		11/19/2014	0	0	0
		11/25/2014	4	0	0
	3	10/15/2014	0	0	0
		11/19/2014	0	0	0
		Peshastin Cr. Total	**58**	**61**	**7**
Roaring Creek	1	10/13/2014	0	0	0
		10/27/2014	0	0	0
		11/17/2014	0	0	0
		12/1/2014	0	0	0
		Roaring Cr. Total	**0**	**0**	**0**
Wenatchee River	1	10/2/2014	0	39	0
		10/16/2014	3	29	7

		10/23/2014	0	3	0
		10/30/2014	0	3	1
		11/6/2014	4	6	11
		11/13/2014	3	12	0
		11/18/2014	4	4	1
		11/20/2014	43	15	7
		11/26/2014	2	1	0
		12/5/2014	0	2	6
		12/10/2014	0	1	5
		12/17/2014	0	0	1
Wenatchee River	2	10/1/2014	0	37	0
		10/3/2014	0	15	0
		10/16/2014	1	38	1
		10/23/2014	0	0	0
		11/6/2014	0	0	0
		11/18/2014	12	6	12
		11/20/2014	4	8	8
Wenatchee River	3	10/9/2014	0	31	1
		10/12/2014	0	10	2
		10/19/2014	1	45	7
		10/26/2014	0	26	6
		11/2/2014	0	0	0
		11/16/2014	7	17	30
		11/23/2014	7	26	17
Wenatchee River	4	10/1/2014	0	0	0
		10/8/2014	0	2	0
		10/15/2014	12	105	1
		10/22/2014	47	124	14
		10/29/2014	40	110	4
		11/5/2014	9	25	2
		11/11/2014	27	38	16
		11/19/2014	30	73	19
		11/25/2014	4	25	3
		12/4/2014	3	9	1
Wenatchee River	4RB	9/25/2014	0	0	0
		10/1/2014	0	13	0
		10/8/2014	0	10	0
		10/15/2014	1	15	0
		10/21/2014	10	25	3
		10/29/2014	57	150	18
		11/2/2014	0	0	3
		11/5/2014	27	50	13

		11/9/2014	0	0	11
		11/12/2014	20	25	15
		11/19/2014	22	45	19
		11/24/2014	7	44	10
		12/4/2014	0	5	12
		12/8/2014	4	5	1
		12/15/2014	0	0	3
Wenatchee River	5	10/13/2014	0	0	0
		10/20/2014	0	1	0
		10/27/2014	0	0	0
Wenatchee River	6	10/25/2014	1	2	0
		11/8/2014	1	0	0
Wenatchee River	7	10/19/2014	0	5	0
		11/7/2014	0	1	0
		Wenatchee R. Total	**413**	**1,281**	**291**
		Wenatchee Basin Total	**1,495**	**8,138**	**801**

Stream	Reach	Date	New Redds	Live Fish	Dead Fish
Methow	1 - Mouth to Steel Bridge	Did Not Survey	-	-	-
	2 - Steel Bridge to Lower Burma Bridge	Did Not Survey	-	-	-
	3 - Lower Burma Bridge to Upper Burma Bridge	10/2/2014	0	0	0
		10/7/2014	0	2	0
		10/14/2014	2	22	0
		10/21/2014	3	2	0
		11/1/2014	0	0	0
		11/14/2014	0	0	0
		11/20/2014	5	0	0
	4 - Upper Burma Bridge to Lower Gold Creek Bridge	10/1/2014	0	0	0
		10/2/2014	0	0	0
		10/7/2014	0	2	0
		10/14/2014	1	3	2
		10/21/2014	4	5	1
		11/1/2014	0	0	0
		11/14/2014	2	1	2
		11/19/2014	1	0	0
		11/20/2014	1	0	1
	5 - Lower Gold Creek Bridge to Carlton	10/1/2014	0	0	0
		10/7/2014	0	7	0
		10/14/2014	11	21	0

		10/21/2014	15	14	2
		11/1/2014	0	0	0
		11/14/2014	1	8	3
		11/19/2014	5	2	0
	6 - Carlton to Holterman's Hole	10/1/2014	0	0	0
		10/6/2014	0	0	0
		10/13/2014	3	11	0
		10/20/2014	6	25	3
		10/23/2014	19	16	7
		10/27/2014	11	16	10
		10/30/2014	4	13	12
		11/3/2014	2	39	9
		11/5/2014	2	0	0
		11/6/2014	9	47	0
		11/13/2014	1	0	0
		11/18/2014	1	6	0
		11/22/2014	0	0	0
		12/8/2014	0	2	0
	7 - Holterman's Hole to MVID dam	10/2/2014	0	0	0
		10/6/2014	0	2	0
		10/9/2014	0	41	0
		10/13/2014	0	18	1
		10/16/2014	1	5	0
		10/20/2014	3	9	6
		10/23/2014	0	6	3
		10/27/2014	7	21	3
		10/28/2014	0	0	2
		10/30/2014	3	3	6
		11/4/2014	18	44	17
		11/11/2014	19	30	0
		11/13/2014	3	3	0
		11/17/2014	0	0	0
		11/20/2014	1	6	0
		11/24/2014	1	5	0
		12/10/2014	0	0	0
	8 - MVID dam to Red barn	10/2/2014	0	0	0
		10/6/2014	0	6	0
		10/9/2014	0	62	0
		10/13/2014	0	82	0
		10/16/2014	1	33	1
		10/20/2014	5	49	7
		10/23/2014	2	11	9

		10/27/2014	15	61	10
		10/30/2014	2	4	12
		11/3/2014	30	77	44
		11/6/2014	31	59	0
		11/10/2014	3	6	0
		11/13/2014	1	5	0
		11/17/2014	4	9	0
		11/20/2014	3	4	0
		11/24/2014	0	7	0
		12/10/2014	0	0	0
	9 - Red barn to Wolf Creek	10/7/2014	0	0	0
		10/16/2014	1	6	0
		10/20/2014	0	13	0
		10/29/2014	1	14	0
		11/6/2014	5	9	3
		11/12/2014	1	1	1
		11/17/2014	0	0	2
		11/21/2014	0	1	1
		12/4/2014	0	0	1
		12/10/2014	0	0	0
	10 - Wolf Creek to Rip Rap	10/7/2014	0	0	0
		10/16/2014	2	3	0
		10/20/2014	2	12	0
		10/29/2014	4	18	0
		11/6/2014	1	14	1
		11/12/2014	5	9	1
		11/17/2014	1	0	1
		11/21/2014	4	0	0
		12/4/2014	1	0	0
		12/10/2014	0	0	0
	11 - Rip Rap to Weeman Bridge	10/7/2014	0	0	0
		10/16/2014	0	1	0
		10/20/2014	0	1	0
		10/29/2014	0	1	0
		11/6/2014	2	2	0
		11/12/2014	0	1	1
		11/17/2014	0	0	0
		11/21/2014	1	0	0
		12/4/2014	0	0	0
		12/10/2014	0	0	0
		Methow Total	**3**	**6**	**1**
Winthrop NFH Spring	Mouth to Adult Collection	10/16/2014	40	200	4

Creek	Weir				
		10/20/2014	20	200	9
		10/21/2014	4	200	7
		10/24/2014	22	200	5
		10/28/2014	54	600	16
		10/31/2014	0	600	20
		11/4/2014	47	500	25
		11/10/2014	0	500	44
		11/12/2014	16	0	0
		11/14/2014	2	0	0
		11/19/2014	6	0	0
	Adult collection Weir to Irrigation Diversion	10/18/2014	0	0	10
		10/25/2014	0	0	2
		11/8/2014	15	0	0
		12/6/2014	0	0	0
		Winthrop Total	**226**	**3,000**	**142**
WDFW Methow FH Outfall	Mouth to Hatchery Adult Weir	10/18/2014	5	11	0
		10/22/2014	6	30	2
		11/8/2014	36	51	13
		11/12/2014	2	56	2
		11/15/2014	3	33	7
		11/25/2014	0	11	1
		12/2/2014	0	0	0
		12/6/2014	1	3	0
		12/12/2014	0	0	0
		WDFW Total	**53**	**195**	**25**
Twisp	1 - Mouth to Lower Poorman Bridge	10/8/2014	0	2	0
		10/15/2014	7	11	0
		10/19/2014	9	8	1
		10/22/2014	10	10	3
		10/25/2014	3	41	4
		10/28/2014	2	2	1
		10/31/2014	1	4	2
		11/5/2014	3	9	7
		11/8/2014	1	8	0
		11/13/2014	1	0	0
		11/21/2014	0	0	1
		11/25/2014	1	2	7
		12/11/2014	0	0	0
	2 - Lower Poorman Bridge to Upper Poorman Bridge	10/8/2014	1	1	0
		10/15/2014	2	4	0
		10/19/2014	9	10	0

		10/22/2014	5	9	3
		10/25/2014	4	8	0
		10/28/2014	9	0	0
		10/31/2014	3	13	4
		11/5/2014	2	4	1
		11/8/2014	2	2	0
		11/13/2014	3	0	1
		11/21/2014	0	0	0
		12/11/2014	0	0	0
	3 – Upper Poorman Bridge to Twisp River Weir	10/8/2014	0	0	0
		10/15/2014	3	0	0
		10/22/2014	1	3	0
		10/25/2014	2	3	0
		10/28/2014	0	6	0
		10/31/2014	0	1	0
		11/5/2014	5	6	0
		11/8/2014	0	0	0
		11/13/2014	0	0	0
		11/24/2014	1	0	0
		12/11/2014	0	0	0
	4 – Twisp River Weir to Newby Creek Bridge	10/8/2014	0	0	0
		10/15/2014	0	0	0
		10/22/2014	0	0	0
		10/25/2014	0	0	0
		10/28/2014	0	0	0
		10/31/2014	0	1	0
		11/5/2014	0	0	1
		11/8/2014	0	0	0
		11/13/2014	0	0	1
		11/24/2014	0	0	0
		12/11/2014	0	0	0
	5 – Newby Creek Bridge to Buttermilk Creek Bridge	10/30/2014	1	0	0
		11/5/2014	0	0	1
		12/11/2014	1	0	1
	6 – Buttermilk Creek Bridge to War Creek Bridge	12/13/2014	0	0	0
		Twisp Total	**92**	**168**	**39**
Hancock	Mouth to Source	11/7/2014	0	1	0
		12/3/2014	0	0	0
		Hancock Total	**0**	**1**	**0**
Gold	1 –Private Land to South Fork Gold Creek Bridge	10/15/2014	3	7	0
		10/24/2014	1	23	0

		11/1/2014	0	3	1
		11/15/2014	1	5	1
		11/24/2014	1	0	1
	2 – South Fork Gold Creek Confluence to Acclimation Ponds	10/24/2014	2	25	0
		11/1/2014	3	0	1
		12/12/2014	0	1	0
		12/15/2014	0	0	0
		Gold Total	**11**	**64**	**4**
Suspension	Mouth to 250 M Upstream	11/21/2014	0	0	0
		12/3/2014	0	0	0
		Suspension Total	**0**	**0**	**0**
Libby	Mouth to Hwy 153	10/7/2014	0	0	0
		10/24/2014	1	4	0
		10/29/2014	0	2	0
		11/15/2014	0	0	0
		11/25/2014	0	0	0
		12/12/2014	1	0	0
		12/15/2014	0	0	0
		Libby Total	**2**	**6**	**0**
1890	Mouth to Culvert	11/6/2014	4	43	5
		11/15/2014	15	21	17
		1890 Total	**19**	**64**	**22**
Chewuch	1 - Mouth to Fulton Dam	10/21/2014	0	0	0
		11/7/2014	0	0	1
		11/11/2014	0	0	0
	2 - Fulton Dam to Co. Hwy 1613	10/21/2014	4	10	0
		10/28/2014	5	4	1
		11/4/2014	4	10	0
		11/7/2014	1	2	0
		11/11/2014	3	3	0
		11/18/2014	2	0	0
	3- Co. Hwy 1613 to Methow State Wildlife Area	10/9/2014	0	0	0
		10/24/2014	0	0	0
		10/29/2014	1	1	2
		11/7/2014	1	0	1
		11/29/2014	1	0	0
		Chewuch Total	**22**	**30**	**5**
		Methow Basin Total	**718**	**4,566**	**422**

APPENDIX C: Wenatchee and Methow Basin Coho Release Numbers and Mark Groups, BY2012.

Basin	River	Acclimation Site	Rearing Hatchery	Brood Source	Begin Release Date	End Release Date	FPP at Release	CWT Code	Pre-Release Retention	Total Smolts Received	Total Smolts Released *	CWTs Released	PIT tags
Wenatchee	Nason Cr	Coulter Pond	Willard NFH	MCR-WEN	1-May	11-Jun	16.1	**19-03-57+BT**	99.3%	62,997	58,965	58,552	5,500
										62,997	**58,965**	**58,552**	**5,500**
Wenatchee	Nason Cr	Butcher Pond	Willard NFH	MCR-WEN	6-May	11-Jun	17.0	**19-03-54+BT**	99.1%	17,380	16,772	16,621	-
Wenatchee	Nason Cr	Butcher Pond	Willard NFH	MCR-WEN	6-May	11-Jun	17.0	**19-03-56+BT**	99.1%	64,694	62,430	61,868	-
Wenatchee	Nason Cr	Butcher Pond	Willard NFH	MCR-WEN	6-May	11-Jun	17.0	**19-03-49+BT**	99.0%	30,310	29,252	28,959	-
										112,384	**108,453**	**107,448**	-
Wenatchee	Nason Cr	Rolfing's Pond	Willard NFH	MCR-WEN	6-May	11-Jun	16.4	**19-03-48+BT**	98.8%	88,275	85,824	84,794	-
										88,275	**85,824**	**84,794**	**-**
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	1-May	24-Jun	17.1	**19-03-50+BT**	98.9%	27,675	25,433	25,154	2,669
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	1-May	24-Jun	17.1	**19-03-51+BT**	99.4%	26,364	24,229	24,083	2,668
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	1-May	24-Jun	17.1	**19-03-52+BT**	99.3%	31,000	28,489	28,290	-
Wenatchee	Beaver Cr	Beaver Creek	Willard NFH	MCR-WEN	1-May	24-Jun	17.1	**19-53-53+BT**	99.7%	25,344	23,291	23,221	-
										110,383	**101,442**	**100,748**	**5,337**
Wenatchee	Icicle Cr	LNFH SFL 19, 20	Willard NFH	MCR-WEN	18-Apr	18-Apr	21.3	**19-03-55**	98.0%	63,979	61,676	60,442	2,890
Wenatchee	Icicle Cr	LNFH SFL 21, 22, 23	Cascade FH	MCR-WEN	18-Apr	18-Apr	21.5	**19-03-46**	98.9%	96,975	93,484	92,456	2,890

Wenatchee	Icicle Cr	LNFH SFL 8, 9, 11	Cascade FH	MCR-WEN	18-Apr	18-Apr	20.3	**19-03-44**	98.0%	106,620	102,249	100,204	-
Wenatchee	Icicle Cr	LNFH SFL 10, 12, 25	Cascade FH	MCR-WEN	18-Apr	18-Apr	19.3	**19-03-45**	99.5%	105,457	101,133	100,628	5,729
										373,031	**358,541**	**353,729**	**11,509**
Wenatchee	Icicle Cr	LNFH LFL 1	Willard NFH	MCR-WEN	17-Apr	17-Apr	22.4	**19-03-43**	96.9%	102,000	96,900	93,896	2,835
Wenatchee	Icicle Cr	LNFH LFL 2	Cascade FH	MCR-WEN	17-Apr	17-Apr	20.0	**19-03-59**	98.6%	48,674	46,873	46,217	2,859
Wenatchee	Icicle Cr	LNFH LFL 2	Cascade FH	MCR-WEN	17-Apr	17-Apr	20.0	**19-03-60**	98.9%	48,901	47,092	46,574	-
Wenatchee	Icicle Cr	LNFH LFL 3	Willard NFH	MCR-WEN	16-Apr	16-Apr	19.7	**19-03-47**	97.6%	70,150	67,554	65,933	-
										269,725	**258,419**	**252,620**	**5,694**
Methow	Methow	Wolf Creek	Cascade FH	MCR-MET	14-May	30-May	18.3	**19-03-61**	94.5%	64,697	58,625	55,401	
										64,697	**58,625**	**55,401**	**-**
Methow	Methow	Gold Creek	Cascade FH	MCR-MET	2-May	17-Jun	15.6	**19-03-58**	98.7%	49,752	48,724	48,091	5,737
										49,752	**48,724**	**48,091**	**5,737**
Methow	Methow	Twisp Ponds	Cascade FH	MCR-MET	12-May	30-May	14.8	**19-03-63**	97.4%	44,698	40,586	39,531	5,311
				MCR-MET	12-May	30-May	14.8	**19-03-64**	98.5%	44,778	40,521	39,913	**-**
										89,476	**81,107**	**79,444**	**5,311**
Methow	Methow	Winthrop NFH BC	Cascade FH	MCR-MET	22-Apr	28-May	15.2	**19-03-62**	96.2%	49,816	47,797	45,981	5,681
										49,816	**47,797**	**45,981**	**5,681**

Methow	Methow	Winthrop NFH C12-16	Winthrop NFH	MCR-MET	18-Apr	14-May	18.0	**19-03-65**	95.1%	171,189	169,060	160,776	5,911
					18-Apr	14-May	18.0	**19-03-66**	91.6%	109,061	107,679	98,634	
										280,250	**276,739**	**259,410**	**5,911**
									Total	**1,550,786**	**1,484,637**	**1,446,217**	**50,680**

	Total Coho	Total CWTs
Wenatchee Basin	971,645	957,891
Methow Basin	512,992	488,326