MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY:

2015 ANNUAL REPORT
February 1, 2015 through January 31, 2016

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1.0 INTRODUCTION

Wild stocks of coho salmon (*Oncorhynchus kisutch*) were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). By the early 1900s, native coho populations had been extirpated from several Columbia River tributaries (Wenatchee, Entiat and Methow rivers; Mullan 1983). The restoration of viable coho populations within these areas will rely heavily on hatchery coho releases. The 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 reintroduction 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; Murdoch et al. 2005), 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 these coho reintroduction efforts are to succeed, lower-river derived parent stocks must be able to adapt to the rigors and energetic demands associated with prolonged migration. This local adaptation will require that sufficient genetic variation facilitate the ability to respond to ever-changing selective pressures. 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 promote the local adaptation process. The long-term success of this reintroduction effort will also require that adult returns remain 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 reintroduction program.

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 as not only an indicator of project performance, but also to track potential short and long-term program benefits from the outlined strategies.

This report documents coho restoration activities and results for the performance period of February 2015 through January 2016, 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 2015. This trap is operated with joint funding from Grant County Public Utility District (GCPUD, #430-2365) and BPA coho (#1996-040-00); detailed population and productivity estimates are included as a supplemental document (Ishida et al. 2016; Appendix A).

2.0 BROODSTOCK COLLECTION AND SPAWNING

2.1 WENATCHEE RIVER BASIN

2.1.1 Broodstock Collection

Dryden Dam left and right-bank fish traps were passively operated up to five days per week, twenty-four hours per day, from September 1 through October 30, with unimpeded passage allowed on Saturdays and Sundays. Trapping at Dryden Dam in the month of November was prevented by high flows. Collections at Tumwater Dam were performed up to five days per week, eight hours per day, between September 1 and November 15. Although Dryden Dam has previously acted as the primary location for broodstock collection, Tumwater Dam has become increasingly significant, as we target upper basin returning adults demonstrating the ability to ascend Tumwater Canyon.

Supplemental collections were performed at Leavenworth National Fish Hatchery (LNFH) and the Grant County Public Utility District’s (GCPUD) Priest Rapids Dam fish bypass. Trapping at the LNFH upper bay ladder weir was performed from November 5 through November 16. Collection of coho at Priest Rapids Dam occurred during nine events between September 25, and October 15. In light of the poor 2015 adult return, both locations functioned as a back-up broodstock collection sites, using all available avenues to fulfill programmatic goals during transition through Broodstock Development Phase II (YN FRM 2012).

A total of 1,224 coho were collected for broodstock; 458 females and 766 males (Table 1). Of these, 62.4% and 10.9% were collected at Tumwater dam and Dryden dam facilities, respectively. The remaining brood originated from LNFH ladder (1.7%) or Priest Rapids Dam (25%) collections. All coho collected were comprised of brood year (BY) 2012 (5th generation) Mid-Columbia River (MCR) returning adults. There were no BY2013 jacks incorporated into the 2015 hatchery efforts.

All coho encountered had their condition assessed prior to retention. Fish displaying signs of significant abrasions or wounds, fungus, and/or were overripe (factors that would decrease the likelihood of an individual to survive to spawning) were rejected. Coho collected at Priest Rapids Dam, LNFH, and Tumwater Dam were tagged in the dorsal sinus with white, orange, and Green floy tags, respectively. Those collected at Dryden Dam were not tagged. Differential marking allowed us to parse out supplemental collections when evaluating smolt-to-adult survivals rates and determining migratory success. All coho broodstock were transported to LNFH daily and held until spawning. There were no mortalities incurred during transportation.

During the broodstock collection process, incidental species were only encountered at Dryden Dam (Table 1). The handling of non-coho species there was limited to removal from the trap, and transfer to on-site Washington Department of Fish and Wildlife (WDFW) personnel for their broodstock assessment needs. Sorting of fish at Priest Rapids Dam and Tumwater Dam was performed by WDFW personnel only. Adult coho were the only species captured at the LNFH ladder in 2015.

Table 1. Wenatchee program Coho salmon and incidentals handled during trapping, 2015.

Location	Coho (*broodstock*)[1]	Steelhead	Sockeye	Summer Chinook	Bull Trout
Priest Rapids Dam	306 (*306*)	N/A	N/A	N/A	N/A
Dryden Dam	773 (*764*)	126	105	159	3
Tumwater Dam	133 (*133*)	N/A	N/A	N/A	N/A
LNFH Ladder	21 (*21*)	0	0	0	0

[1]Parenthesized figure denotes coho retained for broodstock

2.1.2 Spawning

Spawning occurred at LNFH on a weekly basis between October 13 and November 17. Total coho spawned included 873 viable adults; 429 females and 444 males (Table 2). Temporal spawning distribution was normal, with a peak occurring in the fourth week (125 viable females; Figure 1). Contributions to the total brood by in-basin and out-of-basin (Priest Rapids Dam) collection points were 637 and 236 adults, respectively. Pre-spawn mortality rate at LNFH was 18.5% (227 fish; 29 females and 198 males), an increase over the previous five-year (2010-2014) mean of 6.1%. The relatively high incidence of pre-spawn mortality was the likely due to the effects of high water temperatures during migration and holding. Assessment by an on-station fish health specialist (USFWS) determined that 2015 broodstock had elevated fungus and bacteria levels. We suspect that the unseasonably high water temperatures contributed to the proliferation of both. Upon completion of spawning activities, 124 excess males were returned to Icicle Creek.

Eggs from individual females were fertilized with one primary and one back-up male. During fertilization, a 1.0% saline solution was used to increase sperm motility. Combined eggs and milt were held for a minimum of 2-3 minutes allowing for maximum fertilization. Subsequently, excess milt, ovarian fluid, and other organics were decanted, and eggs soaked in 75 ppm povidone-iodine (PVP-I) solution for disinfection. This treatment occurred for 30 min, followed by a freshwater rinse and transfer to an incubation vessel.

Coded-wire tag (CWT) analysis of spawned fish showed that 372 were LNFH-origin returns, 292 were acclimated and released from upper Wenatchee River basin ponds, and 107 were out-of-basin hatchery origin (Table 2). Scale analysis revealed the remaining 102 fish unidentifiable by CWT consisted of 82 hatchery origin fish with unknown release locations, 17 natural origin, and 3 unknown origin (analyses were inconclusive due to scale degeneration) coho.

Table 2. Summary of coded-wire-tag and scale analysis from coho spawned at Leavenworth National Fish Hatchery in 2015.

Juvenile Release Location		BY2012 Adults	BY2013 Jacks	Percentage of Brood by Release Site
Leavenworth NFH	*Small Foster-Lucas Ponds*	197	0	22.57%
	Large Foster-Lucas Ponds	175	0	20.04%
Upper Wenatchee River Basin	*Coulter Creek*	60	0	6.87%
	Beaver Creek	81	0	9.28%
	Rohlfing's Pond	94	0	10.77%
	Butcher Pond	57	0	6.53%
Out-of-Basin Hatchery Origin		107	0	12.26%
Unknown Hatchery Origin		82	0	9.39%
Unknown Origin		3	0	0.34%
Natural Origin		17	0	1.95%
Total		**873**	**0**	**100.00%**

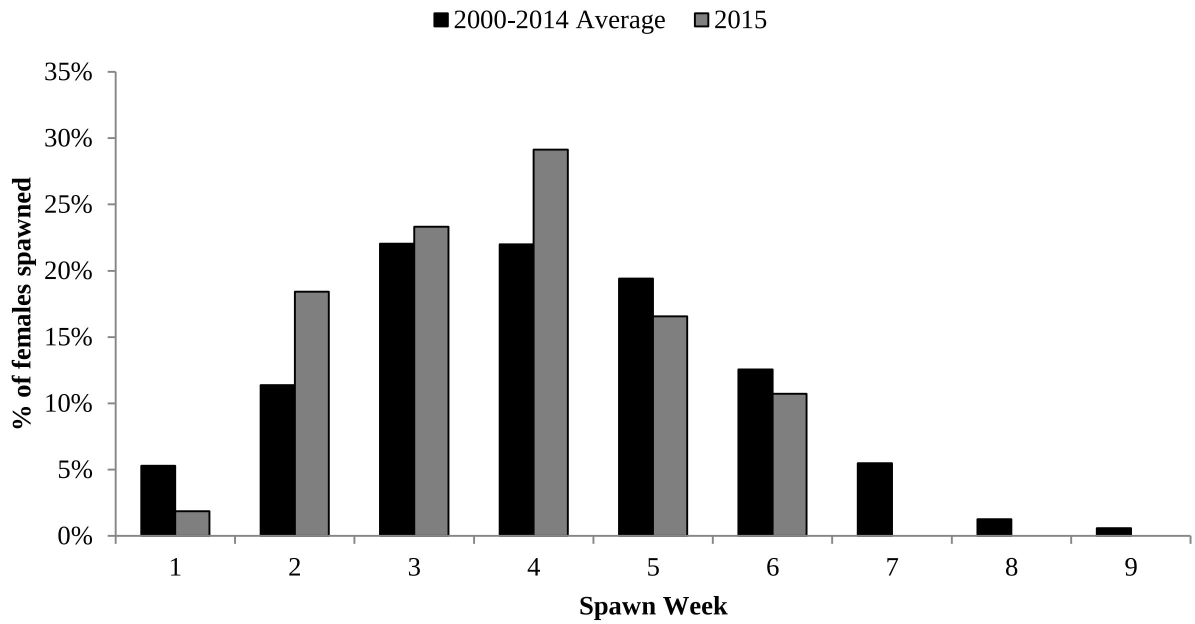


Figure 1. Temporal spawning distribution: brood years 2000-2014 and 2015 at Leavenworth NFH.

2.1.3 Incubation

A total of 837,820 green eggs were collected in 2015; 461,594 were incubated at LNFH while the remaining 376,226 were transported to the YN-operated Peshastin Incubation Facility (PIF; Table 3). Vertical stacks were used to incubate coho eggs at LNFH while eggs at PIF were bulk incubated in troughs. Trough incubation allows a relatively large number of eggs to be 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). Four to five gallons per minute of chilled water at 44° F and 41° F was provided to coho eggs at PIF and LNFH, respectively. Water sources for the two facilities were 100% groundwater and non-chlorinated city water with a groundwater backup.

Eyed-egg totals for LNFH and PIF were 379,432 and 237,993 respectively (Table 3). Combined total average eye-up rate for the 2015 brood was 73.9%; below the preceding five-year mean of 84.2%. Poor fertilization of eggs transported to PIF may have resulted in the low eye-up rates on November 3 and 10. Eyed-eggs from both incubation facilities were transported to Willard NFH and Cascade FH between early December and early January for long-term rearing to the pre-smolt stage (see Appendix D). Transportation from incubation to 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, 2015.

Incubation Location	Spawn Date	Trans. Date	Viable Females	Green eggs	Dead eggs	Eyed eggs	Avg. Eggs per female	Avg. Eyed eggs per female	Avg. % Eye-up	Receiving/ rearing hatchery
LNFH	13-Oct	14-Dec	7	15,766	4,354	11,412	2,252	1,630	72.4%	Willard NFH
LNFH	20-Oct	23-Dec	74.5	155,843	39,369	116,475	2,092	1,565	74.8%	Cascade FH
LNFH	27-Oct	29-Dec	87.5	204,985	24,997	179,988	2,343	2,057	87.8%	Cascade FH
LNFH	3-Nov	5-Jan	41	85,000	13,443	71,557	2,073	1,745	84.2%	Cascade FH
PIF	3-Nov	17-Dec	81	166,992	67,415	99,577	2,062	1,231	59.7%	Willard NFH
PIF	10-Nov	29-Dec	66.5	129,457	57,628	71,829	1,947	1,080	55.5%	Willard NFH
PIF	17-Nov	6-Jan	44.5	79,777	13,190	66,587	1,793	1,497	83.5%	Willard NFH
Total			**402**	**837,821**	**220,396**	**617,425**	**2,084**	**1,540**	**73.9%**	

2.2 METHOW RIVER BASIN

2.2.1 Broodstock Collection

Broodstock collections occurred at Douglas County Public Utility District's (DCPUD) Wells Hydroelectric Project (Wells Dam) east and west fish ladders, Winthrop National Fish Hatchery (WNFH), and Methow Fish Hatchery (MFH) between September 15 and November 24. Wells Dam east and west fish ladders were used as primary collection facilities to ensure representative run-of-the-river (hatchery and natural origin fish) were obtained. Both ladder traps were actively operated by YN and/or Wells FH staff for no more than three days per week until September 26, after which, collection efforts increased to five days per week between September 27 and October 9, and seven days per week thereon. This was a new trapping schedule for 2015 and authorized under the programs' ESA Section 7 BiOp. Supplemental collections at WNFH and MFH relied on volitional swim-ins to their adult collection weirs and occurred continuously throughout the trapping period.

A total of 727 coho were collected for broodstock; 284 females and 443 males (Table 4). The majority of broodstock collected (71.4%) were intercepted at Wells Dam, with smaller collections at WNFH (24.3%) and MFH (4.3%). All coho collected were comprised of brood year (BY) 2012 (4th generation) Upper-Columbia River (UCR) returning adults. There were no BY2013 jacks incorporated into the 2015 hatchery efforts.

All coho encountered had their condition assessed prior to retention. Fish displaying signs of significant abrasions or wounds, fungus, and/or were overripe (factors that would decrease the likelihood of an individual to survive to spawning) were rejected. Adults collected at Wells Dam were externally marked in the dorsal sinus with sequentially numbered floy tags, and given a sinistral opercule punch prior to transport to WNFH. 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 in-basin adult weirs were transported to the WNFH holding pond on a daily basis. There were no mortalities incurred during transport.

Coho collection activities at Wells Dam were between September 15 and October 30. At times, this occurred concurrently with Wells Fish Hatchery (Wells FH) steelhead and summer Chinook broodstock collections. Incidental take was enumerated as total non-coho species handled while Wells FH collections were not simultaneous (Table 4).

Table 4. Methow program Coho salmon and incidentals handled during trapping, 2015.

Location	Coho (*broodstock)*	Steelhead (*Wells FH broodstock*)	Summer Chinook *(Wells FH broodstock*)	Bull Trout	Sockeye
WNFH adult holding pond/collection weir	177 (177)	N/A	N/A	0	0
Methow Fish Hatchery weir	31 (31)	0	2	0	3
Wells Dam West/East Ladders	521 (*519*)	772[1]	3,033[1]	0	0

[1] Adult steelhead and summer Chinook YN staff diverted back to the fish ladders during coho collections only

2.2.2 Spawning

Spawning at WNFH occurred on a weekly basis between October 21 and November 24. Total coho successfully spawned included 526 viable adults; 262 females and 264 males (Table 5). Temporal spawning distribution was normal, with a peak occurring in the third week of (87 viable females; Figure 2). Contributions to the total brood by Wells Dam and in-basin collection sites were 385 and 141 adults, respectively. Pre-spawn mortality at WNFH was 7.7% (56 fish; 20 females and 36 males); slightly higher than the preceding ten-year mean of 6.3%. Although not as significant as in the Wenatchee basin, high water temperatures likely contributed to the increase in pre-spawn mortality. Aside from fish spawned, 137 excess males were returned to the Methow River, 5 moribund males were culled in an attempt to inhibit in-pond pathogen transfer, and 3 adults (two females and one male) were deemed non-viable (possessing gametes that were underdeveloped or in unsuitable condition for fertilization) at the time of spawning.

Eggs from each female were fertilized by one primary and one back-up male. During fertilization, gametes were mixed along with a 1.0% saline solution to increase sperm motility. Buckets containing fertilized eggs were allowed to stand for a minimum of 10-15 minutes. After fertilization, excess milt, ovarian fluid and other organics were decanted and eggs laid into trays containing 75 ppm PVP-I solution for disinfection. The treatment occurred for 30 minutes and was immediately followed by a freshwater rinse with 100% groundwater at 39° F.

CWT analysis revealed that the majority of adults (107 females and 138 males) successfully spawned originated from 2014 WNFH on-station and back-channel releases Table 5). Forty-one adults were not identifiable by the presence of a CWT; scale analysis revealed thirty-six were of unknown hatchery origin and five were of natural origin.

Table 5. Summary of coded-wire-tag and scale analysis from coho spawned at WNFH, 2015.

Juvenile Release Location		BY2012 Adults	BY2013 Jacks	Percentage of Brood by Release Site
Methow River Basin	*WNFH On-station*	175	0	33.27%
	WNFH Back Channel	70	0	13.31%
	Lower Twisp Ponds	120	0	22.81%
	Wolf Creek Pond	51	0	9.70%
	Gold Creek Ponds	40	0	7.60%
Wenatchee River Basin	*Small Foster-Lucas Ponds*	13	0	2.47%
	Large Foster-Lucas Ponds	7	0	1.33%
	Beaver Creek	6	0	1.14%
	Butcher Pond	1	0	0.19%
	Rolfings Pond	2	0	0.38%
Unknown Hatchery Origin		36	0	6.84%
Natural Origin		5	0	0.95%
Total		**526**	**0**	**100%**

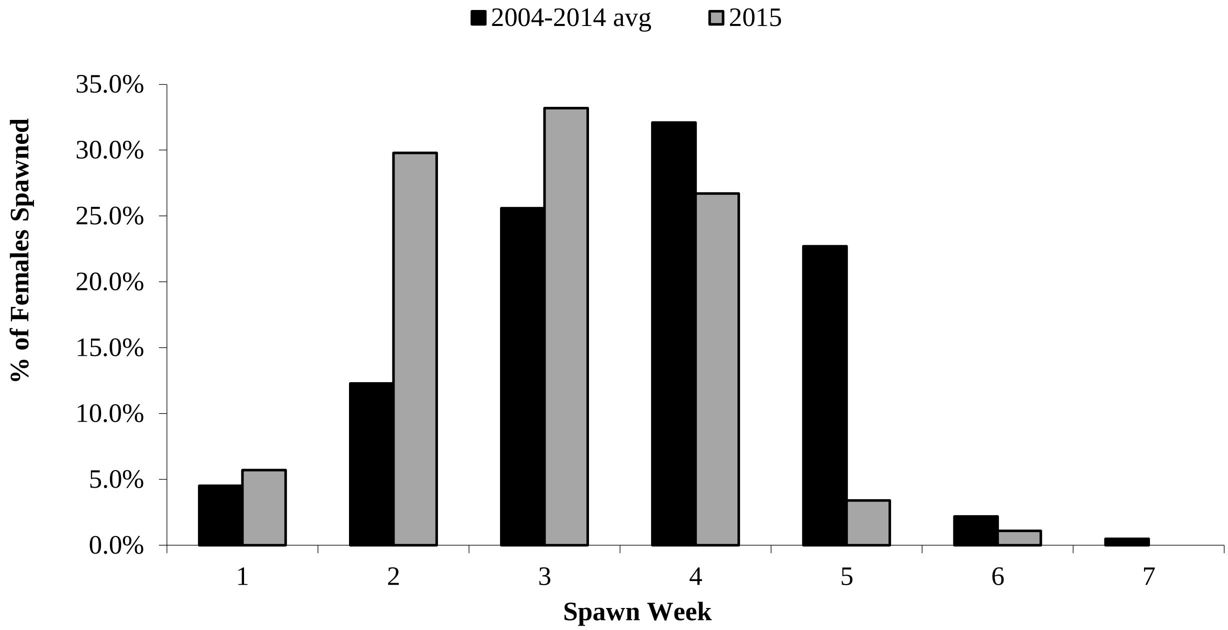


Figure 2. Temporal spawning distribution: brood years 2004-2014 and 2015 at WNFH.

2.2.3 Incubation

A total of 529,094 green eggs were collected from the 2015 Methow broodstock. All eggs were incubated at WNFH in vertical stack incubation units. Chilled 100% groundwater at 39°F was supplied to the eggs at a rate of 4 to 5 gpm.

Eyed eggs for the Methow program totaled 417,970 (Table 6). Average eye-up was 79.0%; below the previous ten-year mean of 84.9%. A total of 260,723 eyed eggs remained on-station at WNFH for full-term rearing. Approximately 113,033 were transported to Cascade FH and 44,214 were transported to Willard NFH between December 14 and 21 for rearing to pre-smolt stage. Eyed eggs transferred to Cascade FH were allocated for the Lower Twisp and WNFH back-channel pond release groups, and eggs transferred to Willard NFH were allocated for the Wolf Creek pond release group in 2017 (see Appendix D). Transportation of these eyed eggs occurred at approximately 600 temperature units (°F).

Table 6. Spawn dates, number of eggs collected, and eye-up rate at WNFH, 2015.

Incubation Location	Spawn Date	Trans. Date	Viable Females	Green eggs	Dead eggs	Eyed eggs	Avg. Eggs per female	Avg. Eyed eggs per female	Avg. % Eye-up	Receiving / rearing hatchery
WNFH	21-Oct	NA	14.5[1]	33,438	4,570	28,868	2,306	1,991	86.3	Winthrop NFH
WNFH	28-Oct	NA	73.0	161,024	38,905	122,119	2,206	1,673	75.8	Winthrop NFH
Winthrop/Willard NFH	4-Nov	14-Dec	82.5[a]	174,090	38,968	135,122[2]	2,110	1,638	77.6	Winthrop/ Willard NFH
Cascade FH	12-Nov	21-Dec	68.0	138,385	25,352	113,033	2,035	1,662	81.7	Cascade FH
WNFH	18-Nov	N/A	9.0	16,380	3,071	13,309	1,820	1,479	81.3	Winthrop NFH
WNFH	24-Nov	N/A	3.0	5,777	258	5,519	1,926	1,840	95.5	Winthrop NFH
Total			**250.0**	**529,094**	**111,124**	**417,970**	**2,116**	**1,672**	**79.0**	

[1] 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.
[2] Approximately 44,214 eyed eggs were transported to Willard NFH

3.0 SPAWNING GROUND SURVEYS

Spawning ground survey objectives were:

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 indicative of the program's Natural Production Implementation Phase (NPIP) have been documented (YNFRM 2010). At that time, representative index reaches may be used to estimate spawner escapement. Current survey reaches were determined by length and duration necessary to complete them in a single day. Our coho survey protocol was derived in part from those of established agencies in the Upper Columbia.

Survey efforts in the Wenatchee River basin focused on reaches that have shown previously high spawner densities and/or are in close proximity to current release sites (Table 7). Surveys of high priority reaches (Nason Creek, Icicle Creek, and lower Wenatchee River) were conducted primarily on a weekly basis, while those historically known to produce little, to moderate coho spawning activity (Beaver Creek, Chiwawa River, Chiwaukum Creek, Chumstick Creek, Mission/Brender Creek, Peshastin Creek, and Roaring Creek) occasionally being covered less frequently.

Methow basin surveys were also prioritized based on historical spawner densities and distributions (Table 7). Survey frequency ranged from weekly (Methow River, Twisp River, Chewuch River, Spring Creek, and MFH outfall), to multiple times per season (Libby Creek, Wolf Creek, Gold Creek, Beaver Creek, Hancock Springs, Suspension Creek, and 1890's side-channel). Out-of-basin surveys were not conducted by YN staff in 2015 due to increased personnel requirements for brood collections, and conflicting surveys within the Methow Basin; historically, these surveys were prioritized secondarily to in-basin reaches. Complete survey records for both basins can be found in Appendix B.

Surveys were conducted either by foot, raft, or pontoon boat depending on the size of waterway and flow conditions. Foot surveys were conducted by two staff members on opposing banks. Raft surveys were performed by three people; one rower, one primary surveyor, and one staff member accompanying in a pontoon boat. Data recorded during each survey included number of new redds, live and dead fish, redd coordinates, survey duration, and stream temperature. Individual redds were either recorded on an aerial map or flagged in the field by tying surveyor's tape to nearby riparian vegetation. Each marker flag listed the date, redd location, identification 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 (POH) lengths measured to the nearest centimeter were recorded on all carcasses collected during surveys. POH measurements are more reliable than those of FL, since recovered carcasses are commonly found with substantially worn snouts and/or caudal fins. For the purpose of accurate comparisons, measurements of POH, rather than FL are described herein. Snouts were removed from all carcasses for subsequent CWT analysis. Sex of each carcass was recorded, if discernible at the time of sampling. Intact females (i.e., without tearing of the abdominal wall) were checked for egg retention by estimating the number of eggs present in the body cavity. Egg voidance was expressed as a percentage of the average fecundity of each basin's broodstock. To prevent re-sampling, removal of the caudal fin served as a visual indicator of prior handling.

Table 7. Spawning ground survey reaches for the Wenatchee and Methow river sub-basins in 2015.

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 Bridge	0.0 –7.2
M2	Steel Bridge to Lower Burma Bridge	7.2 – 14.9
M3	Lower Burma Bridge to Upper Burma Bridge	14.9 – 23.8
M4	Upper Burma Bridge to Lower Gold Creek Bridge	23.8 – 33.7
M5	Lower Gold Creek Bridge 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 Confluence	83.7 – 88.1
M10	Wolf Creek Confluence to Rip Rap	88.1 – 92.7
M11	Rip Rap to Weeman Bridge	92.7 – 98.6
	Chewuch River	
CR1	Mouth to Co. HWY 1613	0.0 – 4.0
CR2	Co. Hwy 1613 to East County Junction	4.0 –15.3
CR3	East County Junction to Eight Mile Ranch	15.3 – 20.2
	Twisp River	
TR1	Mouth to Lower Poorman Bridge	0.0 – 2.9
TR2	Lower Poorman Bridge to Upper Poorman Bridge	2.9 – 7.8
TR3	Upper Poorman Bridge to Twisp River Weir	7.8 – 11.4
TR4	Twisp River Weir to Newby Creek Bridge	11.4 –13.2
TR5	Newby Creek Bridge to Buttermilk Creek Bridge	13.2 – 21.1
TR6	Buttermilk Creek Bridge to War Creek Bridge	21.1 – 28.5
	Spring Creek	
SPC1	Mouth to WNFH adult weir	0.0 – 0.4
	WDFW/ MFH 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 250 meters upstream	0.0 – .25
	Wolf Creek	
WC1	Mouth to Wolf Creek Acclimation Ponds	0.0 – 1.6
WC2	Wolf Creek Acclimation Ponds to Foot Bridge	1.6 – 3.0
	Beaver Creek (MET)	
BC1	Mouth to Hwy. 153 Culvert	0.0 – 0.4
BC2	Hwy. 153 Culvert to Hwy. 20 Bridge	0.4 – 3.0
	Libby Creek	

3.1 WENATCHEE BASIN REDD COUNTS

In 2015, YN identified a total of 80 redds and collected 18 adult coho carcasses throughout the Wenatchee River subbasin for an overall sample rate of 9.8% (Table 8). All redds were located in the lower Wenatchee River and its tributaries at/or downstream of Leavenworth. Successful passage of adult coho above Tumwater Dam remained low throughout the fall due to the small return, and increased broodstock collection efforts.

Table 8. Summary of Wenatchee River coho redd counts, distribution and carcass recovery in 2015.

Stream	Redd Count				Live Fish				Recovered Carcasses				Sample Rate[a]
	Oct	**Nov**	**Dec**	**Tot.**	**Oct**	**Nov**	**Dec**	**Tot.**	**Oct**	**Nov**	**Dec**	**Tot.**	**FINAL**
Beaver Cr.	0	0	—	0	0	0	—	0	0	0	—	0	**0.0%**
Chiwaukum Cr.	0	0	—	0	0	0	—	0	0	0	—	0	**0.0%**
Chiwawa R.	0	0	—	0	0	0	—	0	0	0	—	0	**0.0%**
Chumstick Cr.	0	0	0	0	3	2	0	5	0	0	0	0	**0.0%**
Icicle Cr.	31	24	0	55	80	70	0	150	4	2	1	7	**5.5%**
Mission/Brender Cr.	3	3	—	6	0	5	—	5	1	0	—	1	**7.2%**
Nason Cr.	0	0	—	0	0	1	—	1	0	0	—	0	**0.0%**
Peshastin Cr.	2	1	—	3	7	1	—	8	4	0	—	4	**58.0%**
Roaring Cr.	0	—	—	0	0	—	—	0	0	—	—	0	**0.0%**
Wenatchee R.	12	4	0	16	21	7	0	28	4	2	0	6	**16.3%**
Total	**48**	**32**	**0**	**80**	**111**	**86**	**0**	**197**	**13**	**4**	**1**	**18**	**9.8%**

[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 observed

All carcasses were recovered in the lower, to mid reaches of the Wenatchee River and its tributaries. Analysis of 11 recovered CWTs revealed that 7 carcasses originated from LNFH juvenile releases, while 3 were released from upper Wenatchee River acclimation ponds (Table 9). One carcass recovered in the lower basin was released as a juvenile from WNFH. Origins of fish unidentifiable via CWT analysis are noted in table 10. The proportion of natural origin returns in the Wenatchee Basin based on recovered carcasses was 5.5%.

Table 9. Summary of carcass distribution and origin throughout the Wenatchee River and its tributaries, 2015.

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	–	–	–	1	–	–	–	–	–	–	1
	LNFH LFL 2	–	1	–	–	–	–	–	–	–	–	1
	LNFH SFL 8, 9, 11	–	1	–	2	1	–	–	–	–	–	4
	LNFH SFL 10,12,25	–	–	–	1	–	–	–	–	–	–	1
Upper Wenatchee	Beaver Creek Acc. Pond	–	1	–	–	–	–	–	–	–	–	1
	Rolfing's Acc. Pond	–	–	–	1	1	–	–	–	–	–	2
Methow River Basin	WNFH	–	–	–	–	1	–	–	–	–	–	1
TOTAL		0	3	0	5	3	0	0	0	0	0	11

Table 10. Origin of carcasses without CWTs recovered in the Wenatchee River Basin, 2015.

Carcass Recovery Location	Origin[1]	
	Unknown Hatchery	Natural Origin
Icicle Creek	2	–
Mission/Brender Creek	1	–
Peshastin Creek	1	–
Wenatchee River	2	1
Total	**6**	**1**

[1] Origin determined through scale analysis

3.1.1 Icicle Creek

YN conducted ten weekly spawning ground surveys in the main channel (I1), and eight surveys in the restored side channel (I2) of Icicle Creek between September 29 and December 1 (Figure 3). Several high water events in November produced challenging survey conditions. In total, 37 redds in the main channel and 18 redds in the restored channel were recorded (Icicle Creek total = 55; Table 8). Redds recorded in Icicle Creek represented 68.8% of the total found in the Wenatchee River basin.

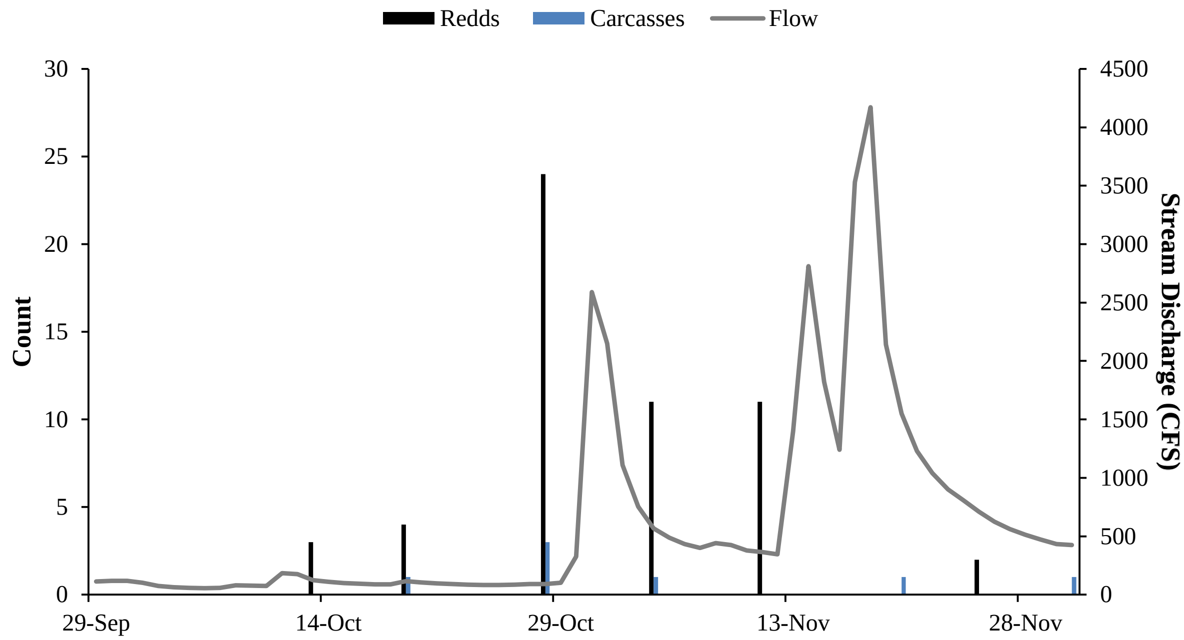


Figure 3. Weekly redd counts conducted in Icicle Creek from September 29 through December 1, 2015.

Seven carcasses (four females, two males, and one unknown) were recovered from Icicle Creek for a sample rate of 5.5%. Mean POH for female carcasses collected was 47.6cm (n = 4; SD = 1.9). One male collected had POH of 53 cm while the other was not intact and could not be measured accurately. Length could also not be recorded on the partial carcass collected of unknown sex. Among female carcasses with intact bodies, mean egg voidance was 73.4% (n = 4; SD = 0.5).

3.1.2 Wenatchee River

A total of 16 redds were recorded on the mainstem Wenatchee River, from Lake Wenatchee to the Columbia River confluence (reaches 1-7), between September 27 and December 3 (Table 8). Weekly surveys were conducted on the lower Wenatchee River reaches from Leavenworth to the mouth (W1 - W4), while upper Wenatchee River reaches (W5 - W7) were surveyed bi-monthly. All redds in the Wenatchee River were documented in the lower reaches i.e., W1 through W4. These accounted for 20.0% of the total in the Wenatchee River basin. YN recovered six (three male and three female) mainstem Wenatchee River carcasses for a sample rate of 16.3%. Mean POH lengths for female and male carcasses were 48.7 cm (n = 3; SD= 1.5) and 46.0cm (n = 3; SD = 1.0), respectively. All females recovered on the Wenatchee River (n = 3) were deemed pre-spawn mortalities.

A total of 157 adult coho were counted at the Tumwater Dam fish ladder in 2015; 24 were allowed to pass upstream while the remainder were retained as broodstock. Despite 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 male-skewed in 2015 (6.5M:1F). The low proportion of females above Tumwater dam likely resulted in low spawning activity relative to total upriver escapement.

3.1.3 Nason Creek

Weekly surveys of Nason Creek were conducted between October 22 and November 30 (Table 8). Several high water events occurring in late October through November presented challenging conditions on reaches normally surveyed on foot. Coverage of was upheld on walking reaches during periods of high discharge via the use of pontoon boats. There were no redds or carcasses documented in Nason Creek.

3.1.4 Mission/Brender Creeks

Weekly surveys of Mission/Brender creeks were conducted between September 28 and November 30. A total of six redds were recorded, representing 7.5% of the total coho redds in the Wenatchee River basin (Table 8). YN recovered one carcass for a sample rate of 7.2%. POH length or egg voidance could not be determined on the single female carcass found due to a non-intact body.

3.1.5 Peshastin Creek

Weekly surveys of Peshastin Creek occurred between September 29 and November 28 (Table 8). Three redds were located in Peshastin Creek, representing 3.8% of the in-basin total. A total of four (two female and two male) carcasses were recovered for a sample rate of 58.0%. Mean POH length for the females collected was 47.5 cm (n = 2; SD = 0.7). One male had a POH of 47 cm while the other was only a partial body. Mean egg voidance for females recovered was 42.8% (n = 2; SD = 0.6).

3.1.6 Chiwawa River

Two surveys of the lower Chiwawa River were conducted on October 24 and November 7. High flows and elevated turbidity levels prevented comprehensive coverage during the survey period. There were no redds documented or carcasses recovered during the surveys performed (Table 8).

3.1.7 Chumstick Creek

Weekly surveys of Chumstick Creek were performed between October 8 and December 3. There were no redds documented or carcasses collected during this period (Table 8). Although live coho were observed in Chumstick Creek in 2015, spawning activity appeared to be absent.

3.1.8 Other Tributaries

Surveys were also conducted on Beaver Creek, Chiwaukum Creek, and Roaring Creek. Beaver Creek was three times between October 22 and November 16, Chiwaukum was surveyed four times between October 22 and November 22, and Roaring Creek was surveyed once on October 26. There were no carcasses, live fish, or redds observed on any of these surveys (Table 8).

3.2 METHOW BASIN REDD COUNTS

In 2015, YN identified 108 redds and collected 24 adult coho carcasses throughout the Methow River subbasin for an overall sample rate of 11.2% (Table 11). The majority of redds (n = 44) were located in the newly restored 1890's side channel and the mainstem Methow River (n = 32).

Table 11. Summary of Methow River coho redd counts, distribution and carcass recovery in 2015.

Stream	Redd Count				Live Fish Count				Recovered Carcasses				Sample Rate[1]
	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	Oct	Nov	Dec	Tot.	FINAL
Methow	2	30	0	32	48	30	2	80	1	10	3	14	**22.1%**
Twisp	4	8	0	12	5	3	0	8	0	1	0	1	**4.2%**
Chewuch	3	1	0	4	1	0	0	1	0	0	0	0	**0.0%**
Libby Creek	0	1	0	1	0	0	0	0	0	0	0	0	**0.0%**
Gold Creek	0	0	0	0	0	7	0	7	0	0	0	0	**0.0%**
Beaver Creek	0	0	0	0	0	0	0	0	0	0	0	0	**0.0%**
Wolf Creek	0	0	0	0	0	0	0	0	0	0	0	0	**0.0%**
WNFH Outfall/Spring Cr	6	7	0	13	2	8	0	10	1	2	0	3	**11.7%**
WDFW/MFH outfall	0	2	0	2	0	8	0	8	0	0	0	0	**0.0%**
1890's Side Channel	12	32	0	44	1	3	0	4	0	6	0	6	**6.9%**
Hancock Springs	0	0	0	0	0	0	0	0	0	0	0	0	**0.0%**
Suspension Creek	-	-	0	0	-	-	0	0	-	-	0	0	**0.0%**
Total	**27**	**81**	**0**	**108**	**57**	**59**	**2**	**118**	**2**	**19**	**3**	**24**	**11.2%**

[1] Sample rate is based on a sex ratio of 1.98M: 1.0F observed at Wells Dam facilities.

Analysis of 17 recovered CWT's revealed that 5 fish originated from WNFH on-station releases, and 12 originated from acclimation ponds used in 2014 (Table 12). All carcasses with origins indeterminate through CWT (n = 7) were found via scale analysis to unknown hatchery origin. Additionally, BioAnalyst staff collected three coho carcasses during summer Chinook redd surveys on the Chelan River. All were found to be of unknown hatchery origin through scale analysis.

Table 12. Summary of carcass distribution and origin throughout the Methow River and its tributaries, 2015.

Juvenile Coho Release Location/Origin through CWT analysis		Adult Recovery Location – Methow River Basin: Methow 1-4	Methow 5-8	Methow 9-11	Twisp River	Chewuch River	Spring Creek	MFH Outfall	Gold Creek	1890's Side Channel	Wolf Creek	Libby Creek	TOTAL
Methow River Basin	**WNFH**	-	3	-	-	-	1	-	-	1	-	-	5
	WNFH Back Channel	-	1	-	-	-	-	-	-	1	-	-	2
	Lower Twisp Ponds	3	1	-	-	-	-	-	-	-	-	-	4
	Gold Creek	2	-	-	-	-	-	-	-	2	-	-	4
	Wolf Creek	1	-	-	-	-	1	-	-	-	-	-	2
TOTAL		**6**	**5**	**-**	**-**	**-**	**2**	**-**	**-**	**4**	**-**	**-**	**17**

3.2.1 Methow River

Methow River redd surveys were conducted every seven to ten days between October 6 and December 16. Surveys included eleven reaches (M1-M11) on the Methow River extending from Weeman Bridge to its confluence with the Columbia River. A total of 32 coho redds were identified on the mainstem; 8 redds in lower reaches M1-M4, 19 redds in middle reaches M5-M8, and the remaining 5 redds in upper reaches M9-M11 (Table 11). Redds in the mainstem Methow River accounted for 29.6% of all redds documented in the Methow subbasin in 2015. A total of 14 carcasses were identified during surveys. Mean POH lengths for females and males were 50.9 cm (n = 8; SD = 2.5) and 44.0 cm (n = 6; SD = 3.9), respectively. Among female carcasses with intact bodies, mean egg voidance was 71.7%. Two of these females possessed intact egg skeins and were determined to be pre-spawn mortalities. Carcass recovery rate for the mainstem Methow River was 22.1%.

3.2.2 WNFH (USFWS)/ Spring Creek and MFH (WDFW) Outfalls

Spring Creek and the MFH outfall were surveyed weekly between October 7 and December 15. The WNFH complex (on-station raceways and back- channel pond) was the primary release location within the Methow River basin in 2014.

A total of thirteen redds were located within Spring Creek between mid-October and mid-November (Table 11). These redds accounted for 12.0% of all coho redds identified within the Methow Basin. Three carcasses were found; two males and one unidentifiable (scavenged). Mean POH lengths for the two identified males were 41.5 cm (n = 2; SD = 9.2). Carcass recovery rate was 11.7%.

Two redds were identified within the MFH outfall in mid-November. These redds accounted for 1.9% of all coho redds identified within the Methow basin. No carcasses were observed during surveys.

3.2.3 Twisp River

Twisp River surveys were conducted between October 16 and December 14. Surveys included six reaches extending from War Creek Bridge to the confluence with the Methow River. Survey reaches TR 1 - 4 were surveyed weekly between October 16 and November 21. These surveys were prioritized due to recent increase in spawning density proximal to the Lower Twisp Ponds. One survey was conducted in TR 5 and 6; during peak spawn on November 3 with no redds or carcasses observed.

A total of 12 redds were located, of which, 3 were documented upstream from the Twisp Ponds acclimation site (Table 11). Spawning activity in the Twisp River accounted for 11.1% of all redds in the Methow basin. One carcass was observed, however, surveyors were unable to identify to sex or accurately measure FL and POH due to predation. Carcass recovery rate was 4.2%.

3.2.4 Chewuch River

Chewuch River surveys were conducted between October 19 and November 23. They were comprised of three survey reaches extending from Eight Mile Creek to the confluence with the Methow River (CR1-CR3). A total of four redds were identified in CR2. Redds identified in the Chewuch River accounted for 3.7% of all documented spawning activity in the Methow Basin (Table 11). No carcasses were observed while conducting surveys in 2015.

3.2.5 Gold Creek

Gold Creek surveys were conducted between October 12 and December 15, and included two survey reaches. The survey area extended from the private land boundary just upstream of the acclimation ponds on South Fork Gold Creek to the confluence with Gold Creek (GC2), and from the confluence to private land downstream. YN staff will continue to work with landowners to further expand surveys within this tributary. There were no redds or carcasses recovered (Table 11).

3.2.6 Libby Creek

Libby Creek surveys were conducted between October 11 and November 24. Surveys were conducted consecutively from Hwy 153 to the confluence with the Methow River.

One Redd was identified within Libby Creek on November 16 and accounted for 0.9% of all coho redds identified within the Methow basin (Table 11). There were no live fish observed or carcasses recovered.

3.2.7 1890's Side-channel

The 1890's side-channel restoration project is a ground-water fed channel entering the Methow River at River Kilometer (RKM) 68.1. The project was completed by the YN Habitat program in the fall of 2014, creating approximately 4,200 linear feet of new perennial flow spring creek within what was the main Methow River channel in the early 1890's. Four surveys were conducted; during peak and post peak spawn between October 19 and November 16. A total of forty-four redds were observed and six carcasses collected (Table 11). Redds in the 1890's Side Channel accounted for 40.7% of all documented spawning activity in the Methow Basin. Mean POH lengths for females and males were 46.0 cm (n = 2; SD = 4.2) and 48.0 cm (n = 4; SD = 7.2), respectively. Mean egg voidance was 96.1% (n = 12) and carcass recovery rate was 6.9%.

3.2.8 Hancock Springs Creek and Suspension Creek

Hancock Spring's surveys were conducted between October 28 and December 8. Surveys were performed consecutively as one reach extending from the confluence with the Methow River to approximately 1.5 kilometers upstream. One survey was conducted on Suspension Creek after peak spawn on December 16. 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 (Table 11).

3.2.9 Wolf Creek

Wolf Creek surveys were conducted post-peak spawn on November 6 and 10. Surveys in 2015 were expanded upstream beyond Wolf Creek acclimation ponds to Rd 5505 Trail Access Foot Bridge. This addition was to account for returning adults from releases at Wolf Creek Pond in 2014. There were no redds or carcasses recovered (Table 11).

3.2.10 Chelan River Outfall

Coho carcass data was collected by BioAnalyst Inc. staff between October 30 and November 2 in the Chelan River outfall during summer Chinook redd surveys. Coho redd data was not recorded. A total of three carcasses were recovered. Mean POH lengths for females were 49.5 cm (n = 2; SD = 12.0). Mean egg voidance was 93.4%.

4.0 SMOLT ACCLIMATION: WENATCHEE AND METHOW

4.1 ACCLIMATION SITES

Both Wenatchee and Methow programs employed the use of low-density rearing in remote earthen acclimation ponds, along with conventional hatchery (raceway) rearing techniques. Natural and earthen ponds may have inherent advantages over conventional hatchery raceways, providing access to a variety of invertebrates for diet supplementation, exposure to natural temperature and flow regimes, and superior water quality. We assume a setting closely mimicking natural in-stream rearing should produce juveniles with adequate imprinting capabilities and improved physical condition. Primarily located in the upper tributaries of both basins, the acclimation ponds also promote wide-spread spawning rather than aggregates limited the vicinity of hatchery outflows.

Within the Wenatchee River basin, YN acclimated coho pre-smolts at LNFH, Beaver Creek, and three sites on Nason Creek. In the Methow River basin, YN acclimated coho pre-smolts at WNFH, Twisp Ponds Complex, Wolf Creek, and Gold Creek acclimation ponds.

4.1.1 Leavenworth National Fish Hatchery (LNFH)

LNFH is located on Icicle Creek (RKM 4.5) east of the city of Leavenworth, WA. Coho smolts were acclimated in refurbished small, and large Foster-Lucas (SFL & LFL) raceways. Originally, these Foster-Lucas ponds were designed for rearing steelhead, sockeye, and spring Chinook. 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 2015, acclimation for both coho and spring Chinook continued until mid-April.

4.1.2 Beaver Creek Acclimation Pond

Beaver Creek acclimation pond is located at RKM 2.4 on Beaver Creek. The drainage enters into the Wenatchee River near Plain, Washington at RKM 74.4. The acclimation pond was created in the mid-1980s on property owned by Mountain Springs Lodge. Originally stocked with Kamloops rainbow trout (*Oncorhynchus mykiss kamloops*), North American river otter (*Lontra canadensis*) predation eventually became too problematic and the stocking was discontinued in the early 1990s. The YN began using the pond for acclimation in 2002. Pre-acclimation activities included the installation of 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.

4.1.3 Nason Creek

In 2015, 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.

4.1.3.1 Rohlfing's Acclimation Pond

Rohlfing's Pond is located on an unnamed seasonal tributary of Mahar Creek, which meets Nason Creek at RKM 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. In 2012, a well was installed to provide a reliable year-round water source. Pre-acclimation activities included the installation of a seine net secured to the banks with a system of cables. Its configuration provided unimpeded upstream migration of native fish, and maximum rearing space for juvenile coho.

4.1.3.2 Coulter Creek Acclimation Pond

Coulter Pond is located at RKM 1.6 on Coulter Creek, within the Nason wetlands area. This natural beaver pond contains multiple braided channels which coalesce into one, large, widened waterway where rearing occurs. A seine net was used to encircle the entire rearing area to prevent both movement downstream, and into the peripheral wetlands. Fish released from Coulter Pond emigrate through an extensive wetland complex en route its confluence with Nason Creek at RKM 13.7. Releases from Coulter Pond are closely monitored to ensure unimpeded passage while exiting the wetland.

4.1.3.3 Butcher Creek Acclimation Pond

Butcher Creek acclimation site is located at RKM 13.2 on Nason Creek. This site, which was once the original channel of Nason Creek, is now a beaver pond fed by Butcher Creek. Coho smolts were volitionally released directly into Nason Creek from the pond. Prior to the addition of fish, 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 (WNFH)

Coho smolts released into the Methow River from WNFH (RKM 80.6) were acclimated from the fingerling stage to release in seven primary raceways. Two additional raceways were used as alternative on-station rearing spaces for the release group originally allocated for the WNFH back-channel pond. The back-channel pond area was not available in 2015 due to the requirement that hatchery staff maintain elevated flows through Spring Creek to maximize the facility's water right, as directed by Department of Ecology. The resulting high flows prohibited installation of the pond's containment infrastructure. The availability of the two raceways was made possible by a reduction in spring Chinook production at the facility.

4.1.5 Lower Twisp Acclimation Ponds

The Lower Twisp Ponds site, located at RKM 1.6 on the Twisp River, functions as a semi-natural acclimation facility owned and operated by the Methow Salmon Recovery Foundation (MSRF). The site was constructed in 2002, and consists of a series of five earthen ponds receiving surface water from the Twisp River from an inlet at RKM 2.5. 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 due to low discharge. Coho acclimation occurs in the furthest downstream pond. The pond is approximately 42.0 meters in length and includes a small outlet 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. Acclimation at this location in 2015 marked the seventh consecutive year these ponds were used by the MCCRP.

4.1.6 Gold Creek Acclimation Pond

Gold Creek Acclimation area is comprised of four, man-made ponds on private property adjacent to South Fork Gold Creek at RKM 1.0. The site is intended to provide an additional release location in-basin, prior to the program's implementation of NPIP. Prior to transfer, containment nets within each pond were installed to segregate incoming hatchery pre-smolts from naturally-produced juveniles inhabiting the same pond. Once the net was installed, 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 net was secure, and determine if use by different species, primarily outside of the contained area, occurs. The configuration of barrier nets was such that migratory access through each pond was maintained.

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)***.

4.2 TRANSPORTATION AND VOLITIONAL RELEASE

4.2.1 Wenatchee River Basin

Mid-Columbia coho pre-smolts (BY2013) were transported to LNFH from rearing facilities at Willard NFH and Cascade FH on February 4 and 11 (see Appendix D). Transfers of coho from both rearing facilities to upper-basin acclimation ponds occurred between March 12 and 25. All coho reared in the Wenatchee basin were Wenatchee-origin MCR progeny, with the exception of one LFL containing lower Columbia River (LCR)-origin (Tanner Creek) coho. The LCR group was released to help determine the extent of adaptation in MCR-reared coho versus their downriver conspecifics. The rearing of both groups at LNFH was identical.

Coho of Tanner Creek origin (LNFH LFL 2) were the only Wenatchee basin release group CWT-tagged, with a 93.6% pre-release retention rate. The control group in the MCR-LCR comparison (LFL 1) was body-tagged at 98.4% retention rate. CWT's were largely forgone in MCR-origin coho in a shift toward Parentage-Based Tagging (PBT). PBT is a genetic-based, non-invasive method of parentage assignment based on genotype (Anderson & Garza 2005). Given prior determination of genotype in their parental class, returning adults can be tracked back to their specific parents with a non-lethal tissue sample. Age, origin, release timing, and other information previously obtained through CWTs can subsequently be determined without lethal sampling. Using PBT, our tracking potential will extend beyond broodstock and recovered carcasses, into all fish handled. In addition to CWT or PBT marking, approximately 4% of coho juveniles were released from the Wenatchee River basin with PIT tags (Table 13).

Coho smolts acclimated in LNFH LFL and SFL raceways were force-released on April 13 and 14 (Table 13). All releases from LNFH were non-volitional, with no coho held on-station thereafter. Upper-basin volitional releases at Coulter Creek Pond, Rohlfing's Pond, and Beaver Creek Pond were initiated between April 24 and 30. All upper-basin acclimation sites were visually deemed empty by June 30. In total, 582,090 hatchery produced coho smolts were released from the Wenatchee River basin in 2015. For detailed mark and release information, see Appendix C.

Table 13. Mid-Columbia coho smolt release summary, 2015.

Location	Release Date	Release Number	Mark	Size @ release (FPP)	No. PIT Tags
Beaver Creek	24-Apr	95,950	PBT	14.8	5,677
Coulter Creek	30-Apr	51,388	PBT	15.7	n/a
Rohlfing's Pond	30-Apr	94,545	PBT	15.8	5,701
Butcher Creek	30-Apr	96,137	PBT	15.3	4,385
Leavenworth NFH LFL 1	13-Apr	84,750	PBT, BWT	18.6	4,122
Leavenworth NFH LFL 2 (Tanner Cr.)	13-Apr	96,206	CWT	18.0	n/a
Leavenworth NFH SFL's	14-Apr	63,114	PBT	19.2	4,175
Wenatchee Total		**582,090**			**24,060**
Winthrop NFH (on-station raceways C11-15)	18-Apr	241,333	CWT	16.2	5,988
Winthrop NFH (on-station raceways C10 and 16) [1]	4-May	86,052	CWT	16.7	5,836
Lower Twisp Ponds	6-May	69,117	CWT	15.2	5,581
Gold Creek	6-May	35,094	CWT	16.4	5,772
Wolf Creek	4-May	43,673	CWT	16.5	—
Methow Total		**475,269**			**23,177**
Wenatchee/Methow Totals		**1,057,359**			**47,243**

4.2.2 Methow River Basin

Juvenile coho were transported from Willard NFH by Oregon Department of Fish and Wildlife (ODFW) personnel to WNFH on February 25. Juvenile transports to Gold and Wolf Creek ponds occurred on March 20, and transport to Lower Twisp pond occurred on April 9. All juveniles acclimated and released from WNFH on-station raceways C11-15 were 100% MCR progeny from the Methow program. Release groups from on-station raceways C10, C16, and all acclimation ponds were progeny from consolidated Methow and Wenatchee stocks (Due to low adult returns in 2013, additional eyed eggs from the Wenatchee program were required to meet Methow program production goals in 2015).

Pre-release CWT retention from juveniles acclimating in on-station raceways at WNFH was 96.0%. Juveniles acclimated at the Lower Twisp, Gold, and Wolf Creek ponds were 88.7%, 90.5%, and 87.0%, respectively. Approximately 5% of all coho released in the Methow basin were additionally PIT tagged (Table 13).

Volitional releases at all in-basin sites occurred between April 15 and May 6 (Table 13). Follow-up forced releases for juveniles rearing in C bank raceways were initiated between May 3 and 10. Forced releases occurred to allow sufficient time for staff to conduct routine raceway maintenance prior to transferring BY2014 juveniles out of the nursery tanks. Emigrations from all acclimation ponds were visually deemed complete by June 10. In total, 475,269 coho juveniles were released for the Methow program. For detailed mark and release information, see Appendix C.

4.3 PREDATION ASSESSMENT

Moribund and deceased coho were recovered daily from all sites to determine known mortality during acclimation. Because known mortality is typically low (avg. < 2%), we assume that the majority of in-pond loss occurs through predation. Exposure of juvenile salmonids in a hatchery environment has been showed to increase post-release survival through gradual avoidance training (Maynard et. al 1998). However, given high predator densities in hatchery and remote pond locations, we assume that unchecked predation may cause significant negative impacts through direct loss and constant stress. YN used both a predator consumption model and PIT tag detection (where applicable) to estimate in-pond predation.

4.3.1 Estimated Mortality-Predator Consumption Model versus PIT tag Detection

4.3.1.1 Predation Model

Primary predators observed during the acclimation period were the North American river otter 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). 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, American mink (*Neovison vison*), belted kingfishers (*Megaceryle alcyon*), great blue herons (*Ardea herodias*), and hooded mergansers (*Lophodytes cucullatus*) have all been documented throughout the basin and observed in small numbers at some of the sites. Mallards (*Anas platyrhynchos*) 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 sightfeeding 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 proved 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

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 all upper basin acclimation sites included blue herons, mallards, American mink, and North American river otters. Although the mallard piscivorous dietary intake is relatively unknown, these opportunistic individuals have been observed occasionally feeding on coho pre-smolts.

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, and mallards. Predator sightings were highest at the Wolf Creek pond, primarily common mergansers, belted kingfishers, and mallard ducks. Similar to the Lower Twisp ponds, this location is a preferred nesting habitat for a variety of avian species. All predator species observed at Wolf Creek pond were also observed at Lower Twisp pond. Documented sightings at Lower Twisp pond were lower than observed in previous years, and may be attributed to increased human presence associated with frequent public education programs that occur at this location during acclimation season. Predator species documented at Gold Creek pond was limited to one belted kingfisher and one common merganser throughout the season. At WNFH, 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.

Table 14. Known and estimated mortality at all acclimation sites in the Methow and Wenatchee river basins, 2015.

Release Location	Known Mortality[1]	Estimated Mortality (Predator Consumption Model)	Total Loss
Beaver Creek	15	1,197	1,212
Butcher Creek	7	5,207	5,214
Coulter Creek	17	3,815	3,832
LNFH LFL's	1,788	4,571	6,359
LNFH SFL's	68	986	1,054
Rohlfing's Pond	98	168	266
Gold Creek Ponds	21	58	79
Lower Twisp Ponds	16	1,378	1,394
WNFH C10 and C16	104	NA[2]	104
WNFH C11 - C15	6,290	NA[2]	6,290
Wolf Creek Ponds	14	4,226	4,240

[1]Dead coho recovered from ponds
[2]Mortality due to consumption not represented – direct predation not observed at WNFH

4.3.1.2 PIT tag Detection

In addition to predator enumeration and mortality estimation, select locations had an in-pond survival estimate determined via PIT tags. Each selected group that was tagged varied in the proportion of PIT tagged fish, but a minimum of 4,500 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 (Methow basin) as downstream detections are more than sufficient to perform release-to-McNary survival estimates.

Prior to the 2015 acclimation, YN installed PIT tag antenna arrays at Rohlfing's Pond, Beaver Pond, Butcher Pond, Gold Creek, and Lower Twisp Ponds to detect any possible escapees immediately after transport. Additional units were added prior to initiating releases. Releases from WNFH were monitored by the USFWS Mulit-plex arrays. 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, $\underline{D_{outlet}}$ = unique detections at the pond outlet, $\underline{E_{detection}}$ = estimated PIT detection efficiency at the outlet, and $\underline{PIT_{total}}$ = 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.

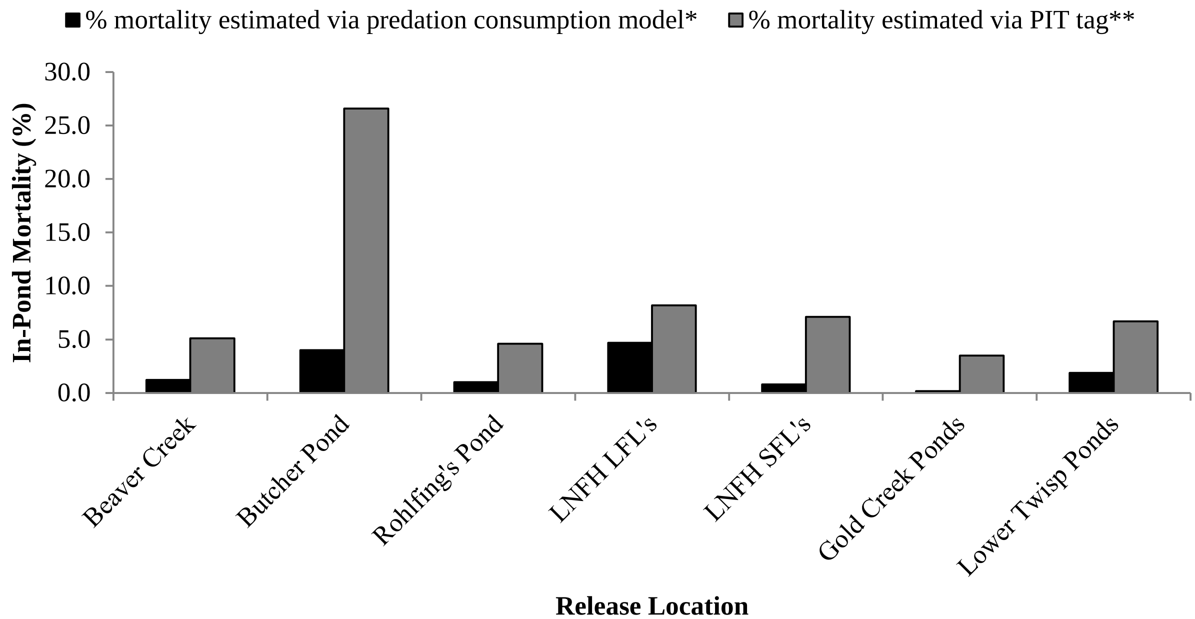
$$E_{detection} = \frac{\text{\# unique outlet detections that were also detected downstream}}{\text{Total number of downstream detections}}$$

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. Known mortality is accounted for in the PIT tag survival calculation. 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, 2015.

	Wenatchee Basin					**Methow Basin**			
	LNFH LFLs	**LNFH SFLs**	**Rohlfing's Pond**	**Beaver Pond**	**Butcher Pond**	**Gold Creek**	**Lower Twisp Ponds**	**WNFH C11-15[a]**	**Winthrop NFH C10,16**
Total PITs	4,492	4,492	5,976	5,981	5,982	5,981	5,983	6,630	5,899
Unique Outlet Detections	3,903	3,053	5,600	5,603	2,927	5,004	5,445	5,521	4,614
Unique Downstream Detections	792	871	2,716	925	1,029	2,532	1,480	2,013	1,600
Downstream and Outlet Detections	750	637	2,668	913	686	2,195	1,444	1,856	1,265
Detection Efficiency	94.7%	73.1%	98.2%	98.7%	66.7%	96.5%	97.6%	92.2%	79.1%
PITs released	4,122	4,175	5,701	5,677	4,391	5,772	5,581	5,988	5,836
In-Pond Survival	**91.8%**	**92.9%**	**95.4%**	**94.9%**	**73.4%**	**96.5%**	**93.3%**	**90.3%**	**98.9%**

A comparison of in-pond mortality estimates based upon PIT tags and predator consumption model expansions can be found in Figure 4. 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.



* WNFH estimates not made - lack of observed direct predation.
** Coulter Pond and Wolf Creek Pond estimates not made - lack of PIT tags

Figure 4. Comparison of in-pond mortality estimation methods; PIT tag versus a predator consumption model, 2015.

5.0 SURVIVAL RATES

5.1 Smolt Survival Rates – Release to McNary Dam

5.1.1 2015 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. A summary of release-to-McNary survival rates for the 2015 releases can be found in Table 16.

Table 16. PIT tag release numbers and locations, 2015.

Basin	Release Tributary	Release Location	Rearing Facility	Brood Origin	*n*	McNary survival % (SD)
Methow	Spring Creek	WNFH On-station C10 an 16	Willard NFH	MCR	5,836	51.6 (1.9)
		WNFH On-station C11-15[a]	WNFH	MCR	5,988	26.9 (3.9)
	Twisp River	Lower Twisp Ponds	Willard NFH	MCR	5,581	41.1 (12.1)
	Gold Creek	Gold Creek Ponds	Willard NFH	MCR	5,772	52.2 (18.7)
Wenatchee	Beaver Creek	Beaver Pond	Cascade FH	MCR	5,981	50.7 (5.6)
	Nason Creek	Butcher Pond	Cascade FH	MCR	5,982	33.0 (7.7)
		Rohlfing's Pond	Willard NFH	MCR	5,976	40.0 (9.8)
	Icicle Creek	SFL	Willard NFH	MCR	4,492	23.6 (4.4)
		LFL	Cascade FH	MCR	4,492	37.4 (4.8)

5.2 2015 Run Escapement

For coho returning to the Wenatchee River basin, we estimated abundance 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 three has been deemed the most reliable due to input from both Wenatchee basin collection points, as well was natural spawning activity (Table 17). Variables such as estimated trapping efficiency (Method 1) and unaccounted-for fallback (Method 3) make the other methods less reliable.

Table 17. Estimated coho run size to the Wenatchee River, 2015.

Method	Est. Run Size
1) Dryden Dam counts expanded for non-trapping days plus redds located below Dryden Dam[1]	1,267 (1,211 adults & 56 jacks)
2) Redd counts plus broodstock collected[1]	1,173 (1,150 adults & 23 jacks)
3)Tumwater Dam counts, redds below Tumwater Dam, and broodstock collected[1]	1,430 (1,408 adults & 22 jacks)
4) Mainstem Dam Counts[2]	2,517 (2,344 adults & 173 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.

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.

Method one has been deemed the most reliable measure of adult escapement in the Methow basin (Table 18). Method two was not used as it did not account for fallback as well as variable spawning success.

Table 18. Estimated coho run size to the Methow River, 2015.

Method	Est. Run Size
1) Redd counts plus broodstock collected [1]	675 (664 adults & 11 jacks)
2) Wells Dam Counts plus Wells Dam broodstock collected[2]	1,666 (1,590 adults & 76 jacks)

[1] Each redd count was expanded by 1.98 fish per redd based on the sex ratio of coho observed at Wells Dam facilities, .98M:1.F

[2] Coho collected for broodstock at Wells Dam were not incorporated into daily fish passage counts for 2015. Broodstock collected only reflects the proportion of fish taken at Wells Dam and not volunteer swim-ins at WNFH.

5.3 Smolt-to-Adult Ratio (SAR) for Brood Year 2012

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 (Tbl. 19 & 20). 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. A comparison of smolt-smolt survival and smolt-to-adult survival across years (1997-2012 brood years) can be found in Table 21.

Table 19. Wenatchee River brood year 2012 SARs by release site, brood origin, and rearing facility.

Release Site	Minimum Acclimation Duration[1]	Brood Origin	Rearing Facility	*n* (Adult Returns)	*n* (Adult Returns)	SARs[2]
Coulter Pond	4 Weeks	MCR-Wenatchee	Willard NFH	94	58,552	0.16%
Butcher Pond	5 Weeks	MCR-Wenatchee	Willard NFH	126	107,448	0.12%
Rohlfing's Pond	7 Weeks	MCR-Wenatchee	Willard NFH	138	84,794	0.16%
Beaver Pond	5-5.5 Weeks	MCR-Wenatchee	Willard NFH	181	100,748	0.18%
LNFH SFL 19,20	19.5 Weeks	MCR-Wenatchee	Willard NFH	65	60,442	0.11%
LNFH SFL 21, 22, 23	19.5 Weeks	MCR-Wenatchee	Cascade NFH	142	92,456	0.15%
LNFH SFL 8, 9, 11	8.5 Weeks	MCR-Wenatchee	Cascade NFH	112	100,204	0.11%
LNFH SFL 10, 12, 25	8.5 Weeks	MCR-Wenatchee	Cascade NFH	121	100,628	0.12%
LNFH LFL 1	6 Weeks	MCR-Wenatchee	Willard NFH	95	93,896	0.10%
LNFH LFL 2	6 Weeks	MCR-Wenatchee	Cascade NFH	221	92,791	0.24%
LNFH LFL 3	6 Weeks	MCR-Wenatchee	Willard NFH	98	65,933	0.15%
Total	**—**	**—**	**—**	**1,393**	**957,892**	**0.15%**
Naturally Produced Coho[3]	**N/A**	**N/A**	**N/A**	**37**	**14,317**	**0.26%**

[1]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.

[2] Estimated return to the basin calculated using method 3.

[3] Naturally produced coho were positively identified through scale analysis.

Table 20. Methow River brood year 2012 SARs by release site, brood origin, and rearing facility.

Release Site	Minimum Acclimation Duration[1]	Brood Origin	Rearing Facility	*n* (Adult Returns)	*n* (CWT Release Number)	SARs[2]
WNFH on-station	N/A[3]	MCR-Methow	WNFH	167	259,410	0.06%
WNFH Back Channel	7 weeks	MCR-Methow	Cascade FH	102	45,981	0.22%
Twisp Ponds	6 weeks	MCR-Methow	Cascade FH	235	79,444	0.30%
Gold Creek Ponds	5 weeks	MCR-Methow	Cascade FH	75	48,091	0.16%
Wolf Creek	8 weeks	MCR-Methow	Cascade FH	86	55,401	0.16%
Total	**—**	**—**	**—**	**666**	**488,327**	**0.14%**
Naturally Produced Coho	**N/A**	**N/A**	**N/A**	**9**	**2,373**	**0.38%**

[1]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.
[2] Estimated return to the basin calculated using method 1.
[3]Fish released directly from on-station rearing facility.

Table 21. Hatchery comparison of smolt-to-smolt and smolt-to-adult survival rates, brood years 1997-2013.

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	53.90%	N/A	2000	N/A	0.21% -0.38%
1998	2000	33.30%	63.00%	N/A	2001	0.17%-0.27%	0.17%-0.86%
1999	2001	9.90%	21.60%	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	62.80%	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	0.06%-0.30%	0.10%-0.24%
2013	2015	26.9%-52.2%	23.6%-37.4%	33.0%-50.7%	2016	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 2015; results are briefly summarized below.

- Between September 1 and November 16, YN collected 1,224 Wenatchee River coho broodstock at Priest Rapids Dam, Dryden Dam, Tumwater Dam, and LNFH. At WNFH, MFH adult weir, and Wells Dam, 727 coho were collected for the Methow Basin program between September 15 and November 24. 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 873 coho at Leavenworth NFH and 526 at WNFH. An eye-up rate of 73.9% was calculated for the Wenatchee program and 79.0% for the Methow program.

- During spawning ground surveys in the Wenatchee Basin for 2014, YN found a total of 80 coho redds. Of which, 68.8% (n = 55) were found on Icicle Creek, 20.0% (n = 16) were found on the Wenatchee River, and the remaining 11.2% (n = 9) were located on other tributaries i.e., Mission/Brender Creek and Peshastin Creek.

- During spawning ground surveys in the Methow Basin for 2015, YN found a total of 108 coho redds. Of which, 29.6% (n = 32) were on the Methow River, 11.1% (n = 12) in the Twisp River, 3.7% (n = 4) in the Chewuch River, and the remaining 55.5% (n = 60) within tributaries (i.e. WNFH and MFH outfalls, Libby Creek 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 2015 were 582,090 and 475,269 fish, respectively (Appendix C). Coho released in the Methow Basin achieved a mean, estimated in-pond survival of 94.0%. In the Wenatchee basin, mean in-pond survival was 89.7%.

- YN estimated that the Wenatchee River in-basin SAR for BY2012 hatchery coho smolts was 0.15% (based on estimated return of 1,340 adults). SAR rates between individual release groups ranged from 0.10% to 0.24%. Using scale analysis to verify origin, we estimated that 37 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 0.26% for the 2015 adult return.

- In the Methow River, we estimated that the overall SAR for BY2012 hatchery coho was 0.14% (based on estimated return of 664 adults and 11 jacks). SAR rates of the individual release groups ranged from 0.06% to 0.30%. Using scale analysis to verify origin, we estimated that 9 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 0.38% for the 2015 adult return.

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APPENDIX A: 2015 NASON CREEK SMOLT TRAP REPORT

Population Estimates for Juvenile Salmonids in Nason Creek, WA

2015 Annual Report

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Project No. 1996-040-00

ABSTRACT

In 2015, Yakama Nation Fisheries Resource Management (YNFRM) monitored emigration of Endangered Species Act (ESA) listed Upper Columbia River (UCR) spring Chinook salmon and summer steelhead as well as naturally spawned juvenile coho salmon 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, 2015. We collected 745 spring Chinook salmon, 430 summer steelhead, 1 bull trout, and 5 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 or pooled estimates. All estimates were made with a 95% confidence interval (CI) with total emigration estimates for BY2013 spring Chinook juveniles and coho juveniles of 57,525 (± 39,889) and 161 (± 714), respectively. We estimated the total BY2012 summer steelhead emigration at the trap to be 25,566 (± 6,020). Egg-to-emigrant survival rates for BY2013 spring Chinook and BY2012 summer steelhead were 5.8% and 3.0%, respectively. The egg-to-emigrant survival rate for BY2011 summer steelhead was 0.9%. Productivity, as measured by emigrants-per-redd, for spring Chinook and summer steelhead, was 271 and 162, respectively. With no coho redds on Nason Creek in 2013, egg-to-emigrant survival and productivity could not be estimated for the 2013 brood.

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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 Yakama Nation Fisheries Resource Management (YNFRM) 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, Mclain Johnson, Andrew Murdoch, Ben Truscott, J.B. Walters, and Joshua Williams (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, Yakama Nation Fisheries Resource Management (YNFRM) 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 YNFRM's Mid-Columbia Coho Reintroduction Program (MCCRP) 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. 2015) 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 2015, mean daily discharge for Nason Creek was 285 cfs with mean daily stream temperatures ranging from 0.0°C to 21.3°C (Figure 2 & 3). Spring discharge was extremely limited due to deminished snowpack by the onset of the trapping season. Maximum daily mean discharge in the spring of 2015 was 733cfs; normal maximum mean (12-year) daily flows during spring freshets on Nason Creek are approximately 2,000cfs. The lack of snowpack prompted the early-onset of base-flow conditions (<100cfs) by the end of June. Base-flow conditions persisted into late October, at which time multiple rain-on-snow events pushed Nason Creek into flood conditions.

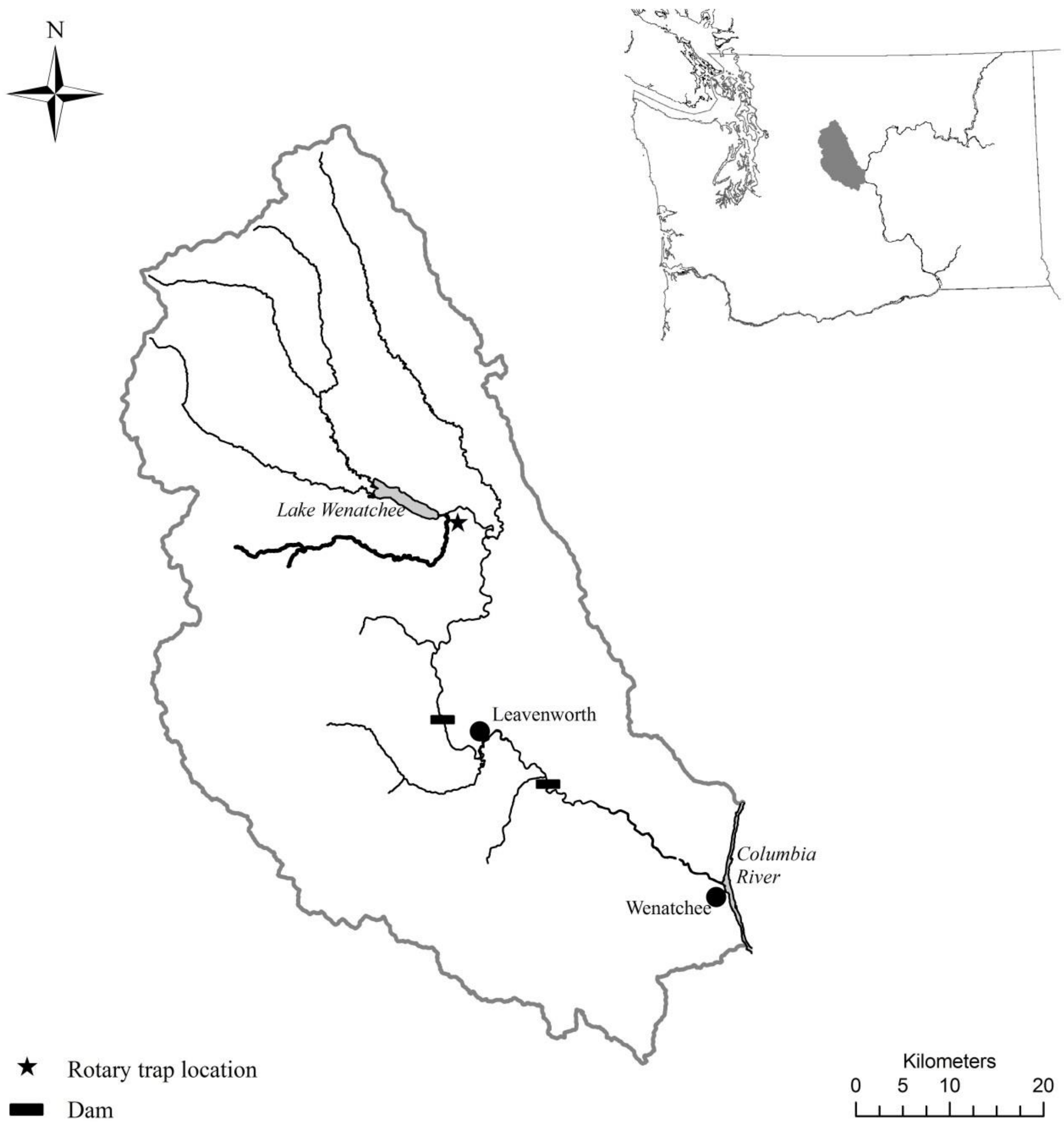


Figure 1. Map of Wenatchee River Subbasin with the Nason Creek rotary trap location.

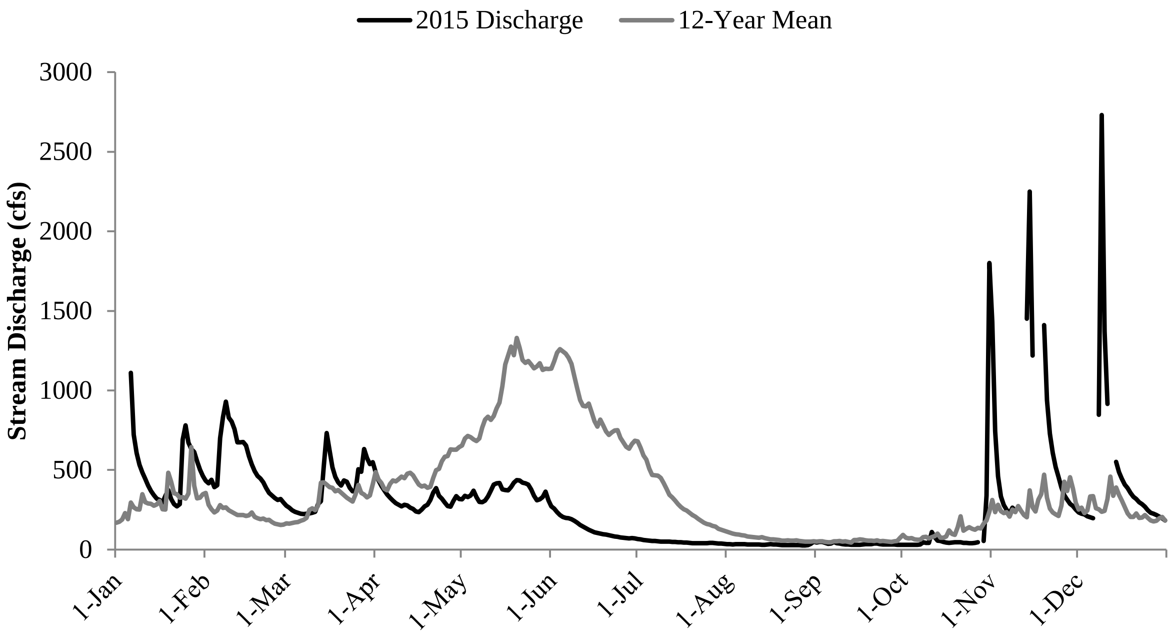


Figure 2. Mean daily stream discharge at the Nason Creek WDOE stream monitoring station in 2015.

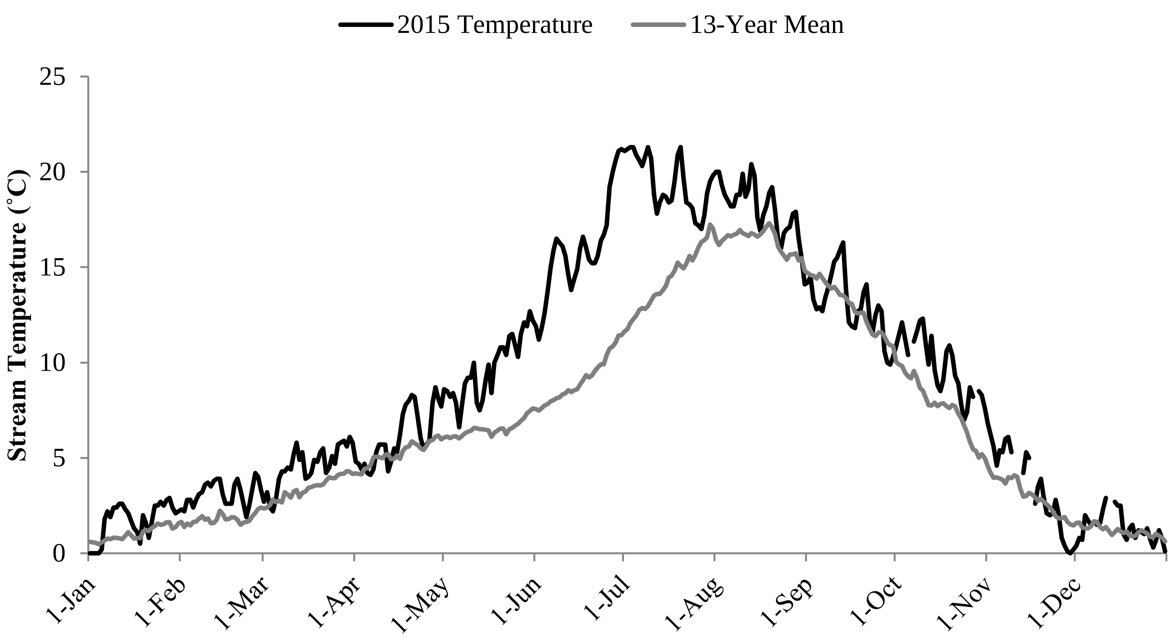


Figure 3. Mean daily water temperature at the Nason Creek DOE stream monitoring station in 2015.

2.0 METHODS

2.1 Trapping Equipment and Operation

The smolt trap was operated continually 24 hours per day, 7 days per week when conditions permitted. During spring snowmelt, operations 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 previously-used campground location, summer operations at the Bolser location were not modified (daytime suspension).

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 YNFRM 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. Mark groups were released by hand 0.8 rkm above the trap at nautical twilight. At each release, fish were distributed evenly along apposing banks in pools and other protected areas. Fish that were not used in mark-recapture trials were released downstream from the trap.

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 2015. 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**).

In the event that low juvenile abundaces could not provide any opportunities for efficiency trials, releases were performed to allow for a pooled estimate. These releases did not have a minimum size and were released at equal intervals across the migratory period. Pooled estimates at the Nason Creek trap were used as an alternative method of estimation prior to the development of a viable regression model.

2.5 Data Analysis

2.5.1 Estimate of Abundance During Smolt Trapping

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:

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

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:

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

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,

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

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,

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

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

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

,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, $\hat{\bar{e}}$ (Part B), and the covariance in daily estimates that arises from using a common estimate of efficiency across all trapping days (Part C):

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

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

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

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

$$V\hat{a}r\left(\hat{\bar{e}}\right) = V\hat{a}r\left(\frac{\sum_{k=1}^{n} r_k}{\sum_{k=1}^{n} m_k}\right) = \frac{\sum_{k=1}^{n}\left(r_k - \hat{\bar{e}}_k m_k\right)^2}{\bar{m}^2 n(n-1)}$$

where $\bar{m}$ 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 Estimate of Abundance 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 the NAL array and the developed regression were then applied to the Bailey estimator, as was peformed with daily trap abundance data (See equation **2.5.1 Estimate of Abundance**). Tag rate determined at the Nason Creek smolt trap was used to account for unmarked emmigrants passing the NAL array.
Tag rate, t_i, was calculated as:

$$t_i = \frac{t}{p}$$

where t = total smolt trap recaptures subsequent to the tagging effort;
p = total catch at the smolt trap.

Daily abundace during the non-trapping period is calculated as:

$$\hat{N}_i = \left(\frac{C_i}{\hat{e}_i}\right) \Big/ t_i\,,$$

where C_i = number of fish caught in period *I*;
$\hat{e}_i$ = trap efficiency estimated from the flow-efficiency relationship, $\sin^2\left(b_0 + b_1 flow_i\right)$;
t_i = tag rate.

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 2015 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 smolt trap was installed on February 25, and operated in its fixed position for the entirety of the trapping season (March 1 to November 30). Removal of the trap occurred on December 2. We attempted to run the trap continuously 24 hours a day, 7 days per week. Intentional suspension of trapping activities occureed for a prolonged period in the summer-early fall due to extreme base flows (July 18 - October 20; Table 1). Pulling of the trap also occurred in the fall as a precaution during two major flood events. Trap stoppages were most frequent from July through November, as heavy debris loads and ice formation prevented continuous operation.

Table 1. Summary of Nason Creek rotary trap operation.

Date of Trap Operations	Trap Status	Description	Days
March 1 to June 30	Operating	Continuous data collection	119
	Interrupted	Interrupted by debris	3
	Pulled	Intentionally pulled during periods of high flow, low flow, or significant ice formation	0
July 1 to November 30	Operating	Continuous data collection	34
	Interrupted	Interrupted by debris, ice and/or low flows	14
	Pulled	Intentionally pulled during periods of high flow, low flow, or significant ice formation	105

3.2 Daily Captures and Biological Sampling

3.2.1 Spring Chinook Yearlings (BY2013)

Between March 1 and June 30, a total of 152 wild Chinook yearlings were captured at the trap (Figure 4). The majority of these fish were collected following an intial spike in flow immediately following operation commencement. A peak catch of 10 yearling smolts coincided with a secondary spike in discharge occurring on March 27. Following the final freshets of March, catch dropped substantially with the last emigrating Chinook yearling captured on May 21. Although three trap stoppages occurred during this period, they likely did not adversely affect total Chinook smolts captured and therefore, estimates were forgone. Mean FL and weight for Chinook yearlings was 93mm (n = 152; SD = 7.0) and 8.4g (n = 152; SD = 2.2; Table 2), respectively. Tissue sample were collected from 138 fish for an ongoing, parental-based DNA analysis by WDFW. Five wild spring Chinook mortalities were incurred.

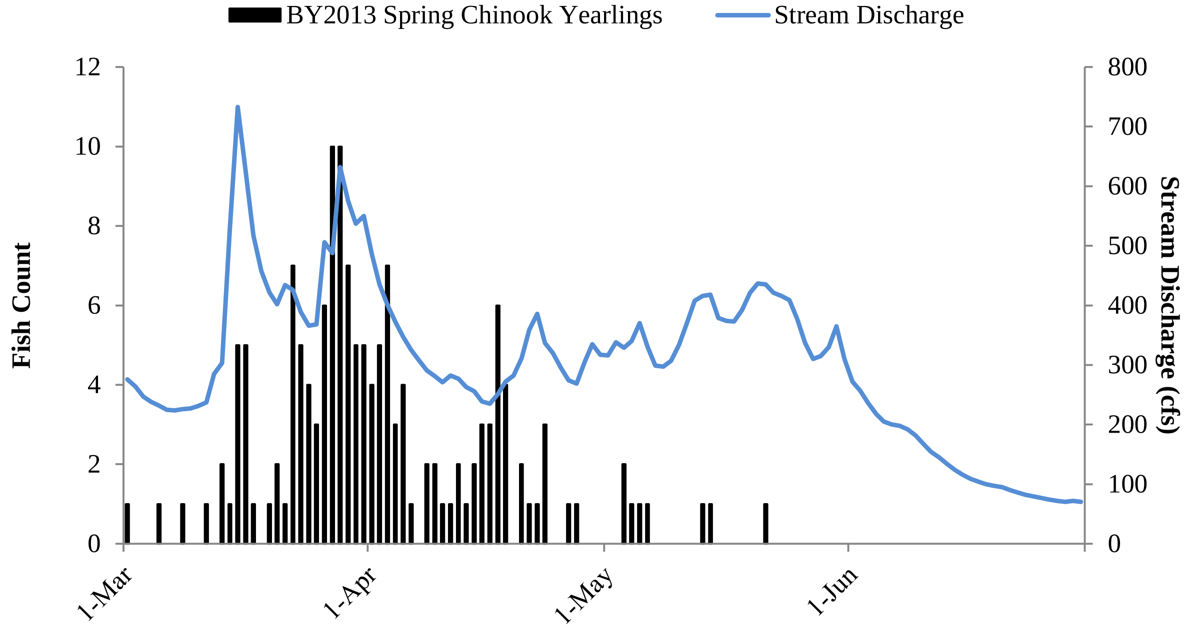


Figure 4. Daily catch of BY2013 spring Chinook yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

Table 2. Summary of length and weight sampling of juvenile spring Chinook captured at the Nason Creek rotary trap in 2015.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2013	Wild Spring Chinook Yearling Smolt	93	152	7.0	8.4	152	2.2	1.03
2014	Wild Spring Chinook Subyearling Fry	45	338	9.9	1.0	338	0.9	0.87
2014	Wild Spring Chinook Subyearling Parr	84	210	8.0	6.5	209	1.7	1.08
2013	Hatchery Spring Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.13

3.2.2 Spring Chinook Subyearlings (BY2014)

A total of 210 wild spring Chinook subyearling parr were captured between July 1 and November 30, with an additional 338 subyearling fry captured prior to July 1 (Figure 5). A peak daily capture of 89 subyearling Chinook parr occurred on November 3, following the first fall high-water event of the year. Mean FL and weight among fall subyearling parr was 84mm (*n* = 210; *SD* = 8.0) and 6.5g (*n* = 209; *SD* = 1.7), respectively. We estimate that an additional 16 Chinook subyearling parr would have been captured during short stoppages (≤3 days) had the trap run without interruption. Estimates of daily abundance during the prolonged period of suspended trapping (July 14 – October 10) were not made due to a lack of documented pre- and post-suspension movement, as well as the duration of the suspenstion. Tissue samples were collected from 213 fish for an ongoing, parental-based DNA analysis by WDFW. A total of 10 subyearling Chinook (9 fry and 1 parr) mortalities occurred in 2015. Causes of death included trapping mortality, tagging/handing mortality, and pre-existing fungal infection/poor condition.

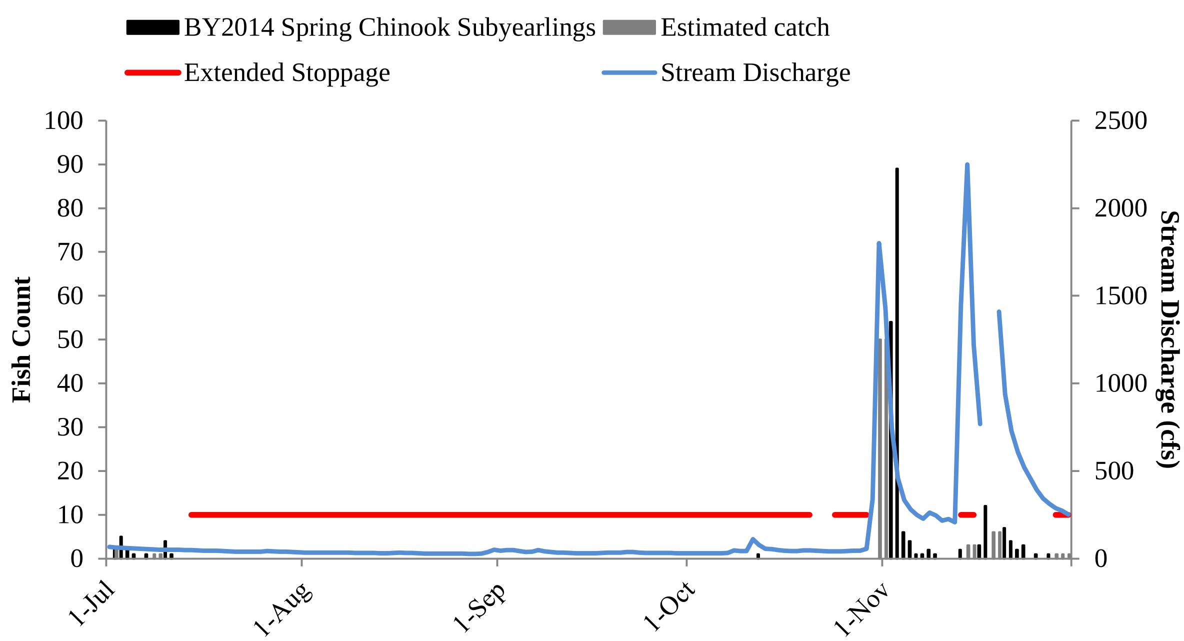


Figure 5. Daily catch of BY2014 spring Chinook subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2015.

3.2.3 Hatchery Spring Chinook Smolts (BY2013)

During the months of April and May, a total of 43,082 hatchery spring Chinook smolts were released into Nason Creek (M. Babiar, personal communication, January 14, 2016). All hatchery spring Chinook were released directly from the Grant County Public Utility District (GCPUD) Nason Creek Acclimation Facility located at rkm17.3. Subsequently, a total of 714 smolts were captured with a mean FL and weight of 136mm (*n* =284; *SD* = 12.3) and 29.5g (*n* = 284; *SD* = 8.8), respectively (Figure 6). Hatchery spring Chinook were not captured at the smolt trap beyond May 10. There were no mortalities incurred.

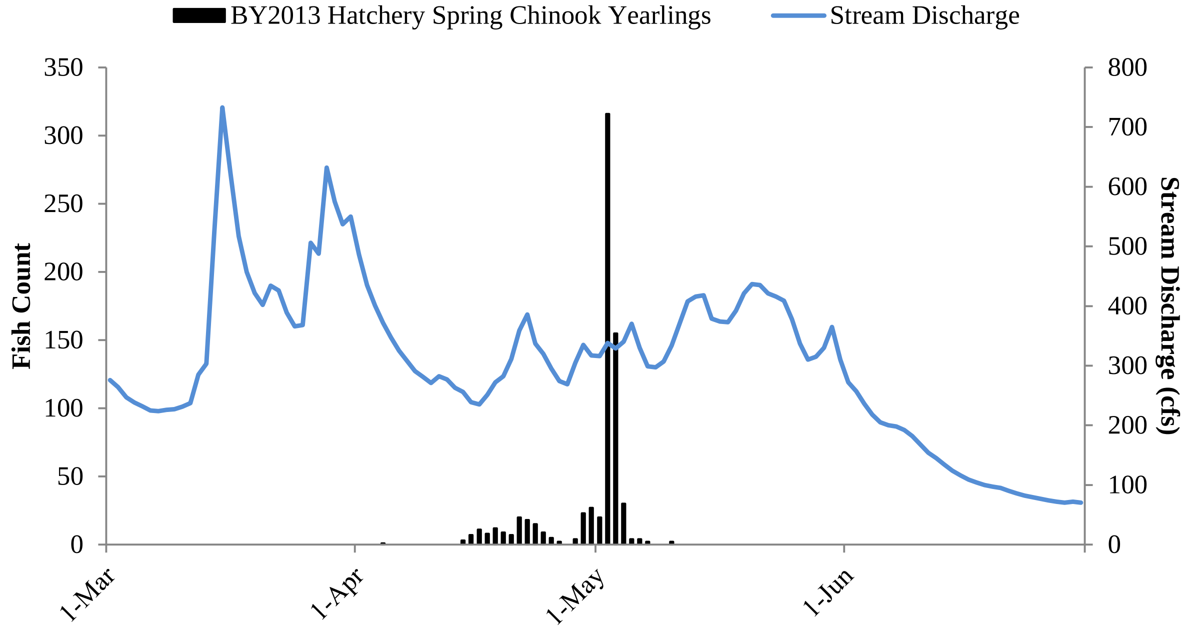


Figure 6. Daily catch of BY2013 hatchery spring Chinook smolts with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.2.4 Summer Steelhead

A total of 430 wild summer steelhead juveniles were captured throughout the season from March 1 to November 30 with a peak catch of 89 juveniles on November 2 (Figure 6). We estimated that an additional 2 age-1 juveniles would have been captured had there been no interruptions to trapping during the migratory period (Mar 1 to July 31). Histogram analysis of known steelhead ages sampled from 2005 to 2014 allowed us to estimate ages of fish captured in 2015 using FL. We estimate that of the total steelhead captured, 182 were young-of-the-year, 233 were age-1, 14 were age-2, and 1 was age-3. Subyearling steelhead caught had a mean FL of 70mm (*n* = 182; *SD* = 15.5), and a mean weight of 4.3(*n* = 176; *SD* = 2.0). 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 88mm (*n* = 233; *SD* = 20.2; Table 3) and 8.3g (*n* = 233; *SD* = 6.7), 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 149mm (*n* = 14; *SD* = 13.5) and 33.7g (*n* = 14; *SD* = 8.2), respectively. A single age-3 fish with a FL of 175mm and weight of 51.3g was also captured. Scales were taken from a sub-sample (*n* = 188) to be used for future age analyses. Two trapping mortalities were incurred (See **3.6 ESA Compliance**).

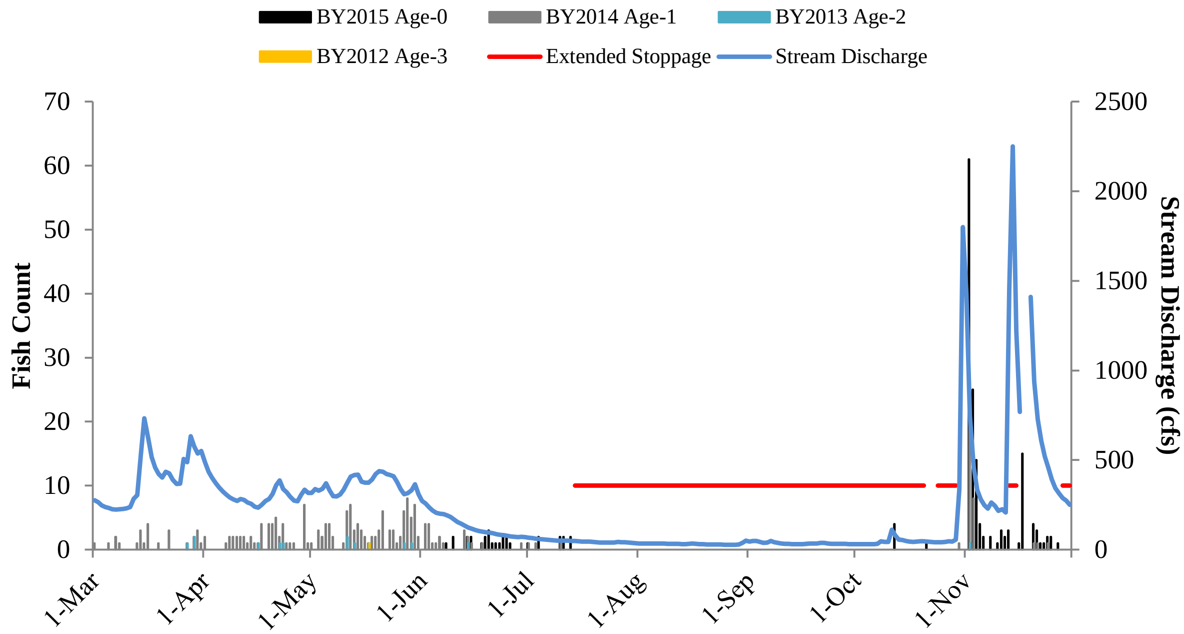


Figure 5. Daily catch of wild summer steelhead with mean daily stream discharge at the Nason Creek rotary trap, March 1 to November 30, 2015. Estimates of fish passage during trap interruptions are not depicted.

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.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2015	Wild Summer Steelhead (Age-0)	70	182	15.5	4.3	176	2.0	1.06
2014	Wild Summer Steelhead (Age-1)	88	233	20.2	8.3	233	6.7	1.04
2013	Wild Summer Steelhead (Age-2)	149	14	13.5	33.7	14	8.2	1.00
2012	Wild Summer Steelhead (Age-3)	191	1	—	73.8	1	—	1.06
2014	Hatch. Summer Steelhead Smolt	175	273	15.2	51.3	273	12.5	0.94

3.2.5 Hatchery Steelhead Smolts (BY2014)

During April and May, WDFW directly planted a total of 86,613 hatchery summer steelhead smolts into Nason Creek (M. Babiar, personal communication, January 14, 2016). Subsequently, a total of 448 hatchery steelhead were captured at the smolt trap with a mean FL and weight of 175mm (n =273; SD = 15.2) and 51.3g (n = 273; SD = 12.5), respectively (Figure 7). The presence of hatchery-origin steelhead at the trap was limited to 45 days after initial release, and did not continue into the summer. Hatchery origin was determined by the presence of coded wire tags (CWT). One mortality was incurred.

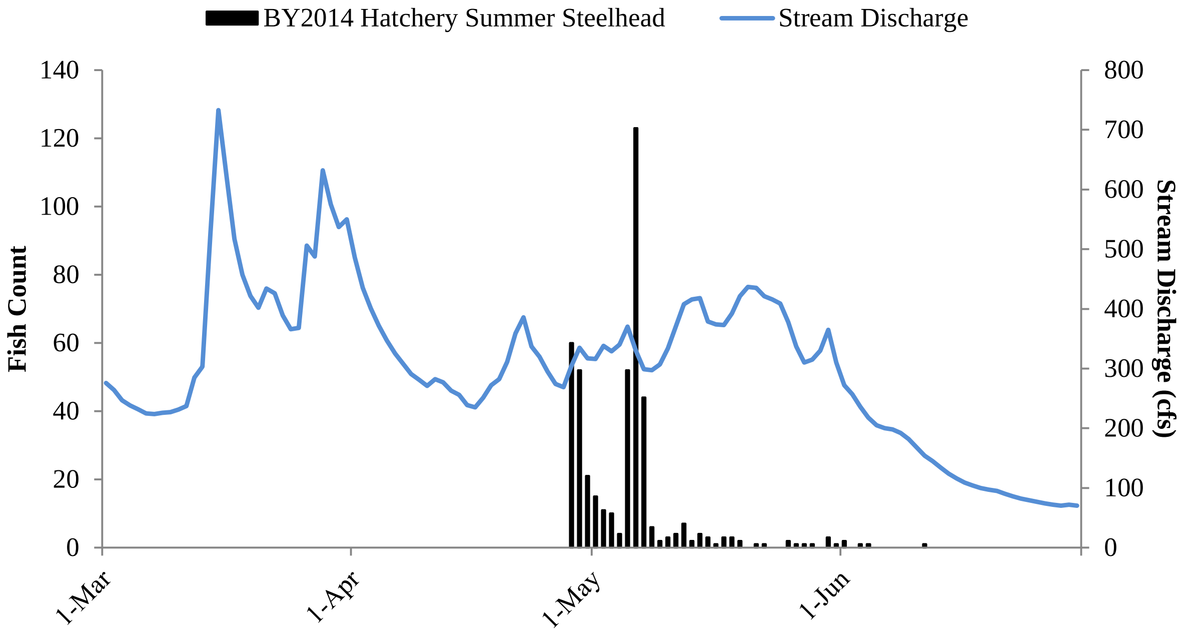


Figure 8. Daily catch of BY2014 hatchery steelhead smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.2.6 Bull Trout

Bull trout presence at the trap in 2015 was limited to a single fish with a FL of 180mm and weight of 50.1g. The bull trout was released immediately after morphometric measurements were taken. No other sampling/tagging activities were performed.

3.2.7 Coho Yearlings (BY2013)

Two naturally produced coho yearlings were captured during spring emigration between March 1 and June 30 (Figure 8). Mean FL and weight were 109mm (n = 2; SD = 4.9) and 12.0g (n = 2; SD = 0.1), respectively (Table 5). Scale and tissue samples were not taken from naturally-produced coho smolts in 2015. There were no coho yearling mortalities.

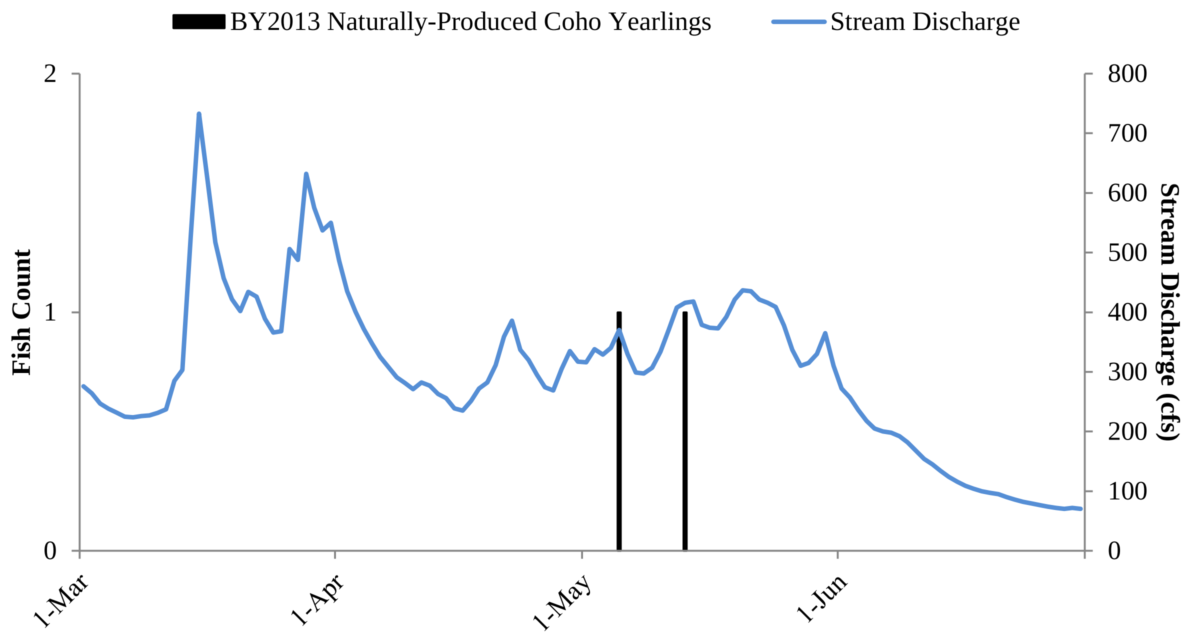


Figure 9. Daily catch of BY2013 naturally-produced coho yearlings with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

Table 4. Summary of length and weight sampling of juvenile coho salmon captured at the Nason Creek rotary trap in 2015.

Brood Year	Origin/Species/Stage	Fork Length (mm)			Weight (g)			K-Factor
		Mean	*n*	SD	Mean	*n*	SD	
2013	Naturally Produced Coho Yearling Smolts	109	2	4.9	12.0	2	0.1	0.95
2014	Naturally Produced Coho Subyearling Fry	47	7	13.7	1.4	7	1.5	0.86
2014	Naturally Produced Coho Subyearling Parr	69	3	7.0	4.0	3	1.3	1.20
2013	Hatchery Coho Yearling Smolts	131	952	9.9	23.3	952	4.8	1.03

3.2.8 Coho Subyearlings (BY2014)

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 69mm (n = 3; SD = 7.0) and 4.0g (n = 3; SD = 1.3), respectively. An additional seven subyearling coho fry were also captured with a mean FL of 47mm. There were no coho subyearling mortalities.

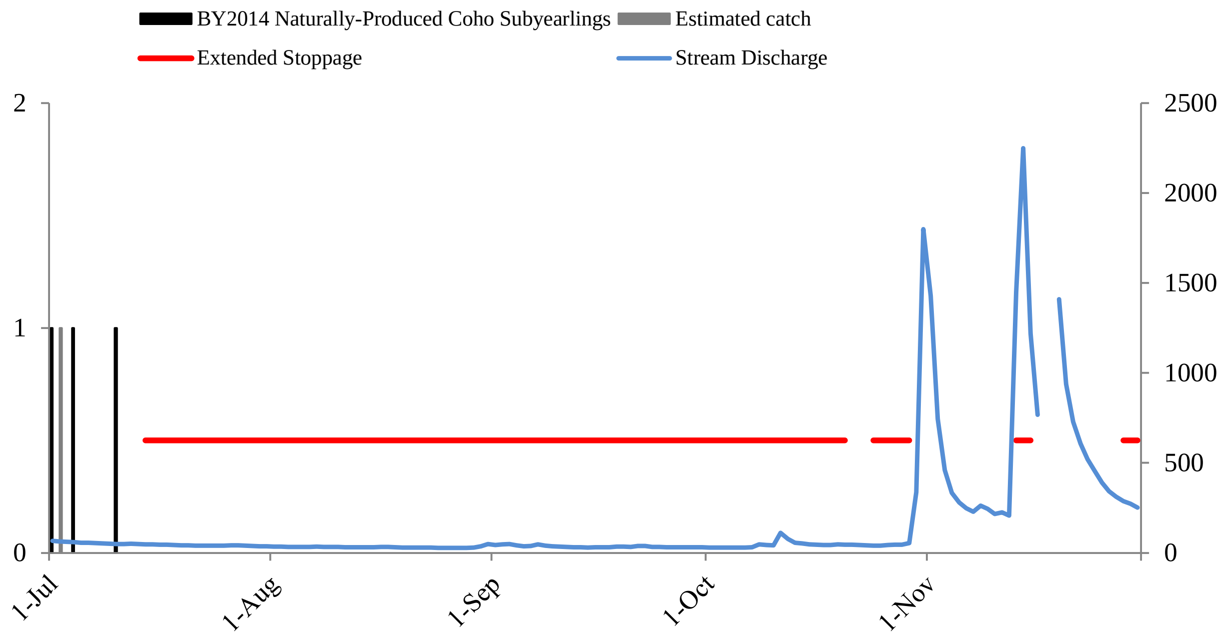


Figure 6. Daily catch of BY2014 naturally-produced coho subyearlings with mean daily stream discharge at the Nason Creek rotary trap, July 1 to November 30, 2015.

3.2.9 Hatchery Coho Smolts (BY2013)

A total of 253,242 hatchery coho were released into Nason Creek above the trap in spring of 2015. 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 1,798 hatchery coho were captured at the trap (Figure 10). Mean FL was 131mm (*n* = 952; *SD* = 9.9) and mean weight was 23.3g (*n* = 952; *SD* = 4.8; Table 2). A peak daily catch of 215 hatchery coho smolts occurred on May 5 following volitional release into Nason Creek. One trapping mortality was incurred. Hatchery coho emigration data at the Nason Creek trap assists the MCCRP by providing size-at-emigration, emigration timing and duration of residence in Nason Creek.

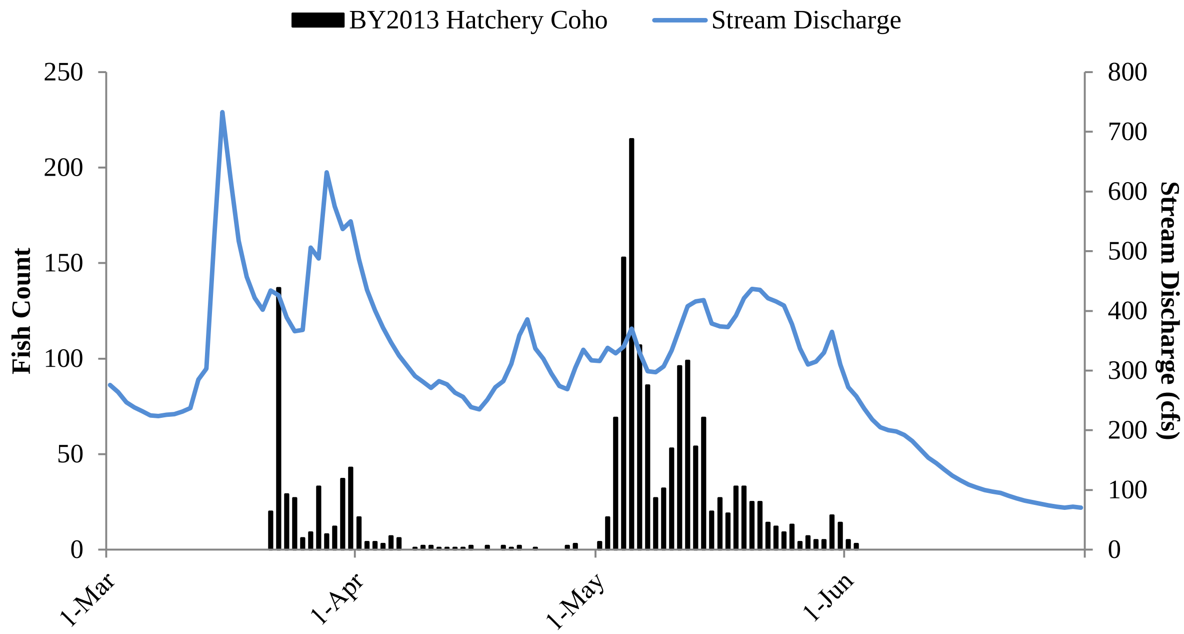


Figure 11. Daily catch of BY2013 hatchery coho smolt with mean daily stream discharge at the Nason Creek rotary trap, March 1 to June 30, 2015.

3.3 Remote Parr Tagging (BY2013 Spring Chinook)

YNFRM and WDFW personnel PIT tagged and released a total of 1,821 BY2013 spring Chinook parr between September 22 and October 24, 2014. The total surveyed area included Nason Creek from rkm 0.8 to 26.1. All collections were performed via backpack electrofisher. Equal capture effort (measured in electrofisher seconds used) was applied across all reaches. Between October 1 and March 30, a total of 311 re-sights of the remote tagged Chinook were documented at the NAL array (Figure 12). Of these detections, only 13 were during the winter non-trapping period. PTAGIS event logs for the NAL array indicated that it operated continuously for the duration of this time with no alterations (PTAGIS 2015).
Subsequent to the remote tagging effort, 30 remote-tagged BY2013 spring Chinook were recaptured at the Nason Creek smolt trap. Total spring Chinook catch at the smolt trap was 798 emigrants during the same period. The pooled tag rate for remote-tagged spring Chinook captured at the Nason smolt trap was 3.8%.

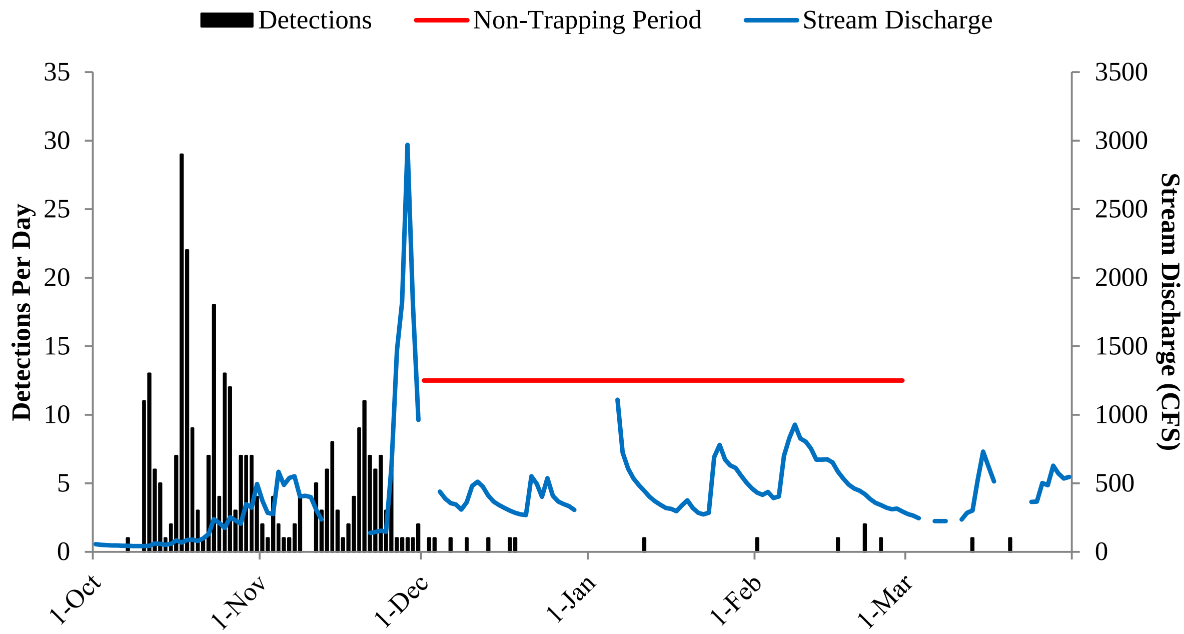


Figure 12. Daily detections of remote-tagged BY2013 spring Chinook at the lower Nason Creek PIT tag antenna array (NAL) between October 2014 and March 2015.

3.4 Trap Efficiency Calibration and Population Estimates

3.4.1 Spring Chinook Yearlings (BY2013)

Infrequent releases, low abundance, and a lack of recaptures did not allow a species-specific model to be used on BY2013 yearling emigrants. In order to produce an estimate, a pooled efficiency (2.07%) composed of spring Chinook yearling and hatchery-origin coho yearling surrogate trials was used (Table 5). We recognize the sub-optimal nature of this estimation methodology, and will recalculate the estimates using linear regression analysis as soon as feasible. We estimated a total of 6,992 (± 32,823; 95% CI) BY2013 Chinook yearlings emigrated in spring of 2015 (Table 7). Parr emmigration during the non-trapping period was estimated using a flow-efficiency regression (r^2 = 0.61; p = 0.0002) based on detections at the NAL pit tag array. We estimated that 6,822 (± 9,035; 95% CI) BY2013 spring Chinook emigrated out of Nason Creek during the non-trapping period. Combined with a recalculated BY2013 subyearling estimate of 43,711 (± 20,788; 95% CI), we estimated that a total of 57,526 (± 39,889; 95% CI) BY2013 spring Chinook juveniles emigrated from Nason Creek.

Table 5. Trap efficiency trials conducted with BY2013 wild spring Chinook yearlings and hatchery-origin coho yearling surrogates.

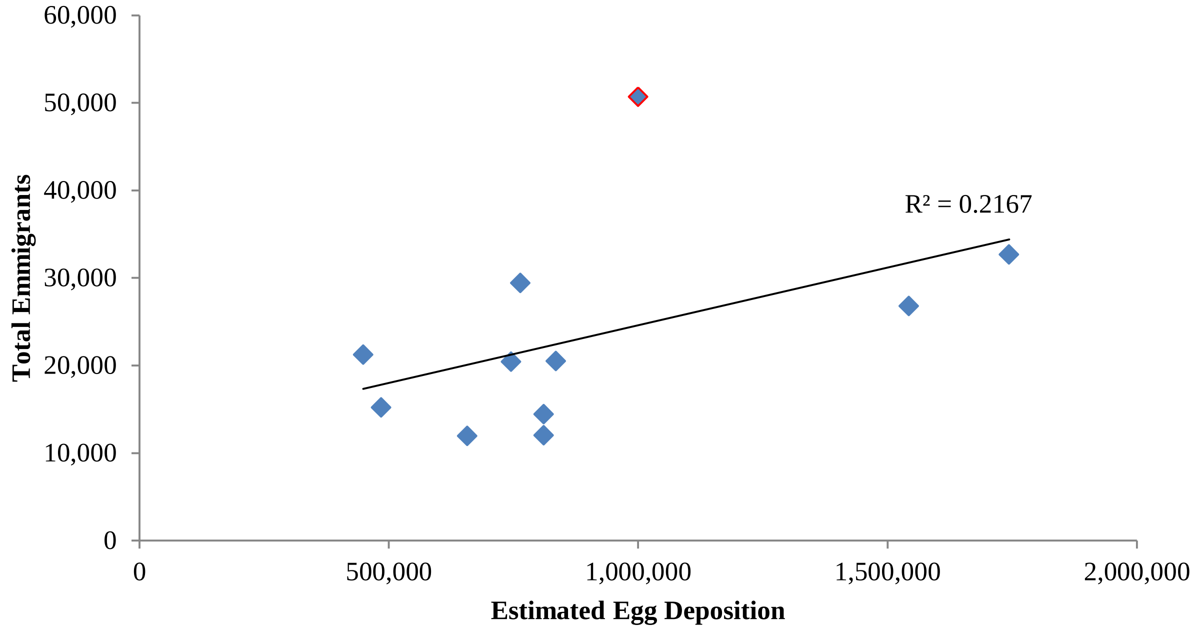
Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (cfs)
Wild Chinook Yearlings	1+	4/23/2015	7	0	337

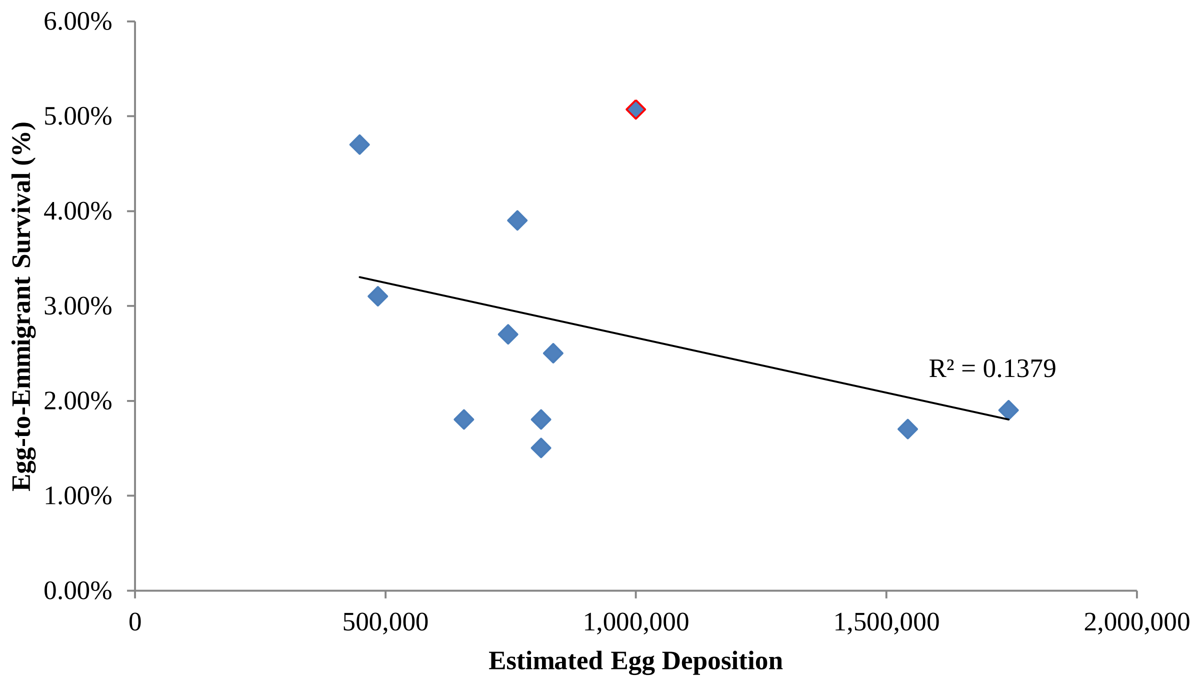
Wild Chinook Yearlings	1+	4/27/2015	2	0	269
Wild Chinook Yearlings	1+	5/6/2015	5	0	330
Wild Chinook Yearlings	1+	5/10/2015	1	0	334
Wild Chinook Yearlings	1+	5/14/2015	22	0	418
Wild Chinook Yearlings	1+	5/22/2015	1	0	421
Hatchery-Origin Coho Yearlings	1+	5/5/2015	98	2	370
Hatchery-Origin Coho Yearlings	1+	5/12/2015	224	8	408
Hatchery-Origin Coho Yearlings	1+	5/14/2015	101	3	418
Hatchery-Origin Coho Yearlings	1+	5/19/2015	102	0	421
Hatchery-Origin Coho Yearlings	1+	5/23/2015	66	0	416
Total			**629**	**13**	

Table 6. 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	3.1%	183
2004	169	4,799	811,031	11,822		2,597	14,419 ± 2,766	1.8%	85
2005	193	4,327	835,111	11,814		8,696	20,510 ± 5,018	2.5%	106
2006	152	4,324	657,248	4,144		7,798	11,942 ± 1,744	1.8%	79
2007	101	4,441	448,541	15,556		5,679	21,235 ± 2,864	4.7%	210
2008	336	4,592	1,542,912	23,182		3,611	26,793 ± 6,756	1.7%	80
2009	167	4,573	763,691	27,720		1,705	29,425 ± 12,777	3.9%	176
2010	188	4,314	811,032	8,491		3,535	12,026 ± 1,954	1.5%	64
2011	170	4,385	745,450	17,991		2,422	20,413 ± 3,889	2.7%	120
2012	413	4,223	1,744,099	28,110		4,561	32,671 ± 4,863	1.9%	79
2013	212	4,716	999,792	43,711	6,822	6,992	57,525 ± 39,889	5.8%	271
2014	115	4,467	513,705	13,903	—	—	—	—	—
Avg.c	199	4,594	894,905	18,306	—	4,905	23,831	2.9%	132

[a] Data provided by Hillman et al. 2015.
[b] Does not include subyearling fry prior to July 1.
[c] 11-year average of complete brood data, BY2003-2013.
[d] Estimated emigration during the winter non-trapping period (December 1 – February 28).


60,000
50,000
40,000
30,000
20,000
10,000
0
Total Emmigrants
R² = 0.2167
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition


6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
Egg-to-Emmigrant Survival (%)
R² = 0.1379
0
500,000
1,000,000
1,500,000
2,000,000
Estimated Egg Deposition

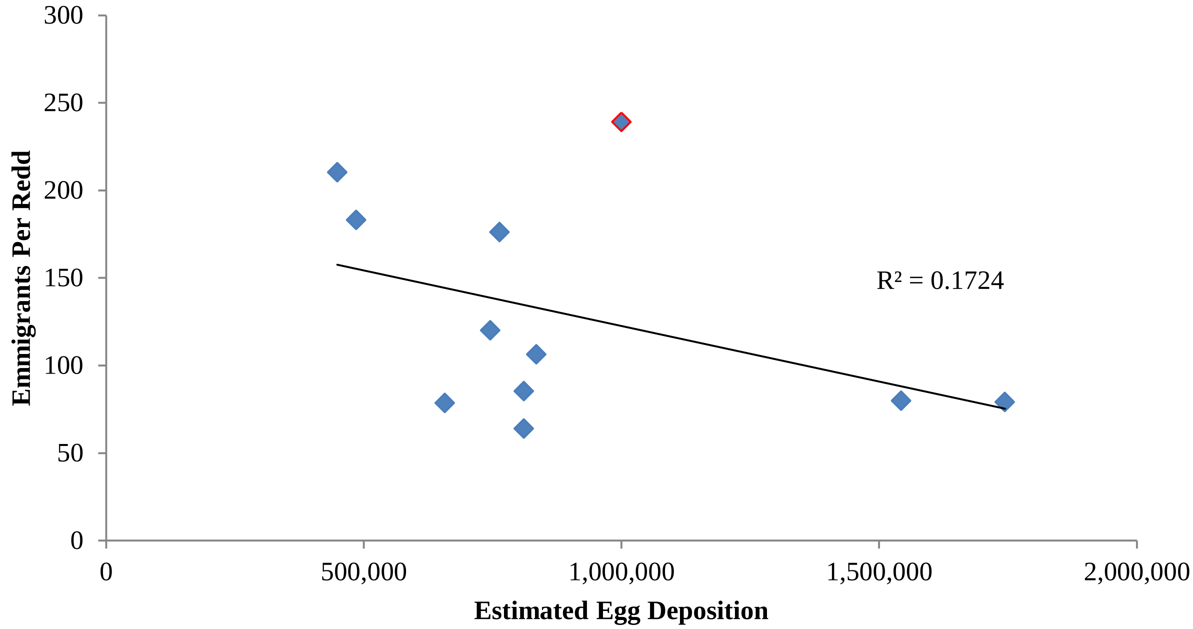


Figure 13. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek spring Chinook, BY 2003 to 2013. *2013 brood (denoted by red border) does not include non-trapping estimate.

3.4.2 Spring Chinook Subyearlings (BY2014)

A linear regression model was developed using subyearling mark groups released in the fall of 2014 and 2015. This weighted regression was not significant ($r^2 = 0.36$; $p = 0.09$) at our accepted limit ($\alpha = 0.05$). However, previous comparisons to pooled estimates suggest that linear regression analysis would be a more viable means of estimation despite less than optimal significance. Also, extreme high flows, low yearling Chinook abundance, and sporadic trap operation in the month of November would have greatly hindered the development of a pooled estimate. As a multi-year regression, this initial flow-efficiency relationship represents the starting point from which we will build further estimates. Using this model we estimated that a total of 13,903 (± 11,963; 95% CI) BY2014 spring Chinook emigrated past the trap in the Fall of 2013 (Table 6).

Table 7. Trap efficiency trials conducted with BY2014 wild spring Chinook subyearlings.

Origin/Species/Stage	Age	Date	Marked	Recaptured	Discharge (cfs)
Wild Chinook Subyearlings	0	11/3/2015	138	0	460
Wild Chinook Subyearlings	0	11/23/2015	9	0	520

3.4.3 Summer Steelhead

Low abundance of summer steelhead emigrants in the spring of 2015 required a pooled estimate be used in light of the inability to meet minimum mark-group sizes (n = 50) for regression analysis (Table 8). Releases of PIT-tagged steelhead were subsequently released every four days upstream at the established release location (Table 9). In a total of 13 separate trials, 116 wild summer steelhead were released upstream with only 1 recapture (0.86%). 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 at the old location to build a model based on young-of-the-year 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 22,504 (± 3,175; 95% CI) BY2014 age-1, 1,508 (± 897; 95% CI) BY2013 age-2, and 116 (± 436; 95% CI) BY2012 age-3 steelhead emigrated past the trap in 2015 (Table 10). We estimate that total (age 1-3) BY2012 emigration to be 25,566 (± 6,020; 95% CI).

Table 8. Efficiency trials conducted with wild summer steelhead juveniles.

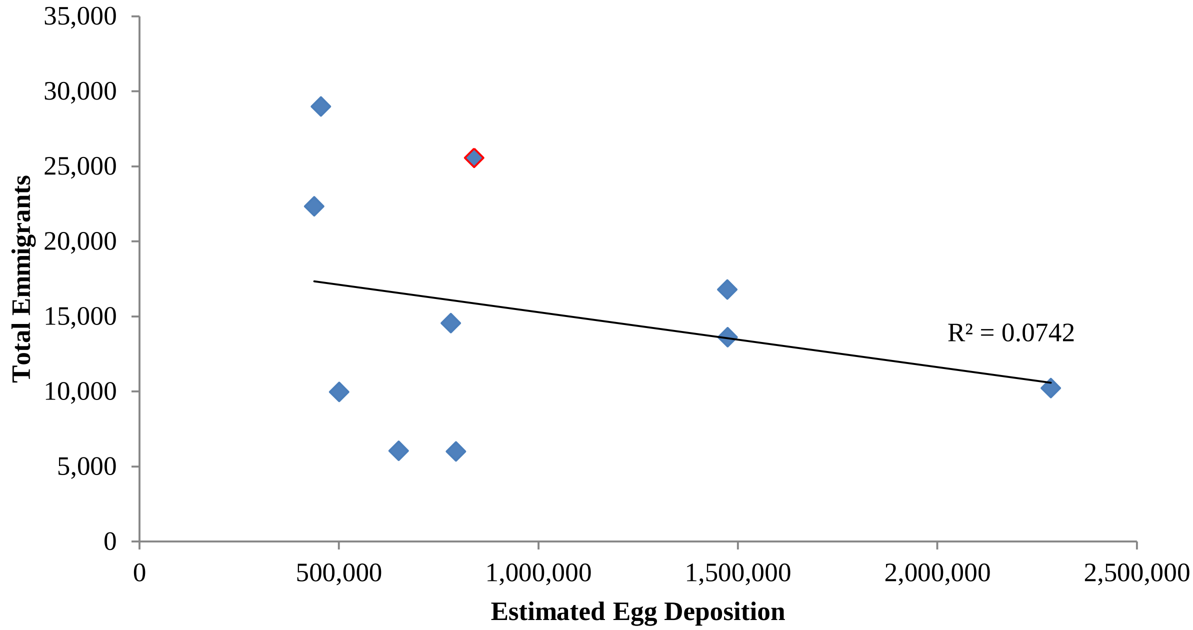
Origin/Species/Stage	Date	Marked	Recaptured	Discharge (cfs)
Wild Steelhead Parr/Smolt	4/23/2015	17	1	337
Wild Steelhead Parr/Smolt	4/27/2015	3	0	269
Wild Steelhead Parr/Smolt	5/2/2015	8	0	338
Wild Steelhead Parr/Smolt	5/6/2015	13	0	330
Wild Steelhead Parr/Smolt	5/10/2015	3	0	334
Wild Steelhead Parr/Smolt	5/14/2015	1	0	418
Wild Steelhead Parr/Smolt	5/18/2015	6	0	392
Wild Steelhead Parr/Smolt	5/22/2015	10	0	421
Wild Steelhead Parr/Smolt	5/26/2015	9	0	337
Wild Steelhead Parr/Smolt	5/30/2015	26	0	365
Wild Steelhead Parr/Smolt	6/4/2015	9	0	218
Wild Steelhead Parr/Smolt	6/8/2015	4	0	192
Wild Steelhead Parr/Smolt	6/16/2015	7	0	109
Total		**116**	**1**	

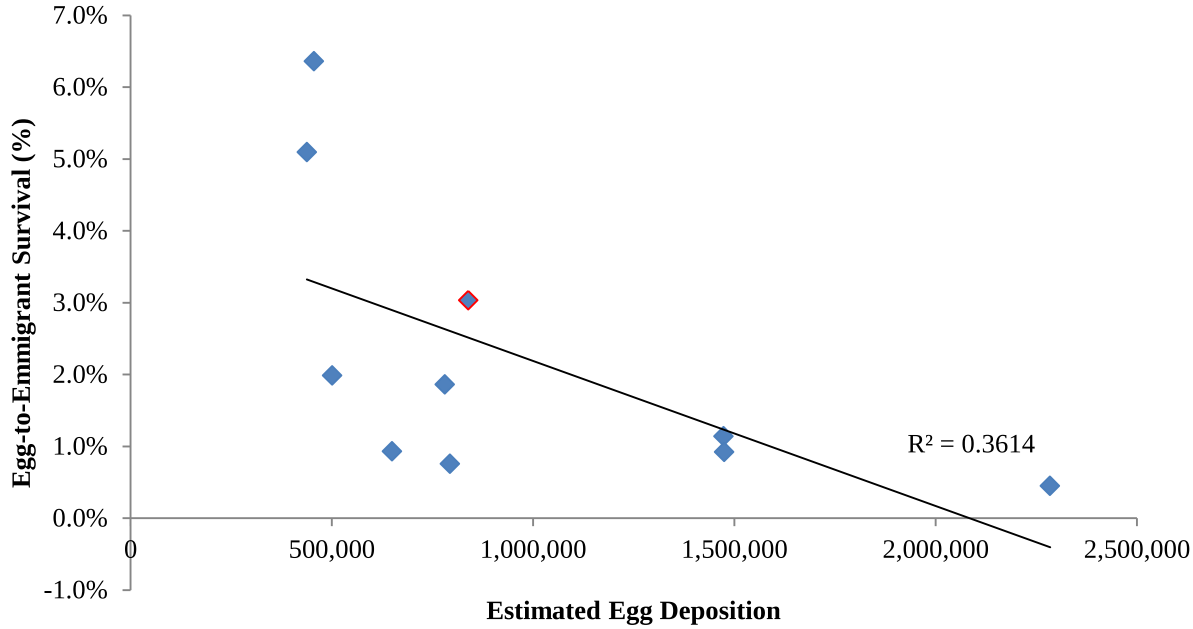
Table 9. Estimated egg-to-emigrant survival and emigrants-per-redd production for Nason Creek summer steelhead.

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	13,591 ± 3,525	0.9%	58
2012	158	5,309	838,822	24,637	813	116[c]	25,566 ± 6,020	3.0%	162
2013	135	5,749	777,735	11,837	1,508[c]	—	—	—	—
2014	198	5,831	1,154,538	22,504[c]	—	—	—	—	—
Avg[b]	169	5,769	969,130	13,646	1,653	90	15,380	2.3%	129

[a] Data provided by Hillman et al. 2015
[b] 10-year average of complete brood estimates, BY2003-2012
[c] Pooled estimate





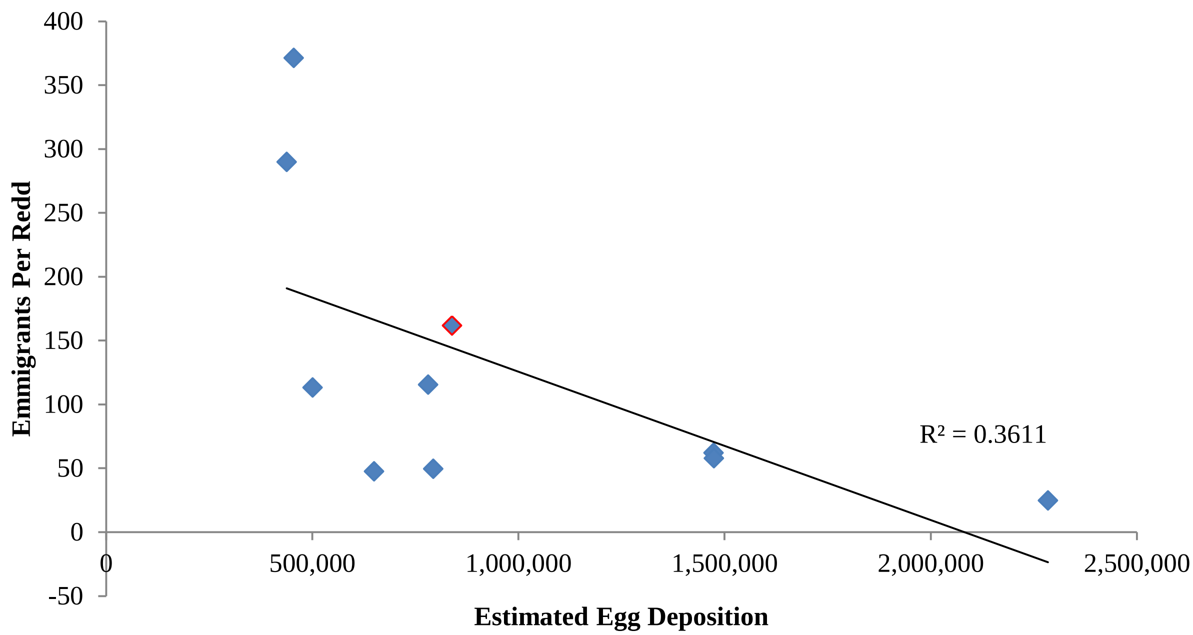


Figure 14. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek summer Steelhead, BY 2003 to 2012. *2012 brood denoted by red border.

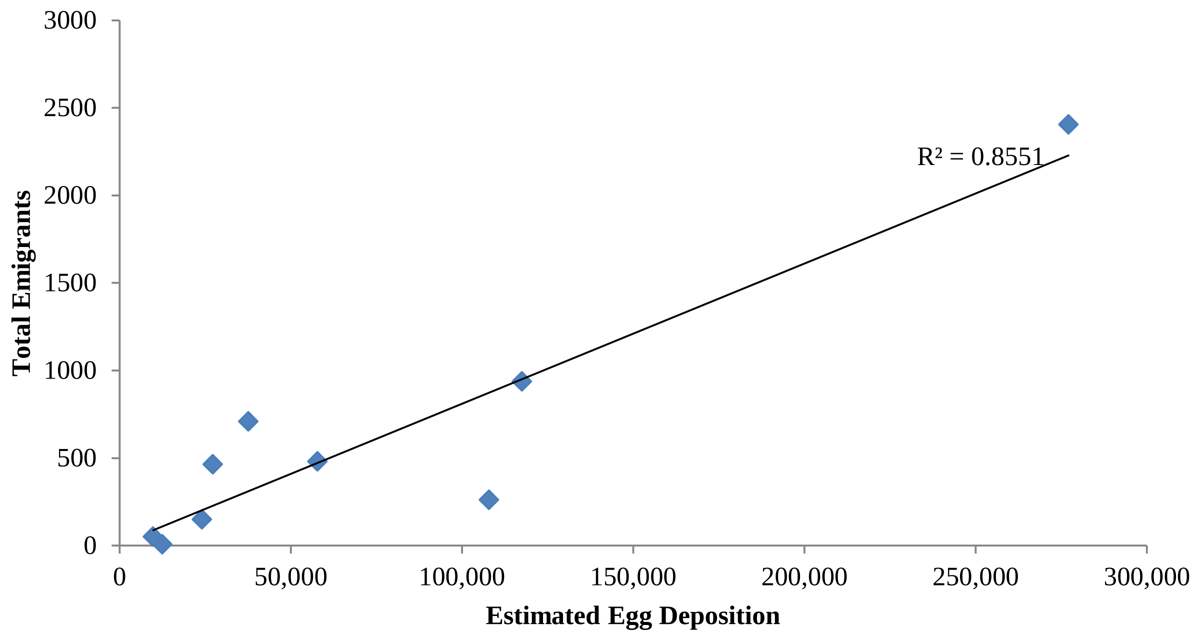
3.4.4 Coho Yearlings (BY2013)

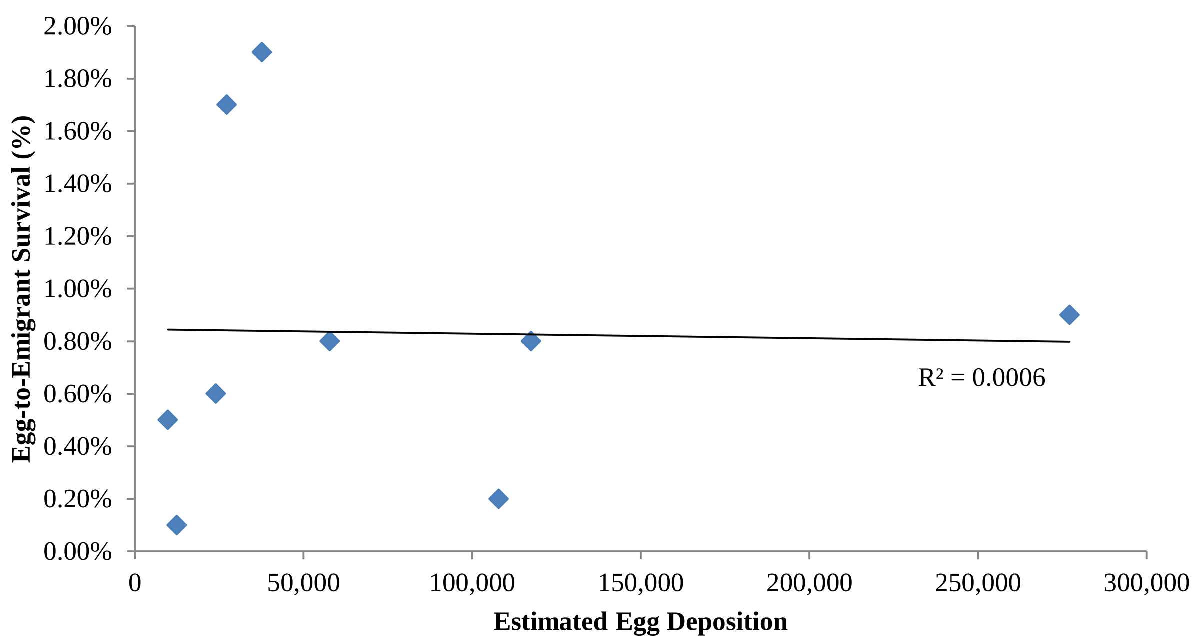
Limited abundance of BY2013 coho yearlings did not provide any opportunities to perform any efficiency trials in the spring of 2015. In lieu of a species-specific model, a pooled estimate using releases of marked hatchery-origin coho smolts was applied to wild coho smolts. In the spring of 2015, we estimated that 91 (± 711; 95% CI) emigrated past the trap (Table 11). This gave us a total BY2013 emigrant estimate of 161 (± 714; 95% CI).

Table 10. 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	2,973	0	70	91	161 ± 714	NA	NA
2014	16	2,992	47,872	84	—	—	—	—
Avg.[b]	23	2,970	67,174	193	369	562	0.8%	25

[a] Does not include subyearling fry prior to July 1.
[b] 10-year average of complete brood data, BY2004-2013.


Total Emigrants
Estimated Egg Deposition
R² = 0.8551
3000
2500
2000
1500
1000
500
0
0
50,000
100,000
150,000
200,000
250,000
300,000


Egg-to-Emigrant Survival (%)
Estimated Egg Deposition
R² = 0.0006
2.00%
1.80%
1.60%
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
0
50,000
100,000
150,000
200,000
250,000
300,000

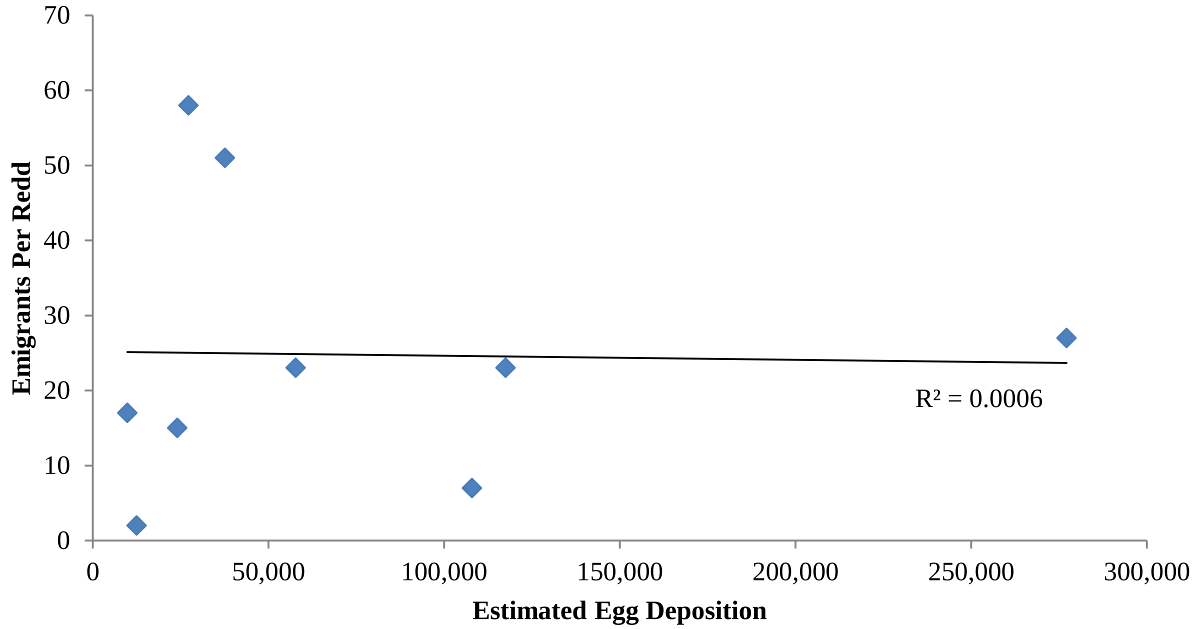


Figure 15. Relationships between estimated egg deposition and total emigrants produced, egg-to-emigrant survival, and emigrants per redd for Nason Creek naturally-produced coho, BY 2004 to 2012.

3.4.5 Coho Subyearlings (BY2014)

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. The subyearling spring chinook flow-efficiency regression model was used to estimate subyearling coho parr emigrants. We estimated that 84 (± 70 ; 95% CI) emigrated past the trap in the fall of 2015 (Table 11).

3.5 PIT Tagging

During the 2015 trapping season, we PIT tagged 361 wild spring Chinook, 383 steelhead, and 2 naturally produced coho (Table 12). All tagging files were submitted to the PTAGIS database. One shed PIT tag (implanted in steelhead parr) was recovered in holding boxes where fish had been held for 24-72 hours after tagging.

Table 11. Number of PIT tagged coho, Chinook, and steelhead with shed rates at the Nason Creek rotary trap in 2015.

Species/Stage	Year-to-date Catch	Year-to-date PIT Tagged	No. of Shed Tags	Percent Shed Tags
Chinook Yearling Smolt	152	142	0	0.00%
Chinook Subyearling Parr (Mar 1 to June 30)	111	28	0	0.00%
Chinook Subyearling Parr (July 1 to Nov 30)	201	191	0	0.00%
Steelhead Parr	388	371	1	0.27%

Steelhead Smolt	12	12	0	0.00%
Coho Yearling Smolt	2	2	0	0.00%
Coho Subyearling Parr	5	0	—	—

* 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 YNFRM 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.*, summer sockeye salmon fry *Oncorhynchus nerka*, and mountain whitefish *Prosopium williamsoni*.

Table 12. Summary of length and weight sampling of incidental species captured at the Nason Creek rotary trap in 2015.

Species	Total Count	Length (mm)			Weight (g)		
		Mean	N	SD	Mean	N	SD
Bull Trout	1	180	1	—	50.1	1	—
Cutthroat Trout	1	168	1	—	45.3	1	—
Fathead Minnow	2	46	2	12.0	1.1	2	0.9
Longnose Dace	117	92	117	24.8	11.7	116	6.6
Northern Pikeminnow	11	142	11	78.9	58.4	11	78.8
Redside Shiner	8	58	8	13.8	2.8	7	1.1
Sculpin	81	78	81	38.7	12.3	78	17.3
Sucker	39	120	39	91.4	20.7	34	58.5
Summer Sockeye Fry	2	32	2	8.5	0.5	1	—
Whitefish Fry	4	40	4	9.3	0.8	3	0.1
Whitefish	21	97	21	68.8	25.0	20	65.5

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 wild summer steelhead, hatchery summer steelhead, and bull trout (Table 14). Final spring Chinook lethal take for 2015 was at the 2% maximum. Exceedance of this maximum in early March was addressed in a memo sent to

NMFS (See Appendix D). Stream temperatures did not exceed 18˚C at any time in which fish were being handled.

Table 13. 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 (BY2013)	152	5*	3.29%
Spring Chinook Subyearling (BY 2014)	548	9*	1.64%
Total Wild Spring Chinook	**700**	**14**	**2.00%**
Total Hatchery Spring Chinook	**714**	**0**	**0.00%**
Steelhead Age-0 (BY2015)	182	1	0.55%
Steelhead Age-1 (BY2014)	233	1	0.43%
Steelhead Age-2 (BY2013)	28	0	0.00%
Steelhead Age-3 (BY2012)	1	0	0.00%
Total Wild Summer Steelhead	**444**	**2**	**0.45%**
Total Hatchery Summer Steelhead	**448**	**1**	**0.22%**
Total Bull Trout	**1**	**0**	**0.00%**
Coho Yearling (BY2013)	2	0	0.00%
Coho Subyearling (BY2014)	5	1	20.00%
Total Naturally-Produced Coho	**7**	**1**	**14.29%**

*Majority occurring during incident detailed in Appendix D.

4.0 DISCUSSION

Operations in 2015 marked the first full season of continuous trapping at the Bolser site. Preliminary trapping this new site has achieved the goal of minimizing interactions with the public; we have yet to encounter any act of vandalism or tampering with the trap since the move. Aside from the benefit of added safety to the public and captured fish, relocation of the Nason Creek trap was intended to improve the quality of data collected via simplified trapping regime and favorable channel morphology. Initial subyearling Chinook releases in the fall of 2014 suggested that the flow-efficiency relationship was statistically significant at the flows tested (r^2 =0.63, p = 0.007). However, in three of the contributing trials, a stoppage or inconsistent operation during the recapture period dictated that they be omitted from any expansions performed (non-continuous operation of the trap in the 3-day recapture period is a violation of our estimation protocol). Although the flow-efficiency regression was ultimately rendered unusable, subyearling Chinook efficiency trials in 2014 were an indication that a consistent flow-efficiency relationship is present at the new site.

Attempts to further develop our flow-efficiency models in 2015 were largely prevented by extreme low spring/summer and high fall flow conditions, as well as low fish abundance. Steelhead and Chinook mark-group releases were generally small ($n \leq 26$), providing little chance for recaptures given potentially low trap efficiency. A single large release of 138 subyearling spring Chinook on November 3 failed to produce any recaptures, initially suggesting a trap efficiency of less than 1.0%. Later examination of daily subyearling spring Chinook catch showed that the release was performed concurrently with a significant drop in abundance, from 89 to 6 fish captured. The release also coincided with a rapidly decreasing hydrograph following a significant peak in discharge. The precipitous drop in catch may have resulted in a lack of active migration, with the spring Chinook subyearlings becoming less prone to downstream displacement as flows subsided. The suspected non-migratory behavior of spring Chinook subyearlings in Nason Creek during that period likely contributed to a lack of recaptures despite the large mark-group size. However, given that the trial occurred during the recognized subyearling spring Chinook migratory period and lacked any violations of release or trapping protocols, it was deemed valid.

With viable regression models unavailable for all species/stages, pooled estimates were predominantly used. These estimates were used as a means to produce some form of emigrant estimate, albeit with a higher degree of bias. All pooled estimates reported are considered provisional, and will be recalculated as viable flow-efficiency regressions are developed.

Spring Chinook

Nason Creek spring Chinook egg-to-emigrant survival rates are generally lower than those of the Chiwawa River and White River populations (Figure 16). However, the 2013 Nason Creek spring Chinook brood deviated from this trend markedly, with an survival rate exceeding those of the other two tributaries. Whereas the Chiwawa River and White River populations saw egg-to-emigrant survival rates typical of their corresponding estimated egg depositions in 2013, Nason Creek produced an outlier value (Figures 13 & 17). The total BY2013 spring Chinook estimate (excluding the non-trapping period) of 50,703 (± 38,852; 95% CI) emigrants greatly exceeded the corresponding 11-year average (n = 23,211).

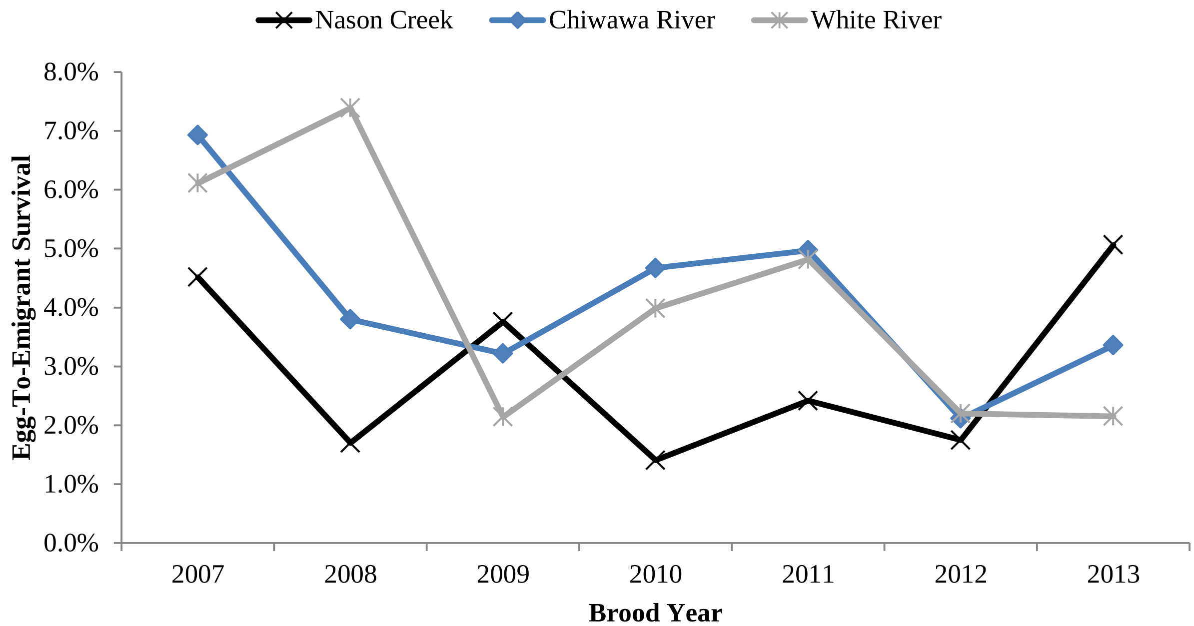


Figure 16. Comparison of wild spring Chinook abundance estimates (BY2007-2013) made at the White River, Nason Creek, and Chiwawa River smolt traps. *Non-trapping estimates not included.

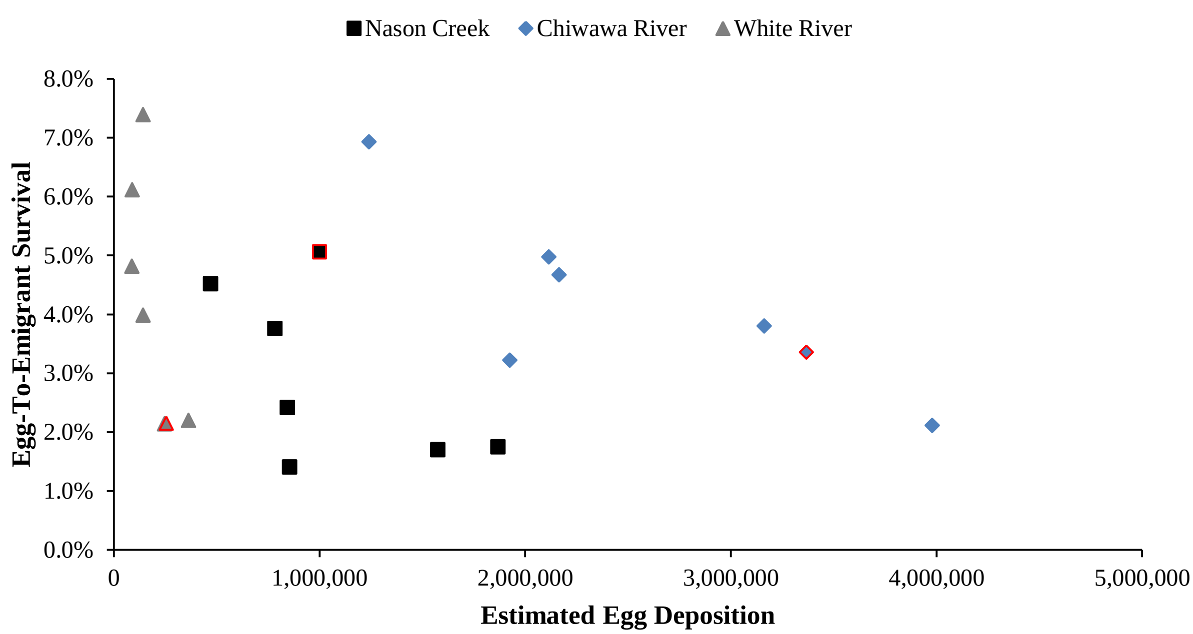


Figure 17. Comparison of egg-to-emigrant survival (BY 2007-2013) and egg deposition for Nason Creek, Chiwawa River, and White River spring Chinook. *Non-trapping estimates not included.

Though possible that the Nason Creek population alone saw above-average survival, it is likely that some degree of overestimation by our modeled and pooled estimates occurred. Composed primarily of smaller ($n \leq 96$) trials, the weighted (mark-group size) model was heavily influenced by the aforementiomned large (n = 138) release in 2015 that did not produce any recaptures. Because the unsuccessful trial was performed at the high end of the discharge range tested, it decreased the slope of the regression, and therefore the trap efficiencies used to expand catch at elevated flows. Additional trials at higher flows will mitigate the effect of this subyearling release outlier and likely produce a lower emigrant estimate when recalculated. Overestimation of the yearling pooled estimate was also likely influenced by a lack of consistent releases throughout the migratory period. We expect that eventual recalculation of BY2013 yearlings will also contribute to a lowering of the overall emigrant estimate.

The non-trapping period estimate of 6,822 (± 9,035; 95% CI) BY2013 migrants suggests that movement out of the system was present in the winter, but at a much lower rate in comparison to the fall. Winter emigration for the 2013 spring Chinook brood accounted for 11.9% of the total estimate, whereas fall subyearling migrants made up a total of 76.0%. Yearling spring emigrants composed a slightly larger proportion than non-trapping period, with 12.1% of the total run. Upon eventual recalculation of the BY2013 trapping estimates, proportion of non-trapping period to total run will likely increase as the smolt trap-derived estimates decrease. Although detections during the winter confirm movement, they are too few and infrequent to determine fine-scale temporal trends in emigration and/or relation to environmental conditions.

Summer Steelhead

The pooled estimate used to expand 2015 steelhead migrants was based on 13 mark-groups; a total of 116 fish released, and 1 recapture. Consequently, the model tended to overestimate emigrant abundance as an efficiency of 0.86% was used to expand all daily catch. With no prior mark-group releases at this location, we are unsure if the low efficiency observed is accurate, or the product of the abnormally low water-year and its potential effects on steelhead migratory behavior. Comparisons of yearling Chinook and hatchery coho efficiencies at the new trap site to those of the old show they are comparatively lower, but not to the degree seen in 2015 summer steelhead migrants.

The total estimate of 25,566 (± 6,020; 95% CI) BY2012 steelhead exceeded the 10-year mean of 15,380 emigrants, and was the second highest estimate in the past 10 broods. Although the model used to expand age-3 fish was admittedly skewed toward overestimation, their contribution to the overall estimate was small (n = 116), and therefore did not impact it greatly. Both models used to calculate the bulk of the estimate (age-1 and age-2) were satistically robust ($\alpha \leq 0.05$); the product of trapping at the former site. The above-average emigrant survival and emigrants per redd of the 2012 brood despite relatively low egg deposition is characteristic of Nason Creek. In previous years, the highest rates of survival have corresponded to the lowest levels of spawner success, suggesting denstiy-dependence.

The migratory timing of summer steelhead captured in 2015 was typical of what we have previously seen in Nason Creek. Of the steelhead caught in the spring migratory period, 81.5% were were age-1, with age-2 (5.4%) and age-3 (0.4%) classes constituting a small portion of the total. The majority of the summer/fall non-migratory period was not trapped as a consequence of low flows. This period is normally dominated by young-of-the-year fry and parr.

Coho

A poor return of adult coho in 2013 required exhaustive measures to collect program broodstock, including increased retention at Tumwater Dam (Kamphaus et al. 2016). As a result, a limited number of adult coho (n =32) were allowed to pass into the upper-basin. Spawner escapement into Nason Creek was estimated at zero fish, with no redds documented during surveys in the fall of 2013. We attribute the capture of natural-origin coho to surveyor error, which may have lead to one or more redds to go unseen.

The BY2013 naturally-produced coho estimate of 161 (± 714; 95% CI) was likely overestimated to some degree by the under-developed models used for expansion. Despite the likely overestimation, the BY2013 estimate was less than the 10-year mean emigrant abundace (n = 562), and the third lowest estimate thus far at Nason Creek. We assume that the comparatively low estimate is a reflection of the poor spawner escapement of 2013. Recalculation of BY2013 emigrants will likely produce and even lower emigrant abudance.

2016 Trap Operations at Nason Creek

Pooled estimates have been used here, and in previous reports as an alternative when regression analysis is not feasible. However, this has proven problematic as each method requires a different efficiency-testing strategy. While flow-efficiency modeling can be built by gauging efficiency at specific flows over multiple years, a pooled estimate is based on regular releases over discrete strata. Pooled estimates based on few, unevenly-spaced releases will utimately be skewed toward the efficiencies of the discrete periods tested, not the entire migratory period. Recognizing the necessity to produce viable models depite potentially low emigrant abundaces in 2016, we have revised our system of efficiency trials to accommodate both pooled, and regression models. Along with the accustomed targeting of specific flows, regular releases at even intervals will occur throughout the year. Regardless of mark group size, or flows tested, migratory juveniles will be transported every three to four days upstream to be released. In doing so, we will ensure that estimates made with either methodology are as sound as possible. Additionally, we will verify that the location of our upstream release point upholds smolt trapping assumption 3: that marked fish are randomly dispersed in the population prior to recapture. Currently, marked fish are released evenly on both sides of the creek to eliminate the potential bias of a single release point on one bank. In 2016, pre-release scans of both right, and left-bank release-groups will test if recapture probability differs depending on the side of the channel. In the event that recapture rates are markedly different between the two sites, we will pursue a different release point.

5.0 LITERATURE CITED

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APPENDIX A. Daily Stream Discharge and Stream Temperature

Date	Stream Discharge (CFS)	Water Temperature (˚C)
1/1/2015		0.0
1/2/2015		0.0
1/3/2015		0.0
1/4/2015		0.0
1/5/2015		0.2
1/6/2015	1110	1.8
1/7/2015	723	2.2
1/8/2015	607	1.9
1/9/2015	534	2.4
1/10/2015	485	2.4
1/11/2015	444	2.6
1/12/2015	402	2.6
1/13/2015	368	2.3
1/14/2015	343	2.1
1/15/2015	319	1.7
1/16/2015	311	1.3
1/17/2015	296	1.1
1/18/2015	338	0.5
1/19/2015	375	2.0
1/20/2015	318	1.6
1/21/2015	285	0.8
1/22/2015	272	1.7
1/23/2015	286	2.5
1/24/2015	691	2.5
1/25/2015	781	2.7
1/26/2015	673	2.5
1/27/2015	632	2.8
1/28/2015	613	2.9
1/29/2015	556	2.4
1/30/2015	503	2.1
1/31/2015	463	2.2
2/1/2015	433	2.3
2/2/2015	417	2.2
2/3/2015	438	2.8
2/4/2015	392	2.8
2/5/2015	404	2.4
2/6/2015	701	2.8
2/7/2015	832	3.1
2/8/2015	929	3.2
2/9/2015	829	3.6
2/10/2015	804	3.7
2/11/2015	756	3.5
2/12/2015	675	3.8
2/13/2015	674	3.9
2/14/2015	677	3.9
2/15/2015	653	3.1
2/16/2015	587	2.6
2/17/2015	536	2.6
2/18/2015	492	2.6
2/19/2015	463	3.6
2/20/2015	447	3.9
2/21/2015	422	3.3
2/22/2015	387	2.6
2/23/2015	357	1.9
2/24/2015	341	2.5
2/25/2015	323	3.4
2/26/2015	312	4.2
2/27/2015	317	4.0
2/28/2015	295	3.3
3/1/2015	276	2.7
3/2/2015	264	3.2
3/3/2015	247	2.4
3/4/2015	238	2.2
3/5/2015	232	2.8
3/6/2015	225	3.9
3/7/2015	224	4.3
3/8/2015	226	4.3
3/9/2015	227	4.5
3/10/2015	231	4.4
3/11/2015	237	5.2
3/12/2015	285	5.8
3/13/2015	303	4.9
3/14/2015	526	5.3
3/15/2015	733	3.9
3/16/2015	624	4.0
3/17/2015	517	4.2
3/18/2015	457	4.9
3/19/2015	422	4.8
3/20/2015	402	5.3
3/21/2015	434	5.5
3/22/2015	426	4.2

3/23/2015	389	4.5	5/6/2015	330	6.6
3/24/2015	366	5.1	5/7/2015	299	7.8
3/25/2015	368	4.7	5/8/2015	297	8.9
3/26/2015	506	5.7	5/9/2015	307	9.2
3/27/2015	488	5.8	5/10/2015	334	9.2
3/28/2015	632	5.9	5/11/2015	371	10.0
3/29/2015	575	5.6	5/12/2015	408	7.9
3/30/2015	537	6.1	5/13/2015	416	7.5
3/31/2015	550	5.8	5/14/2015	418	8.0
4/1/2015	486	4.8	5/15/2015	379	9.1
4/2/2015	435	4.7	5/16/2015	374	9.9
4/3/2015	401	4.4	5/17/2015	373	8.4
4/4/2015	372	4.7	5/18/2015	392	10.0
4/5/2015	347	4.2	5/19/2015	421	10.4
4/6/2015	325	4.1	5/20/2015	437	10.8
4/7/2015	308	4.4	5/21/2015	435	10.8
4/8/2015	291	5.3	5/22/2015	421	10.4
4/9/2015	281	5.7	5/23/2015	416	11.4
4/10/2015	271	5.7	5/24/2015	409	11.5
4/11/2015	282	5.7	5/25/2015	378	10.9
4/12/2015	277	4.3	5/26/2015	337	10.3
4/13/2015	263	4.8	5/27/2015	310	11.5
4/14/2015	256	5.5	5/28/2015	315	12.1
4/15/2015	239	5.3	5/29/2015	330	11.9
4/16/2015	235	6.2	5/30/2015	365	12.7
4/17/2015	251	7.3	5/31/2015	310	12.2
4/18/2015	272	7.8	6/1/2015	272	11.9
4/19/2015	282	8.0	6/2/2015	257	11.2
4/20/2015	311	8.3	6/3/2015	236	11.8
4/21/2015	359	8.2	6/4/2015	218	12.6
4/22/2015	386	7.2	6/5/2015	205	13.8
4/23/2015	337	6.0	6/6/2015	200	15.0
4/24/2015	320	5.5	6/7/2015	198	15.9
4/25/2015	295	5.7	6/8/2015	192	16.5
4/26/2015	274	5.9	6/9/2015	182	16.3
4/27/2015	269	7.9	6/10/2015	168	16.1
4/28/2015	305	8.7	6/11/2015	154	15.6
4/29/2015	335	8.1	6/12/2015	145	14.6
4/30/2015	317	7.7	6/13/2015	134	13.8
5/1/2015	316	8.6	6/14/2015	124	14.4
5/2/2015	338	8.5	6/15/2015	116	14.9
5/3/2015	329	8.2	6/16/2015	109	16.0
5/4/2015	340	8.4	6/17/2015	104	16.6
5/5/2015	370	7.9	6/18/2015	100	16.0

6/19/2015	97.2	15.4	8/2/2015	33.9	20.0
6/20/2015	95.1	15.2	8/3/2015	33.1	19.3
6/21/2015	90.3	15.2	8/4/2015	33.7	18.8
6/22/2015	85.9	15.6	8/5/2015	33.2	18.5
6/23/2015	82.1	16.4	8/6/2015	33.7	18.2
6/24/2015	79.6	16.7	8/7/2015	34.1	18.2
6/25/2015	76.9	17.2	8/8/2015	33.1	18.8
6/26/2015	74	19.2	8/9/2015	32.3	18.8
6/27/2015	72.1	20.0	8/10/2015	32.2	19.9
6/28/2015	70.2	20.6	8/11/2015	31.8	18.7
6/29/2015	71.8	21.1	8/12/2015	31.7	19.1
6/30/2015	70.5	21.2	8/13/2015	30.4	20.4
7/1/2015	66.2	21.1	8/14/2015	30.3	19.8
7/2/2015	63.8	21.2	8/15/2015	31.9	17.6
7/3/2015	61.1	21.3	8/16/2015	33.4	16.9
7/4/2015	58.8	21.3	8/17/2015	32.2	17.7
7/5/2015	56.8	20.9	8/18/2015	31.2	18.2
7/6/2015	55.2	20.6	8/19/2015	30	18.9
7/7/2015	53.5	20.3	8/20/2015	28.9	19.2
7/8/2015	52.5	20.8	8/21/2015	28.5	18.0
7/9/2015	50.9	21.3	8/22/2015	28.7	16.4
7/10/2015	49.7	20.7	8/23/2015	28.6	16.0
7/11/2015	49.5	18.8	8/24/2015	28	16.8
7/12/2015	50.2	17.8	8/25/2015	27.5	17.0
7/13/2015	48.9	18.4	8/26/2015	27.5	17.1
7/14/2015	47.8	18.8	8/27/2015	27	17.8
7/15/2015	46.5	18.7	8/28/2015	27.1	17.9
7/16/2015	45.3	18.4	8/29/2015	29	16.5
7/17/2015	44.8	18.5	8/30/2015	37.1	15.5
7/18/2015	43.9	19.5	8/31/2015	49.4	14.1
7/19/2015	42.7	20.9	9/1/2015	43.9	14.2
7/20/2015	41.1	21.3	9/2/2015	47.7	14.5
7/21/2015	40.1	19.7	9/3/2015	48.1	13.3
7/22/2015	39.7	18.4	9/4/2015	42.2	12.8
7/23/2015	39.6	18.3	9/5/2015	37.1	12.9
7/24/2015	39.3	18.1	9/6/2015	38.6	12.7
7/25/2015	40	17.3	9/7/2015	48	13.4
7/26/2015	42.7	17.2	9/8/2015	40.4	13.9
7/27/2015	41.5	17.0	9/9/2015	37.2	14.6
7/28/2015	40.2	17.7	9/10/2015	34.7	15.3
7/29/2015	38.8	18.9	9/11/2015	33	15.5
7/30/2015	37.2	19.5	9/12/2015	32	15.9
7/31/2015	35.9	19.8	9/13/2015	30.6	16.3
8/1/2015	34.7	20.0	9/14/2015	30.1	13.8

9/15/2015	30.5	12.1
9/16/2015	30.8	11.9
9/17/2015	31.4	11.8
9/18/2015	34.3	12.7
9/19/2015	34.2	12.8
9/20/2015	33.4	13.7
9/21/2015	38.1	14.1
9/22/2015	38	12.2
9/23/2015	33.8	11.6
9/24/2015	32.5	12.5
9/25/2015	32	13.0
9/26/2015	32	12.7
9/27/2015	31.7	10.6
9/28/2015	31.3	10.0
9/29/2015	30.8	9.9
9/30/2015	30.5	10.3
10/1/2015	30.1	10.9
10/2/2015	29.7	11.5
10/3/2015	29.5	12.1
10/4/2015	30	11.3
10/5/2015	30.1	10.4
10/6/2015	29.9	
10/7/2015	31.9	11.1
10/8/2015	46.9	11.6
10/9/2015	42.8	12.2
10/10/2015	42.2	12.3
10/11/2015	111	11.0
10/12/2015	78.3	9.9
10/13/2015	56.2	11.4
10/14/2015	53.4	9.6
10/15/2015	47.9	8.8
10/16/2015	44.8	8.5
10/17/2015	43	9.1
10/18/2015	43.8	10.6
10/19/2015	46.8	10.9
10/20/2015	46	10.4
10/21/2015	45.5	9.3
10/22/2015	43	8.9
10/23/2015	41.7	7.8
10/24/2015	40.7	7.0
10/25/2015	40.9	7.4
10/26/2015	42.8	8.7
10/27/2015	45.7	8.2
10/28/2015		
10/29/2015	54.9	8.5
10/30/2015	338	8.3
10/31/2015	1800	7.6
11/1/2015	1430	6.8
11/2/2015	745	6.2
11/3/2015	460	5.6
11/4/2015	333	4.6
11/5/2015	280	5.4
11/6/2015	249	5.3
11/7/2015	228	6.0
11/8/2015	263	6.1
11/9/2015	245	5.3
11/10/2015		
11/11/2015		
11/12/2015		
11/13/2015	1450	4.2
11/14/2015	2250	5.3
11/15/2015	1220	5.0
11/16/2015		
11/17/2015		2.6
11/18/2015		3.5
11/19/2015	1410	3.9
11/20/2015	938	2.9
11/21/2015	728	2.1
11/22/2015	607	2.0
11/23/2015	520	2.1
11/24/2015	457	2.8
11/25/2015	391	2.1
11/26/2015	343	0.8
11/27/2015	313	0.4
11/28/2015	288	0.1
11/29/2015	273	0.0
11/30/2015	251	0.2
12/1/2015	234	0.4
12/2/2015	226	0.8
12/3/2015	222	0.7
12/4/2015	210	2.0
12/5/2015	203	1.7
12/6/2015	198	1.5
12/7/2015		
12/8/2015	848	1.5
12/9/2015	2730	1.6
12/10/2015	1370	2.3
12/11/2015	915	2.9

12/12/2015		
12/13/2015		
12/14/2015	551	2.7
12/15/2015	486	2.5
12/19/2015	357	1.3
12/20/2015	332	1.5
12/21/2015	318	0.8
12/22/2015	298	1.2
12/23/2015	285	1.1
12/24/2015	269	1.0
12/25/2015	248	1.3
12/26/2015	232	0.7
12/27/2015	225	0.3
12/28/2015	217	0.7
12/29/2015	207	1.2
12/30/2015	197	0.8
12/31/2015	184	0.1

12/16/2015	444	2.5
12/17/2015	409	1.0
12/18/2015	387	0.7

APPENDIX B. Daily Trap Operation

Date	Trap Status	Comments
3/1/2015	Op.	
3/2/2015	Op.	
3/3/2015	Op.	
3/4/2015	Op.	
3/5/2015	Op.	
3/6/2015	Op.	
3/7/2015	Op.	
3/8/2015	Op.	
3/9/2015	Op.	
3/10/2015	Op.	
3/11/2015	Op.	
3/12/2015	Op.	
3/13/2015	Op.	
3/14/2015	No Op.	Stopped - debris
3/15/2015	No Op.	Stopped - debris
3/16/2015	Op.	
3/17/2015	Op.	
3/18/2015	Op.	
3/19/2015	Op.	
3/20/2015	Op.	
3/21/2015	Op.	
3/22/2015	Op.	
3/23/2015	Op.	
3/24/2015	Op.	
3/25/2015	Op.	
3/26/2015	Op.	
3/27/2015	Op.	
3/28/2015	Op.	
3/29/2015	Op.	
3/30/2015	Op.	
3/31/2015	Op.	
4/1/2015	Op.	
4/2/2015	Op.	
4/3/2015	Op.	
4/4/2015	Op.	
4/5/2015	Op.	
4/6/2015	Op.	
4/7/2015	Op.	
4/8/2015	Op.	
4/9/2015	Op.	
4/10/2015	Op.	
4/11/2015	Op.	
4/12/2015	Op.	
4/13/2015	Op.	
4/14/2015	Op.	
4/15/2015	Op.	
4/16/2015	Op.	
4/17/2015	Op.	
4/18/2015	Op.	
4/19/2015	Op.	
4/20/2015	Op.	
4/21/2015	Op.	
4/22/2015	Op.	
4/23/2015	Op.	
4/24/2015	Op.	
4/25/2015	Op.	
4/26/2015	Op.	
4/27/2015	Op.	
4/28/2015	Op.	
4/29/2015	Op.	
4/30/2015	Op.	
5/1/2015	Op.	
5/2/2015	Op.	
5/3/2015	Op.	
5/4/2015	Op.	
5/5/2015	Op.	
5/6/2015	Op.	
5/7/2015	Op.	
5/8/2015	Op.	
5/9/2015	Op.	
5/10/2015	Op.	
5/11/2015	Op.	
5/12/2015	Op.	
5/13/2015	Op.	
5/14/2015	Op.	
5/15/2015	Op.	
5/16/2015	Op.	
5/17/2015	Op.	
5/18/2015	Op.	
5/19/2015	Op.	
5/20/2015	Op.	
5/21/2015	Op.	

5/22/2015	Op.	
5/23/2015	Op.	
5/24/2015	Op.	
5/25/2015	Op.	
5/26/2015	Op.	
5/27/2015	Op.	
5/28/2015	Op.	
5/29/2015	Op.	
5/30/2015	Op.	
5/31/2015	Op.	
6/1/2015	Op.	
6/2/2015	Op.	
6/3/2015	Op.	
6/4/2015	Op.	
6/5/2015	Op.	
6/6/2015	Op.	
6/7/2015	Op.	
6/8/2015	Op.	
6/9/2015	Op.	
6/10/2015	Op.	
6/11/2015	Op.	
6/12/2015	Op.	
6/13/2015	Op.	
6/14/2015	Op.	
6/15/2015	Op.	
6/16/2015	Op.	
6/17/2015	No Op.	Stopped - debris
6/18/2015	Op.	
6/19/2015	Op.	
6/20/2015	Op.	
6/21/2015	Op.	
6/22/2015	Op.	
6/23/2015	Op.	
6/24/2015	Op.	
6/25/2015	Op.	
6/26/2015	Op.	
6/27/2015	Op.	
6/28/2015	Op.	
6/29/2015	Op.	
6/30/2015	Op.	
7/1/2015	Op.	
7/2/2015	No Op.	Stopped - bed contact
7/3/2015	Op.	

7/4/2015	Op.	
7/5/2015	Op.	
7/6/2015	Op.	
7/7/2015	Op.	
7/8/2015	No Op.	Stopped - bed contact
7/9/2015	No Op.	Stopped - bed contact
7/10/2015	Op.	
7/11/2015	Op.	
7/12/2015	Op.	
7/13/2015	Op.	
7/14/2015	No Op.	Stopped - bed contact
7/15/2015	No Op.	Stopped - bed contact
7/16/2015	No Op.	Stopped - low flow
7/17/2015	No Op.	Stopped - low flow
7/18/2015	No Op.	Pulled - low water
7/19/2015	No Op.	Pulled - low water
7/20/2015	No Op.	Pulled - low water
7/21/2015	No Op.	Pulled - low water
7/22/2015	No Op.	Pulled - low water
7/23/2015	No Op.	Pulled - low water
7/24/2015	No Op.	Pulled - low water
7/25/2015	No Op.	Pulled - low water
7/26/2015	No Op.	Pulled - low water
7/27/2015	No Op.	Pulled - low water
7/28/2015	No Op.	Pulled - low water
7/29/2015	No Op.	Pulled - low water
7/30/2015	No Op.	Pulled - low water
7/31/2015	No Op.	Pulled - low water
8/1/2015	No Op.	Pulled - low water
8/2/2015	No Op.	Pulled - low water
8/3/2015	No Op.	Pulled - low water
8/4/2015	No Op.	Pulled - low water
8/5/2015	No Op.	Pulled - low water
8/6/2015	No Op.	Pulled - low water
8/7/2015	No Op.	Pulled - low water
8/8/2015	No Op.	Pulled - low water
8/9/2015	No Op.	Pulled - low water
8/10/2015	No Op.	Pulled - low water
8/11/2015	No Op.	Pulled - low water
8/12/2015	No Op.	Pulled - low water
8/13/2015	No Op.	Pulled - low water

8/14/2015	No Op.	Pulled - low water	9/27/2015	No Op.	Pulled - low water
8/15/2015	No Op.	Pulled - low water	9/28/2015	No Op.	Pulled - low water
8/16/2015	No Op.	Pulled - low water	9/29/2015	No Op.	Pulled - low water
8/17/2015	No Op.	Pulled - low water	9/30/2015	No Op.	Pulled - low water
8/18/2015	No Op.	Pulled - low water	10/1/2015	No Op.	Pulled - low water
8/19/2015	No Op.	Pulled - low water	10/2/2015	No Op.	Pulled - low water
8/20/2015	No Op.	Pulled - low water	10/3/2015	No Op.	Pulled - low water
8/21/2015	No Op.	Pulled - low water	10/4/2015	No Op.	Pulled - low water
8/22/2015	No Op.	Pulled - low water	10/5/2015	No Op.	Pulled - low water
8/23/2015	No Op.	Pulled - low water	10/6/2015	No Op.	Pulled - low water
8/24/2015	No Op.	Pulled - low water	10/7/2015	No Op.	Pulled - low water
8/25/2015	No Op.	Pulled - low water	10/8/2015	No Op.	Pulled - low water
8/26/2015	No Op.	Pulled - low water	10/9/2015	No Op.	Pulled - low water
8/27/2015	No Op.	Pulled - low water	10/10/2015	No Op.	Pulled - low water
8/28/2015	No Op.	Pulled - low water	10/11/2015	No Op.	Pulled - low water
8/29/2015	No Op.	Pulled - low water	10/12/2015	No Op.	Stopped - low flow
8/30/2015	No Op.	Pulled - low water	10/13/2015	No Op.	Pulled - low water
8/31/2015	No Op.	Pulled - low water	10/14/2015	No Op.	Pulled - low water
9/1/2015	No Op.	Pulled - low water	10/15/2015	No Op.	Pulled - low water
9/2/2015	No Op.	Pulled - low water	10/16/2015	No Op.	Pulled - low water
9/3/2015	No Op.	Stopped - low flow	10/17/2015	No Op.	Pulled - low water
9/4/2015	No Op.	Pulled - low water	10/18/2015	No Op.	Pulled - low water
9/5/2015	No Op.	Pulled - low water	10/19/2015	No Op.	Pulled - low water
9/6/2015	No Op.	Pulled - low water	10/20/2015	No Op.	Pulled - low water
9/7/2015	No Op.	Pulled - low water	10/21/2015	Op.	
9/8/2015	No Op.	Pulled - low water	10/22/2015	Op.	
9/9/2015	No Op.	Pulled - low water	10/23/2015	Op.	
9/10/2015	No Op.	Pulled - low water	10/24/2015	No Op.	Stopped - low flow
9/11/2015	No Op.	Pulled - low water	10/25/2015	No Op.	Pulled - low water
9/12/2015	No Op.	Pulled - low water	10/26/2015	No Op.	Pulled - low water
9/13/2015	No Op.	Pulled - low water	10/27/2015	No Op.	Pulled - low water
9/14/2015	No Op.	Pulled - low water	10/28/2015	No Op.	Pulled - low water
9/15/2015	No Op.	Pulled - low water	10/29/2015	No Op.	Pulled - low water
9/16/2015	No Op.	Pulled - low water	10/30/2015	No Op.	Stopped - low flow
9/17/2015	No Op.	Pulled - low water	10/31/2015	No Op.	Pulled - low water
9/18/2015	No Op.	Pulled - low water	11/1/2015	No Op.	Pulled - low water
9/19/2015	No Op.	Pulled - low water	11/2/2015	Op.	
9/20/2015	No Op.	Pulled - low water	11/3/2015	Op.	
9/21/2015	No Op.	Pulled - low water	11/4/2015	Op.	
9/22/2015	No Op.	Pulled - low water	11/5/2015	Op.	
9/23/2015	No Op.	Pulled - low water	11/6/2015	Op.	
9/24/2015	No Op.	Pulled - low water	11/7/2015	Op.	
9/25/2015	No Op.	Pulled - low water	11/8/2015	Op.	
9/26/2015	No Op.	Pulled - low water	11/9/2015	Op.	

11/10/2015	Op.		11/12/2015	Op.
11/11/2015	Op.			
11/13/2015	No Op.	Pulled - high water		
11/14/2015	No Op.	Pulled - high water		
11/15/2015	No Op.	Pulled - high water		
11/16/2015	Op.			
11/17/2015	Op.			
11/18/2015	No Op.	Pulled - high water		
11/19/2015	No Op.	Pulled - high water		
11/20/2015	Op.			
11/21/2015	Op.			
11/22/2015	Op.			
11/23/2015	Op.			
11/24/2015	Op.			
11/25/2015	Op.			
11/26/2015	Op.			
11/27/2015	Op.			
11/28/2015	No Op.	Stopped - ice		
11/29/2015	No Op.	Stopped - ice		
11/30/2015	No Op.	Stopped - ice		

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: Chinook Subyearling (Fall '14-'15) Bolser Site (r^2 = 0.36; p = 0.09)

Origin/Species/Stage	Age	Date	Trap Position	Mark	Recap	Trap Efficiency (R+1)/M	ASIN Transform	Discharge

Wild Chinook Parr	0	7/14/2014	Back	89	7	0.09	0.30	171
Wild Chinook Parr	0	7/21/2014	Back	74	4	0.07	0.26	129
Wild Chinook Parr	0	7/27/2014	Back	72	4	0.07	0.27	113
Wild Chinook Parr	0	10/27/2014	Back	71	3	0.06	0.24	91
Wild Chinook Parr	0	10/30/2014	Back	70	5	0.09	0.30	79
Wild Chinook Parr	0	11/1/2014	Back	96	6	0.07	0.27	46
Wild Chinook Parr	0	11/3/2015	Back	138	0	0.01	0.09	121

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 = 0.61; p = 0.0002)

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	11/13/2010	74	41	0.57	0.85	140
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	378
Wild Chinook Parr	0	11/11/2012	328	66	0.20	0.47	223
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	130
Wild Chinook Parr	0	11/8/2013	106	39	0.38	0.66	148
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	11/4/2014	114	5	0.05	0.23	370
Wild Chinook Parr	0	11/1/2014	96	5	0.06	0.25	583
Wild Chinook Parr	0	11/10/2014	78	8	0.12	0.35	398

APPENDIX D. Historical Morphometric Data

Spring Chinook (2004-2015)

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	337	5	1.1
2004	2003	Wild Chinook Subyearling Fry	39.5	82	5.1	0.6	79	0.3	1
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
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
2007	2005	Wild Chinook Yearling Smolt	89	676	8.2	8	675	6.1	1.1
2007	2006	Wild Chinook Subyearling Fry	39	24	3.7	0.6	24	0.5	1
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
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
2009	2008	Wild Chinook Subyearling Parr	70.1	2,333	12	4.2	2,333	2	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	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
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	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	7.9	239	2.1	1.1
2013	2012	Wild Chinook Subyearling Fry	45.6	1,824	6.8	1	1,803	0.6	1.1
2013	2012	Wild Chinook Subyearling Parr	70	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
2015	2013	Wild Chinook Yearling Smolt	93	152	7.0	8.4	152	2.2	1.0
2015	2014	Wild Chinook Subyearling Fry	45	338	9.9	1.0	338	0.9	0.9
2015	2014	Wild Chinook Subyearling Parr	84	210	8.0	6.5	209	1.7	1.1
2015	2013	Hatchery Chinook Yearling Smolt	136	284	12.3	29.5	284	8.8	1.1

Summer Steelhead (2004-2015)

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	358	10	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
2004	2001	3	Wild Summer Steelhead	201.6	43	11.2	76	43	21.2	0.9
2004	2003	1	Hat. Summer Steelhead	182.8	523	22.4	62.1	497	21.2	1
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	343	24	1
2006	2006	0	Wild Summer Steelhead	66.3	180	5.8	2.5	180	1	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
2006	2003	3	Wild Summer Steelhead	197	2	—	73.5	2	—	1
2006	2005	1	Hat. Summer Steelhead	—	—	—	—	—	—	—
2007	2007	0	Wild Summer Steelhead	54.2	329	11.7	2	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
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	122	15.5	1.1
2008	2005	3	Wild Summer Steelhead	180.3	13	18.9	57.4	13	16.4	1
2008	2007	1	Hat. Summer Steelhead	179.4	389	16.5	55.9	388	14.8	1
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	40.9	72	15.5	1.1
2009	2006	3	Wild Summer Steelhead	195	3	5	73	3	6.7	1
2009	2008	1	Hat. Summer Steelhead	183.1	280	16.7	60.8	280	18.2	1
2010	2010	0	Wild Summer Steelhead	55	1,287	11.1	2.5	917	1.3	1.5
2010	2009	1	Wild Summer Steelhead	89.8	1,079	19.1	9	1,072	7.1	1.2
2010	2008	2	Wild Summer Steelhead	144.9	87	25.1	35	87	17.4	1.2
2010	2007	3	Wild Summer Steelhead	184	8	12.2	61.9	8	10.2	1
2010	2009	1	Hat. Summer Steelhead	183.5	531	19.5	61.3	526	19.6	1
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	59.1	464	17.6	1
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	23.7	132	14.5	1.2
2012	2009	3	Wild Summer Steelhead	161	4	32	40.5	4	15.6	1
2012	2011	1	Hat. Summer Steelhead	154.8	318	20.9	37.7	318	14	1
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
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	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
2015	2015	0	Wild Summer Steelhead	70	182	15.5	4.3	176	2.0	1.1
2015	2014	1	Wild Summer Steelhead	88	233	20.2	8.3	233	6.7	1.0
2015	2013	2	Wild Summer Steelhead	149	14	13.5	33.7	14	8.2	1.0
2015	2012	3	Wild Summer Steelhead	191	1	—	73.8	1	—	1.1
2015	2014	1	Hat. Summer Steelhead	175	273	15.2	51.3	273	12.5	0.9

Coho (2007-2015)

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	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	1.1
2007	2006	Nat. Orig. Coho Subyearling Fry	—	—	—	—	—	—	—
2007	2006	Nat. Orig. Coho Subyearling Parr	83	1	—	6.2	1	—	1.1

2007	2005	Hatchery Coho Yearling Smolt	116	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	1	—	6.4	1	—	1
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	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	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	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	3	1.5	1.1
2011	2009	Hatchery Coho Yearling Smolt	124.6	969	8.6	21	969	4.8	1.1
2012	2010	Nat. Orig. Coho Yearling Smolt	102.1	17	9.1	11.9	17	3	1.1
2012	2011	Nat. Orig. Coho Subyearling Fry	36	1	—	—	—	—	—
2012	2011	Nat. Orig. Coho Subyearling Parr	78.4	84	9.3	5	84	2.1	1
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	81	10	10	81	3.1	1.1
2013	2012	Nat. Orig. Coho Subyearling Fry	47.3	3	1	1	3	1	0.9
2013	2012	Nat. Orig. Coho Subyearling Parr	87.8	4	3.8	6.6	4	1	1
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	1.1
2014	2013	Nat. Orig. Coho Subyearling Fry	36	1	—	—	—	—	—
2014	2013	Nat. Orig. Coho Subyearling Parr	73	3	22.5	5.9	3	4.7	1.5
2014	2012	Hatchery Coho Yearling Smolt	127	1,203	9.7	21.7	1,207	5	1.1
2015	2013	Nat. Orig. Coho Yearling Smolt	109	2	4.9	12.0	2	0.1402	0.9
2015	2014	Nat. Orig. Coho Subyearling Fry	47	7	13.7	1.4	7	1.4511	0.9
2015	2014	Nat. Orig. Coho Subyearling Parr	69	3	7.0	4.0	3	1.2583	1.2
2015	2013	Hatchery Coho Yearling Smolt	131	952	9.9	23.3	952	4.7946	1.0

Appendix E: Memo to NMFS Re: Exceedance of Allowed Lethal Take

MEMORANDUM

Yakama Nation Fisheries

Columbia River
Honor. Protect. Restore.

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To: Craig Busack

CC: Michelle Guay, Tom Scribner, Keely Murdoch, Bryan Ishida

From: Bryan Ishida

Date: March 15, 2015

RE: Nason Creek Smolt Trap Mortalities - 3/15/15

Dear Mr. Busack,

On March 15, 2015 YN FRM personnel arrived at the Nason rotary smolt trap at 9:00am to find it stopped by a 5'x6"x6" pressure-treated beam that had become wedged between the cone and the starboard pontoon. The halted rotation subsequently caused a small-diameter debris blockage at the rear of the cone preventing movement of fish and additional debris into the livebox. As a result, six wild spring Chinook subyearling fry and four wild spring Chinook yearling smolt mortalities were incurred. With a total of only 37 wild spring Chinook captured since trapping began on March 1, our mortality rate for the species is currently at 27%. The increase in debris load is attributed to a rapid spike in discharge level brought on by heavy rains. At the time of the stoppage, spring night operations (personnel on-site during hours of operation) had not yet commenced.

This event occurred during initial spring operations at the new Nason Creek smolt trap site (rkm 0.3). Due to its location on the outside of a channel bend, this new location appears to be more susceptible to debris stoppages than the previously-used site (rkm 0.9). In order to prevent further such instances, we will increase the duration of our night operations schedule to include high-water events prior to the scheduled May 1start as needed. Upon initial onset of elevated spring flows, we will begin night operations and continue until discharge levels have subsided. Discharge data from the upstream Department of Ecology gauge and snowpack data from nearby snow telemetry (SNOTEL) sites will be used to will be used to predict trends in flow and guide trap operations. Additionally, the Nason Creek smolt trap will also be manned during fall freshets to mitigate the increased stoppage potential at the new site. We will increase our vigilance in the monitoring of high-water events and take the necessary precautions to prevent any further loss of ESA-listed species. Please feel free to contact me with any questions regarding this event.

Sincerely,

Bryan Ishida

APPENDIX B: SPAWNING GROUND SURVEY RECORDS FOR THE WENATCHEE AND METHOW RIVERS, 2015

Stream	Reach	Date	New Redds	Live Fish	Dead Fish
Beaver Creek	1	10/22/2015	0	0	0
		11/9/2015	0	0	0
		11/16/2015	0	0	0
		Beaver Cr. Total	**0**	**0**	**0**
Chiwaukum Creek	1	10/22/2015	0	0	0
		11/9/2015	0	0	0
		11/5/2015	0	0	0
		11/12/2015	0	0	0
		Chiwaukum Cr. Total	**0**	**0**	**0**
Chiwawa River	1	10/24/2015	0	0	0
		11/7/2015	0	0	0
		Chiwawa R. Total	**0**	**0**	**0**
Chumstick Creek	1	10/8/2015	0	0	0
		10/15/2015	0	1	0
		10/21/2015	0	2	0
		10/29/2015	0	0	0
		11/5/2015	0	2	0
		11/12/2015	0	0	0
		12/3/2015	0	0	0
		Chumstick Cr. Total	**0**	**5**	**0**
Icicle Creek	1	9/29/2015	0	0	0
		10/5/2015	0	15	0
		10/13/2015	3	4	0
		10/19/2015	4	9	1
		10/28/2015	9	26	1
		11/4/2015	9	29	1
		11/11/2015	10	19	0
		11/20/2015	0	0	1
		11/25/2015	2	7	0
		12/1/2015	0	0	1
	2	10/13/2015	0	1	0
		10/19/2015	0	1	0
		10/28/2015	15	24	2
		10/5/2015	0	0	0
		11/4/2015	2	12	0

		11/11/2015	1	3	0
		11/20/2015	0	0	0
		12/1/2015	0	0	0
		Icicle Cr. Total	**55**	**150**	**7**
Mission/Brender Creek	1	9/28/2015	0	0	0
		10/15/2015	0	0	0
		10/15/2015	0	0	0
		10/19/2015	0	0	0
		10/29/2015	3	0	1
		11/5/2015	1	3	0
		11/12/2015	2	2	0
		11/25/2015	0	0	0
		11/30/2015	0	0	0
		M/B Cr. Total	**6**	**5**	**1**
Nason Creek	1	10/22/2015	0	0	0
		10/26/2015	0	0	0
		11/8/2015	0	1	0
		11/23/2015	0	0	0
		11/29/2015	0	0	0
	2	10/26/2015	0	0	0
		11/9/2015	0	0	0
		11/16/2015	0	0	0
		11/23/2015	0	0	0
	3	10/26/2015	0	0	0
		11/3/2015	0	0	0
		11/9/2015	0	0	0
		11/16/2015	0	0	0
		11/24/2015	0	0	0
		11/30/2015	0	0	0
	4	10/25/2015	0	0	0
		11/9/2015	0	0	0
		11/30/2015	0	0	0
		Nason Cr. Total	**0**	**1**	**0**
Peshastin Creek	1	9/29/2015	0	0	0
		10/5/2015	0	0	0
		10/6/2015	0	0	0
		10/14/2015	0	3	0
		10/21/2015	1	3	2
		10/28/2015	1	1	2
		11/5/2015	0	1	0
		11/11/2015	1	0	0

		11/28/2015	0	0	0
	2	10/16/2015	0	0	0
		10/21/2015	0	0	0
		10/28/2015	0	0	0
		11/5/2015	0	0	0
		11/11/2015	0	0	0
		11/28/2015	0	0	0
	3	10/17/2015	0	0	0
		Peshastin Cr. Total	**3**	**8**	**4**
Roaring Creek	1	10/26/2015	0	0	0
		Roaring Cr. Total	**0**	**0**	**0**
Wenatchee River	1	9/27/2015	0	0	0
		10/3/2015	0	2	0
		10/10/2015	0	0	0
		10/21/2015	0	3	2
		10/30/2015	0	0	1
		11/6/2015	1	1	0
		11/13/2015	1	2	0
		11/21/2015	0	0	0
		11/26/2015	0	2	1
		12/3/2015	0	0	0
	2	10/3/2015	0	1	1
		10/23/2015	0	0	0
		10/29/2015	0	1	0
		11/5/2015	0	0	1
		11/12/2015	0	0	0
	3	10/4/2015	0	4	0
		10/20/2015	0	0	0
		11/10/2015	0	0	0
		11/30/2015	0	0	0
	4	10/6/2015	0	0	0
		10/11/2015	0	0	0
		10/21/2015	8	6	0
		10/28/2015	3	3	0
		11/4/2015	1	1	0
		11/11/2015	1	1	0
		11/25/2015	0	0	0
		12/1/2015	0	0	0
	4RB	9/29/2015	0	0	0
		10/5/2015	0	0	0
		10/13/2015	1	0	0

		10/19/2015	0	1	0
		10/28/2015	0	0	0
		11/4/2015	0	0	0
		11/11/2015	0	0	0
		11/20/2015	0	0	0
		11/25/2015	0	0	0
		12/1/2015	0	0	0
	5	10/29/2015	0	0	0
		11/5/2015	0	0	0
		11/12/2015	0	0	0
	6	10/31/2015	0	0	0
	7	10/24/2015	0	0	0
		11/7/2015	0	0	0
		Wenatchee R. Total	**16**	**28**	**6**
		Wenatchee Basin Total	**80**	**197**	**18**

Stream	Reach	Date	New Redds	Live Fish	Dead Fish
Methow River	1 - Mouth to Steel Br.	11/8/2015	1	0	0
	2 - Steel Br. to Lower Burma Br.	11/4/2015	0	0	4
		11/8/2015	1	0	0
	3 - Lower Burma Br. to Upper Burma Br.	10/6/2015	0	0	0
		10/7/2015	0	0	1
		10/25/2015	0	0	0
		11/1/2015	0	0	0
		11/8/2015	0	0	0
		11/13/2015	2	0	0
		11/23/2015	1	0	1
		11/30/2015	0	0	0
	4 - Upper Burma Br.e to Lower Gold Creek Br.	10/7/2015	0	0	0
		10/8/2015	0	0	0
		10/25/2015	0	0	0
		11/1/2015	0	3	0
		11/8/2015	0	0	1
		11/13/2015	2	5	0
		11/14/2015	0	0	1
		11/17/2015	1	4	0
		11/23/2015	0	1	0
		11/30/2015	0	0	1
	5 - Lower Gold Creek Br. to Carlton	10/8/2015	0	1	0

		11/1/2015	0	0	0
		11/8/2015	0	0	0
		11/14/2015	5	1	0
		11/17/2015	0	0	0
		11/23/2015	3	1	0
	6 - Carlton to Holterman's Hole	10/14/2015	0	8	0
		10/26/2015	2	1	0
		11/1/2015	1	2	0
		11/9/2015	0	0	1
		11/15/2015	1	2	0
		11/22/2015	3	0	0
		11/30/2015	0	0	0
		12/15/2015	0	0	0
	7 - Holterman's Hole to MVID dam	10/20/2015	0	7	0
		10/26/2015	0	6	0
		11/2/2015	0	0	0
		11/5/2015	0	1	0
		11/9/2015	0	5	0
		11/16/2015	3	0	0
		11/20/2015	0	1	0
		11/29/2015	0	0	0
		12/2/2015	0	0	1
		12/9/2015	0	0	0
		12/14/2015	0	0	0
	8 - MVID dam to Red barn	10/20/2015	0	21	0
		10/26/2015	0	4	0
		11/2/2015	0	0	0
		11/5/2015	0	3	0
		11/9/2015	0	0	0
		11/16/2015	1	0	1
		11/20/2015	0	1	0
		11/29/2015	0	0	0
		12/2/2015	0	1	2
		12/9/2015	0	0	0
		12/14/2015	0	0	0
	9 - Red barn to Wolf Cr.	11/2/2015	0	0	0
		11/9/2015	0	0	0
		11/15/2015	0	0	0
		11/19/2015	1	0	0
		11/29/2015	0	0	0
		12/2/2015	0	0	0

		12/7/2015	0	1	0
		12/13/2015	0	0	0
	10 - Wolf Cr. to Rip Rap	11/2/2015	0	0	0
		11/9/2015	0	0	0
		11/15/2015	0	0	0
		11/19/2015	3	0	0
		11/29/2015	0	0	0
		12/2/2015	0	0	0
		12/7/2015	0	0	0
		12/13/2015	0	0	0
	11 - Rip Rap to Weeman Br.	11/2/2015	0	0	0
		11/9/2015	0	0	0
		11/15/2015	1	0	0
		11/19/2015	0	0	0
		11/29/2015	0	0	0
		12/2/2015	0	0	0
		12/7/2015	0	0	0
		12/13/2015	0	0	0
		Methow R. Total	**32**	**80**	**14**
WNFH Spring Creek	Mouth to Adult Collection Weir	10/7/2015	0	0	0
		10/16/2015	2	0	0
		10/23/2015	1	0	0
		10/28/2015	3	2	1
		11/4/2015	5	6	1
		11/12/2015	2	2	1
		11/19/2015	0	0	0
		11/25/2015	0	0	0
		Spring Cr. Total	**13**	**10**	**3**
WDFW MFH Outfall	Mouth to Adult Collection Weir	10/7/2015	0	0	0
		10/14/2015	0	0	0
		10/21/2015	0	0	0
		10/27/2015	0	0	0
		11/3/2015	0	0	0
		11/12/2015	2	7	0
		11/18/2015	0	1	0
		11/23/2015	0	0	0
		12/1/2015	0	0	0
		12/8/2015	0	0	0
		12/15/2015	0	0	0
		WDFW Outfall Total	**2**	**8**	**0**

Twisp River	1 - Mouth to Lower Poorman Br.	10/16/2015	1	1	0
		10/23/2015	2	4	0
		10/31/2015	0	0	0
		11/7/2015	2	0	0
		11/10/2015	0	0	0
		11/15/2015	0	0	0
		11/21/2015	2	0	1
		12/9/2015	0	0	0
		12/14/2015	0	0	0
	2 - Lower Poorman Br. to Upper Poorman Br.	10/16/2015	1	0	0
		10/31/2015	0	0	0
		11/7/2015	0	2	0
		11/10/2015	0	0	0
		11/15/2015	0	0	0
		11/21/2015	2	0	0
		12/14/2015	0	0	0
	3 – Upper Poorman B. to Twisp R. Weir	10/25/2015	0	0	0
		11/1/2015	1	1	0
		11/10/2015	1	0	0
		11/18/2015	0	0	0
	4 – Twisp R. Weir to Newby Creek Br.	10/25/2015	0	0	0
		11/1/2015	0	0	0
		11/10/2015	0	0	0
		11/16/2015	0	0	0
	5 – Newby Cr. Br. to Buttermilk Cr. Br.	11/3/2015	0	0	0
	6 – Buttermilk Cr. Br. to War Cr. Br.	11/3/2015	0	0	0
		Twisp R. Total	**12**	**8**	**1**
Hancock Creek	Mouth to Source	10/28/2015	0	0	0
		12/8/2015	0	0	0
		Hancock Cr. Total	**0**	**0**	**0**
Beaver Creek	1 – Mouth to Hwy. 153 Br.	11/18/2015	0	0	0
		12/16/2015	0	0	0
	2 – Hwy. 153 Br. to Hwy. 20 Br.	12/16/2015	0	0	0
		Beaver Cr. Total	**0**	**0**	**0**
Gold Creek	1 – Private Land to SF Gold Cr. Confluence	10/12/2015	0	0	0
		10/21/2015	0	0	0
		10/27/2015	0	0	0
		11/3/2015	0	0	0
		11/12/2015	0	0	0
		11/16/2015	0	0	0
		11/24/2015	0	1	0

		12/8/2015	0	0	0
		12/15/2015	0	0	0
	2 – SF Gold Cr. Confluence to Acclimation Ponds	10/21/2015	0	0	0
		10/27/2015	0	0	0
		11/3/2015	0	0	0
		11/12/2015	0	3	0
		11/16/2015	0	3	0
		11/24/2015	0	0	0
		12/8/2015	0	0	0
		12/15/2015	0	0	0
		Gold Cr. Total	**0**	**7**	**0**
Suspension Creek	Mouth to 250 M Upstream	12/16/2015	0	0	0
		Suspension Cr. Total	**0**	**0**	**0**
Wolf Creek	1 - Mouth to Acclimation Pond	11/6/2015	0	0	0
	2 - Acclimation Pond to Rd 5505 Trail Access	11/10/2015	0	0	0
		Wolf Cr. Total	**0**	**0**	**0**
Libby Creek	Mouth to Hwy. 153	10/11/2015	0	0	0
		10/27/2015	0	0	0
		11/2/2015	0	0	0
		11/16/2015	1	0	0
		11/24/2015	0	0	0
		Libby Cr. Total	**1**	**0**	**0**
1890's Side Channel	Mouth to Culvert	10/19/2015	9	1	0
		10/20/2015	3	0	0
		11/6/2015	23	3	2
		11/16/2015	9	0	4
		1890 Total	**44**	**4**	**6**
Chewuch River	1 - Mouth to Fulton Dam	10/19/2015	0	0	0
		10/27/2015	0	0	0
		11/3/2015	0	0	0
		11/10/2015	0	0	0
		11/16/2015	0	0	0
		11/23/2015	0	0	0
	2 - Fulton Dam to Co. Hwy 1613	10/27/2015	3	1	0
		11/3/2015	1	0	0
		11/10/2015	0	0	0
		11/16/2015	0	0	0
		11/23/2015	0	0	0
	3- Co. Hwy 1613 to MSWA	11/6/2015	0	0	0
		Chewuch R. Total	**4**	**1**	**0**

		Methow Basin Total	**108**	**118**	**24**
Chelan River[a]	Mouth upstream to Habitat Channel	10/30/2015	0	0	1
		11/2/2015	0	0	2
		Chelan R. Total	**0**	**0**	**3**
		Out of Basin Total	**0**	**0**	**3**

APPENDIX C: Wenatchee and Methow Basin Coho Release Numbers and Mark Groups, BY2013.

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 Released
Wenatchee	Nason Cr	Coulter Pond	Cascade FH	MCR-WEN	30-Apr	10-Jun	15.7	PBT	n/a	**55,220**	**51,388**	n/a	-
Wenatchee	Nason Cr	Butcher Pond	Cascade FH	MCR-WEN	30-Apr	17-Jun	15.3	PBT	n/a	**130,977**	**96,006**	n/a	**4,385**
Wenatchee	Nason Cr	Rolfing's Pond	Willard NFH	MCR-WEN	30-Apr	30-Jun	15.8	PBT	n/a	**99,104**	**94,545**	n/a	**5,702**
Wenatchee	Beaver Cr	Beaver Pond	Cascade FH	MCR-WEN	24-Apr	25-Jun	14.8	PBT	n/a	**101,106**	**95,950**	n/a	**5,677**
Wenatchee	Icicle Cr	LNFH SFL's 23-25	Willard NFH	MCR-WEN	14-Apr	14-Apr	20.6	PBT	n/a	**67,938**	**62,979**	n/a	**4,165**
Wenatchee	Icicle Cr	LNFH LFL 1	Cascade FH	MCR-WEN	13-Apr	13-Apr	18.0	PBT	n/a	92,320	84,750	n/a	4,122
Wenatchee	Icicle Cr	LNFH LFL 2	Cascade FH	LCR-TAN	13-Apr	13-Apr	19.2	19-03-94	93.6%	104,800	96,206	90,049	-
										197,120	**180,956**	**90,049**	**4,122**
Methow	Methow	Wolf Creek	Willard NFH	MCR-MET	4-May	15-May	16.5	19-03-92	87.0%	47,913	43,673	37,996	-
										47,913	**43,673**	**37,996**	**-**
Methow	Methow	Gold Creek	Willard NFH	MCR-MET	6-May	10-Jun	16.4	19-03-93	90.5%	36,365	35,094	31,760	-
										36,365	**35,094**	**31,760**	**5,772**
Methow	Methow	Twisp Ponds	Willard NFH	MCR-MET	6-May	31-May	15.2	19-03-91	88.7%	74,095	69,117	61,307	-

										74,095	**69,117**	**61,307**	**5,581**
Methow	Methow	WNFH BC1	Willard NFH	MCR-MET	4-May	11-May	16.7	19-03-90	94.6%	86,125	84,039	79,501	-
										86,125	**84,039**	**79,501**	**5,836**
Methow	Methow	WNFH	WNFH	MCR-MET	15-Apr	3-May	16.2	19-03-95	96.7%	131,301	118,587	114,674	2,994
					15-Apr	3-May	16.7	19-03-96		131,301	118,587	114,674	2,994
										262,602	**237,174**	**229,347**	**5,988**
									Total	**1,158,565**	**1,050,921**	**529,960**	**47,228**

Appendix D: Mid-Columbia Coho Production at U.S. Fish & Wildlife Service Facilities

US FISH AND WILDLIFE SERVICE

Mid-Columbia Coho Production at U.S. Fish & Wildlife Service Facilities

Leavenworth National Fish Hatchery, Lower Columbia River Fish Health Center, Olympia Fish Health Center, Willard National Fish Hatchery, Winthrop National Fish Hatchery

Steve Wingert, Willard National Fish Hatchery Manager – Steve Croci, Leavenworth Fisheries Complex Deputy Manager – Chris Pasley, Winthrop National Fish Hatchery Manager – Andrew Goodwin, Fish Health Program – Dr. Sonia Mumford, Olympia Fish Health Center Veterinary Medical Officer– Mary Peters, Lower Columbia River Fish Health Center Microbiologist – Spencer Meinzer, Lower Columbia River Fish Health Center Technician

February 1, 2015 – January 31, 2016

BPA Project No. 1996-040-00
Contract No. 67517

Statement of Work:

The activities in this contract are outlined in the Master Yakama Nation contract under Operation and Maintenance objectives and tasks and identified as Bonneville Power Administration (BPA) direct fund work.

This contract allows the U.S. Fish and Wildlife Service (Service) to rear coho salmon at Willard National Fish Hatchery (NFH), Leavenworth NFH, and Winthrop NFH including adult spawning, egg incubation, nursery rearing, and raceway rearing for transfer to Mid-Columbia River sites, main stem Columbia, Wenatchee, and Methow Rivers as part of the Yakama Nation coho reintroduction effort. Work also includes fish health laboratory and field services provided by the Olympia Fish Health Center (OFHC) and the Lower Columbia River Fish Health Center (LCRFHC) for monitoring for adult and juvenile coho salmon health. The Statement of Work (SOW) included within this contract represents activities for the time frame of February 1, 2015 through January 31, 2016.

Background:

The long term vision of this restoration project is to restore coho salmon to the Wenatchee and Methow rivers in the Mid-Columbia River basin at or near carrying capacity, and provide harvest opportunities for tribal and non-tribal fisheries. The project works toward development of locally adapted, naturally spawning coho populations in the Wenatchee and Methow basins by increasing the fitness of reintroduced coho salmon by reducing domestication and emphasizing local adaptation. The program uses strict broodstock collection protocols, which ultimately will place a limit on the proportion of natural origin adults in the hatchery program and place a limit on the proportion of hatchery origin adults on the spawning ground. Hatchery smolt production work is covered under BPA contracts with other agencies.

The Service, with funding from BPA, has assisted the Yakama Nation in an effort to re-establish and increase the number of coho salmon in the Upper Columbia River system using both locally adapted and lower river stocks of fish. The highest priority rearing program involves the use of gametes collected from fish returning to the Wenatchee and Methow River system in an attempt to develop a locally adapted stock of fish with a long term goal to re-establish coho salmon with enough numbers to be near carrying capacity and provide harvesting opportunities for tribal and non-tribal fisheries.

The Service is contracted to manage on the ground efforts and provide administrative support for this project. Work involves support of BPA's programmatic requirements including preparation of narrative and status reports that describe contract progress, achievement of milestones, preparation of SOW's, financial reports necessary to accomplish contract work and the preparation of an annual report that documents contract performance for all Service coho rearing activities. The Service provides equipment, and utilities to full-term rear and care for coho salmon eyed eggs until reaching a life stage necessary to achieve optimal survival following transfer to the Mid-Columbia Region at Willard NFH and Winthrop NFH. Additionally, the Service provides facilities, labor, equipment and services for the spawning, incubation, shipping, rearing, acclimation, and releasing juveniles at Leavenworth NFH and Winthrop NFH. The OFHC and LCRFHC monitor the health of coho salmon at Winthrop, Willard and Leavenworth NFHs which includes exams, pathology sampling, laboratory processing of samples, discussions with fish culture staff, and consultation with other fish health professionals. In addition, the LCRFHC processes the pre-release exams of coho reared for the Mid-Columbia program at Oregon's Cascade Hatchery and USFWS Willard NFH.

Willard NFH:
All deliverables described in the SOW for the Willard NFH were accomplished. Willard NFH production is initiated with the receipt of up to 672,000 eyed eggs resulting in up to 650,000 pre-smolts for transfer to various acclimation and release sites within the Mid-Columbia River Basin including sites in the Methow, Wenatchee and main stem Columbia Rivers. Provide labor and fish food necessary to hold and rear up to 650,000 juvenile coho salmon from the previous brood year for transfer as pre-smolts following 18 months of rearing to acclimation facilities within the Mid-Columbia River Basin to assist reintroduction efforts.

During this report period a total of 468,239 brood year 2013coho salmon, derived from a native, locally adapted stock returning to and spawned on the Wenatchee River, WA, were reared at the Willard NFH and transferred to the Wenatchee or Methow River watersheds for release by biologists from the Yakama Nation. Through a MOU, 60% of this project is supported by the Yakama Nation using BPA funds and the remaining 40% is provided by NOAA-Fisheries Mitchell Act funding. This is a cooperative effort by the Service and the Yakama Nation to assist with the reintroduction of coho salmon and development of locally adapted, naturally spawning populations of fish in the Wenatchee River watershed.

Brood Year 2012 Coho Salmon Production Summary

The following tables display brood year 2013 coho salmon production. Table 1 displays the inventory of brood year 2013 coho at the beginning of the report period.

Table 1. Willard NFH brood year 2013 coho salmon production as of February 1, 2015.

		Willard National Fish Hatchery				OUTDOOR RACEWAYS									
		COS-WEN-13-Wi-45													
Raceway Number	Current Number	Size (#/Lb.)	Weight	Length (Inches)	Density Index	Flow Index	Monthly % Morts	Basin	Strain/Cross	Transfer Date	FPP Goal	Tagcodes		Initial Retention	Retention	Destination
1*	29,666	38.6	769.4	4.28	0.12	0.39	0.00	WEN	PIF 11/15/2013	Mar. 2015	22-23	PBT + CWT	19-03-90	99.6	96	WNFH BACK CHANNEL
2	29,667	38.6	769.4	4.28	0.12	0.39	0.00	WEN	PIF 11/15/2013	Mar. 2015	22-23	PBT + CWT				WNFH BACK CHANNEL
3	29,662	38.6	769.3	4.28	0.12	0.39	0.01	WEN	PIF 11/15/2013	Mar. 2015	22-23	PBT + CWT				WNFH BACK CHANNEL
4	24,409	32.2	758.0	4.55	0.11	0.36	0.00	WEN	PIF Cell#3	Mar. 2015	22-25	PBT + CWT	19-03-92	99.5	92	WOLF CREEK PONDS
5*	24,415	32.2	758.2	4.55	0.11	0.36	0.00	WEN	PIF Cell#3	Mar. 2015	22-25	PBT + CWT				WOLF CREEK PONDS
6*	33,353	35.6	937.7	4.40	0.14	0.47	0.00	WEN	PIF Cell#4	Apr. 2015	22-25	PBT + CWT	19-03-91	98.3	88.6	TWISP PONDS
7	33,784	35.6	949.8	4.40	0.14	0.47	0.00	WEN	PIF Cell#4	Apr. 2015	22-25	PBT + CWT				TWISP PONDS
8*	15,638	31.8	491.2	4.57	0.07	0.23	0.01	WEN	PIF Cell#6	Apr. 2015	22-25	PBT + CWT				TWISP PONDS
9*	21,653	33.7	643.5	4.48	0.09	0.31	0.01	WEN	PIF Cell#5	Mar. 2015	22-25	PBT + CWT	19-03-93	99.8	91.6	GOLD CREEK
10	20,529	33.7	610.1	4.48	0.09	0.30	0.00	WEN	PIF Cell#5	Mar. 2015	22-23	PBT + CWT				GOLD CREEK
11*	21,005	32.0	658.1	4.56	0.09	0.32	0.10	WEN	Sp Cr & VHS Parents	Feb. 2015	22-25	PBT	n/a			LNFH-SFL's
12	16,524	32.0	517.1	4.56	0.07	0.25	0.11	WEN	Eagle Cr	Feb. 2015	TBD	Ad-Clip				Y.N. SUPPLEMENTAL
13*	26,971	32.0	843.6	4.56	0.12	0.40	0.06	WEN	Eagle Cr	Feb. 2015	TBD	Ad-Clip				Y.N. SUPPLEMENTAL
14	27,142	32.0	848.9	4.56	0.12	0.41	0.06	WEN	Eagle Cr	Feb. 2015	TBD	Ad-Clip				Y.N. SUPPLEMENTAL
15	26,939	32.0	842.6	4.56	0.12	0.40	0.06	WEN	Eagle Cr	Feb. 2015	TBD	Ad-Clip				Y.N. SUPPLEMENTAL
16*	32,633	35.8	912.0	4.39	0.14	0.45	0.02	WEN	LNFH Batch 5	Mar. 2015	22-23	PBT				ROLFING'S POND
17	32,648	35.8	912.2	4.39	0.14	0.45	0.00	WEN	LNFH Batch 5	Mar. 2015	22-23	PBT				ROLFING'S POND
18	33,834	35.8	945.4	4.39	0.14	0.47	0.00	WEN	LNFH Batch 5	Mar. 2015	22-23	PBT				ROLFING'S POND
19*	35,278	36.7	961.9	4.35	0.14	0.48	0.06	WEN	LNFH Batch 5,7,8	Feb. 2015	22-23	PBT				LNFH-SFL's
20	35,291	36.7	962.2	4.35	0.14	0.48	0.07	WEN	LNFH Batch 5,7,8	Feb. 2015	22-25	PBT				LNFH-SFL's
TOTAL >>	551,041	34.6	15,861	4.45	0.12	0.39	0.03%							99.30		

Brood Year 2014 Coho Salmon Production Summary

The following tables summarize brood year 2014 coho salmon production during this report period at Willard NFH. Table 2 displays the inventory of brood year 2014 coho after all lots had been ponded and table 3 displays the fish inventory at the end of the contract period.

Table 2. Willard NFH brood year 2014 coho salmon production, initial lot status.

		Willard National Fish Hatchery					INDOOR NURSERY TANKS		
		COS-WEN-14-Wi-02							**"Lot Update"**
Tank Number	Current Number	Size (#/Lb.)	Weight	Length (Inches)	Density Index	Flow Index	Monthly % Morts	Strain/ Cross/ Inc Facility	Notes
17*	12,212	1040.0	11.7	1.428	0.09	0.27	0.63	PBT = LNFH	ponded 3/24
18	10,209	1042.7	9.8	1.427	0.07	0.23	0.53	PBT = Beaver	ponded 3/24
19	10,196	1042.7	9.8	1.427	0.07	0.23	0.65	PBT = Beaver	ponded 3/24
20	10,180	1042.7	9.8	1.427	0.07	0.23	0.81	PBT = Beaver	ponded 3/24
21	10,222	1042.7	9.8	1.427	0.07	0.23	0.40	PBT = Beaver	ponded 3/24
22	10,212	1042.7	9.8	1.427	0.07	0.23	0.50	PBT = Beaver	ponded 3/24
23	8,591	790.5	10.9	1.565	0.07	0.23	0.75	PBT = LNFH	ponded 3/11
24	8,616	790.5	10.9	1.565	0.08	0.23	0.46	PBT = LNFH	ponded 3/11
29	8,623	790.5	10.9	1.565	0.08	0.23	0.38	PBT = LNFH	ponded 3/11
30*	8,617	790.5	10.9	1.565	0.08	0.23	0.45	PBT = LNFH	ponded 3/11
31*	10,193	1106.3	9.2	1.399	0.07	0.22	0.68	PBT = Beaver	ponded 3/24
32	10,227	1042.7	9.8	1.427	0.07	0.23	0.35	PBT = Beaver	ponded 3/24
33	10,217	1042.7	9.8	1.427	0.07	0.23	0.45	PBT = Beaver	ponded 3/24
34	10,207	1042.7	9.8	1.427	0.07	0.23	0.55	PBT = Beaver	ponded 3/24
35*	10,228	979.2	10.4	1.457	0.08	0.24	0.34	PBT = Beaver	ponded 3/24
36	12,212	1040.0	11.7	1.428	0.09	0.27	0.63	PBT = LNFH	ponded 3/24
TOTAL >>	160,962	975.2	165	1.459	0.03	0.08	0.54		

Table 3. Willard NFH brood year 2014 coho salmon production at the end of this report period.

		Willard National Fish Hatchery				OUTDOOR RACEWAYS					
		COS-WEN-14-Wi-02									
Raceway Number	Current Number	Size (#/Lb.)	Weight	Length (Inches)	Density Index	Flow Index	Monthly % Morts	Basin	Transfer Date	Tagcodes	Destination
1	27,643	36.4	758.8	4.37	0.11	0.41	0.03	NPT	2/11/2016	19-04-50	LNFH
2	27,644	36.4	758.8	4.37	0.11	0.41	0.02	NPT	2/11/2016	19-04-50	LNFH
3	27,613	36.4	758.0	4.37	0.11	0.41	0.01	NPT	2/11/2016	19-04-50	LNFH
4	27,556	36.4	756.4	4.37	0.11	0.40	0.12	NPT	2/11/2016	19-04-50	LNFH
7	29,980	26.8	1118.7	4.84	0.15	0.54	0.08	WEN	2/29/2016	PBT = Butcher	Butcher P
8*	29,644	26.8	1106.1	4.84	0.15	0.53	0.01	WEN	2/29/2016	PBT = Butcher	Butcher P
9	30,579	27.1	1130.5	4.82	0.15	0.55	0.01	WEN	2/29/2016	PBT = Butcher	Butcher P
10*	30,970	27.1	1144.9	4.82	0.16	0.55	0.01	WEN	2/29/2016	PBT = Butcher	Butcher P
11	17,143	22.7	756.2	5.11	0.10	0.35	0.00	WEN	3/17/2016	PBT = LNFH	LNFH
12*	17,097	22.7	754.2	5.11	0.10	0.34	0.01	WEN	3/17/2016	PBT = LNFH	LNFH
13*	20,177	24.4	828.3	4.99	0.11	0.39	0.01	WEN	2/17/2016	PBT = Beaver	Beaver Cr
14	20,236	24.4	830.7	4.99	0.11	0.39	0.01	WEN	2/17/2016	PBT = Beaver	Beaver Cr
15	20,182	24.4	828.5	4.99	0.11	0.39	0.07	WEN	2/17/2016	PBT = Beaver	Beaver Cr
16	20,187	24.4	828.7	4.99	0.11	0.39	0.00	WEN	2/17/2016	PBT = Beaver	Beaver Cr
17	20,247	24.4	831.2	4.99	0.11	0.39	0.00	WEN	2/17/2016	PBT = Beaver	Beaver Cr
18*	24,241	29.1	833.3	4.71	0.12	0.41	0.00	WEN	3/17/2016	PBT = LNFH	LNFH
TOTAL >>	391,139	28.1	14,023	4.79	0.12	0.43	0.03%				

Brood Year 2015 Coho Salmon Production Summary
Table 4 summarizes brood year 2015 coho salmon egg and fry incubation during this report period at the Willard NFH.

Table 4. Willard NFH brood year 2015 coho salmon egg and fry incubation as of January 30, 2016.

		Coho			Willard NFH
	Yakama	Egg	Summary		
				Number	
		Date	Date	of eggs	T.U.'s
	Stock	Spawned	Received	received	Delivery
x	winthrop wolf cr		12/14/15	44,214	627
butcher	LNFH rolfing	10/13/15	12/14/15	11,400	589
butcher	pif rolfing	11/03/15	12/17/15	101,273	600
rohling	pif Beaver	11/10/15	12/29/15	68,162	637
x	pif beaver	11/17/15	01/06/16	32,657	637
x	pif rohlfing	11/17/15	01/06/16	34,100	637
	Total/avg.			291,806	621
		Date		%	total eggs
		Spawned	Egg pick off	pick off	after pick off
x	winthrop wolf cr		2639	5.97%	41,575
butcher	LNFH rohlfing	10/13/15	525	4.61%	10,875
butcher	pif rolfing	11/13/15	3821	3.77%	97,452
rohling	pif Beaver	11/10/15	3226	4.73%	64,936
x	pif beaver	11/17/15	360	1.10%	32,297
x	pif rolfing	11/17/15	578	1.70%	33,522
	Total/avg.		11,149	3.82%	280,657

Lower Columbia River Fish Health Center:

The first year of funding to the LCRFHC for the Mid-Columbia coho program at Willard NFH, WA, and Cascade Hatchery, OR, began in 2014. Extensive budget negotiations and the VHSV isolation substantially increased the amount of time and resources expended by the LCRFHC, field staff and FWS Regional Office personnel for the program. Eggs from the females that were pooled with the VHSV-positive female were transported to Willard NFH for rearing with other eggs from this program (Leavenworth-Wenatchee). The eggs from parents testing negative for VHSV were transported to the ODFW Cascade Hatchery for rearing. In addition, Willard received 100,000 eggs from the Eagle Creek NFH BY13 coho adults (virus-free) in order to backfill shortages of the mid-Columbia adapted stock. This stock was reared at Willard NFH for release to the mid-Columbia Wenatchee program, but ultimately, the Eagle Creek coho were deemed unnecessary, and they were instead released to the Yakima River for the YN's YKFP fisheries.

Fish Health at Willard NFH:

LCRFHC staff performed routine juvenile monitoring of brood years 2013 and 2014 during the period from February 2015 through January 2016. Monitoring included on site examinations and necropsies of juveniles captured from representative ponds of coho salmon to determine overall health and potential infections with bacteria or parasites.

Monthly exams of the Leavenworth-Wenatchee BY13 stock showed healthy fish with normal, non-pathogenic external parasite findings. Pre-release exams of 60 coho yearlings of the same stock in February and March 2015 revealed no virus or findings of reportable bacteria. Cold water disease bacteria was not detected; fish were healthy.

A 60-fish sample of the Leavenworth-Wenatchee BY14 fry was negative for virus at ponding in April, 2015. Monthly exams were negative for pathogenic bacteria and external parasites, with only non-pathogenic external parasite findings. These coho were once again negative for cold water disease.

Fish Health at Cascade Hatchery, OR:

The LCRFHC performed the pre-release BY13 yearling prerelease exam for the state of Oregon at Cascade Hatchery in February, 2015. There were no significant fish health findings, fish were negative for virus and reportable bacteria.

In July, 2015 a prerelease exam was completed on the Cascade coho in anticipation of transfer to Willard NFH. No virus was detected. Subsequent routine fish health exams of this stock at Willard showed no pathogenic bacteria, and only a low level of non-pathogenic external parasites.

Leavenworth Fisheries Complex:

Leavenworth NFH:
All deliverables described in the statement of work for Leavenworth NFH were accomplished. Leavenworth NFH ensured adequate water flow to coho rearing units; removed snow on a recurring basis in order to access coho rearing units; responded to water alarms and coordinated with YN prior to severe weather events; monitored effluent

discharge to maintain compliance with the NPDES permit; provided electrical power to operate pumps and other equipment; provided guidance on or assisted with equipment repair and maintenance; and provide program administrative services in support of coho reintroduction program. To accommodate acclimation and rearing of juvenile coho salmon Leavenworth NFH provided adequate water and space and assisted the YN with planning and execution of fish release and other fish culture issues such as water temperature, dissolved oxygen and flow rates. In support of holding, spawning and incubating maintenance activities the Leavenworth NFH assisted YN staff with installation, operation, maintenance, and modifications of the ladder fish trap, holding pond, spawning area and egg incubation system. The hatchery purchased chemicals (formalin, iodine, and disinfectant) required for fish holding, spawning, rearing, and egg incubation.

Coordination meetings, discussions, and consultations with Yakama Nation staff responsible for rearing and care of these fish were performed during this time period. Coordination and consultation with Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, and US Fish and Wildlife Service Fish Health Specialists/Biologists was conducted during this time period regarding fish health concerns and transfer requirements for this program.

Winthrop NFH:
All deliverables described in the statement of work for Winthrop NFH were accomplished and included performing routine and preventative maintenance on facilities and equipment to accommodate the Coho salmon production program.

Brood Year 2013 Coho Salmon
This group originated entirely from adult Coho salmon collected at Winthrop NFH and Wells Dam.
Two hundred eighty four adults were processed at Winthrop NFH this brood year, which included 115 females and 113 males spawned, 36 returned to the river, and 19 mortalities. A total of 335,403 eggs were harvested, which resulted in 277,230 eyed-eggs at an eye-up rate of 82.7%. No excess eggs were available (due to low adult returns), and therefore no eggs were transferred off station from this Brood year. The progeny from these spawning events were released into the Methow River directly from the station's raceways using a volitional release strategy that began in mid-April and concluded on the 9th of May, 2015. There were a total of 260,917 coho smolts released from the raceways. In addition to this release, another group was transferred in from Willard NFH. There were an estimated 86,877 coho smolts released from the Willard group during the same release period.

Brood Year 2014 Coho Salmon
This group originated entirely from adult Coho salmon collected at Winthrop NFH and Wells Dam. There were a total of 635 adult salmon processed at Winthrop NFH this brood year. There were a total of 218 females and 215 males spawned for production/program needs, 85 adults returned to the stream, 85 fish returned to stream, 50 males surplus killed, and a total of 58 mortalities. A total of 576,881 eggs were harvested

from these spawning events resulting in an estimated 432,475 eyed eggs for an overall eye-up rate of 75.00%. Approximately 68,314 eyed-eggs were transferred to Cascade Locks SFH leaving an estimated 364,341 eyed-eggs on station. At the end of January 2016, there were approximately 337,566 yearling coho on station. These fish have performed well through the rearing cycle and are on track for release in the spring of 2015.

Brood Year 2015 Coho Salmon
This group originated entirely from adult Coho salmon collected at Winthrop NFH and Wells Dam. There were a total of 708 adult salmon processed at Winthrop NFH this brood year. There were a total of 262 females and 265 males spawned for production/program needs, 120 adult males returned to the stream, and a total of 61 mortalities. A total of 529,094 eggs were harvested from these spawning events resulting in an estimated 417,970 eyed eggs for an overall eye-up rate of 79.00%. Approximately 44,214 eyed-eggs were transferred to Willard NFH and 113,033 were transferred to Cascade Locks SFH leaving an estimated 260,723 eyed-eggs on station.

Olympia Fish Health Center:

Coordination meetings, discussions, and consultations with Yakama Nation staff responsible for rearing and care of these fish were performed during this time period. Coordination and consultation with Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Western Fisheries Research Center and US Fish and Wildlife Service Fish Culturists and Fish Health Specialists/Biologists was conducted during this time period regarding fish health concerns and transfer requirements for the coho program at Leavenworth and Winthrop NFHs. Extensive budget negotiations and the VHSV isolation substantially increased the amount of time and resources expended by OFHC laboratory and field staff and FWS Regional Office personnel for the program again this year.

Fish Health at Leavenworth NFH:

OFHC staff performed routine juvenile monitoring of brood year 2013 coho during the period from February 2015 through January 2016. Juvenile monitoring included routine and pre-release on-site examinations and necropsies of fish with appropriate lab work to evaluate overall health and identify viruses, bacteria or parasites that can cause disease in Pacific salmon. Incidental detections of *Flavobacterium psychrophilum* and *Renibacterium salmoninarum* were found in BY 2013 coho without disease consequences. Additional diagnostic trips were performed during this time period as requested by fish culture staff and as deemed necessary by OFHC staff. Preventive measures and treatment options were discussed with the coho fish culturists as needed.

In October and November 2015, broodstock testing was performed on the fish spawned at Leavenworth. Due to the isolation of VHSV-4a in 2012 and 2013, ovarian fluid samples were numbered and tracked in the lab correlating with identification numbers used on the egg incubation trays. This was arranged with ODFW to allow eggs from females testing negative for

VHSV to be transferred into Oregon.   Numbered and tracked pooled samples of ovarian fluid from 222 females were tested for viruses, pooled kidney-spleen samples from 60 fish were tested for viruses and culturable bacteria; *Renibacterium salmoninarum* infections were evaluated by ELISA and qPCR.

Adults had incidental detections of IHNV (likely one fish) and *Renibacterium salmoninarum* by both ELISA and qPCR.

Fish Health at Winthrop NFH:

OFHC staff performed routine juvenile monitoring of brood years 2013 and 2014 during the period from February 2015 through January 2016. Juvenile monitoring included routine and pre-release on-site examinations and necropsies of fish with appropriate lab work to evaluate overall health and identify viruses, bacteria or parasites that can cause disease in Pacific salmon. Incidental detections of *Flavobacterium psychrophilum* and *Renibacterium salmoninarum* were found in BY 2013 coho without disease consequences. BY 2014 had slightly elevated mortality associated with *Aeromonas salmonicida* which resolved within a week. Additional diagnostic trips were performed during this time period as requested by fish culture staff and as deemed necessary by OFHC staff. Preventive measures and treatment options were discussed with the coho fish culturists as needed.

In October and November 2015, broodstock testing was performed on the spawned fish. Pooled samples of ovarian fluid from 150 females were tested for viruses, pooled kidney-spleen samples from 60 fish were tested for viruses and culturable bacteria; *Renibacterium salmoninarum* infections were evaluated by ELISA and qPCR. *Flavobacterium psychrophilum* and *Renibacterium salmoninarum* were detected from the spawning population.

No viruses were detected from any coho, but IHNV was detected in other populations on station without disease issues.