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Broodstock Development

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MID-COLUMBIA COHO REINTRODUCTION FEASIBILITY STUDY:

2003 ANNUAL BROODSTOCK DEVELOPMENT REPORT

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Chapter 1: 2003 Pre-Smolt Acclimation

Introduction

Wild stocks of coho salmon *Oncorhynchus kisutch* were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). Since the early 1900s, the native stock of coho has been decimated in the tributaries of the middle reach of the Columbia River (the Wenatchee, Entiat, Methow, and Okanogan rivers) (Mullan 1983). Efforts to restore coho within the mid- and upper Columbia Basin rely upon large releases of hatchery coho. The feasibility of re-establishing coho in the tributaries of the mid-Columbia Basin may initially depend on the resolution of two central issues: the adaptability of domesticated lower Columbia River coho stocks used in the re-introduction efforts and associated survival rates; and the ecological risk to listed and sensitive species.

The Yakama Nation (YN), as the lead agency, began research to evaluate the feasibility of re-introducing coho salmon to mid-Columbia tributaries in 1996. The long term goal of the Mid-Columbia Coho Reintroduction Project is to re-establish naturally reproducing coho salmon populations in mid-Columbia River basins, with number at or near carrying capacity. In the short term, the feasibility study seeks to determine whether a localized broodstock can be developed from lower Columbia River coho stocks and to initiate natural production in areas of low risk to sensitive species (HGMP 2002).

Acclimation of coho pre-smolts is required to achieve the goals of the feasibility study. Acclimation may reduce residualism; increase smolt-to-adult survival rates, yield returning adults capable of producing naturally spawned progeny, and minimize adult straying into other watersheds.

This document reports the number, locations, size, and marking of reprogrammed lower Columbia River coho salmon and the developing mid-Columbia broodstock that were transported to acclimation sites in the mid-Columbia River tributaries.

Wenatchee River Basin Acclimation Sites

Icicle Creek

The Icicle Creek coho acclimation site is located at river kilometer (RK) 4.5 on a side channel of Icicle Creek adjacent to the Leavenworth National Fish Hatchery (LNFH) (HGMP 2002). The acclimation site is located behind a historic dam built between 1939 and 1941, originally designed to hold adult salmonids returning to the LNFH prior to spawning. Icicle Creek is the focal watershed for broodstock development.

Transportation

Oregon Department of Fish and Wildlife (ODFW) and Yakama Nation (YN) transported approximately 493,207 hatchery coho pre-smolts to the Icicle Creek acclimation site on March 17-26, 2003. Of these hatchery pre-smolts, 295,406 originated from ODFW's Cascade Fish Hatchery. The pre-smolts transported from Cascade FH were 1st generation mid-Columbia brood. ODFW transported an additional 37,186 hatchery coho from Willard National Fish Hatchery on March 26, 2003. YN transported approximately 160,615 pre-smolts from Winthrop National Fish Hatchery to the Icicle Creek acclimation site. All coho transported to the Icicle Creek acclimation site from Winthrop NFH were 1st generation mid-Columbia progeny from returns to the Methow River.

Mortality

During the five-week acclimation period, 1,956 moribund coho were recovered off the outlet screens and floating structures (Figure 1). A large portion of the mortality (*n=1,268; 64.8%)* occurred during transportation to the acclimation site. The mortality rate was relatively low after transportation. Two percent of these mortalities (*n=37*) displayed signs of mammalian/aviary predation such as missing appendages, open wounds on the dorsal surface, puncture wounds, and scarring. The total loss during acclimation is difficult to enumerate because of unobserved mortality (buried in sediment, predation, etc.). For this reason, an estimated mortality rate was calculated using known loss plus an estimation of predator consumption. This estimate was determined using the following equation:

$$E_c = C_t * FPP * N_i * C_d$$

E_c *= Estimated consumption for an individual predator*
C_t *= Consumption total per day in kilograms for an individual predator*
FPP *= Fish per pound*
N_i *= Number of same species predators observed during time interval i*
C_d *= Duration of same species predators observed*

The target predators in determining fish loss were the North American river otter (*Lutra canadensis*) and the common merganser (*Mergus merganser*). During acclimation, two adult otters were observed. Adult river otters can consume as much as 20% their body weight in the natural environment (Beckel 1982). Average weights for male and female river otters were 25 and 19 pounds, respectively. Mergansers can consume upwards of one pound of fish per day. In addition to these key predators, a mink and belted kingfisher were observed during coho acclimation. Estimated predation loss was 8,422 coho. The estimated mortality rate (known loss + estimated mortality) for the Icicle Creek acclimation site in 2003 was approximately 2.1% (*n=10,379*).

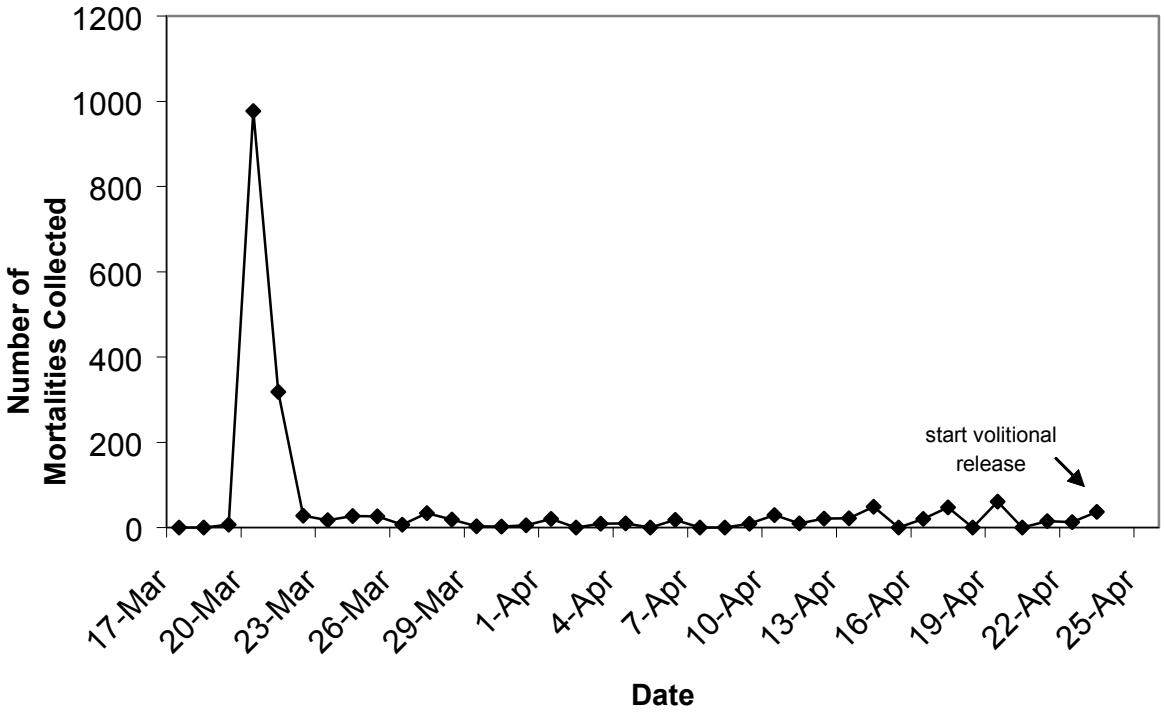

Figure 1. The number of known mortalities collected from the Icicle Creek coho acclimation site, 2003.

Marks and Tags

Coho transported from Cascade FH, Willard and Winthrop NFH's were coded wire tagged (CWT'ed) with no external mark (Cascade FH CWT codes: 050577 and 050581; Willard NFH CWT code: 054320; Winthrop NFH CWT code: 054533). The number of CWT juveniles released from the Icicle Creek acclimation site was 464,630. This accounts for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss. The total number of juvenile coho released from the acclimation site was 482,828.

Coho reared at all three facilities were CWT'ed mid-to late summer prior to transport. In addition to the CWTs, 7,989 coho smolts tagged with passive integrated transponder (PIT) tags were released. These coho juveniles were PIT tagged at Cascade FH

approximately seven weeks prior to transport to ensure adequate retention and reduce post tagging stress.

Table 1. CWT tagged coho released from Icicle Creek acclimation pond, 2003.

Hatchery	Number of fish tagged	Mark	Tag Retention (%)	Tag Code	Tag loss and mortality	Number CWT released
Cascade FH	150,257	CWT only	95.4	050971	8,426	141,831
Cascade FH	140,053	CWT only	95.6	054531	9,050	131,003
Winthrop NFH	162,708	CWT only	99.8*	054533	5,866	156,922
Willard NFH	37,483	CWT only	95.8	054320	2,609	34,874

**-A final retention was not completed on the coho at Winthrop NFH. The tag retention was calculated was 3 days post-tagging and not the required minimum of 30 days post-tagging*

Size and Growth

Juvenile coho transported from Cascade FH and Winthrop NFH to the Icicle Creek acclimation site averaged 21.6 and 24.6 fish per pound (FPP), respectively. Willard NFH coho were slightly heavier at 17.1 FPP. In-pond sampling was performed once a week from March 29 to April 23, 2003. Five random dip-net samples were collected within the acclimation pond and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and FPP for the five samples are noted in Table 2. The final sample occurred on April 23, the start of the volitional release.

Table 2. Coho growth during acclimation, Icicle Creek, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
March 29	121.0	20.3	1.14	22.4
April 6	123.5	21.2	1.13	21.4
April 11	125.7	23.2	1.17	19.6
April 20	127.8	24.6	1.18	18.5
April 23	129.3	25.1	1.16	18.3

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. The three classification stages were parr, transitional, and smolt. Parr coho expressed obvious vertical markings along the lateral body (usually between 8-12 parr marks) with a noticeable sickle-shaped anal fin. The orange pigment in the anal, caudal, and dorsal fins was expressed in a variety of tones, usually very faint.

The first three anal fin rays contained white coloration followed by a fourth black fin ray. Observed coloration of the dorsal body varied from a light to medium brown. Coho smolts were easily identified by their silvery appearance and displayed a blue-green coloration along the dorsal surface. Parr marks were faint or absent. The anal, caudal, and dorsal fins appeared transparent. Transitional juveniles displayed both parr and smolt characteristics. Fin coloration seemed to fade but parr marks were still obvious. A silvery color was observed throughout the body. Physiological changes that occur during these developmental transformations include elevated plasma levels of cortisol and thyroid hormones as well as increased gill Na^+, K-ATPase activity (Patino et. al. 1986). Overall, the proportion of smolt and transitional coho increased throughout acclimation while parr decreased (Figure 2).

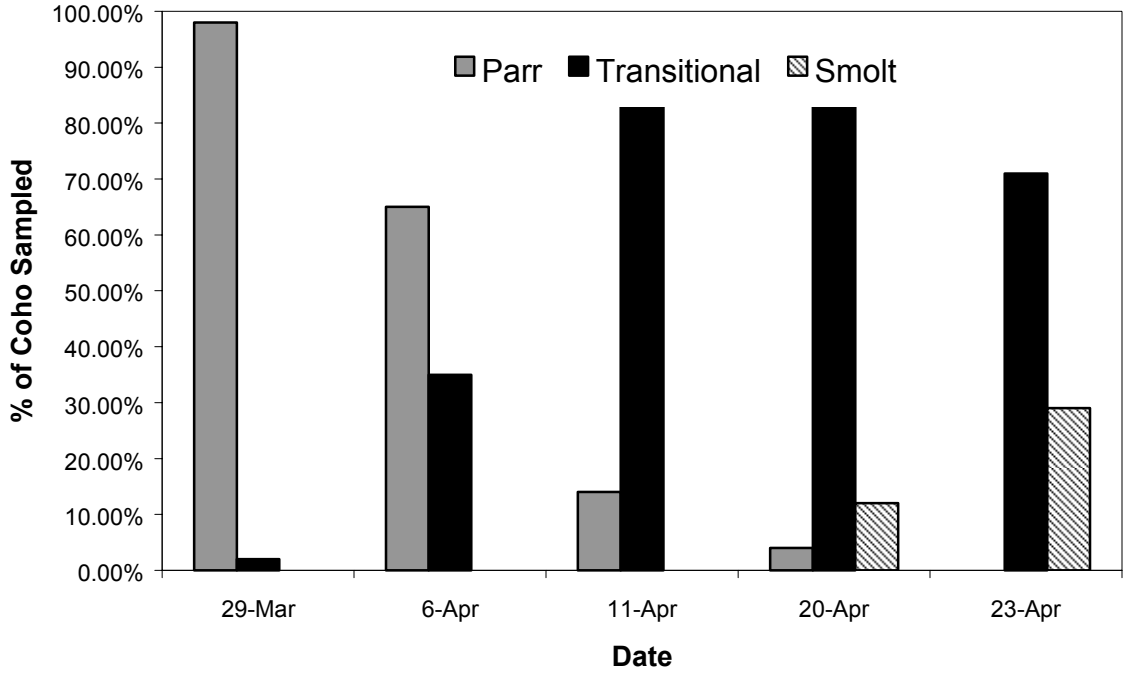

Figure 2. Proportion of coho parr, transitional, and smolts during acclimation, Icicle Creek, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall health by evaluating the normality of external features (eyes, fins, opercules, etc.) as well as internal organs and blood components. These procedures are done to note abnormalities, not to diagnose the cause of certain conditions. Results from the assessment concluded that individuals prior to release were in good condition with no abnormalities observed (Table 3).

Table 3. Pre-release fish health assessment for Icicle Creek juvenile coho, 2003.

Eyes[1]	Gill[1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen[1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
100	100	100	100	2.1	100	100	100	100	60/40	100	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.

2- Mesenteric fat was based on a 0-3 numerical system average. A value of 2 equals more than 50% of the ceaca covered with fat, which is healthy.

Volitional Release

Coho smolts were volitionally released from the Icicle Creek acclimation site. The release began on April 23 at 3 p.m. and continued through June 17, when visual observation determined that all fish had exited the pond. Juvenile coho emigration was documented at the rotary smolt trap located upstream from the town of Monitor (RK 11.4; Figure 3). The trap is operated by Washington Department of Fish and Wildlife (WDFW). YN personnel assisted WDFW with coho data collection during the peak migration of hatchery coho smolts. A sub-sample (*n=721*) of coho smolts was measured and stage of smoltification was recorded (Table 4). Developmental stages recorded at the trap were a composite of all coho release sites in the basin. After May 26, coho migration data was collected by WDFW personnel. The number of coho passing the smolt trap after May 26 did not warrant additional personnel. Ninety-five percent of the emigrating coho juveniles were trapped prior to June 3 (Figure 3). Information regarding downstream smolt survival rates can be found in Murdoch et al. (2005). During 2003 trap operations, 199 naturally produced coho and 8,684 hatchery reared coho were captured (Seiler et al. 2004) (Figure 3).

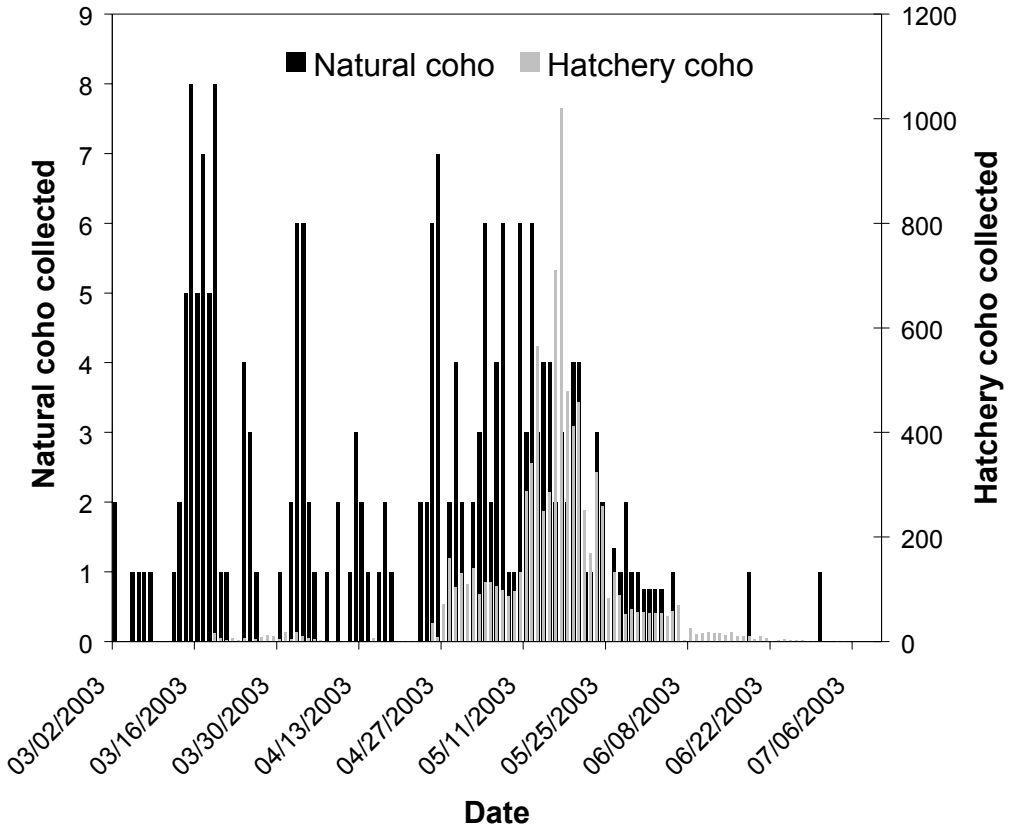

Figure 3. The proportion of natural and hatchery coho smolts captured in a rotary smolt trap located near the town of Monitor on the Wenatchee River (RKM 11.4) during spring, 2003.

Table 4. Juvenile coho identified by rearing type and developmental stage collected at the Monitor rotary smolt trap (February 21-July 30) by WDFW and YN, 2003.

Origin and Stage (*P,T,S*)	Mean Fork Length in mm (*SD*)	Sample Size (*N*)	Percent of Collection Total by Origin (%)
Hatchery-Transitional	134.2 (9.1)	573	79.5
Hatchery-Smolt	139.7 (10.5)	148	20.5
Natural-Transitional	111.2 (10.5)	99	90.8
Natural-Smolt	113.7 (6.7)	10	9.2

Nason Creek

The Nason Creek acclimation sites for 2003 have expanded to include three primary locations within the Nason Creek watershed (Butcher Creek, Coulter Creek, and Mahar Pond). The long-term goal of establishing a self-sustaining population in the upper Wenatchee basin may depends on the success of these releases.

Butcher Creek

The Butcher Creek acclimation site is located at RK 13.2 on Nason Creek (HGMP 2002). This acclimation site is a natural beaver pond located at the mouth of Butcher Creek. Coho smolts are volitionally released directly into Nason Creek from the pond. Prior to transportation, a barrier net was placed at the outlet to contain coho during acclimation.

Transportation and Size

A total of 149,652 hatchery coho pre-smolts were transported to the Butcher Creek acclimation pond from Cascade FH on March 27-28, 2003. Fish transported to the acclimation pond averaged 20.9 FPP and were mid-Columbia brood origin (BY 2001) (Appendix A). We sampled coho in the pond once a week between April 3 and May 4, 2003. Random dip net samples were collected within the acclimation pond and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and fish per pound for the five weekly samples are reported in Table 5. The final sample occurred on May 4 prior to the start of the volitional release.

Table 5. Coho growth sampling during acclimation at Butcher Creek pond, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
April 3	129.4	22.5	1.04	20.1
April 9	128.3	23.2	1.1	19.5
April 18	129.6	23.8	1.1	19.0
April 23	129.9	23.8	1.09	19.1
May 4	130.7	25.0	1.12	18.1

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. We classified the coho as either parr, transitional, or smolt (see "Icicle Creek"). The proportion of transitional and smolt coho increased throughout acclimation, while the proportion of parr decreased (Figure 4). The pre-release sample demonstrated that all of the coho prior to release were either in the transitional or smolt developmental stage (68.0% transitional; 32.0% smolt). It may be advantageous for coho emigrating from mid-Columbia basins to exit acclimation ponds as transitionals due to their extended seaward migration. Long emigration distances may require juveniles to migrate early in the smoltification process to ensure complete transformation by the time

they enter the marine environment. Similarly, most naturally produced spring chinook yearlings (76.1%) emigrating from the Chiwawa River in the Wenatchee River basin emigrate as transitionals (WDFW unpublished data). Other variables to consider during the juvenile emigration are increased photoperiod, increased water temperatures, and increased river flows due to spring run-off; all which can affect the timing of smolt migration.

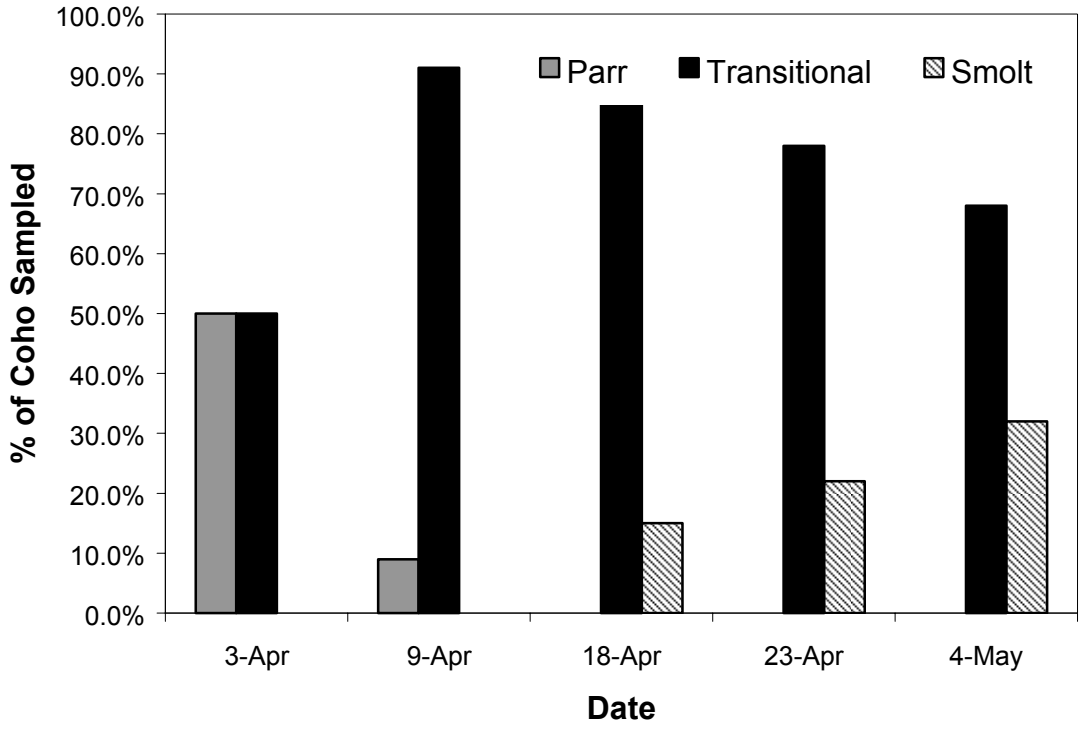

Figure 4. Proportion of coho parr, transitional, and smolts during Butcher Creek acclimation, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall juvenile health (see "Icicle Creek"). Results from the assessment concluded that 6.7% of the individuals suffered from eye loss while 26.7% had missing or badly damaged fins. In addition, 11.0% of the sample displayed predation scars. Mesenteric fat levels were lower than expected (= or > than 2). These observed conditions could be attributed to aviary and mammalian predation and the affects of prolonged exposure. Primary and secondary responses to intense and prolonged stressors such as predation can lead to tertiary, or whole-animal, performance changes. Such changes would include osmotic instability as well as a multitude of other survival-decreasing factors such as depressed growth, immunosupression, and decreased swimming performance (Barton, 2002). One might expect overall fitness of the population to be lower than expected as a result of these observations. (Table 6).

Table 6. Pre-release fish health assessment for Butcher Creek juvenile coho, 2003.

Eyes[1]	Gill [1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen [1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
93.3	100	100	100	1.8	100	100	100	100	67/33	73.3	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.

2- Mesenteric fat was based on a 0-3 numerical system average. A value under 2 equals less than 50% of the pyloric ceaca covered with fat, which is fair.

Mortality

Three hundred and sixty nine coho pre-smolt mortalities were recovered from the Butcher Creek pond during the acclimation period. The actual number of mortalities was unknown. It was difficult to estimate the number of moribund fish that were not visible or consumed by predators. The mortality rate was higher than normal during the first week of acclimation (most likely delayed transport mortality) but quickly normalized for the remainder of acclimation. Predators observed were 6-8 mergansers, a blue heron, and a mink. The estimated mortality rate in Butcher Creek pond for 2003 was 2.83%. Applying the predation estimate previously demonstrated on the Icicle Creek side channel, in-pond loss was 4,233 coho.

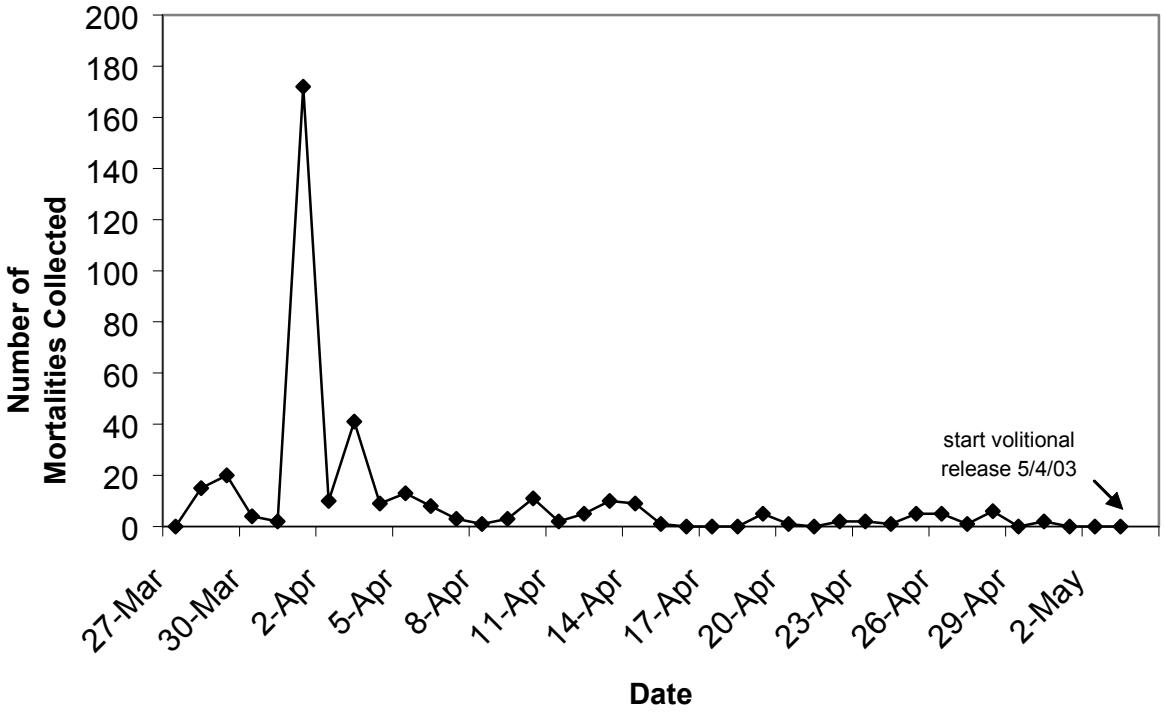

Figure 5. The number of known mortalities collected from the Butcher Creek coho acclimation site, 2003.

Marks and Tags

Coho smolts released from the Butcher Creek acclimation site in 2003 were CWT'ed (CWT code: 050972) with no external marks (adipose fin present). In addition to CWTs, 7,986 coho were PIT tagged. PIT-tagged coho allowed for analysis of survival rates from release to McNary Dam (Murdoch et al. 2004).

PIT-tag Detection System

The Butcher Creek outlet system was constructed of two 8-inch PVC pipes buried within a natural beaver dam that separated the pond and Nason Creek. A custom-built 8"x20" antenna was placed on the pond side of the release pipes. The antenna was designed to encompass both release pipes without multiple, overlapping detection fields. The transceiver was powered by a deep-cell battery and placed in a storage tote for weather protection. Twelve efficiency trials were performed at various water depths (Table 7). Each trial consisted of "wooden fish" being passed through the outlet pipes for a total sample size of 50 per release. These "artificial coho" were constructed out of 5-inch pieces of dowel rod with a PIT tag inserted into a pre-drilled hole. A staff gauge at Nason Creek campground was used to record daily water depth. A correlation between depth vs. detection efficiency was attempted. Detection efficiencies ranged from 90-100% detection. Increased water depths and discharge in Nason Creek did not correlate

with detection efficiencies (r^2=.05). A pooled detection efficiency of 96.2% was applied to determine estimated detections.

Table 7. PIT tag efficiency trials conducted at Butcher Creek acclimation pond, 2003.

Date	Staff gauge depth (ft)	Number of detections	Detection efficiency (%)
May 1	1.85	48/50	96.0
May 8	1.75	48/50	96.0
May 11	1.92	48/50	96.0
May 12	2.02	50/50	100.0
May 13	2.1	50/50	100.0
May 15	2.3	90/100	90.0
May 20	1.68	48/50	96.0
May 24	3.4	46/50	92.0
May 27	2.9	50/50	100.0
June 2	2.84	48/50	96.0

Volitional Release

Coho smolts were volitionally released from Butcher Creek acclimation site beginning on May 4, 2003. The known number of PIT tag detections for 2003 was 5,880 tags. Peak emigration occurred from May 8 to 21. During this period, 4,992 tags were detected (70.1%). Expanding the peak detections by the proportion of PIT tagged juveniles within the population, we estimated 93,483 coho left during this time period. To determine the estimated number of total detections, we expanded the known detections by the pooled detection efficiency to calculate daily estimates. An estimated 7,121 (+/- 33.0) tagged fish left the pond. Applying the proportion of the population that was PIT tagged (5.3%), an estimated 133,462 total coho (+/- 505) exited Butcher Creek acclimation site in 2003 (Figure 6). In-pond survival was estimated at 89.2% (+/-0.4%). Predation (range: 4,233-5,317) and PIT tag detection (95%CI: 15,685-16,694) estimations were considerably different. The predation estimate (see "Icicle Creek") was derived from observance of 6-8 mergansers, one blue heron, and one mink during acclimation at Butcher Creek. One possible explanation for the mortality difference could be the linear regression estimates for May 15-16 when the detection system failed. This was during peak emigration and could have underestimated the number of juveniles that actually exited during this time period. To try and alleviate this difference between the two estimation methods, we will be installing a second detection antenna in series with the original system for the 2004 acclimation season at Butcher Creek. The release continued through June 25 when PIT-tagged fish were no longer detected.

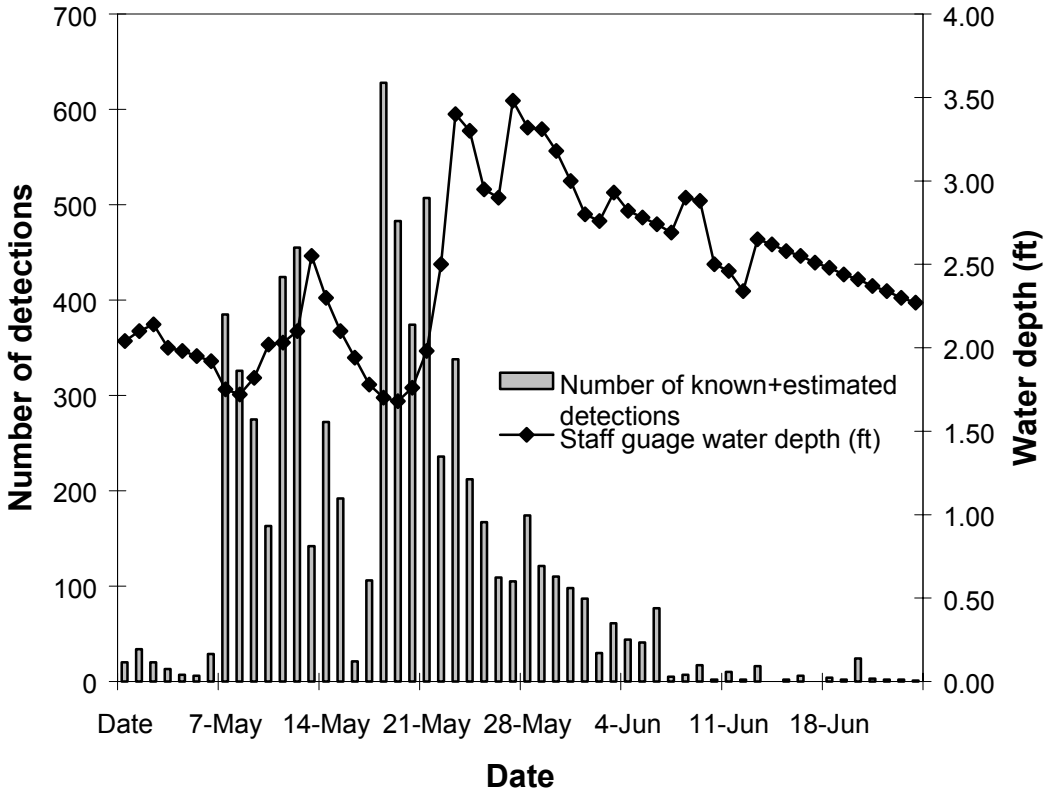

Figure 6. PIT tags detected during emigration at Butcher Creek acclimation site, 2003.

Coulter Creek

The Coulter Creek acclimation site is located at RK 1.6 on Coulter Creek. The Coulter Creek drainage enters into Nason Creek at RK 13.7. This natural site is composed of multiple braided channels that condense into a large, widened waterway for acclimation. A large barrier net encircled the majority of the channel to ensure containment during acclimation. Prior to release, the migration corridor was cleared to ensure connectivity from the pond to the existing Coulter Creek. Before entering Nason Creek, Coulter and Roaring creeks connect within a massive beaver pond. We cleared existing channels to ensure fish passage through the beaver dam before entering Nason Creek. The acclimation site is privately owned and known to have had a small population of brook trout inhabiting the complex.

Transportation and Size

A total of 86,013 hatchery coho pre-smolts were transported to Coulter Creek acclimation site from Cascade FH and Willard NFH between March 28 and April 1, 2003. Fish transported to Coulter Creek averaged 21.3 FPP and were mid-Columbia brood origin (BY 2001) (Appendix A). We sampled coho in the pond once a week between April 8 and April 30, 2003. Random dip net samples were collected within the acclimation pond

and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and fish per pound for the four weekly samples are reported in Table 8. The final sample occurred on April 30, one day prior to the start of the volitional release.

Table 8. Coho growth sampling during acclimation at Coulter Creek pond, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
April 8	132.1	24.4	1.06	18.6
April 17*	***132.7***	***28.9***	***1.24***	***15.7***
April 22	139.2	27.8	1.03	16.3
April 30	135.6	28.7	1.15	15.8

** Due to windy weather conditions during sampling, fish weights may not be accurate.*

Mortality

Eighty-one coho pre-smolt mortalities were recovered from the Coulter Creek site during the acclimation period. The actual number of mortalities was unknown. It was difficult to estimate the number of moribund fish that were not visible or consumed by predators. The mortality rate was higher than normal during the first week of acclimation (most likely delayed transport mortality) but quickly normalized for the remainder of acclimation. Predators observed were an otter and a blue heron. The estimated mortality rate in Coulter Creek acclimation site for 2003 was 3.93%. Applying the predation estimate demonstrated at previous acclimation sites, in-pond loss was 3,382 coho.

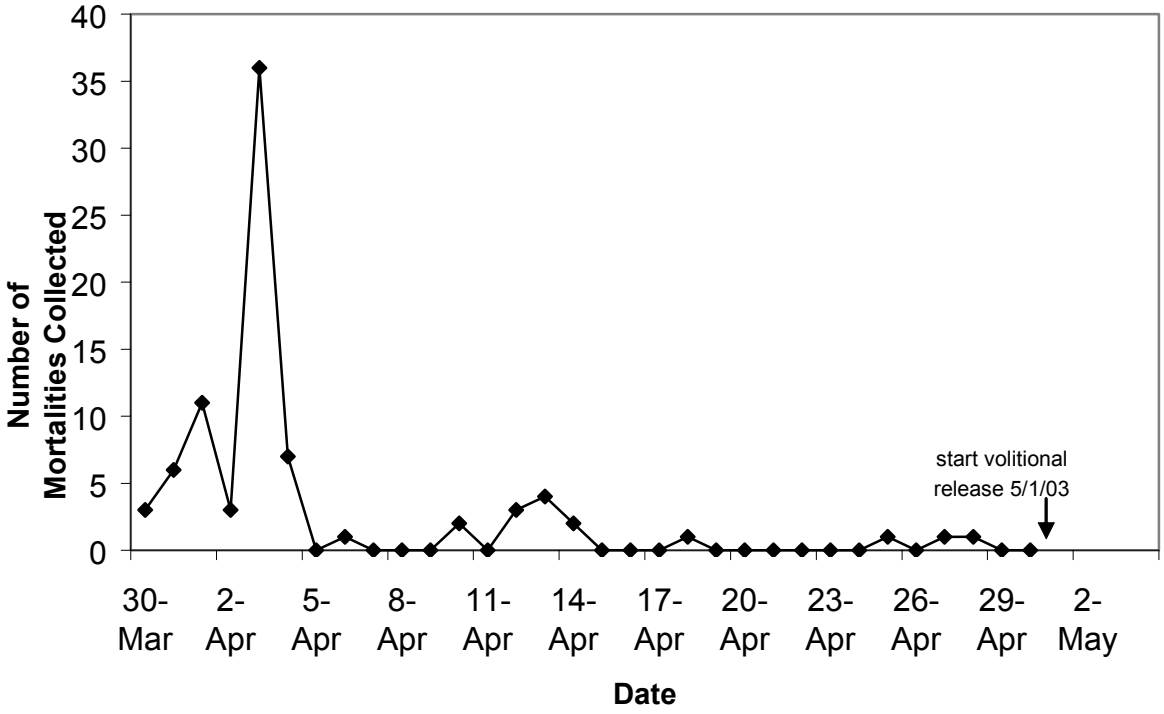

Figure 7. The number of known mortalities collected from the Coulter Creek coho acclimation site, 2003.

Marks and Tags

Coho transported from Cascade FH and Willard NFH were coded-wire tagged (CWT'ed) with no external marks (Cascade CWT code: 050968; Willard NFH CWT code: 054326). Accounting for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss, the number of CWT juveniles released from the Coulter Creek acclimation site was 79,824. The total number of juvenile coho released from the acclimation site was 82,631.

Table 9. CWT tagged coho released from Coulter Creek acclimation pond, 2003.

Hatchery	Number of fish tagged	Mark	Tag Retention (%)	Tag Code	Tag loss and mortality	Number CWT released
Cascade FH	52,959	CWT only	95.6	050968	5,652	47,307
Willard NFH	34,701	CWT only	98.1	054326	2,184	32,517

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. We classified the coho as either parr, transitional, or smolt (see "Icicle Creek"). The proportion of transitional and smolt coho increased throughout acclimation, while the proportion of parr decreased (Figure 7).

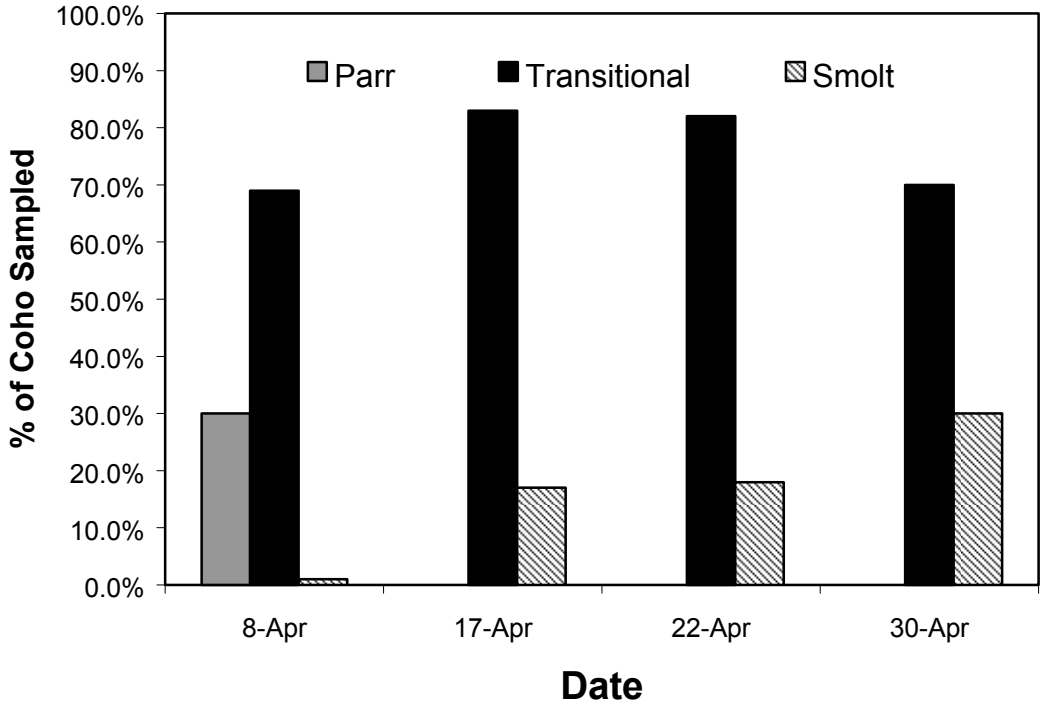

Figure 8. Proportion of coho parr, transitional, and smolts during Coulter Creek acclimation, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall health (see "Icicle Creek"). Results from the assessment concluded that the majority of the juveniles were in good condition prior to release. Fin fraying was noticed but within only a small proportion of the population. The average mesenteric fat level was 2.0 (Table 10).

Table 10. Pre-release fish health assessment for Coulter Creek juvenile coho, 2003.

Eyes[1]	Gill [1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen [1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
100	100	100	100	2.0	100	100	100	100	60/40	86.0	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.

2- Mesenteric fat was based on a 0-3 numerical system average. A value under 2 equals less than 50% of the pyloric ceaca covered with fat, which is fair.

Volitional Release

Coho smolts were volitionally released from the Coulter Creek acclimation site. The release began on May 1 at 6 p.m. and continued through June 17, when visual observation determined that all fish had exited the pond. An estimated 82,631 juvenile coho exited the acclimation site during this time period.

Mahar Pond

Mahar Pond acclimation site is located on an unnamed, seasonal creek which connects to the lower end of Mahar Creek before draining into Nason Creek at RK 20.3. The earthen pond was constructed and developed by the property owner. The migration corridor from the acclimation site to Nason Creek is approximately 200 meters in length. The inflow is supplied by an intermittent stream. Prior to receiving pre-smolts, a barrier net was placed at the outlet for containment purposes.

Transportation and Size

A total of 34,375 hatchery coho pre-smolts were transported to Mahar Pond acclimation site from Willard NFH on April 1, 2003. Fish transported to Mahar Pond averaged 19.0 FPP. These juveniles were progeny of mid-Columbia adult matings in 2001. Growth sampling occurred in-pond once a week between April 7 and April 29, 2003. Random dip net samples were collected within the acclimation pond and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and fish per pound for the four weekly samples are reported in Table 10. The final sample occurred on April 29, seven days prior to the start of the volitional release.

Table 11. Coho growth sampling during acclimation at Mahar Pond, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
April 7	128.5	24.9	1.17	18.2
April 17	130.5	27.1	1.22	16.7
April 21	130.3	26.9	1.22	17.6
April 29	133.7	29.1	1.22	15.6

Mortality

Forty-three coho pre-smolt mortalities were recovered from Mahar Pond during the acclimation period. The actual number of mortalities was unknown. It was difficult to estimate the number of moribund fish that were not visible or consumed by predators. The mortality rate was relatively constant throughout acclimation. An otter was the only predator observed during acclimation. The estimated mortality rate at Mahar Pond acclimation site for 2003 was 3.0%. Applying the predation estimate demonstrated at previous acclimation sites, in-pond loss was 1,031 coho.

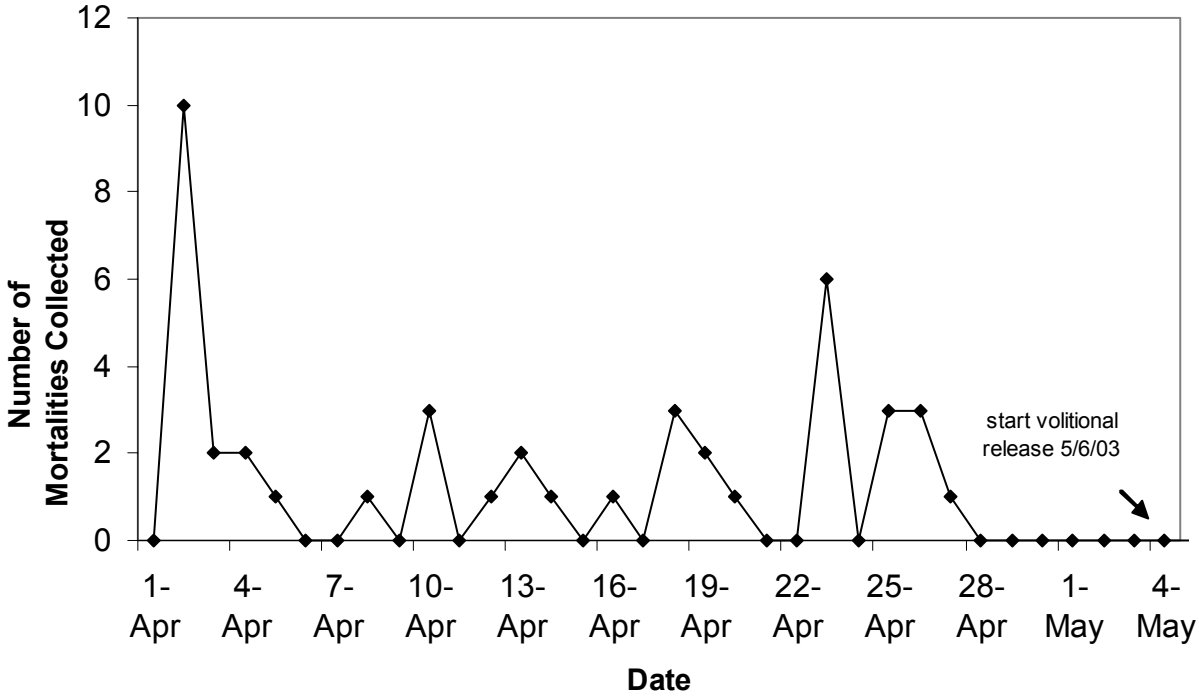

Figure 9. The number of known mortalities collected from the Mahar Pond coho acclimation site, 2003.

Marks and Tags

Coho transported from Willard NFH were coded-wire tagged (CWT'ed) with no external marks (CWT code: 054328). Accounting for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss, the number of CWT juveniles released from Mahar Pond acclimation site was 32,677. The total number of juvenile coho released from the acclimation site was 33,344.

Table 12. CWT tagged coho released from Mahar Pond acclimation pond, 2003.

Hatchery	Number of fish tagged	Mark	Tag Retention (%)	Tag Code	Tag loss and mortality	Number CWT released
Willard NFH	35,033	CWT only	98.0	054328	2,356	32,677

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. We classified the coho as either parr, transitional, or smolt (see "Icicle Creek"). The proportion of transitional and smolt coho increased throughout acclimation, while the proportion of parr decreased (Figure 7).

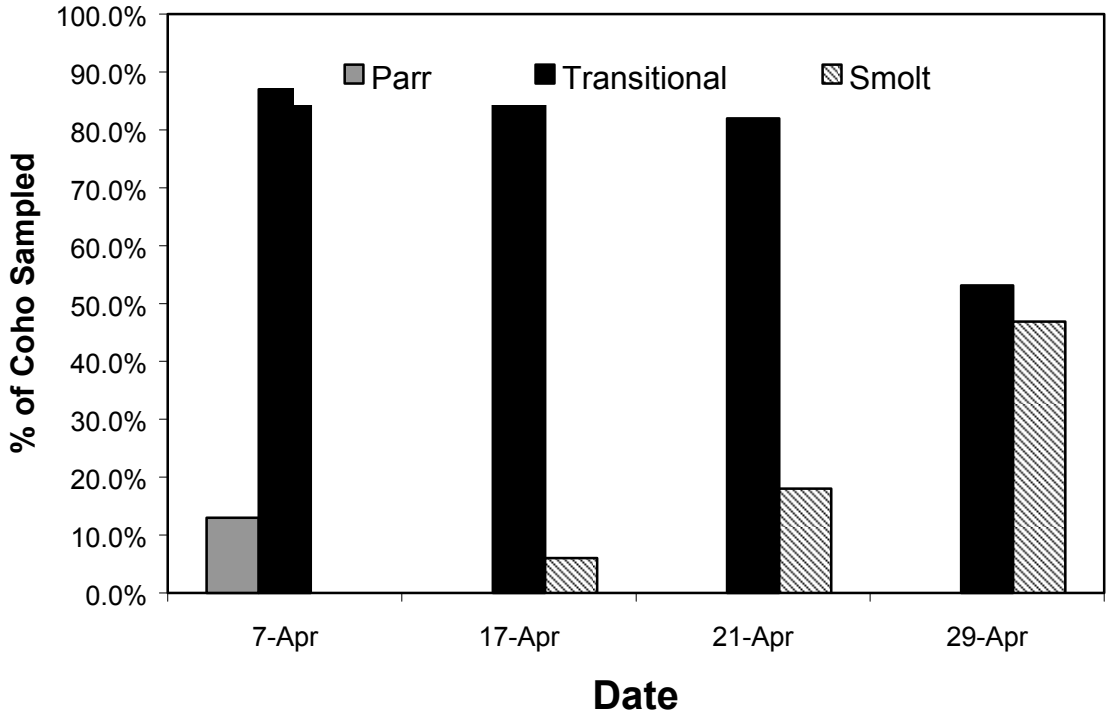

Figure 10. Proportion of coho parr, transitional, and smolts during Mahar Pond acclimation, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall health (see "Icicle Creek"). The results from the assessment concluded that the juveniles were in good condition prior to release with no major abnormalities. Fin fraying was noticed but within only a small proportion of the population. The average mesenteric fat level was 2.2 (Table 13).

Table 13. Pre-release fish health assessment for Mahar Pond juvenile coho, 2003.

Eyes[1]	Gill [1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen [1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
100	100	100	100	2.2	100	100	100	100	55/45	93.3	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.
2- Mesenteric fat was based on a 0-3 numerical system average. A value under 2 equals less than 50% of the pyloric ceaca covered with fat, which is fair.

Volitional Release

Coho smolts were volitionally released from the Mahar Pond acclimation site. The release began on May 6 at 5 p.m. and continued through June 18, when visual observation determined that all fish had exited the pond. An estimated 33,344 juvenile coho exited the acclimation site during this time period.

Beaver Creek

The Beaver Creek acclimation site is located at RK 2.4 on Beaver Creek. Returning adults will be given the opportunity to naturally spawn in Beaver Creek and Wenatchee River tributaries located above Tumwater Canyon but below Nason Creek. Beaver Creek enters the Wenatchee River near Plain, WA at RK 74.4. The Beaver Creek acclimation pond was constructed in the mid 1980s and is located behind Mountain Springs Lodge. Originally, the pond was stocked with Kamloops rainbow trout for aesthetic purposes. Predation on these year-round residents became too problematic and the stocking was discontinued. Since then, the pond has not been stocked with fish until the introduction of coho juveniles. Containment structures were installed at the pond inlet and outlet.

Transportation and Size

A total of 75,043 hatchery coho pre-smolts were transported to Beaver Creek acclimation site from Cascade FH on April 2, 2003. Fish transported to Beaver Creek averaged 20.2 FPP. These juveniles were progeny of mid-Columbia adult matings in 2001. Growth sampling occurred in-pond once a week between April 7 and May 5, 2003. Random dip net samples were collected within the acclimation pond and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and fish per pound for the four weekly samples are reported in Table 14. The final sample occurred on May 5 which was immediately followed by the volitional release.

Table 14. Coho growth sampling during acclimation at Beaver Creek acclimation site, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
April 7	126.5	23.6	1.17	19.2
April 13	130.5	25.8	1.16	17.6
April 23	1329	26.8	1.14	16.9
May 5	140.6	30.1	1.08	15.1

Mortality

Forty-seven coho pre-smolt mortalities were recovered from Beaver Creek during the acclimation period. The actual number of mortalities was unknown. It was difficult to estimate the number of moribund fish that were not visible or consumed by predators. The mortality rate was higher than normal during the first week of acclimation (most likely delayed transport mortality) but quickly normalized for the remainder of acclimation. Predators observed during acclimation were two otters and a blue heron. The estimated mortality rate at Beaver Creek acclimation site for 2003 was 6.1%. Applying the predation estimate demonstrated at previous acclimation sites, in-pond loss was 4,566 coho.

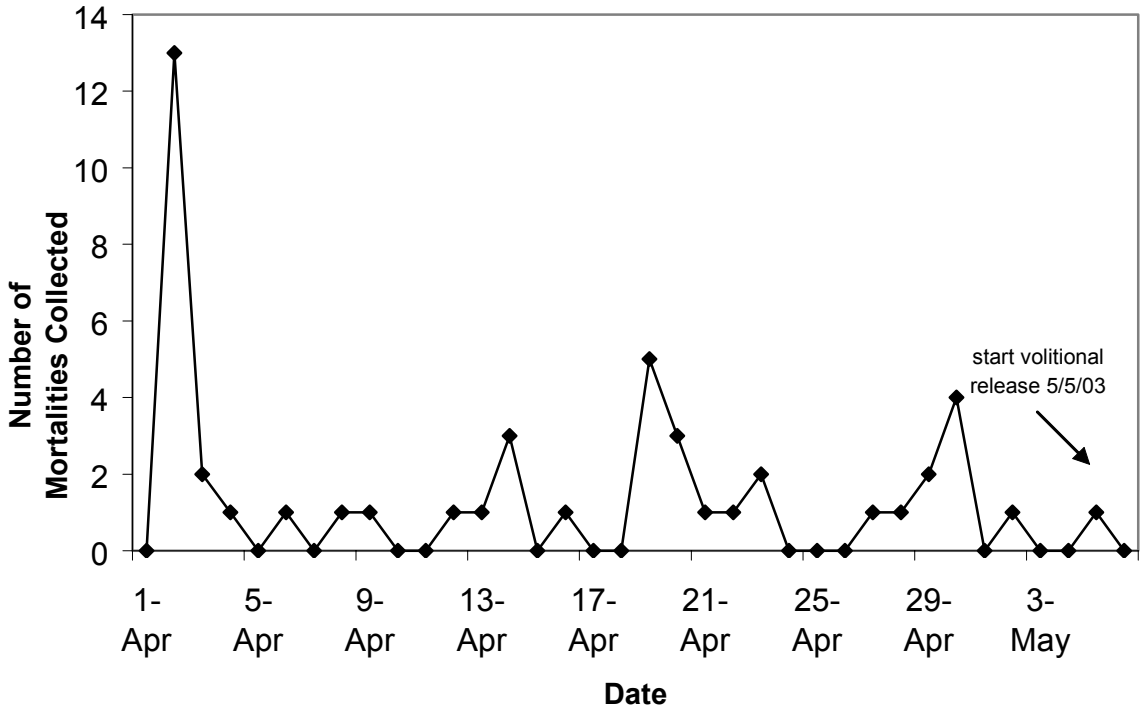

Figure 11. The number of known mortalities collected from the Beaver Creek coho acclimation site, 2003.

Marks and Tags

Coho transported from Cascade FH were coded-wire tagged (CWT'ed) with no external marks (CWT code: 050969). Accounting for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss, the number of CWT juveniles released from Beaver Creek acclimation site was 67,376. The total number of juvenile coho released from the acclimation site was 70,477.

Table 15. CWT tagged coho released from Beaver Creek acclimation pond, 2003.

Tagging Hatchery	Number of fish tagged	Mark	Tag Retention (%)	Tag Code	Tag loss and mortality	Number CWT released
Cascade FH	75,043	CWT only	95.6	050969	7,667	67,376

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. We classified the coho as either parr, transitional, or smolt (see "Icicle Creek"). The proportion of transitional and smolt coho increased throughout acclimation, while the proportion of parr decreased (Figure 7).

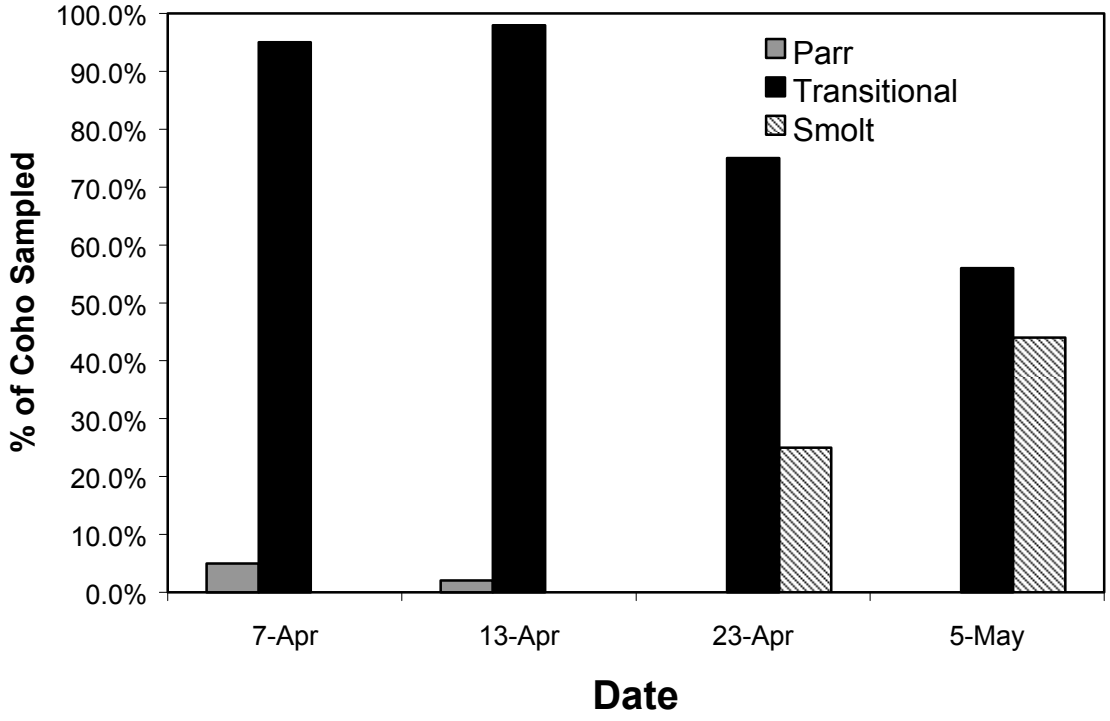

Figure 12. Proportion of coho parr, transitional, and smolts during Beaver Creek acclimation, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall health (see "Icicle Creek"). Results from the assessment concluded that prior to release the fish were in good condition without any abnormalities (Table 16).

Table 16. Pre-release fish health assessment for Beaver Creek juvenile coho, 2003.

Eyes[1]	Gill [1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen [1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
100	100	100	100	2.2	100	100	100	100	45/55	100	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.

2- Mesenteric fat was based on a 0-3 numerical system average. A value under 2 equals less than 50% of the pyloric ceaca covered with fat, which is fair.

Volitional Release

Coho smolts were volitionally released from the Beaver Creek acclimation site. The release began on May 5 at 3 p.m. and continued through June 16, when visual observation determined that all fish had exited the pond. Immediately after the release began, fish were observed again not exiting the acclimation site similarly seen in 2002. We cleared debris from the upstream channel to supply increase flow to the pond. The increased flow appeared to create more attraction water exiting the pond. Fish were observed exiting the pond shortly thereafter. An estimated 70,477 juvenile coho exited the acclimation site during the release period.

Two Rivers

The Two Rivers acclimation site is located at the Two Rivers gravel pit at RK 1.6 on the Little Wenatchee River. The site consists of an overflow channel that was used during high water The Little Wenatchee River is one of two inlet rivers for Lake Wenatchee. This site was originally an overflow channel for high water events on the Little Wenatchee. Water was supplied to the acclimation site by pumping water in from the adjacent, existing quarry lake. A containment screen was inserted during the acclimation period. The migration corridor from the pond consisted of approximately one mile of concrete/earthen channel that enters directly into the Little Wenatchee River. Coho smolts are volitionally released. Due to the remote location of this site, and the need for continuous pump operation, personnel were on-station 24 hours a day, seven days a week throughout acclimation.

Transportation and Size

A total of 100,234 hatchery coho pre-smolts were transported to Two Rivers acclimation pond from Willard NFH on March 20-21, 2003. Fish transported to the acclimation pond averaged 20.9 FPP and were mid-Columbia brood origin from the 2001 adult matings (Appendix A). We sampled coho in the pond once a week between April 4 and April 28, 2003. Random dip net samples were collected within the acclimation pond and pooled together to provide a weekly size estimate (*n=100*). The mean length, weight, condition factor and fish per pound for the five weekly samples are reported in Table 17. The final sample occurred on April 28, one day prior to the start of the volitional release.

Table 17. Coho growth sampling during acclimation at Two Rivers, 2003.

Date	Mean Fork Length(mm)	Mean Weight (g)	K-factor	Fish per pound (FPP)
April 4	127.8	24.4	1.17	18.6
April 10	125.7	24.2	1.22	18.8
April 18	131.7	26.7	1.17	17.0
April 28	136.8	29.5	1.15	15.4

Juvenile Morphology and Development

Coho juveniles were identified by developmental and morphological differences seen during growth sampling. We classified the coho as either parr, transitional, or smolt (see "Icicle Creek"). The proportion of transitional and smolt coho increased throughout acclimation, while the proportion of parr decreased (Figure 13). The pre-release sample demonstrated that all of the coho prior to release were either transitional or smolt developmental stage (57.0% transitional; 43.0% smolt).

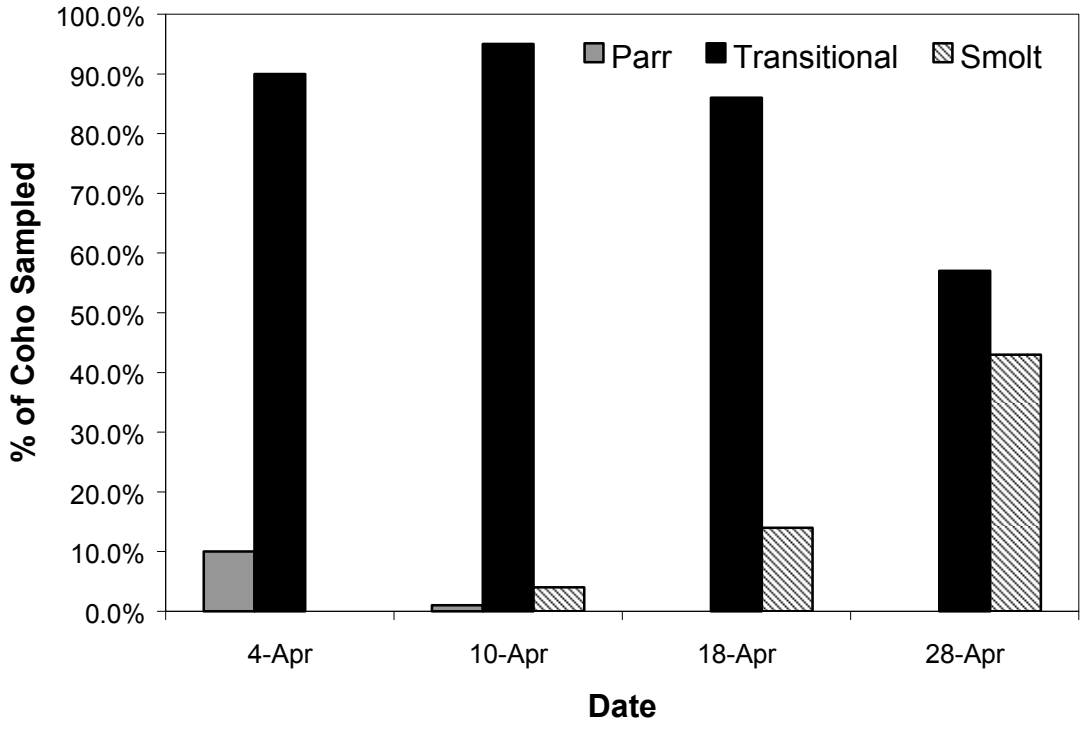

Figure 13. Proportion of coho parr, transitional, and smolts during Two Rivers acclimation, 2003.

Fish Health/Condition Assessment

We performed a pre-release fish condition assessment (*n=20*) to examine overall health (see "Icicle Creek"). Results from the assessment concluded that a small proportion of the population had frayed fins but most of the damage to the fins were pre-transfer injuries

(Table 18). Overall, the population was in good condition and no abnormalities were observed.

Table 18. Pre-release fish health assessment for Two Rivers juvenile coho, 2003.

Eyes[1]	Gill [1]	Psuedo-branchs[1]	Thy-mus[1]	Mes. Fat[2]	Spleen [1]	Hind[1] Gut	Kid-ney[1]	Liver[1]	Gender MvsF	Fin Cond.[1]	Opercle[1]
100	100	100	100	2.4	100	100	100	100	50/50	93.3	100

1- All components were based on a normality index (% norm). Variance in organ color and size was not looked at.

2- Mesenteric fat was based on a 0-3 numerical system average. A value under 2 equals less than 50% of the pyloric ceaca covered with fat, which is fair.

Mortality

Fifty-three coho pre-smolt mortalities were recovered from the Two River site during the acclimation period. The actual number of mortalities was unknown. It was difficult to estimate the number of moribund fish that were not visible or consumed by predators. The mortality rate was relatively low throughout acclimation (Figure 14). Predators observed were two mergansers and one river otter. The estimated mortality rate for Two Rivers in 2003 was 2.42%. Applying the predation estimate previously demonstrated on the Icicle side channel, in-pond loss was 2,427 coho.

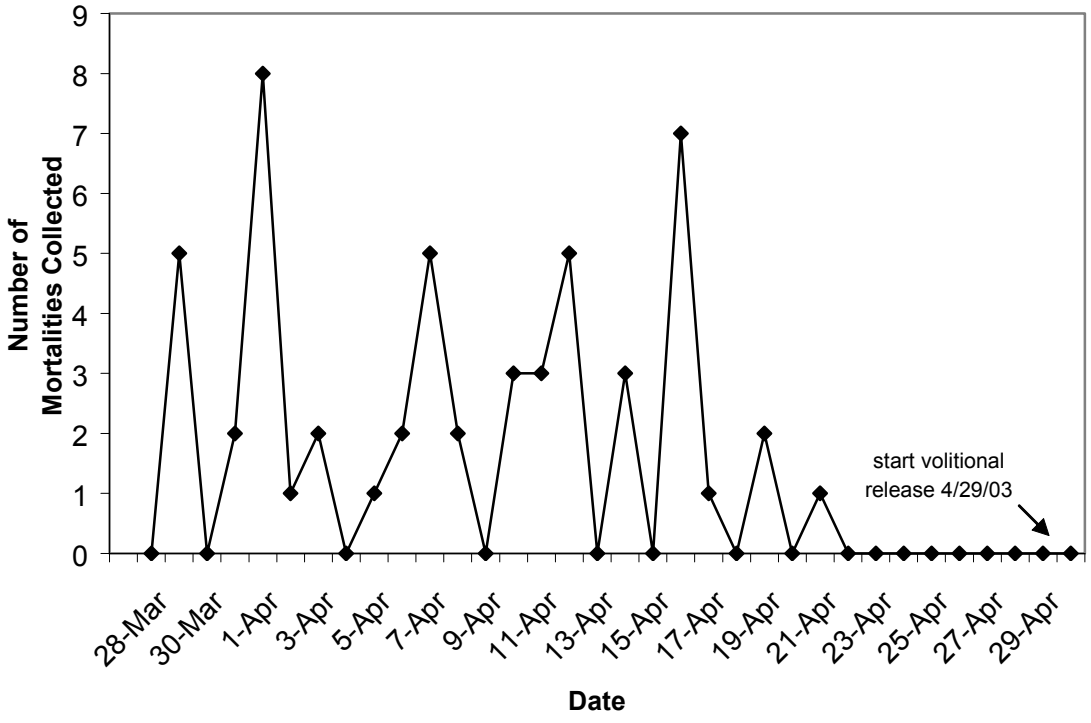

Figure 14. The number of known mortalities collected from Two Rivers coho acclimation site, 2003.

Marks and Tags

Coho transported from Cascade FH were coded-wire tagged (CWT'ed) with no external marks (Table 19). Accounting for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss, the number of CWT juveniles released from Beaver Creek acclimation site was 95,199. The total number of juvenile coho released from the acclimation site was 97,807. In addition to CWTs, 8,994 PIT tagged coho were transported to the site. PIT-tagged coho allowed for analysis of survival rates from release to McNary Dam (Murdoch et al. 2005).

Table 19. CWT tagged coho released from Two Rivers acclimation pond, 2003.

Tagging Hatchery	Number of fish tagged	Mark	Tag Retention (%)	Tag Code	Tag loss and mortality	Number CWT released
Willard NFH	33,728	CWT only	95.8	054324	2,388	31,340
Willard NFH	33,684	CWT only	98.6	054325	1,466	32,218
Willard NFH	33,385	CWT only	97.6	054327	1,744	31,641

PIT-tag Detection System

The Two Rivers outlet system was constructed of approximately 200 meters of concrete channel which entered an earthen slough that drained into the Little Wenatchee. At the uppermost part of the channel, notched dam boards were placed to regulate pond depth. A custom-built 4'x4' antenna was placed below the outlet containment screen/dam boards anchored in place by a wood frame fitted into the channel. The antenna was designed to encompass the entire cross-sectional area of the channel while maximizing detection efficiency. Below the antenna, a second set of notched dam boards were placed to create a reservoir within the channel. The theory behind this was that by creating a pool, detection efficiency would improve drastically. The 1001-A transceiver was powered by a four deep-cell batteries and placed in a storage tote for weather protection. A second tote was designed to contain a laptop computer also powered by four deep-cell batteries. This detection system setup was designed for instantaneous data transfer from transceiver to computer. Efficiency trials were performed prior to release at various water depths. Each trial consisted of "wooden fish" being passed through the outlet pipes for a total sample size of 100 per test. These "artificial coho" were the same used in the Butcher Creek trials. Water depth was measured in-pond with a staff gauge. A correlation between depth vs. detection efficiency was attempted. Detection efficiencies were 100% (*N=6*). The high detection efficiencies were due to the reservoir environment that was created.

Volitional Release

Coho smolts were volitionally released from Two Rivers acclimation site beginning on April 28, 2003. The known number of PIT tag detections for 2003 was 5,720 tags (63.6%). Peak emigration occurred from April 30 through the May 8. During this period, 3,822 tags were detected (66.8%). Expanding the peak detections by the proportion of PIT tagged juveniles within the population, we estimated 42,595 coho left during this time period. Applying the proportion of the population that was PIT tagged (9.0%), an estimated total of 63,747 coho exited Two Rivers acclimation site in 2003 (Figure 15). This was the first year for the Two Rivers detection system and it was problematic. The system was extremely sensitive to both internal and external noises, which created a decreased detection field. The internal noise was being created with alternating power sources from DC power to AC power between the transceiver and the laptop computer. External noise came from the equipment being operated at the gravel pit. Fish milling within the exit channel reservoir created massive tag collisions. When a PIT tagged fish milled within the detection field, the antenna was not able to detect other tagged fish passing through. This milling behavior also resulted in repetitive detections of a single tagcodes. A total of 60,054 "hits" were detected during the release. A "hit" was a single detection of a unique tagcode entering the detection field at any given time. We observed coho entering the detection field, being detected, exiting the field, and then re-entering the field again numerous times. The detection transceiver does not have the ability to sort through previously detected tagcodes and the release continued through May 30 when we no longer detected any PIT-tagged fish. Overall emigration timing was not well demonstrated because of the interruption during the release. Coho were prevented from leaving the pond during detection system maintenance periods. The second peak in emigration was likely the result of delay caused by system maintenance.

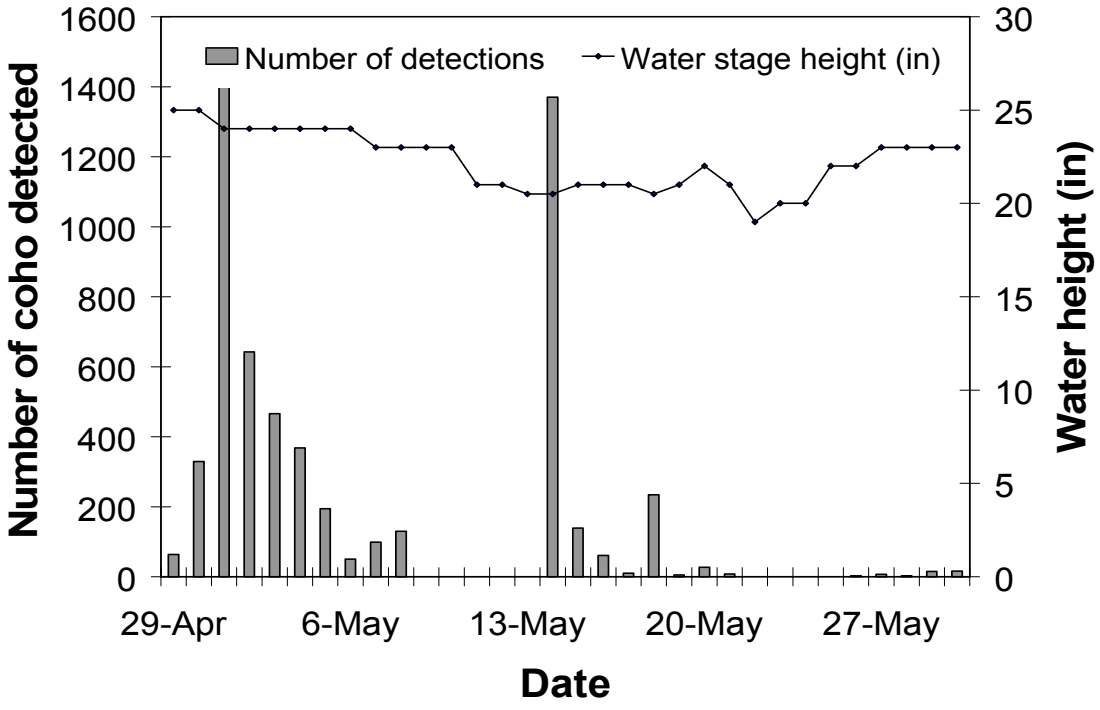

Figure 15. PIT tags detected during emigration at Two Rivers acclimation site, 2003.

Methow River Basin

Winthrop National Fish Hatchery

Coho smolts released into the Methow River in 2003 were acclimated and released at the Winthrop National Fish Hatchery, located at RK 80.6 on the Methow River. All coho juveniles were derived from lower Columbia River (LCR) stock.

Transportation

Approximately 242,936 hatchery coho pre-smolts were transported to the Winthrop NFH from Willard NFH on March 18-21, 2003. The coho previously on-station were transported to the Wenatchee River basin for acclimation and release from Icicle Creek side-channel. The received fish were all progeny of lower Columbia River stock spawned and reared at Willard NFH. Approximately 59,940 coho were immediately direct-planted into Spring Creek (the hatchery outfall) while the remaining 182,996 juveniles were held on-station in raceways.

Mortality

Mortality and predation were consistently low throughout acclimation. Predation was only documented with coho that were held on-station and not coho acclimated in the back channel (Spring Creek hatchery outfall). Reduced predation has been a direct result of

acclimating on hatchery grounds. Total mortality during acclimation at Winthrop NFH was 518 pre-smolt coho (0.24%). Mortality for coho acclimated in the back channel is unknown.

Marks and Tags

Coho transported from Willard NFH to Winthrop NFH were coded-wire tagged (CWT'ed) with no external marks. Accounting for pre-transfer mortality, in-pond acclimation mortality, and estimated tag loss, the number of CWT juveniles released from Winthrop NFH was 233,247 (Table 20).

Table 20. LCR stock coded-wire tagged coho released from Winthrop NFH, 2003.

Tagging Hatchery	Number of fish tagged	Mark	Tag Retention (%)*	Tag Code	Tag loss and mortality	Number CWT released
Willard NFH	29,439	CWT only	98.6	054909	510	28,929
Willard NFH	30,818	CWT only	99.0	054331	524	30,294
Willard NFH	36,252	CWT only	98.2	054330	1206	35,046
Willard NFH	35,570	CWT only	98.4	054329	969	34,601
Willard NFH	37,610	CWT only	94.8	054323	2254	35,356
Willard NFH	37,543	CWT only	92.8	054322	2853	34,690
Willard NFH	37,725	CWT only	92.2	054321	3394	34,331

Volitional Release and Size

The USFWS volitionally released 182,415 coho smolts from the Winthrop NFH between April 19 and 30, 2003. On April 30, the remaining juvenile coho were forced out of the raceways. Fish size at release was 18.6 FPP (B. Galyean pers. comm.).

Summary

Acclimating pre-smolts on local waters may be key to the successful reintroduction of coho salmon in mid-Columbia River basins. The Mid-Columbia Coho Hatchery and Genetic Management Plan (HGMP 2002) establishes program release numbers. Smolt release goals for the Methow and Wenatchee rivers in 2003 were 250,000 and 1,000,000 fish, respectively. Coho within the Methow program, were released solely from Winthrop NFH, and achieved an estimated 99.7% transport-to-release survival for the on-station releases. In the Wenatchee basin, overall survival was 97.1% from transport to release. This survival is lower than what was seen in 2002 (99.0%), but possibly more accurate because it accounted for in-pond predation. A total of 911,422 coho were

released in the Wenatchee basin, and 242,355 coho were released into the Methow River in 2003 (Appendix A).

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Chapter 2: 2003 Broodstock Development: Collection, Spawning, Incubation and Transportation

Introduction

Inter-basin salmon transfers throughout this century were common for most coho hatcheries in the lower Columbia River. Many of these lower Columbia River coho hatcheries have been in operation since the early 1900s. Given the lengthy culture history of these stocks, it is likely many have been subjected to intensive domestication selection for generations. Domestication is usually attributed to the effects of genetic drift which may result from low founding broodstock numbers and selection pressures from rearing fish in the hatchery environment (Calaprice 1969; Cross and King 1983; Allendorf and Phelps 1980). Fish populations which have been subjected to artificial selection may perform well in the hatchery, but poorly in the wild (Busack et al. 1997). The hatchery environment shifts mortality to later stages of life, and may produce opportunity for genetic change within the population (Waples 1991).

Success of the coho re-introduction program relies on the development of a local broodstock from the adult returns of reprogrammed coho from lower Columbia River hatcheries. Our ability to trap returning coho is essential to the broodstock development process.

In 2003, coho trapping efforts were centered on collection at Dryden Dam. The Dryden Dam fish traps are not designed to be 100% effective. The efficiency of Dryden Dam depends upon river flows and fish migration patterns (K. Petersen, WDFW, pers. comm.). Adult traps were placed on the downstream side of Dam 5 located on Icicle Creek side channel to supplement Dryden Dam broodstock collection. Although not used in 2003 for broodstock collection, other potential trapping sites for the Wenatchee River broodstock include Tumwater Dam and Priest Rapids Dam.

Coho returning to the Methow River basin are trapped at Winthrop National Fish Hatchery and the Wells Dam west ladder trap. At Winthrop NFH, coho volunteer into the adult holding ponds. Trapping at Wells Dam occurred concurrently with Washington Department of Fish and Wildlife (WDFW) steelhead broodstock collection.

The discussion below describes coho trapping and spawning in the Wenatchee and Methow rivers and fundamentals of the broodstock development process.

Wenatchee River Basin

Broodstock Collection

Hatchery coho returning to the Wenatchee River in 2003 were trapped from the left and right banks at Dryden Dam (Wenatchee RK 28.2). Trapped coho were either transported to Entiat National Fish Hatchery (USFWS) for holding/spawning or released to the river if weekly broodstock collection goals had been met.

A total of 2,693 adult coho were trapped between September 8 and November 24. Of the 1,706 total adult coho collected for broodstock, the Dryden Dam trapping facility supplied 1,654 (97.0%) coho for broodstock. The male-to-female sex ratio for the 2003 brood year was 1:4:1. In addition to Dryden Dam, 52 coho adults were collected from Dam 5. Coho broodstock were collected at Dam 5 while high flows in the Wenatchee River rendered the Dryden trap inoperable (Table 1). Coho trapping occurred from September 8th through November 24th. Trap operations ceased when high water and trap malfunction made it impossible to continue. Between October 7 and October 17, we trapped 55.6% of the overall run sampled at Dryden Dam; peak collection occurred on October 15 (310 coho; Figure 1).

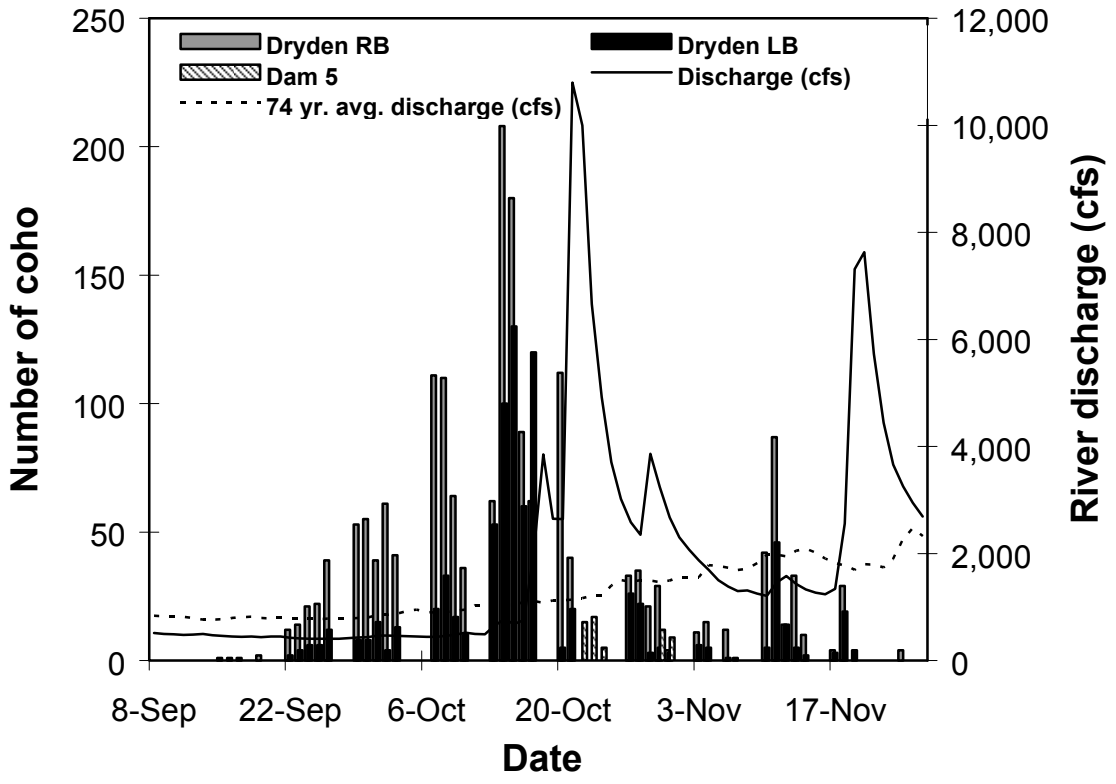

Figure 1. Distribution of coho salmon trapped at Dryden Dam right bank (RB), left bank (LB), and Dam 5 in relation to discharge (cfs), 2003.

Dryden Dam appeared to be an effective trapping site for coho in 2003. The trap efficiency varied depending on river flow and fish migration patterns. Typically, the Wenatchee River flows are low during the months when coho return (range: 850-2300 cfs; 74 yr. avg.). Wenatchee River flows exceeded the average twice during trapping last year with unusually high amount of precipitation. Flows peaked at 10,800 and 7,630 cfs during these two periods. High flows more than likely decreased trapping efficiencies during these two periods. Dryden Dam will remain the primary trapping site in the basin.

Spawning

Of the 1,706 coho collected, 46.5% were females (*n=793*) and 53.5% were males (*n=913)*. While in the holding pond, the pre-spawn mortality rate was 13.9% (*n=237*). A total of 1,419 coho adults (679 females and 740 males) were spawned between October 14 and November 18, 2003. Peak spawning occurred on November 4 with one hundred eighty-three ripe females (Figure 2). The spawn timing for the 2003 brood was succinct compared to previous years; six versus eight or nine weeks (Figure 3).

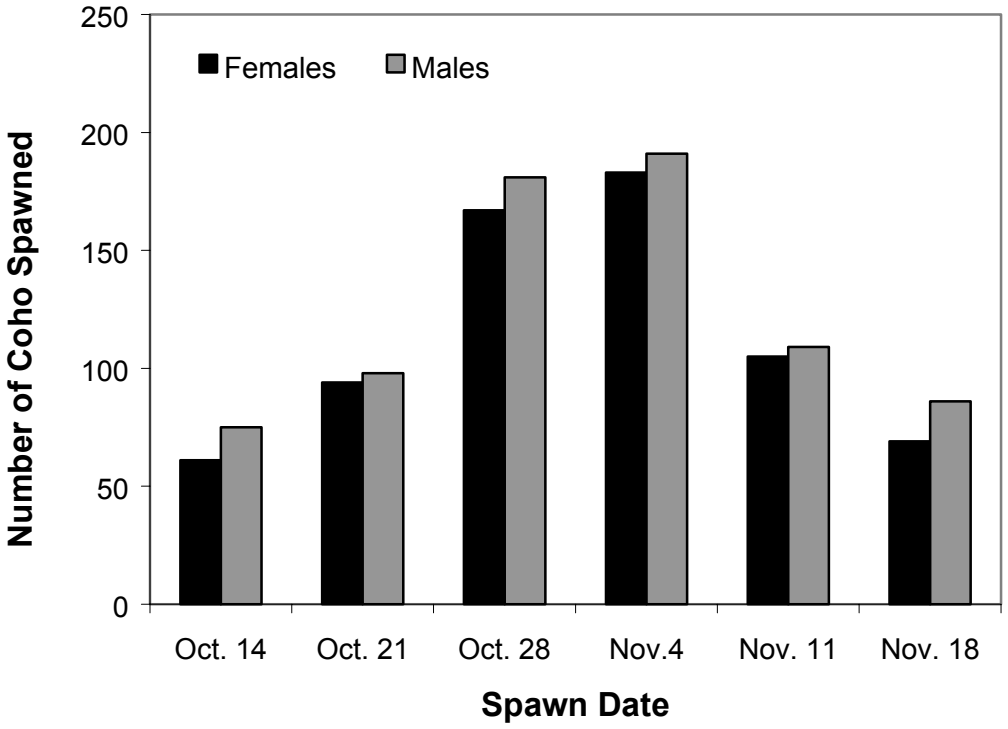

Figure 2. Number of coho spawned at Entiat National Fish Hatchery (ENFH), 2003.

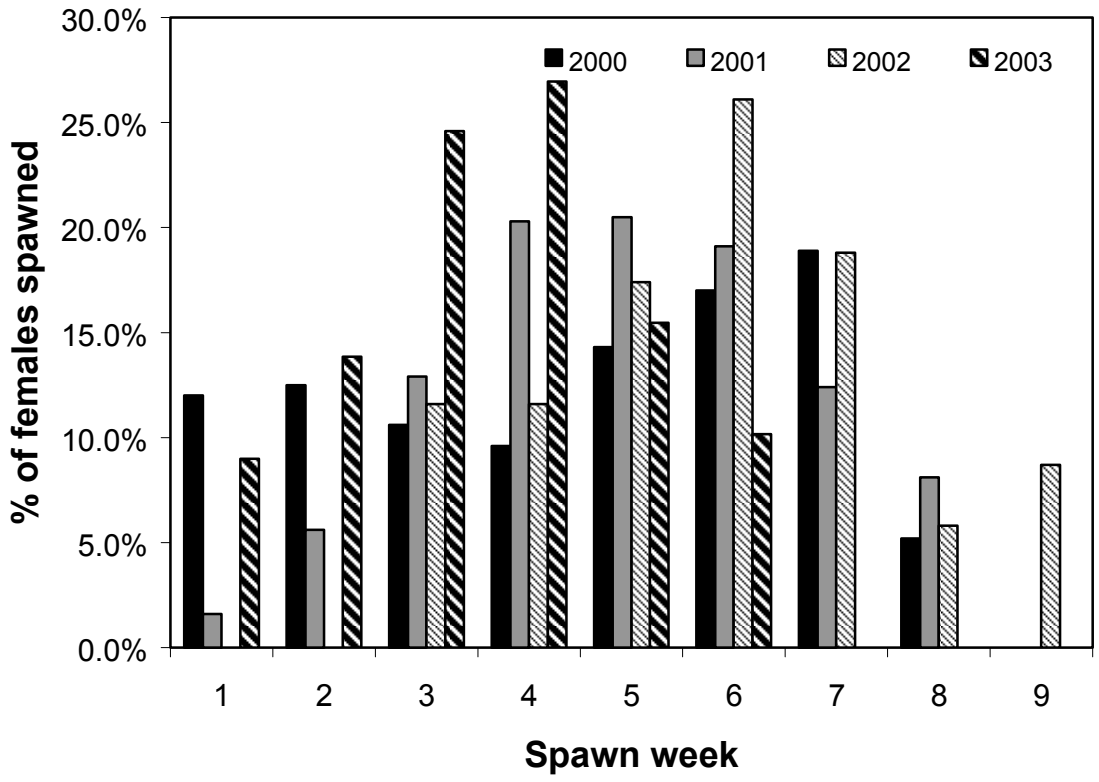

Figure 3. Spawning duration in weeks for brood years 2000 through 2003.

In addition to on-station mating, 30 males were spawned and transported to a cryopreservation facility in Pullman, WA. The cryopreserved milt will be used in 5 to 10 years to evaluate the broodstock development process and resulting phenotypic and/or genetic divergence from the founding stock. Twenty males were surplused at the end of spawning.

Broodstock Composition

The mean fork length (FL) of the females and males within the broodstock was 66.7 cm and 63.3 cm, respectively (SD=7.3, SD=7.7; Table 1). The 2003 brood females were significantly larger in fork length ($p<.01$) than the 2003 brood males (Figure 4). The results of a two-sample T-test indicated that 2003 brood males and females were significantly larger ($p<.01$) than their 2002 counterparts. No significant difference in fork length was observed between 2003 and 2001 males ($p=.15$) and females ($p=.29$). Age composition of Wenatchee brood coho in 2003 was determined from CWT and scale analysis ($n=1,706$; Table 1). No jacks (2 year-old males) were collected in the 2003 broodstock. A jack cut-off was not determined due to the lack of jacks in the population. Using coho collected in 2002 as a reference, we can assume that anything = or < 42 cm would be considered a jack. The 2002 brood may be an invalid reference because of the

unusual freshwater rearing pattern displayed within the 2002 returning adults. The unusual rearing history stemmed from poor out-migrant conditions in the Columbia River during the spring/summer of 2001.

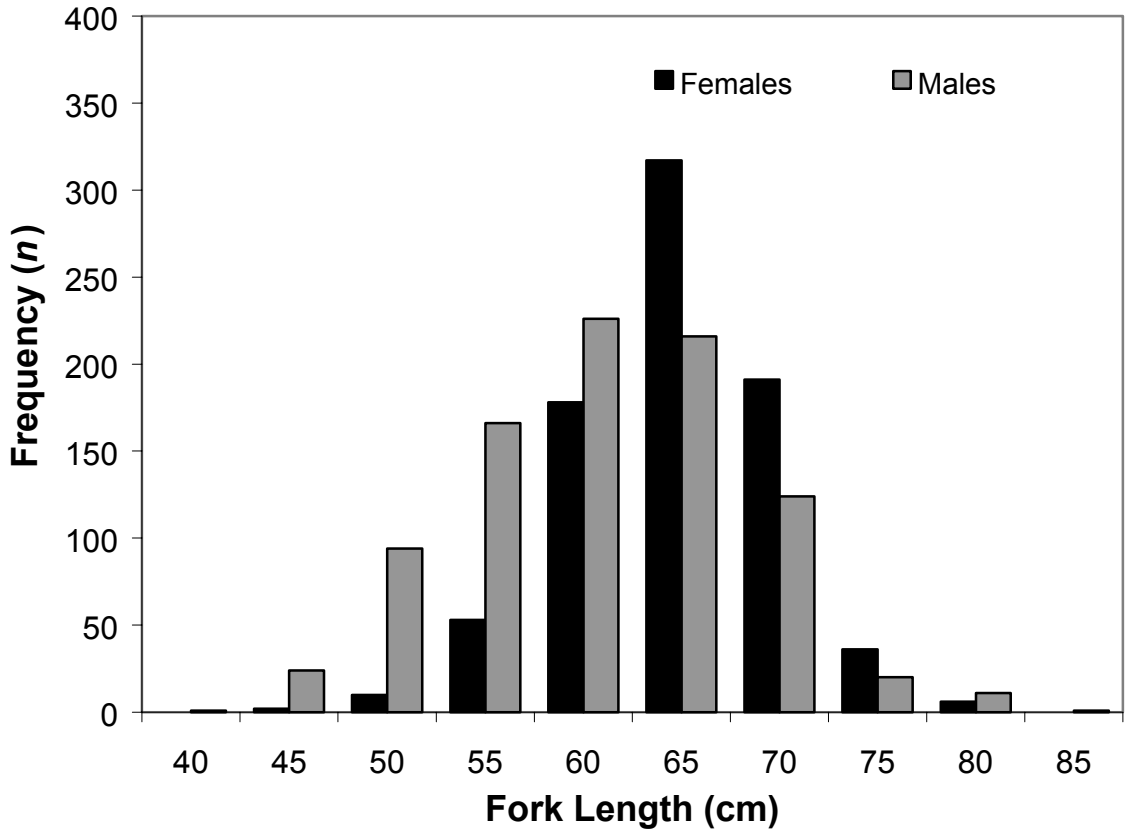

Figure 4. Length-frequency distribution of coho spawned in the Wenatchee River basin, 2003.

Table 1. Mean fork length and POH by sex and age of 2003 Wenatchee brood coho.

	Mean length at age- cm (SD,*N*)		
	1.0	1.1	2.0
		Males	
Fork	0.0	63.3	0.0
	(0.0,*0*)	(7.7,*913*)	(0.0,*0*)
POH	0.0	46.7	0.0
	(0.0,*0*)	(6.5,*913*)	(0,*0*)
		Females	
Fork	0.0	66.7	0.0
	(0.0,*0*)	(7.3,*793*)	(0.0,*0*)
POH	0.0	50.7	0.0
	(0.0,*0*)	(6.3,*793*)	(0.0,*0*)

Of the 1,706 coho collected for broodstock, we identified twenty naturally produced fish through scale analysis (J. Sneva, WDFW, pers. comm.). These twenty fish are from the first naturally produced coho return to the Wenatchee River basin (BY 2000). An estimate of the total number of coho returning to the Wenatchee River, both naturally produced and hatchery, and smolt-to-adult survival rates can be found in Murdoch et al. (2005).

Coded Wire Tag (CWT) Recovery

Snouts were removed and CWTs extracted from spawned adults and pre-spawn mortalities. A total of 1,523 snouts were collected and 1,451 CWT's recovered. Seventy-seven percent (*n=1,061*) of the snouts recovered were from coho acclimated on Icicle Creek. One-hundred and ninety-five (14.1%) and 101 (7.3%)snouts recovered were from coho released from the Butcher Creek and Beaver Creek acclimation ponds, respectively (Table 2). In 2004, all returning hatchery coho will be CWT tagged (based on 100% tagging of 2003 releases). Smolt-to-adult survival rates based on CWT recovery can be found in Murdoch et al (2005).

Table 2. Coded wire tag codes and origin of Wenatchee brood coho spawned at Entiat National Fish Hatchery, 2003.

Tag code	*N*	Release Year	Release Location
050577	532	2002	Icicle Creek
050578	195	2002	Butcher Creek
050581	121	2002	Icicle Creek/Early Pond
050582	101	2002	Beaver Creek
054332	4	2002	Winthrop NFH
054532	285	2002	Icicle Creek
055012	141	2002	Icicle Creek
Total	**1,379**		

Egg Fertilization and Incubation

Coho trapped in the Wenatchee River were transported to the ENFH for holding and spawning. The gametes from each spawn were split between Entiat NFH and the Peshastin Incubation Facility. At both facilities, the coho eggs were incubated in deep troughs supplied with 4-6 gal/min chilled well water.

As done in 2002, a 1% saline solution was used during fertilization to increase sperm motility. Eggs from each female were mated with one primary and one back-up male. After fertilization, all excess liquid was strained from the eggs. The eggs were then soaked in 75 ppm iodine treatment for 30 minutes prior to being placed in the incubator.

We incubated 796,105 and 868,272 green eggs in the Peshastin and Entiat NFH deep troughs, respectively (Table 3). Egg takes were split between Peshastin and Entiat throughout the duration of spawning except for the last spawn where all eggs were

incubated at Entiat (Table 3). Average fecundity for the 2003 brood was 2,473 eggs per female.

Table 3. Spawn dates, number of eggs collected and eye-up rate at ENFH and Peshastin incubation sites, 2003.

Incubation Location	Spawn Date	Transport Date	Number of Females	Number eyed eggs	Number dead eggs	Total eggs	Eggs per Female	Eyed eggs per female	Percent Eye-up	Receiving/ Rearing Hatchery
Peshastin	14-Oct	18-Nov	41	75182	20273	95455	2328	1834	78.8	Cascade
ENFH	14-Oct	18-Nov	22	46465	5473	51938	2597	2323	89.5	Cascade
Peshastin	21-Oct	2-Dec	72	140273	35000	175273	2434	1948	80.0	Cascade & Winthrop*
ENFH	21-Oct	18-Nov	20	41895	5848	47743	2387	2095	87.6	Cascade
Peshastin	28-Oct	2-Dec	67	123273	41091	164364	2453	1840	75.0	Cascade
ENFH	28-Oct	5-Dec	103	194900	42520	237420	2374	1949	82.1	Cascade
Peshastin	4-Nov	10-Dec	97	192545	51727	244273	2518	1985	78.8	Cascade
ENFH	4-Nov	18-Dec	88	171360	28074	199434	2319	1993	85.9	Cascade
Peshastin	11-Nov	17-Dec	71	151455	37454	188909	2661	2133	80.2	Willard
ENFH	11-Nov	18-Dec	35	65880	10640	76520	2251	1938	86.1	Willard
ENFH	18-Nov	18-Dec	71	118000	18700	136700	2629	2290	86.3	Willard
ENFH	18-Nov	2-Jan		40000		46350	2727	2353	86.3	Willard

** 100,000 eyed eggs were transported to Winthrop NFH and 40,273 eyed eggs were sent to Cascade FH*

In the Peshastin deep troughs, we calculated an eye-up rate of 78.6% (range: 75.0-80.2; Table 3). In the ENFH deep troughs we estimated an eye-up rate of 85.2% (range: 82.1-89.5; Table 3). Overall eye-up for the 2003 Wenatchee brood was 81.8%. Increasing the period of gamete mixing could possibly increase fertilization success. At the Peshastin Incubation Facility, eggs in the last cells of each incubation trough appeared slightly soft. Effectiveness of the formalin treatments may have been reduced in the last cells after passing through the fully loaded front cells of the incubation trough. Soft-shell was not observed at ENFH. Due to the occurrence of soft-shell in coho eggs incubated at ENFH in 2002, in 2003 ENFH personnel increased the concentration and frequency of formalin treatments, coupled with weekly iodine drips. In future years, iodine will only be administered soft-shell is first detected. Formalin is effective for combating external bacterial growth (Bowser 1999). Jensen (1996) reported that iodine treatments can provide additional hardness to developing salmonid eggs while acting as a disinfectant.

Upon reaching between 500 and 600 temperature units, the eyed eggs at Peshastin were shocked, sorted, and then transported to Cascade FH, Willard NFH, and Winthrop NFH for rearing. Eggs were shocked with fewer temperature units at Entiat NFH (range of 450-470 T.U.'s) than seen at other coho incubation facilities (Peshastin: 540-560 T.U.'s; Cascade FH: 500 T.U.'s; Willard NFH: 567 T.U.'s). At both Cascade FH and Willard NFH, a higher mortality was observed with the ENFH coho eggs versus the Peshastin eggs from eyed-egg to ponding of fry (18.2% vs 6.8%). After extensive discussions with the hatchery managers at the rearing facilities, we concluded that the elevated mortality in eggs incubated at ENFH could have been caused by shocking the eggs prior to gaining enough temperature units. For 2004, both incubation facilities will shock between 550-600 temperature units to ensure sufficient embryonic development.

Methow River Basin

Broodstock Collection

Coho destined for the Methow River basin in 2003 were collected at Winthrop National Fish Hatchery (WNFH; Methow River RK 80.6) and the Wells Dam west and east ladder fish traps. At Wells Dam, coho collection occurred concurrently with ongoing steelhead broodstock collection. A total of 43 coho (20 females and 23 males) were trapped between October 1-21, 2003 at Wells Dam. Thirty-six percent of the female coho collected and held at Winthrop NFH were collected from Wells Dam. A total of 165 coho returned to the Winthrop NFH between October 1 and November 25, 2003. Coho entered the hatchery volitionally and were enumerated weekly during spawning. The peak spawn occurred on October 28; peak collection occurred the same week as determined by the number of adults remaining post spawn. Low smolt-to-adult survival rates (Murdoch and Kamphaus 2004), and a high proportion of males within the broodstock resulted in below-goal egg collection. In future years, we plan to increase broodstock trapping efforts at Wells Dam to ensure that collection goals are made.

Spawning

We a collected total of 208 coho; 55 females (26.4%), 152 males (73.1.%), and one jack (0.50%) (Figure 5). The pre-spawn mortality rate was 18.8% (*n=40*). USFWS personnel spawned 114 coho (48 females; 66 males) between October 28 and November 25. In addition to the spawned fish, 54 males were surplused. Peak spawn occurred on October 28 with 27 females (Figure 6).

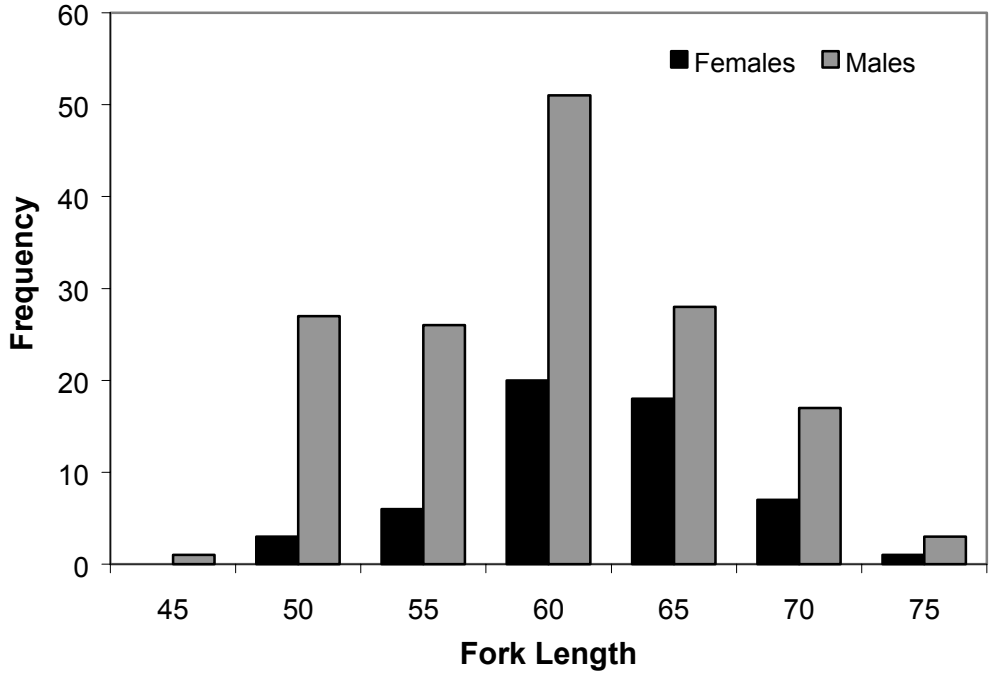

Figure 5. Length-frequency distribution of coho spawned in the Methow River basin, 2003.

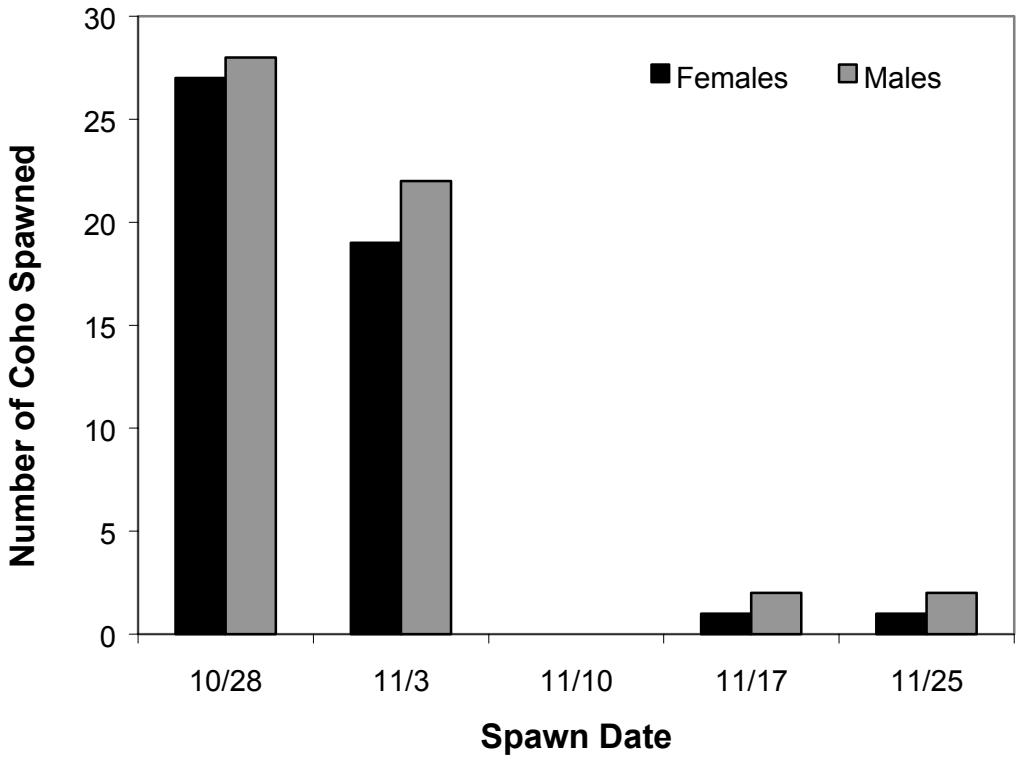

Figure 6. Number of coho spawned at Winthrop National Fish Hatchery, 2003.

The male-to-female ratio for the 2003 brood collected at Winthrop NFH was 2.8:1; which if naturally spawning would equate to 3.8 fish per redd. The male-to-female ratio for coho returning to WNFH may not be representative of the run at large. The male-to-female ratio for collection at Wells Dam was 1.2:1; or 2.2 fish per redd if spawning naturally. This ratio may be representative of the run at large returning to the Methow River basin. We predict that the low female-to-male ratio observed at Winthrop NFH may result from female dropouts, either as pre-spawn mortalities or spawning escapement.

Spawning ground surveys on the Methow River largely occurred after peak spawn and did not demonstrate specific spawn timing (Murdoch et al. 2005). Spawn timing at Winthrop NFH was delayed two weeks compared to the Wenatchee River brood held at Entiat NFH. The mean fork length (FL) of the females was 61.4 cm (SD = 7.9; Figure 4). The mean FL of the males was 61.7 cm (SD=6.6). A T-test was used for the comparison between broods and results demonstrated the 2003 brood males and females were significantly longer ($p<.01$) than their 2002 brood counterparts. There was no significant difference between the length of males and females ($p<.01$) at Winthrop NFH within the 2003 brood.

Egg Fertilization and Incubation

During spawning, gametes were brought into the hatchery building for fertilization. Eggs from each female were mated with one primary and one back-up male. After fertilization, the eggs were rinsed and placed in isolation buckets containing 75 ppm iodine treatment and soaked for 30 minutes prior to rinsing. Coho eggs were initially incubated in isolation buckets until fish health results were confirmed and the eyed-egg stage was reached. The isolation buckets were supplied with 1 - 2 gallons/minute of well water per bucket. After eye up, eggs were enumerated and moved into the vertical stack incubators. Each vertical stack was supplied with approximately 2 - 4 gallons/minute of mixed ground and river water. Since fungus had not been a problem in the incubation of salmon eggs at WNFH, formalin treatments were not required.

Winthrop NFH incubated 106,734 green eggs from the four spawn dates (Table 4). The overall eye-up rate for 2003 brood was 78.3% (range: 74.7-97.1), leaving 83,582 eyed eggs to be reared at WNFH. An additional 100,000 eyed eggs were transported from Peshastin Incubation Facility to Winthrop NFH for rearing. After post-hatch mortalities had been eliminated, 157,368 alevin remained. Ponding of fry began the end of February and continued through early March, 2004.

Table 4. Spawn dates, number of eggs collected and eye-up rate at Winthrop National Fish Hatchery, 2003.

Incubation Location	Spawn Date	Number of Females	Number eyed eggs	Number dead eggs	Total eggs	Eggs per Female	Eyed eggs per female	Percent Eye-up	Rearing Hatchery
Winthrop NFH	28-Oct	27	48580	12501	61081	2262	1799	79.5	Winthrop NFH
Winthrop NFH	3-Nov	19	30960	10475	41435	2181	1630	74.7	Winthrop NFH
Winthrop NFH	17-Nov	21	1917	114	2031	2031	1917	94.3	Winthrop NFH
Winthrop NFH	25-Nov	1	2125	62	2187	2187	2125	97.1	Winthrop NFH

Summary

Development of a locally adapted broodstock from lower Columbia River coho stocks is a goal of the Mid-Columbia Coho Reintroduction Project. In-basin trapping facilities for effective broodstock collection are essential for program success. We handled 2,751 coho between September 8 and December 6 at Dryden Dam and Dam 5 on the Wenatchee River. At WNFH and Wells Dam, we collected 208 coho for the Methow River program. Our broodstock goals for both basins were to collect enough females to fulfill future acclimation release needs of 250,000 juveniles in the Methow River and 1,000,000 juveniles in the Wenatchee River while reducing the influence of lower Columbia River genetics within the brood. Collection goals for the Wenatchee and Methow are 1,464 and 497 adults, respectively. We exceeded the collection goals for the Wenatchee program (117%) to compensate for pre-spawn mortality and to back-filling program shortage in the Methow basin. The record return (*n=4,076*) in the Wenatchee River basin was presumably due to high smolt-to-smolt survival rates during the 2002

out-migration (Murdoch et al. 2004). We spawned 1,419 coho salmon at ENFH and 102 at Winthrop NFH. We calculated an eye-up rate of 81.8% for the Wenatchee program and 78.3% for the Methow program. We saw a slight decrease in eye-up for the Wenatchee program in 2003 versus 2002 (Appendix B). The decrease may be misleading because egg quality improved within the 2003 brood. The absence of "soft-shell" disease and altered incubation practices were responsible for these changes in quality. Increased eye-up rates and improved eyed-egg quality should lead to improved survival from the eyed stage to smolt release. Any increase in survival, from pre-spawn mortality to pre-smolt rearing, will allow for fewer broodstock needed to meet release goals. This will create the opportunity for more natural production to occur within the basin.

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APPENDIX A:
Acclimation release summary for Wenatchee and Methow River Basins, 2003

Release Site	*# of Coho Released*	*Mean FL (mm)*	*Mean Wt. (g)*	*FPP*	*CWT'ed (%)*	*Release Dates*	*# of PIT tags*	*CWT Number*
Wenatchee River Basin								
Icicle Cr. side-channel	149,677	129.3	25.1	18.3	95.4	4/23-6/17	7,989	**050971**
	138,089				95.6			**054531**
	158,368				99.8			**054533**
	36,694				95.8			**054320**
	482,828	**129.3**	**25.1**	**18.3**	**96.9**	**4/23-6/17**	**7,989**	
Butcher Creek	139,919	130.7	25.0	18.1	95.8	5/4-6/25	7,986	**050972**
	139,919	**130.7**	**25.0**	**18.1**	**95.8**	**5/4-6/25**	**7,986**	
Coulter Creek	49,484	135.6	28.7	15.8	98.1	5/1-6/17		**054326**
	33,147				95.6			**050968**
	82,631	**135.6**	**28.7**	**15.8**	**96.6**	**5/1-6/17**		
Mahar Pond	33,344	133.7	29.1	15.6	98.0	5/6-6/18		**054328**
	33,344	**133.7**	**29.1**	**15.6**	**98.0**	**5/6-6/18**		
Beaver Creek	70,477	140.6	30.1	15.1	95.6	5/5-6/16		**050969**
	70,477	**140.6**	**30.1**	**15.1**	**95.6**	**5/5-6/16**		
Two River Acclimation Site	32,713	136.8	29.5	15.4	95.8	4/29-5/30	8,994	**054324**
	32,675				98.6			**054325**
	32,419				97.6			**054327**
	97,807	**136.8**	**29.5**	**15.4**	**97.3**	**4/29-5/30**	**8,994**	
Methow River Basin								
Winthrop NFH (on-station)	35,753	-	-	18.6	98.2	4/19-4/30		**054330**
	35,206				98.4			**054329**
	37,213				94.8			**054323**
	37,030				92.4			**054322**
	37,213				92.2			**054321**
	182,415	**-**	**-**	**18.6**	**95.2**	**4/19-4/30**		
Winthrop NFH (direct-plant)	29,340	-	-	18.0	98.6	3/18		**054909**
	30,600				99.0			**054331**
	59,940	**-**	**-**	**18.0**	**98.8**	**3/18**		

APPENDIX B:
Broodstock Collection and Incubation for BY 2000 - 2003

Brood year	*Brood origin*	*Spawn M*	*Mean FL (SD)*	*Spawn F*	*Mean FL (SD)*	*Pre-spawn Mortality (%)*	*Total Green Eggs*	*Total Eyed-Eggs*	*% Eye-up*	*Eggs per F*
Wenatchee River Basin										
2000	WEN	417	65.2cm (3.8)	407	67.7cm (2.6)	8.7%	1,107,864	844,467	76.2%	2,722
2001	WEN	566	64.1cm (6.5)	502	66.2cm (5.7)	11.9%	1,288,483	911,951	70.8%	2,593
2002	WEN	84	51.6cm (12.7)	69	63.2cm (8.7)	2.4%	175,733	150,647	85.7%	2,663
2003	WEN	740	63.3cm (7.7)	687	66.7cm (5.2)	13.9%	1,664,377	1,361,227	81.8%	2,458
Methow River Basin										
2001	MET	95	61.4cm (7.9)	93	60.6cm (7.9)	9.4%	241,680	190,622	78.9%	2,599
2002	MET	33	52.2cm (4.4)	11	49.5cm (6.8)	15.4%	21,701	17,806	82.1%	1,973
2003	MET	54	64.1cm (5.5)	48	61.9cm (6.5)	19.2%	106,734	83,582	78.3%	2,224

APPENDIX C:
Broodstock Development Progress Report, 1996-2003

Brood year	Release year	Location	Brood source	Adult return year	MCR Adult brood-to-Hatchery Smolt Production
1996	1998	Methow	LCR (341K)	1999	***143,000 MCR A***
1997	1999	LNFH	LCR (450K)	2000	***585,000 MCR B***
		Swamp Creek	LCR (50K)		
1998	2000	Methow	LCR (200K)	2001	***162,800 MCR C_m***
		Dam 5	LCR (890K)		***738,900 MCR C_w***
		Butcher Creek	LCR (77K)		
1999	2001	Methow	LCR (260K)	2002	***22,000 MCR D_m***
		Dam 5	LCR (855K)		***133,000 MCR D_w***
		Butcher Creek	***MCR A (142K)***		
2000	2002	Methow	LCR (186K)	2003	***206,000 MCR E_m***
		Dam 5	***MCR B (350K)*** LCR (450K)		
		Butcher Creek	***MCR B (146K)***		***1,400,000 MCR E_w***
		Early Pond	***MCR B (17K)***		
		Beaver Pond	***MCR B (73K)***		
2001	2003	Methow	LCR (244K)	2004	NA
		Dam 5	LCR (37K) ***MCR C_w (290K) MCR C_m (163K)***		NA
		Butcher Creek	***MCR C_w (150K)***		

		Coulter Creek	***MCR C_w (88K)***		
2001	2003	Mahar Pond	***MCR C_w (35K)***	2004	NA
		Two Rivers	***MCR C_w (100K)***		
		Beaver Creek	***MCR C_w (75K)***		

LCR*- Lower Columbia River brood*
MCR*- Mid-Columbia River brood*
MCR A*- Methow River origin mid-Columbia brood released in the Wenatchee basin in 2001*
MCR B*- Wenatchee River origin mid-Columbia brood released in the Wenatchee basin in 2002*
MCR C_m*- Methow River origin mid-Columbia brood released in the Wenatchee basin in 2003*
MCR C_w*- Wenatchee River origin mid-Columbia brood released in the Wenatchee basin in 2003*
MCR D_m*- Methow River origin mid-Columbia brood released in the Methow basin in 2004*
MCR D_w*- Wenatchee River origin mid-Columbia brood released in the Wenatchee basin in 2004*
MCR E_m*- Methow River origin mid-Columbia brood released in the Methow basin in 2005*
MCR E_w*- Wenatchee River origin mid-Columbia brood released in the Wenatchee basin in 2005*