

**Chillie Creek, Eco-Trap or Eco-Refuge.
Juvenile Coho Salmon Abundance and Survival in Chillie Creek, July 9- Sept 23, 2020**

**by
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Introduction

This is a summary of the fish sampling that was undertaken in lower Chillie Creek during the summer of 2020. The sampling was undertaken because the results of the first G-minnow trapping July 9, 2020, showed that many juvenile coho salmon (*Oncorhynchus kisutch*) were isolated in the lower 208 m of Chillie Creek below Dove Creek Road. There was some initial sampling to salvage these fish, however, it soon became clear that moving these fish to the Tsolum River was likely to be counter productive due to the much higher water temperatures in the Tsolum River compared to Chillie Creek. A decision was therefore made to track how many juvenile coho were present throughout the rest of the summer in lower Chillie Creek, and thus what their survival was over the summer.

Study Area

The specific section of Chillie Creek sampled extended downstream of the large wooden culvert on Dove Creek Road (UTM 10 354300 5509085) where Dove Creek Road closely parallels the Tsolum River. Upstream of Dove Creek Road, Chillie Creek was dry, but was wetted downstream of Dove Creek Road for 208 m, at which point a dam blocked off Chillie Creek, preventing fish above the dam from emigrating to the Tsolum River. This dam looked like an old beaver dam; however, it did not appear to be active because it lacked fresh woody debris. The channel was dry below the dam for another 79 m to where it joined the Tsolum River. There was a second more man-made looking dam 23 m below the first dam, and a water intake 42 m below the first dam.

Total length of Chillie Creek from Dove Creek Road to the Tsolum River was 287 m. Total distance from Dove Creek Road to the top of the first dam was 208 m. Specific stream habitat units between Dove Creek Road and the first dam downstream included, in downstream order of appearance, Pool 1 (30 m), Riffle 1 (5 m), Pool 2 (5 m), Riffle 2 (5 m), Pool 3 (15 m), Riffle 3 (12 m), and Pool 4 (136 m).

Water Quality

Chillie Creek upstream of Dove creek road was almost dry in early July, and completely dry by the end of July. The presence of water in Chillie Creek below Dove Creek Road throughout the summer indicated that the water in Chillie Creek below Dove Creek Road (Site 1) was probably ground water discharging into Chillie Creek below Dove Creek Road. A groundwater source below Dove Creek Road is supported by the fact that water temperatures in lower Chillie Creek were 5-8 C degrees cooler overall compared to the adjacent Tsolum River in July and August (Table 1). Low dissolved oxygen levels throughout the summer in Chillie Creek (2.7-3.7 mg/L) also indicates that the water in lower Chillie Creek during the summer was most likely groundwater.

Table 1. Water temperatures and dissolved oxygen concentrations at 0.3 m depths in lower Chillie Creek and the Tsolum River near Chillie Creek, June 23 – Sept 24, 2020, as measured with an Oxyguard Handy Polaris DO/Temperature Meter.

Date	Location	Water Temperature (C)	Dissolved Oxygen (mg/L)
June 23, 2020	Tsolum Site 1	20.8	8.6
July 22, 2020	Tsolum Site 1	21.9	8.8
July 29, 2020	Tsolum Site 1	21.5	8.8
Aug 27, 2020	Tsolum Site 1	17.2	10.0
Sept 24, 2020	Tsolum Site 1	14.7	10.0
July 08, 2020	Chillie Site 1	14.4	2.9
July 12, 2020	Chillie Site 1	13.8	2.7
July 20, 2020	Chillie Site 1	13.8	2.8
Aug 13, 2020	Chillie Site 1	12.4	3.7
Sept 23, 2020	Chillie Site 1	12.2	2.9

Fish Sampling

Juvenile coho in lower Chillie Creek were sampled at approximately monthly intervals from July 9 to Sept 30, 2020. Sample methods included Gee-minnow traps baited with 1-2 grams of pickled salmon roe, and a 12 m X 1.8 m fine mesh pole-mounted seine net. Sample methods, sample effort, the number of juvenile coho captured in each sample and the “Treatment” of each sample is summarized in Table 2.

Table 2. Sample dates, methods, effort, catch and treatment of all juvenile coho salmon captured in lower Chillie Creek, July 9 – Sept 30, 2020.

Date	Method	Effort	Catch	Treatment
July 9, 2020	Gee traps	3 for 24 hrs	35 coho juveniles	All returned to Chillie Ck
July 12, 2020	Gee traps	19 for 2.5 hrs	84 coho juveniles	82 coho adipose clipped, returned to Chillie Ck
July 15, 2020	Gee traps	19 for 2.0 hrs	70 coho juveniles (17 marked, 53 unmarked)	All marked/unmarked fish moved to Tsolum River
	12 m seine net	3 hauls in Pools 2,3, 4	51 coho juveniles (12 marked, 39 unmarked)	All marked/unmarked fish moved to Tsolum River
July 20	Gee Traps	12 for 1.75 hrs	16 coho juveniles (16 unmarked)	All marked/unmarked fish moved to Tsolum River
	12 m seine net	4 hauls in Pond 4	28 coho juveniles (28 unmarked)	All marked/unmarked fish moved to Tsolum River
Aug 14, 2020	Gee traps	10 for 24 hrs	95 coho juveniles (21 marked, 74 unmarked)	All returned to Chillie Ck

Table 2. Continued.

Date	Method	Effort	Catch	Treatment
Sept 23, 2020	Gee traps	12 for 24 hrs	65 coho juveniles (12 marked, 53 unmarked)	25 coho were dead in the traps, including 4 adipose clipped coho; the remaining coho (n=40), including 8 coho with a previous adipose clip, were caudal clipped and returned to Chillie Creek
Sept 30, 2020	Gee traps	12 traps for 21 hrs	49 coho juveniles (12 with adipose clips, 14 with caudal clips and 4 with both clips)	All fish returned to Chillie Ck

Fish Species Composition

A total of 493 juvenile coho were captured from July 9 to September 30, 2020, including 92 juveniles that had been previously marked. Three spine sticklebacks (*Gasterosteus aculeatus*) were 2-3 times more abundant than coho. Only one cutthroat trout (*Oncorhynchus clarki*) and one coastrange sculpin (*Cottus aleuticus*) was captured. No other fish species was captured.

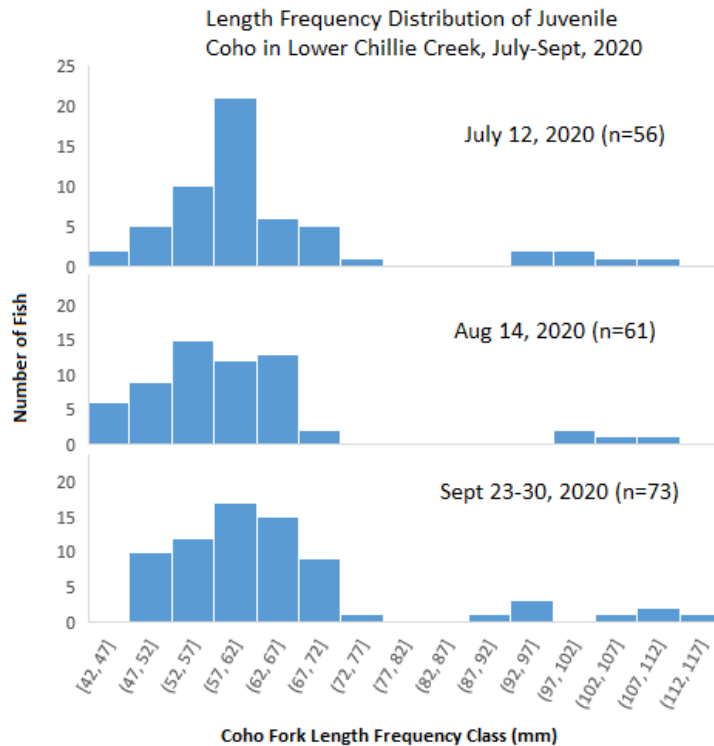


Figure 1. Length frequency distribution of juvenile coho salmon in Chillie Creek downstream of the Dove Creek Road crossing, July 12-Sept 30, 2020.

Age and Growth

Young-of-the-year 0+ coho ranging from 42 to 75 mm in fork length represented 81% of the juvenile coho salmon captured in lower Chillie Creek. The rest of the coho captured appeared to be 1+ fish ranging from 92 to 115 mm in fork length (Figure 1). Neither age class showed any significant growth over the study period, with 0+ coho averaging 59.1 mm fork length July 12 and 60.3 mm fork length September 23-30, and 1+ coho averaging 101.2 mm in fork length July 12 and 102.3 mm fork length September 23-30.

Population Size

The number of juvenile coho salmon present on July 12, 2020, was estimated with a Peterson Index (i.e., a simple mark-recapture estimate) as follows (*in* Seber 1973):

$$N = (M+1) (C+1) / (R+1), \text{ where}$$

N = the size of the population.

M = the number of fish marked.

C = the number of fish caught and checked for marks.

R = the number of fish caught that were marked (i.e., recaptures).

A total of 82 juvenile coho were captured and adipose fin clipped on July 12. All coho subsequently captured July 15-20, August 14, September 23-30 were examined for adipose clips, and the number of coho originally present on July 12 estimated using the above formula, always considering how many fish (marked and unmarked) were transferred to the Tsolum River, and how many marks were lost due to mortalities in the G-minnow traps. These data together provided three separate estimates of the number of juvenile coho that were present at the time the first 82 coho were marked on July 12, 2023.

A total of 40 coho captured on Sept 23, including 8 adipose fin clipped fish, were marked with a partial lower caudal fin clip. A subsequent sample on September 30 were examined for caudal clips to provide a separate mark-recapture estimate of the number of juvenile coho that were present on September 23.

Numbers of coho captured, available for recapture, recaptured and the various mark recapture estimates for July 12 and September 23, 2020, are summarized in Table 3. Depending on how the first 165 coho captured and transferred to the Tsolum River July 15-20 are handled, total population size for coho on July 12 is estimated to be 383-413 fish. The lower number is an average of the three N_1 estimates, where the number of available coho for recapture in Aug and Sept was 82 fish, i.e., the original 82 fish marked on July 12. The higher number is the average of the three N_2 estimates based on there being only 53 coho available for recapture after 29 of the original 82 marks were transferred to the Tsolum River July 15-20. The total number of coho transferred to the Tsolum (marked and unmarked fish, $n=165$) were then added to these estimates for a final estimate.

The number of coho present on September 23 was estimated at 137. Estimated survival from July 12 to September 23 was therefore 33-36% (range 30-42%), depending on which of the two approaches for the mark-recapture estimates are used.

Table 3. Mark-recapture estimates of juvenile coho salmon in lower Chillie Creek on July 12 and Sept 23, 2020.

Date	No. coho captured (C)	No. Coho Marked (M)	No. Coho Recaptured (R)	N ₁	N ₂ (+ 165)
July 12 Population Estimates					
July 15-20	165	82	29	459	459
Aug 14	95	82 (53)	21	362	401
Sept 23-30	114	82 (53)	28	329	379
				X = 383	X = 413
Sept 23 Population Estimate					
Sept 30	49	40	14	137	137

Catch per Unit Effort

Coho catches per Gee-minnow trap set overnight were positively correlated with the mark-recapture estimates. From July 9 to Sept 23, the average juvenile coho catch per minnow trap declined from 11.7 coho per trap on July 9 to 9.5 on August 14, 5.4 coho per trap on Sept 23, and 4.0 on September 30. Apparent coho survival based on catch per unit effort data from July 12 to September 23 was 46%, or about 4-13% higher than the estimates based on the mark-recapture population estimates for the same dates. While not identical, both methods appear to provide reasonable estimates or indices of coho abundance and survival in Chillie Creek. Of the two approaches, catch per unit effort is quicker and easier, but at least one population estimate is needed to correlate catch per unit effort data with actual population size.

Discussion and Conclusions

Estimated summer survival from July 9 to September 23 in Chillie creek (33-36%) was lower than the average late July to late September survivals reported for juvenile coho in Carnation Creek from 1970 to 1986 (65-67%), though there were values as low as 41-46% reported in two years in Carnation Creek (Hartman and Scrivener 1990). Thus, while juvenile coho late summer survival in Chillie Creek in 2020 was low, it was not exceedingly so. Water temperatures (12.2-14.4 C) were lower than what is generally considered optimal for coho (approx. 16.0 C), however, the low dissolved surface oxygen levels (2.7 -3.7 mg/L) were probably more limiting. Coho, and even the normally tolerant three-spine sticklebacks suffered substantial mortality in September in minnow traps set at water depths greater than 1.0 m, where dissolved oxygen levels were always lower (1.7-1.8 mg/L) than the low levels recorded 0.3 m below the surface (2.2 mg/L).

The summer habitat in lower Chillie Creek can be either an “eco-refuge” or an “eco-trap”, depending on small shifts in water quality (or quantity). Because of the low water temperatures, it is an eco refuge when water temperatures in the lower Tsolum River increase to levels that in the past two years (2021-2022) caused the death of many coho, mainly young-of the year fry (Allan Chamberlain, pers. com.). However, given the normally low dissolved oxygen levels of the water in lower Chillie Creek, when Chillie Creek upstream of Dove Creek Road dries up, and all the water below the road appears to be from

groundwater, lower Chillie Creek can then also be an eco-trap if dissolved oxygen levels become too low.

Because of the naturally low dissolved oxygen levels in Chillie Creek during summer, and the stratification evident from the surface to the streambed in deep (>1.0 m) pools, the coho inhabiting lower Chillie Creek in summer are in a precarious position, since even small additional declines in overall dissolved oxygen levels are likely to be lethal. Any activity or weather conditions that disrupt the stratification could lead to an overall decline in dissolved oxygen levels throughout the water column. Seining for example was observed to reduce the surface dissolved oxygen levels, though the precise mechanism is not known. It may be that seining de-stratifies the water or increases the oxygen demand when the stream bottom sediments are stirred up, or both. Animal activity may have the same effect.

In 2021, 82 dead coho were observed in Chillie Creek on June 5-7 (Oates and Adebar 2021). This prompted a fish rescue operation over the next three days when 322 juvenile coho were captured with G traps, a clover leaf trap and seining and transferred to the Tsolum River. An additional 56 coho were fin clipped and released back into Chillie Creek for a possible future population study. Low dissolved oxygen levels were considered the primary cause of the die-off; however, "due to the unprecedented nature of this event" and the proximity of lower Chillie Creek to roads and farms., it was felt that other, unknown introduced substances were also involved.

The die-off of coho in lower Chillie Creek in 2021 was considered unprecedented, but these events may not be as rare as implied. An apparently larger die-off occurred again in June of the following year (Chamberlain 2023). There are no other records of earlier die-offs probably because there has been no one there looking. In this report, the earliest sampling occurred July 9, 2020, so any die-offs that occurred that year before July would have been missed.

Two important factors affecting juvenile coho summer survivals in Lower Chillie Creek are probably the lack of flows in Chillie Creek upstream of Dove Creek Road, and the two dams that prevent fish from emigrating when water levels start to drop. Both factors may be affected by excessive water withdrawals upstream. An assessment of water usage in the Chillie Creek watershed is recommended.

Acknowledgements

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Literature Cited

Chamberlain, A. 2023. Eyes on the Tsolum River 2022. A report to the Tsolum River Restoration Outreach Program. PO Box 488, Merville, BC, V0R2M0. 36 p. + Appendix.

Hartman, G.F. and J.C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Ca. Bull. Fish. Aquat. Sci. 223:148 p

Oates, A., and K. Adebar. 2021. Chillie Creek Fish Kill Investigation. A report to the Tsolum River Restoration Society, PO Box 488, Merville, BC. V0R 2M0. 16 p. + Appendices

Seber, G.A.F. 1973. The Estimation of Animal Abundance. Griffin Press: London. 506 p.