Millard Creek Rearing Channel

Fish Habitat and Productivity Report 2012

Prepared By

Ian Moul RPBio.
1585 Birch Avenue, Comox, B.C.
V9M 2N5

and

Wendy Kotilla
Youth and Ecological Restoration Program
4327 Minto Road, Courtenay, B.C.
V9N 9P7

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I INTRODUCTION

I-A Background

The Millard Creek Rearing Channel was first constructed in 1996 with various modifications and improvements made after that. In 2006 and 2007 the Millard Piercy Watershed Stewards facilitated major work on the channel including installation of a special screen to alleviate problems with plugging of the intake valve, construction of small wetlands along the floodplain adjacent to the channel, and the addition of gravel at various places along the channel. The rearing channel was designed to emulate natural rearing habitat for Coho Salmon and Cutthroat Trout; it was not designed as a spawning area. The rearing channel flows for 800 meters across three private properties.

This report contains habitat quality and fish abundance collected as part of the Youth and Ecological Restoration Program (YER) between the 20th and 24th of August 2012 and compares this information with previous YER studies in 2008 and 2011.

YER provides work experience, training and support for youth under the age of nineteen (YER 2012). Through studying local watersheds with community members youth gain a sense of worth, belonging and place. The focus of YER, Phase I is to work one on one with youth conducting ecological restoration activities with a variety of environmental organizations; YER, Phase II has two youth and two adults concentrating on a specific project to further develop teamwork, research techniques and communication skills. The first three days of this program included habitat assessment and the trapping and measurement of fish, on days four and five the focus is on the preparation and presentation of a public tour by the youth.

The four ecological inventory contributors were YER coordinator, Wendy Kotilla; Registered Professional Biologist, Ian Moul; and two youth participants. This is a citizen science project with a goal of using scientific methods in ways that are interesting to the youth, helping them gain a more in-depth understanding of what makes up a functioning ecosystem, while documenting meaningful information for MPWS.

YER has conducted previous work within the Millard and Piercy watersheds and at the present study site. YER, Phase I work with MPWS includes: invasive species removal, planting native plant species, water quality monitoring, monitoring downstream fish migration, conducting adult spawner counts and fish population estimates. YER, Phase II projects were carried out in 2008 and 2011 to monitor the productivity of fish habitat in the Millard Creek Rearing Channel, as well as a 2011 and 2012 ecological study in forested habitat near the headwaters of Millard Creek.

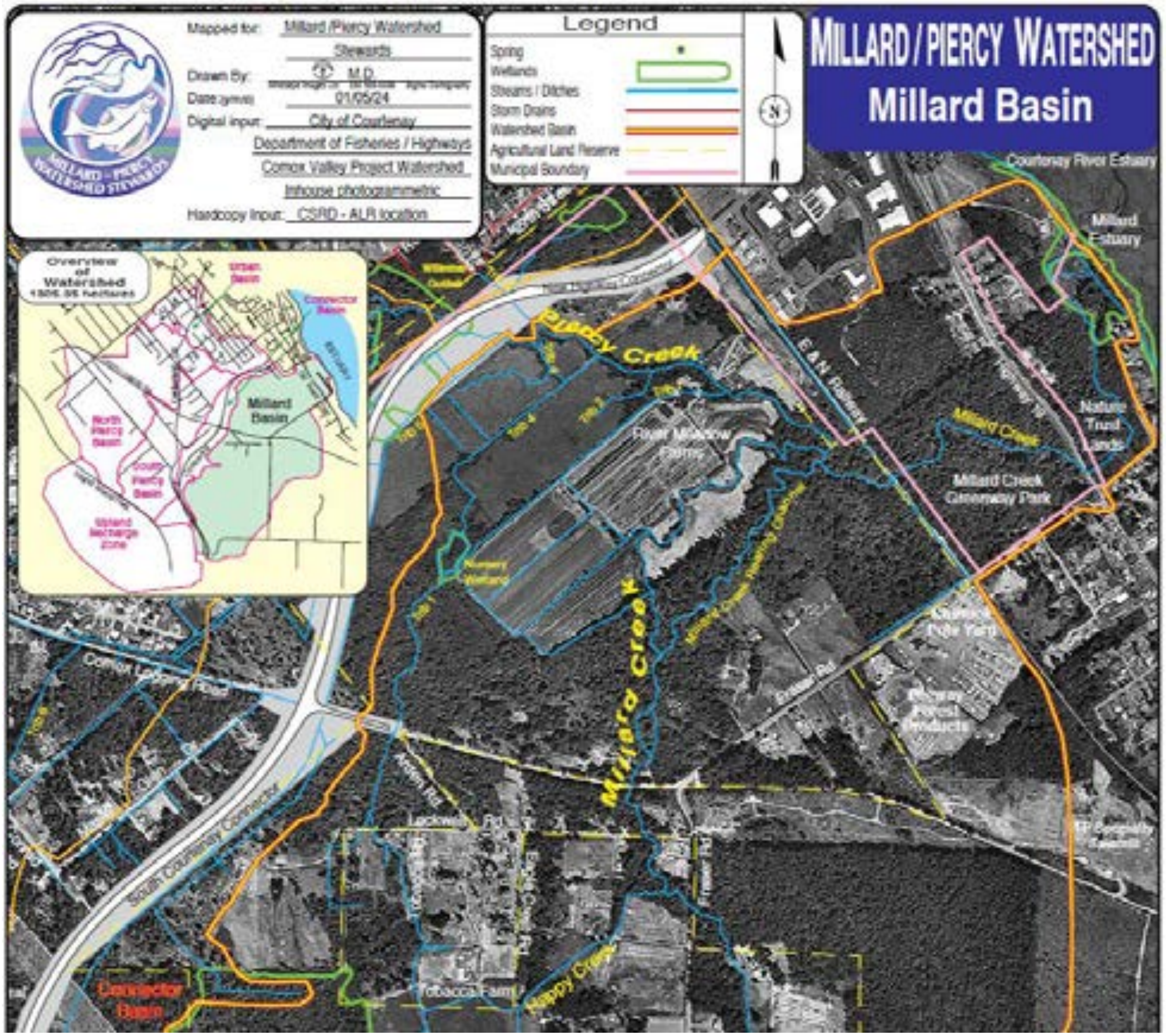
I-B Purpose of the Study

The purpose of this study is twofold:

1) To measure fish abundance and water quality characteristics in the Millard Creek Rearing Channel; and
2) To develop a methodology for an educational experience that is scientifically sound yet is interesting, hands on and understandable by youth that may or may not have experience working, or even spending time in the natural world.

I-C Location

Millard Creek and the Millard Creek Rearing Channel in relation to the South Courtenay Connector and Fraser Road.



This is a clip of the upper section of a map produced by the Project Watershed Mapping Centre

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ecoACTION
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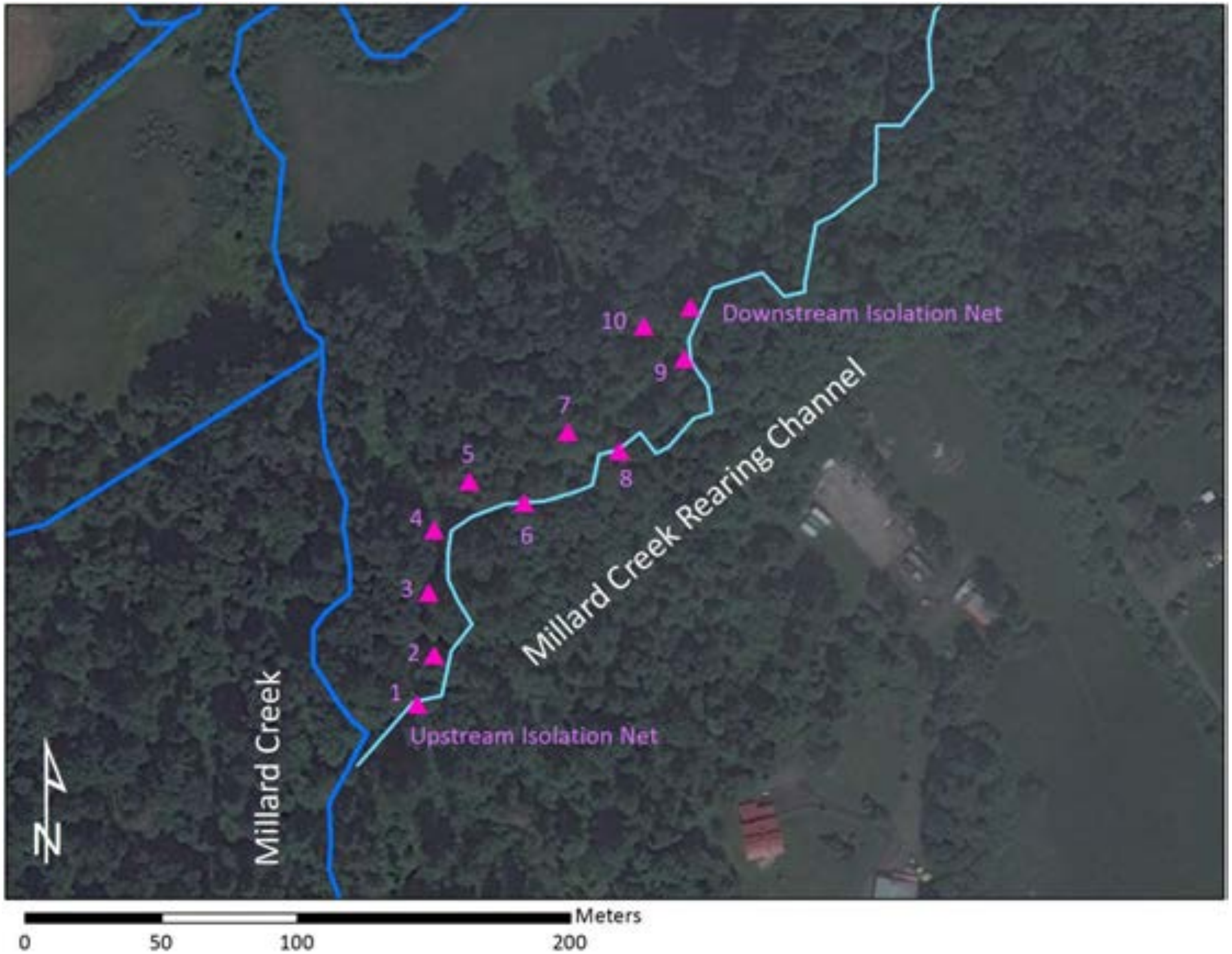

The Millard Creek Rearing Channel fish trap locations in the study site at the upper end of the rearing channel. The study site is on two private properties. The study site and the rearing channel are not open to the public. (Note: The location of the rearing channel was copied from the Project Watershed Map, above. That the GPS locations of the fish traps and the route of the rearing channel differ may be due to heavy foliage obscuring the GPS signal.)

II METHODS

Stream discharge was measured following methods from the Stream-keepers Handbook (Taccogna and Munro 1995). Water quality indicators were measured using a HANNA Instruments HI98129 pH/EC/TDS/Temperature with Only One Tester, and an OxyGuard Handy Beta Portable DO Meter H01B.

Fish were captured in minnow traps baited with salmon roe. Traps were set at approximately 10m intervals starting about 50m downstream from the top of the side channel. Fish traps were placed in locations providing sufficient water depth and were oriented as closely as possible to the direction of the water flow. The trap locations in 2012 were the same as in 2011. We believe they are either the same or close to the same sites as in 2008.

Trapped fish were sedated using Alka-Seltzer™ tablets in a bucket of stream water. The length of each fish was measured to the nearest millimetre from the tip of the mouth to the fork of the tail. Fish were gently dried on a paper towel and were weighed to the nearest tenth of a gram using an electronic balance.

Photocopies of the 2008 and 2011 fish data sheets were available and were used to recalculate fish summary statistics. The averages and ranges for fish length, weight, and condition score differ from Campbell 2011a and Campbell 2011b in that we excluded recaptured marked fish from the summary statistics (we did not double count fish that were caught twice). The condition score was calculated based on the method by Campbell (2011a and 2011b)

The abundance of fish was calculated using the Marked Recapture Method, over a three day period:

- On the first day we set the ten minnow traps;
- On the second day we counted, measured, weighed the fish, clipped the upper caudal fin, and then reset the minnow traps in the same location;
- On the third day we counted measured and weighed the fish noting those fish that were recaptured.....

III RESULTS AND DISCUSSION

III-A Stream Discharge

Stream discharge is calculated by multiplying stream velocity by the wetted channel cross-sectional area (Table 1). Given the shallow water, narrowness of the watercourse and the presence of vegetation in and around the water surface, the method presented in the Streamkeepers Handbook was modified. While the methodology specifies measuring in a 10m section of watercourse, this was considered impractical given the situation and a 5m section of watercourse was used. The cross sectional area was measured at both the start and finish of the 5m channel.

The start of the run was approximately 2m downstream from the inlet valve (Photograph 1). In this location there is a combination of water from the valve, which is connected to the main flow of Millard Creek, (Photograph 2) and from nearby groundwater seepage (Photograph 3). The method suggests using an orange for an object to float in the water and be timed from start to finish points. As there was insufficient depth for an orange, we used a medium sized Douglas-fir cone (Photograph 4). The same fir cone was used in each of the three days (in 2011 a small piece of a stick was used). The Streamkeepers Handbook method involves the floating object traveling along five routes across the watercourse at approximate intervals of 1/6th of the watercourse width. In this case we were lucky to find one path for the fir cone to float along the watercourse without getting held up on vegetation. We used the same route each time for five trials, yet started the trial again if the fir cone was stopped by vegetation.

To compare stream discharge across the three years of study, results from 2008 and 2011 were calculated using the original data. The results presented here, at the bottom of Table 1, for 2008 (0.0496m^3/ second) was different than the (10m^3/second) result reported in Campbell (2012a). We believe our result to be correct based on the original data and also the velocity measure further up in Table 1 of Campbell (2012a).

Photograph 1: Millard Creek side channel inlet control valve – 22nd of August 2012

Photograph 2: Screened inlet pipe in Millard Creek main stem, showing waterflow – 22nd of August 2012

Photograph 3: Water seepage into the start of the Millard Creek side channel – 22nd of August 2012

Photograph 4: Measuring water flow and water discharge in Millard Creek side channel 22nd of August 2012.

The stream discharge in 2012, at 0.0032m/sec is a little over 15 times less than in 2008. This is backed up by photographs of water flowing over a log at the pool where fish trap #1 was placed (Photographs 5 and 6). The reduced flow in the side-channel likely has contributed to the changes in the fish population – as will be discussed later.

Table 1: Stream discharge calculations based on a location 4m downstream of the side-channel inlet valve

Cross-sectional area of wetted stream calculations 20 – 22 of August 2012		20 Aug 2012		21 Aug 2012		22 Aug 2012	
		Start	Finish	Start	Finish	Start	Finish
Wetted channel width (m)[a.]		1.100	0.950	1.100	0.950	1.100	0.950
Wetted depth Measurement location	1/6 from left bank	0.052	0.063	0.028	0.026	0.052	0.074
	1/3 from left bank	0.062	0.102	0.058	0.074	0.047	0.097
	centre stream	0.072	0.120	0.083	0.103	0.066	0.117
	2/3 from left bank	0.062	0.138	0.059	0.097	0.062	0.130
	5/6 from left bank	0.047	0.119	0.032	0.115	0.050	0.116
Average wetted depth (m)		0.059	0.108	0.052	0.083	0.052	0.107
Cross-sectional area of wetted stream (m^2)		0.065	0.103	0.056	0.076	0.061	0.098
Average Cross-section area (m^2)		0.084		0.066		0.080	

a. The wetted width of the sample area was only measured once, on Day 1.

Average stream velocity calculations	20 Aug 2012	21 Aug 2012	22 Aug 2012
Time in seconds	82	82	113
	90	74	82
	148	114	92
	83	103	109
	87	95	91
Average time	98sec	93sec	97sec
Length of glide	5m	5m	5m
Average velocity	0.051m/sec	0.054m/sec	0.052m/sec

Table 1: Stream discharge calculation continued...

Average stream discharge	20 Aug 2012	21 Aug 2012	22 Aug 2012
Average cross sectional area X average velocity X 0.8 correction factor = Average Stream discharge (m^3/sec)	0.0034	0.0028	0.0033

Millard Creek side-channel average stream discharge 2008, 2011 and 2012

2008	2011	2012
0.0496m^3/sec	0.0045m^3/sec	0.0032m^3/sec

Photograph 5: Water flow near Trap 1 in 2008

Photograph 6: Water flow near Trap 1 in 2012

III-B Water Quality

Water quality measurements were taken in the pool by fish trap number 1 (Table 2). The water temperatures recorded fall within a range that is considered as "cool" (13 - 20°C), which is warmer than desired and places the fish at a moderate risk of disease (Taccogna and Munro 1995). The pool where the temperature was recorded is partially shaded and the water is deeper than in many other locations along the side channel raising concerns that these pools may be even warmer. It was at this same location in 2011 where water temperature was 2°C lower (Table 3). Increased water flow might bring the water temperature down to a preferred level of under 13°C.

Table 2: Water quality measurements in Millard Creek side channel – August 2012

	Day 1	Day 2	Day 3
Date	20 Aug 2012	21 Aug 2012	22 Aug 2012
Time of day	11:40	10:20	10:00
Weather	Partial overcast	Overcast	Overcast
Rain in past 24 hours?	Sprinkle	No	Sprinkle
Air Temperature	19.7°C	16.5 °C	17.4
Water Temperature	16.1°C	14.7 °C	14.5
Dissolved Oxygen	91%	93%	91%
pH	8.07	7.80	7.91
Total Dissolved Solids	79 mg/l	82 mg/l	80 mg/l

Table 3: Water quality measurement comparisons of averages across three years

Year	2008	2011	2012
Dates	19 – 21 Aug	29 – 31 Aug	20 – 22 Aug
Time of day			10:40
Air Temperature	13.7°C	15.8 °C	17.9°C
Water Temperature	12.9°C	13.2 °C	15.1°C
Dissolved Oxygen	92%	92%	92%
pH		7.32[a.]	7.93
Total Dissolved Solids	81mg/l	81 mg/l	80 mg/l

a. The Day 1 pH reading in 2011, of 15, was obviously an error in reading the instrument. This average is for days 2 and 3.

The level of dissolved oxygen at 92% is very acceptable for fish health. Healthy streams are saturated with oxygen (90 to 110% saturation) during most of the year (Taccogna and Munro 1995). Dissolved oxygen is linked to both water temperature and conditions in which the water is flowing. Cold, deep and turbulent water tends to have more dissolved oxygen. The site where the dissolved oxygen was measured was directly below a small fall over a log (Photographs 5 and 6). Given the lower Dissolved oxygen expected due to warm water, it may be the turbulence of the small water fall that keeps the water aerated.

The pH scale measures the relative acidity or alkalinity of any substance. The scale ranges from very strong acid, at pH 0, to very strong base, at pH 14 (Taccogna and Munro 1995). Pure water has a neutral pH of 7. Most aquatic organisms are sensitive to small pH changes and prefer a pH of 6.0 to 8.5. Streams that drain soils with high mineral content are usually alkaline, whereas streams that drain coniferous forests are usually acidic. The pH measured in the Millard Creek Rearing Channel is within the acceptable range.

Total Dissolved Solid (TDS) is a measurement of inorganic salts, organic matter and other dissolved materials in water (Wikipedia 2012a). The concentration and composition of TDS in natural waters is determined by the geology of the drainage, atmospheric precipitation, and the water balance (evaporation-precipitation). The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium and chloride associated with runoff of agricultural fertilizers. Total dissolved solids can cause toxicity through increases in salinity, changes in the ionic composition of the water and toxicity of individual ions (Weber-Scannell and Duffy 2007). Changes in the ionic composition of water can exclude some species while promoting population growth of others (Weber-Scannell and Duffy 2007). TDS is usually a measure of salts; the TDS of rainwater is <10ppm, and for freshwater rivers TDS ranges from 100 to 1,000ppm (Waterwatch 2012). The TDS reading of <100ppm measured in the Millard Creek side channel, would be considered as "soft" water and does not suggest a concern over runoffs from agricultural lands upstream of the site.

III-C Water Level and Fish Habitat Quality

The Millard Creek Rearing Channel was designed to provide a complexity of fish habitat that includes areas of pools, riffles and glides. The overall effectiveness of these features must be considered based on their function throughout the year. The time of this study, in August, represents the lowest point of water flow in the year. Given the water level in August 2012 it was only possible to set fish traps in areas of pools – and these had to be carefully chosen to find locations with sufficient water depth.

Pool depth measurements were taken at each location where fish traps were placed (Table 4). Perpendicular to water flow five depth measurements were taken across the wetted width of the pool. The channel width that would be flooded during high flows in winter and spring was measured by considering vegetation and bank profiles. The bank full depth was measured by stretching a tape across the furthest limits of the estimated channel width, and then measuring from the tape to the water, and then added to the deepest of the five wetted depth measurements. Comparing results from 2012 with 2011 (Campbell 2011b) is problematic in that we had no marked points to assure that measurements were taken at the exact same locations. Regardless of these differing results, the real issue for fish habitat is the water quality in each pool if there is a time when flow stops between the pools.

Residual pool depth is the measurement of the pool depth (at its deepest point) at a time when water flow from the pool stops. The stopping of surface flow from a pool, as seen at the downstream or tail end of the pool, does not necessarily mean a complete cessation of water flow as water may continue to flow within gravel and other streambed substrates. The stopping of surface water flow does mean that fish are trapped and subject to increases in water temperature. To actually find the deepest point of a pool might take hundreds of measurements. With systematic measurement the volume of a pool could be calculated and a value given for how long fish might survive in isolation. Perhaps more important to managing the rearing channel is a measurement across the pool tail crest. This was measured using a ruler at the deepest point where water flow exits the pool. Measurements of 1.6cm in the pool by trap # 5 and 1.9cm in the pool by trap # 9 (Table 4) suggest water flows were at a point where fish would have difficulty leaving a pool and moving up or downstream.

Table 4: Habitat Information

Trap #	Depth 1 (m)	Depth 2 (m)	Depth 3 (m)	Depth 4 (m)	Depth 5 (m)	Wetted width (m)	Channel width (m)	Bank-full depth (m)	Pool tail crest depth (cm)
1	0.05	0.15	0.10	0.24	0.12	3.57	4.40	0.36	4.0
2	0.06	0.14	0.18	0.16	0.11	2.00	2.50	0.16	5.5
3	0.18	0.19	0.19	0.15	0.11	1.37	4.35	0.45	2.5
4	0.10	0.16	0.30	0.20	0.12	1.75	3.45	0.62	4.4
5	0.06	0.10	0.16	0.18	0.12	1.90	7.90	0.61	1.6
6	0.22	0.19	0.18	0.07	0.04	2.48	4.55	0.57	7.1
7	0.07	0.14	0.13	0.11	0.05	1.80	5.48	0.36	3.6
8	0.17	0.28	0.27	0.29	0.12	3.71	5.72	0.57	2.4
9	0.21	0.25	0.22	0.20	0.19	1.55	3.20	0.66	1.9
10	0.11	0.24	0.33	0.23	0.13	3.21	3.21	0.64	9.8

III-D Numbers of fish trapped

Ten minnow type fish traps were baited with salmon roe and left overnight (Table 5). The traps were set in pools approximately 10m apart. Three species of fish were caught (Table 6). Fish were measured for length and weight from which a condition score was calculated. Data for one fish, a stickleback caught in 2012, was removed from the calculation of summary statistics as the combination of length and weight produced an impossible condition score of 31.7 and it is assumed that one of the measurements was recorded incorrectly.

Table 5: Fish trap locations and set times

Trap #	UTM coordinates for Zone 10 (+/-10m)		Water depth at trap location (cm)	Day 1 20 Aug 2012	Day 2 21 Aug 2012	Day 3 22 Aug 2012	Soak time	
	East	North		Time in	Time checked and reset	Time checked	Day 1	Day 2
1	356603	5502831	33.5	11:32	10:27	10:09	22:55	23:42
2	356609	5502849	20.0	12:09	11:30	10:28	23:21	22:58
3	356607	5502872	21.5	12:55	11:52	10:45	22:57	22:53
4	355609	5502895	26.0	13:08	14:22	11:10	25:14	20:48
5	356622	5501913	15.0	13:27	12:46	11:52	23:19	23:06
6	356642	5502905	28.0	13:43	13:15	12:05	23:32	22:50
7	356677	5502924	22.0	14:04	13:33	12:05	23:29	22:32
8	356658	5502931	50.0	14:10	13:45	12:29	23:35	22:44
9	356701	5502958	22.0	14:21	13:53	13:37	23:32	23:44
10	356686	5502970	30.5	14:35	14:05	12:55	23:30	22:50

The most striking difference when comparing the numbers of fish caught in the three years of study is the increase of Three-spined Stickleback in 2012. No sticklebacks were found in 2008 and only one in 2011. Given that the rearing channel had major modifications five years before, we might assume this is a natural colonisation. Adding to this, the 50% drop in the number of salmonids over the four years one might ask if there is any relationship between increasing sticklebacks and declining salmon and trout. While this would take a much more in-depth study, the probable answer is that there is no relationship. Given the results of the water flow and depth, we suggest that low flows are most likely a factor contributing to declining use by Coho salmon and Cutthroat Trout.

A second factor that may have resulted in lower number of Coho is the numbers of hatchery fish released in May each year. In 2012, less than 1,000 were released, compared to 10,000 usually being released. All Coho captured were inspected for the removal of their adipose fin – a sign of a hatchery fish. In 2008 51% were of hatchery origin. This dropped to 7% in 2011 and 0% in 2012.

Table 6: Comparison of fish sampling data Millard Creek side-channel 2008, 2001, 2012

Species		2008	2011	2012
Coho salmon	Number caught	37	46	22
	Number with clipped adipose fin (hatchery origin)	19	3	0
	Average length	70mm	61mm	66mm
	Range in length	51 – 86mm	49 – 75mm	48 – 95mm
	Average weight	4.0g	2.5g	3.3g
	Range in weight	1.6 – 7.6g	1.1 – 5.6g	1.1 – 9.2g
	Average condition score	1.15	1.04	1.06
	Range condition score	0.82 – 1.77	0.88 – 1.63	0.92 – 1.24
Cutthroat Trout	Number caught	25	12	13
	Average length	94mm	104mm	93mm
	Range in length	46 – 185mm	51 – 158mm	48 – 135mm
	Average weight	10.1g	11.9g	9.7g
	Range in weight	1.0 – 31.4g	1.2 – 39.2g	1.0 – 23.4g
	Average condition score	1.01	0.89	0.91
	Range in condition score	0.28 – 1.23	0.56 – 1.02	0.56 – 1.23
Three spined Stickleback	Number caught	0	1	53
	Average length		65mm	46mm
	Range in length			33 – 80mm
	Average weight		2.8	1.2g
	Range in weight			0.2 – 4.2g
	Average condition score		1.02	0.93
	Range in condition score			0.49 – 1.28

Catch per unit effort (CPUE) is a measure of the efficiency of the catch and also can be linked to the relative abundance of the population. Table 7 compares the results of 2011 and 2012. While there does not appear to be striking patterns, we can see that that in both years there are less Cutthroat than Coho and that in day two there were less fish caught than in day one. The difference in the species is likely a reflection of the fish size – the size of the trap is most optimal for Coho fingerlings and will exclude any larger Cutthroat Trout that may be present. That the CPUE drops in day two in all situations but Coho in 2011 suggest there is some change occurring between the two days. The simplistic answer is that trapped fish avoid being caught a second time. If this is the case then one of the fundamental assumptions of the Marked-Recapture method is violated (further discussed below).

Table 7: Catch per unit of effort (CPUE)

		2011	2012
Coho	Day 1	0.067	0.068
	Day 2	0.110	0.026
Cut-throat	Day 1	0.029	0.038
	Day 2	0.008	0.018
Stickleback	Day 1	0.004	0.166
	Day 2	0.0	0.061

III-E Marked-Recapture Method for Estimating Population Size

The marked-recapture method is used to estimate the actual numbers of individuals in a population from a sample. The method is accredited to C.G.J. Peterson for estimating populations of flounders in 1896 (Southwood and Henderson 2000). The Marked-Recapture method has been used since for numerous species ranging from insects to large ungulates. It is based on the principle that if a proportion of the population was marked in some way, returned to the original population and then, after complete mixing, a second sample was taken, the proportion of marked individuals in the second sample would be the same as was marked initially in the total population. That is, N (estimated population size) = M (marked initially) x C (total in second sample) / R (marked recaptures).

$$N = MC/R$$

The validity of the Marked-Recapture method is based on five assumptions:

1. the population is closed, so N is constant
2. all animals have the same chance of getting caught in the first sample
3. marking individuals does not affect the ability to catch them a second time
4. animals do not lose marks between the two sampling periods
5. all marks are reported on discovery in the second sample

Various modifications of the equation have been developed. The Chapman Modification (Wikipedia 2012b) adds one to the denominator which means the calculation could mathematically work if no marked individuals were recaptured (one would not be dividing by zero).

$$N=((M+1)(C+1)/(R+1))-1$$

Campbell 2011a and 2011b used:

$$N=((M+1)(C+1)-1)/(R+1)$$

We compared the two modifications and had results within +/- 1.0 (Table 8).

		Coho	Cutthroat	Stickleback
Number of individuals marked in first sample (M)		16	9	40
Total caught in second sample (C)		6	4	29
Total marked individuals recaptured in second sample (R)		1	0	15
Fish population estimate	2012 Campbell method	59.00	49.00	76.81
	2012 Chapman method	58.50	49.00	75.88
	2011 Campbell method	91	26	
	2008 Campbell method	80	65	

We find it a challenge to comment on these results. The result reported in the Catch per Unit Effort in Table 7 suggests a violation of condition number 3 in using this model. We also question the validity of a method when dividing by zero for Cutthroat Trout in 2012 and suggest it is beyond the scope of this project to do the needed research to comment on this. What is of interest and relevant to management of the rearing channel is that the salmonid populations appear to be dropping.

III-F Measurement of Fish Condition

The condition score, sometimes referred to as Fulton's condition score dates back to work by Thomas Wemyss Fulton and others in the early 1900s (Barnham and Baxter 2003, and Nash *et al*. 2006). The condition score (K) is based on the relationship between the weight (W) and length (L)

$$K = W/L^3$$

The basic formula has been adapted to various species to bring the K value close to unity. We have followed Campbell 2011b using weight in grams and length in millimetres. This is a common measurement used in fisheries science for salmonids and particularly common for hatchery fry where the length and weight condition factor is used to determine if a fish is over fed (high condition index) or underfed (low condition index)(Kathy Campbell personal communication). For fry ready to migrate a condition index of about 1 is considered as ideal

$$K = (W \times 100)/ L^3) \times 1000$$

The condition scores for both Coho Salmon and Cut-throat Trout caught in 2012 show a drop from 2008. The results from the calculation suggest that Coho are in better condition than Cutthroat Trout.

IV RECOMMENDATIONS

We suggest that the biggest constraint to Coho Salmon and Cutthroat Trout within the Millard Creek Rearing Channel is low water conditions during the summer dry period. We recommend that the Millard Piercy Watershed Stewards begin systematic monitoring of the water levels and water quality in the rearing channel and increase water flow in the summer if needed. Given the shift in fish population, the large increase in Three spined Stickleback, we recommend further monitoring of fish numbers and species mix. If fish population estimates and habitat quality measurements are to be repeated in the future, we recommend some form of permanent marking of stream channel measuring sites so results across the years are easier to compare.

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YER Team for the Millard Creek Rearing Channel Assessment 2012

Twelve people participated in a tour of the study site

Northern pacific tree frog (*Pseudacris regilla regilla*)

Red-legged Frog (*Rana aurora)*

While we did not systematically look for amphibians, we heard Tree Frogs and observed Red-legged Frogs in several locations along the Millard Creek Rearing Channel

APPENDIX

Fish capture data for Cutthroat Trout in Millard Creek Rearing Channel August 2012

Date	Trap #	Length (mm)	Weight (g)	Index	Clipped
21-Aug	1	106	10.8	0.91	N
21-Aug	1	135	23.4	0.95	N
22-Aug	1	59	1.9	0.93	N
22-Aug	2	55	1.6	0.96	N
21-Aug	3	130	19.1	0.87	N
21-Aug	4	125	11.0	0.56	N
21-Aug	4	115	14.3	0.94	N
21-Aug	5	48	1.0	0.90	N
21-Aug	5	89	8.7	1.23	N
21-Aug	8	94	7.2	0.87	N
22-Aug	8	108	10.8	0.86	N
22-Aug	9	100	9.4	0.94	N
21-Aug	10	88	6.6	0.97	N

Fish capture data for Coho Salmon in Millard Creek Rearing Channel August 2012

Date	Trap #	Length (mm)	Weight (g)	Index	Clipped
21-Aug	1	55	1.8	1.08	N
22-Aug	2	55	1.8	1.08	N
21-Aug	3	65	2.9	1.06	N
22-Aug	3	81	5.2	0.98	N
21-Aug	4	66	3	1.04	N
21-Aug	4	66	3.1	1.08	N
21-Aug	4	67	3.7	1.23	N
21-Aug	4	70	3.8	1.11	N
21-Aug	4	95	9.2	1.07	N
22-Aug	4	70	4	1.17	N
21-Aug	5	56	1.7	0.97	N

Fish capture data for Coho Salmon in Millard Creek Rearing Channel August 2012 continued...

21-Aug	5	69	3.4	1.03	N
22-Aug	5	43	0.9	1.13	Y
22-Aug	5	48	1.1	0.99	N
21-Aug	6	63	2.8	1.12	N
21-Aug	6	65	2.9	1.06	N
21-Aug	6	65	3.4	1.24	N
21-Aug	7	54	1.5	0.95	N
21-Aug	7	63	2.4	0.96	N
21-Aug	7	65	3	1.09	N
21-Aug	10	58	1.8	0.92	N
22-Aug	10	90	7.5	1.03	N

Fish capture data for Three spined Stickleback in Millard Creek Rearing Channel August 2012

Date	Trap #	Length (mm)	Weight (g)	Index	Clipped
21-Aug	1	63	2.5	1.00	N
21-Aug	1	55	1.4	0.84	N
21-Aug	1	60	1.9	0.88	N
21-Aug	1	58	1.7	0.87	N
21-Aug	1	55	1.7	1.02	N
21-Aug	1	59	2.3	1.12	N
21-Aug	1	60	2.5	1.16	N
21-Aug	1	54	1.5	0.95	N
22-Aug	1	63	2.5	1.00	Y
22-Aug	1	62	2	0.84	Y
22-Aug	1	54	1.6	1.02	Y
22-Aug	1	58	1.8	0.92	Y
22-Aug	1	52	2.2	1.56	Y
22-Aug	1	34	0.3	0.76	N
22-Aug	1	55	1.7	1.02	Y

Fish capture data for Three-spined Stickleback in Millard Creek Rearing Channel August 2012 continued...

21-Aug	2	55	1.7	1.02	N
21-Aug	2	68	3.2	1.02	N
21-Aug	2	54	1.5	0.95	N
21-Aug	2	72	3.1	0.83	N
21-Aug	2	55	1.4	0.84	N
21-Aug	2	56	1.7	0.97	N
21-Aug	3	74	4.2	1.04	N
21-Aug	3	36	0.4	0.86	N
21-Aug	3	57	2.1	1.13	N
21-Aug	3	53	1.3	0.87	N
22-Aug	3	74	3.8	0.94	Y
22-Aug	3	52	1.3	0.92	Y
22-Aug	3	80	2.5	0.49	N
22-Aug	3	35	0.5	1.17	N
21-Aug	4	40	0.6	0.94	N
21-Aug	4	58	2.1	1.08	N
21-Aug	4	16	1.3	31.74	N
22-Aug	4	56	2	1.14	Y
22-Aug	4	42	0.7	0.94	N
21-Aug	5	42	0.7	0.94	N
21-Aug	5	35	0.4	0.93	N
21-Aug	5	34	0.4	1.02	N
21-Aug	5	40	0.6	0.94	N
21-Aug	5	37	0.4	0.79	N
21-Aug	5	36	0.4	0.86	N
21-Aug	5	41	0.5	0.73	N
21-Aug	5	40	0.5	0.78	N
21-Aug	5	36	0.5	1.07	N
22-Aug	5	35	0.5	1.17	Y

Fish capture data for Three-spined Stickleback in Millard Creek Rearing Channel August 2012 continued...

22-Aug	5	40	0.6	0.94	Y
22-Aug	5	34	0.6	1.53	Y
22-Aug	5	36	0.4	0.86	Y
22-Aug	5	36	0.4	0.86	Y
21-Aug	6	33	0.2	0.56	N
21-Aug	6	33	0.3	0.83	N
21-Aug	6	37	0.4	0.79	N
21-Aug	6	36	0.3	0.64	N
21-Aug	6	40	0.6	0.94	N
21-Aug	6	37	0.5	0.99	N
21-Aug	6	37	0.5	0.99	N
21-Aug	6	33	0.2	0.56	N
22-Aug	6	36	0.4	0.86	N
22-Aug	6	37	0.4	0.79	N
22-Aug	6	37	0.5	0.99	N
22-Aug	6	35	0.4	0.93	N
22-Aug	6	37	0.6	1.18	N
22-Aug	6	36	0.4	0.86	N
22-Aug	6	38	0.7	1.28	N
22-Aug	6	37	0.5	0.99	N
22-Aug	6	36	0.5	1.07	N
22-Aug	6	37	0.4	0.79	N
21-Aug	8	54	1.7	1.08	N
21-Aug	8	70	4.1	1.20	N
21-Aug	8	69	3.8	1.16	N
22-Aug	10	69	4.4	1.34	Y