Bellevue Summer Electrofishing 2015

Final Report

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HARTCROWSER

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City of Bellevue
Utilities Department
City of Bellevue
450 110th Avenue NE
P.O. Box 90012
Bellevue, WA 98009

Prepared by

Jim Starkes
Associate Fisheries Biologist
190 West Dayton Street Suite 20
Edmonds, WA 98020
425-329-1169
jim.starkes@hartcrowser.com

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Executive Summary

Two urban streams in the City of Bellevue were sampled for fish presence, absence, and diversity during the summer of 2015—two sites on Coal Creek (RM 1.3 and 1.8) and two sites on Richards Creek (RM 0.15 and 0.37). Three of the four sites were associated with recent capital improvement projects (CIPs): a riffle reconstruction/large woody debris project on Coal Creek (which replaced a series of weirs), a high-flow bypass and sediment settling pond adjacent to Coal Creek (with the option of enhancing the stream reach with large woody debris), and a grade and erosion control project on Richards Creek. An important objective of 2015 survey work was to conduct Year 1 fish monitoring to determine fish and habitat use at these CIPs. Another objective of 2015 sampling was a continuation of gastric lavage and stomach content analyses in Kelsey Creek to investigate predation on the invasive New Zealand mud snail. These studies could not be continued because of the unusual warm and dry weather conditions experienced during 2015.

Results from 2015 surveys found a total of six fish species, with cutthroat trout as the dominant species at Richards Creek and torrent sculpin the dominant species at Coal Creek. Length frequency analyses suggest that multiple age classes (i.e., juvenile, subadult, and adult) of both species were present in the streams. Native fish diversity was higher in Coal Creek with five species present while only three species were captured in Richards Creek. Juvenile coho salmon were found at both reaches of Coal Creek, along with cutthroat and sculpin. One rainbow trout was caught in Coal Creek. No non-native fish species were captured in 2015.

Year 1 monitoring at the three CIP sites found relatively high abundances of fish, suggesting the projects were not adversely impacting stream health. Additional annual monitoring will be necessary to determine if these positive results will be representative of future site conditions.

Additional studies are recommended to further evaluate the effectiveness of existing and future capital projects for improving fish habitat and the success of salmonid supplementation efforts. Below is a detailed list of recommendations for the City of Bellevue to facilitate these actions.

- Compare diversity, size, and abundance of fish species across all years for sites with historical data.
- Conduct electrofishing at low, middle, and upper reaches of creeks during the same sampling events to determine how salmonids and native fish are distributed among different habitats than in previous years. This may help determine more accurately the presence/absence of fish within a watershed.
- Determine fish condition index at electrofishing sites to assess the relative health of priority fish species. The index could then be compared to other Western Washington urban streams where this particular data have been collected.
- Collect additional stream habitat data within survey reaches including large and small woody debris counts, percent canopy coverage and shading, cutbank lengths, boulder cluster counts, and substrate type. Annual survey observations strongly suggest that the presence of these stream and riparian habitat attributes effect the abundance and diversity of fish in survey reaches and should be quantified.
- Collect gut content data from priority salmonid species at current benthic index of biotic integrity (BIBI) sites to determine if aquatic or terrestrial prey species dominate and to further

investigate New Zealand mudsnail predation. These data will help determine prey species availability and use by salmonids. Data collected can also help determine if riparian and/or substrate improvements are necessary.

- Compare size of coho and cutthroat fish populations to other Puget Sound lowland reference streams.
- Continue a consistent electrofishing program that visits the same sites during the same time of year to increase robustness of data for determination of status and trends of priority fish species and to determine the prevalence of non-native species.
- Implement a study to evaluate selected electrofishing sites that have shown historical changes in species diversity and density. The study should include key water quality parameters such as temperature and flow conditions; however, other parameters may also need evaluation.
- Include adult coho escapement data in the status and trends database in order to associate coho presence or absence with run size. Continued monitoring is advisable for both juvenile abundance/habitat use and wild recruitment with an objective towards a sustainable run of wild coho salmon.

1.0 Introduction

As part of annual status and trends monitoring, the City of Bellevue (City) conducted electrofishing at two urban streams—Coal Creek and Richards Creek—in July 2015. Both Coal and Richards Creeks are two of the largest stream basins draining the City, discharging into Lake Washington (Figure 1). Historical data exist for both streams, though three of the four locations have not been sampled.

The purpose of electrofishing at these locations was to develop a multi-year baseline for fish species presence/absence and diversity, and evaluate trends in previously sampled locations. These sites can be revisited in coming years to determine if cumulative changes (habitat, operation of public facilities, private development, and land use regulations) are having positive or detrimental effects on fish population structures. Three of the four sites were associated with the following recent capital improvement projects (CIPs).

- At river mile (RM) 1.8 on Coal Creek, a riffle reconstruction/large woody debris (LWD) project was constructed to improve stream channel habitats, improve fish passage,and stabilize steep stream banks in this reach. Revegetation of the stream banks also was conducted. This project replaced a series of wooden weirs in the stream channel. In addition, this site is immediately downstream of the Coal Creek Parkway Crossing where fish passage and grade improvements were constructed.

- At RM 1.3 on Coal Creek, a settling pond was constructed adjacent to the stream to direct high flows during high water periods and to collect excess sediments. Sampling at this reach is also a pre-CIP evaluation because the City is considering further enhancement of the stream reach adjacent to the pond with LWD.

- At RM 0.15 on Richards Creek, a grade and erosion control project was constructed directly in the stream channel to stabilize flows and stream banks during high water periods.

- At RM 0.37 on Richards Creek, there is no CIP project, but this stream reach was substituted for another grade and erosion control project reach located immediately upstream. The CIP reach was not surveyed because of warm water temperatures and the potential stress this could have on fish.

An important objective of 2015 survey work was to conduct Year 1 fish monitoring at each of these CIPs to determine habitat use.

In addition, 2015 surveys were to include the collection and gut content analysis of cutthroat trout in Kelsey Creek, continuing the investigation of the invasive New Zealand mud snail started in 2014. Unfortunately, very warm water temperatures occurring in Kelsey Creek resulted in cancellation of this survey.

This report describes the methods used for sampling, results from electrofishing in the summer of 2015, and recommendations for future actions. The data presented in this report represent a reference point

from which the City can determine possible changes in the status and trends of fish populations in response to local or basinwide environmental changes.

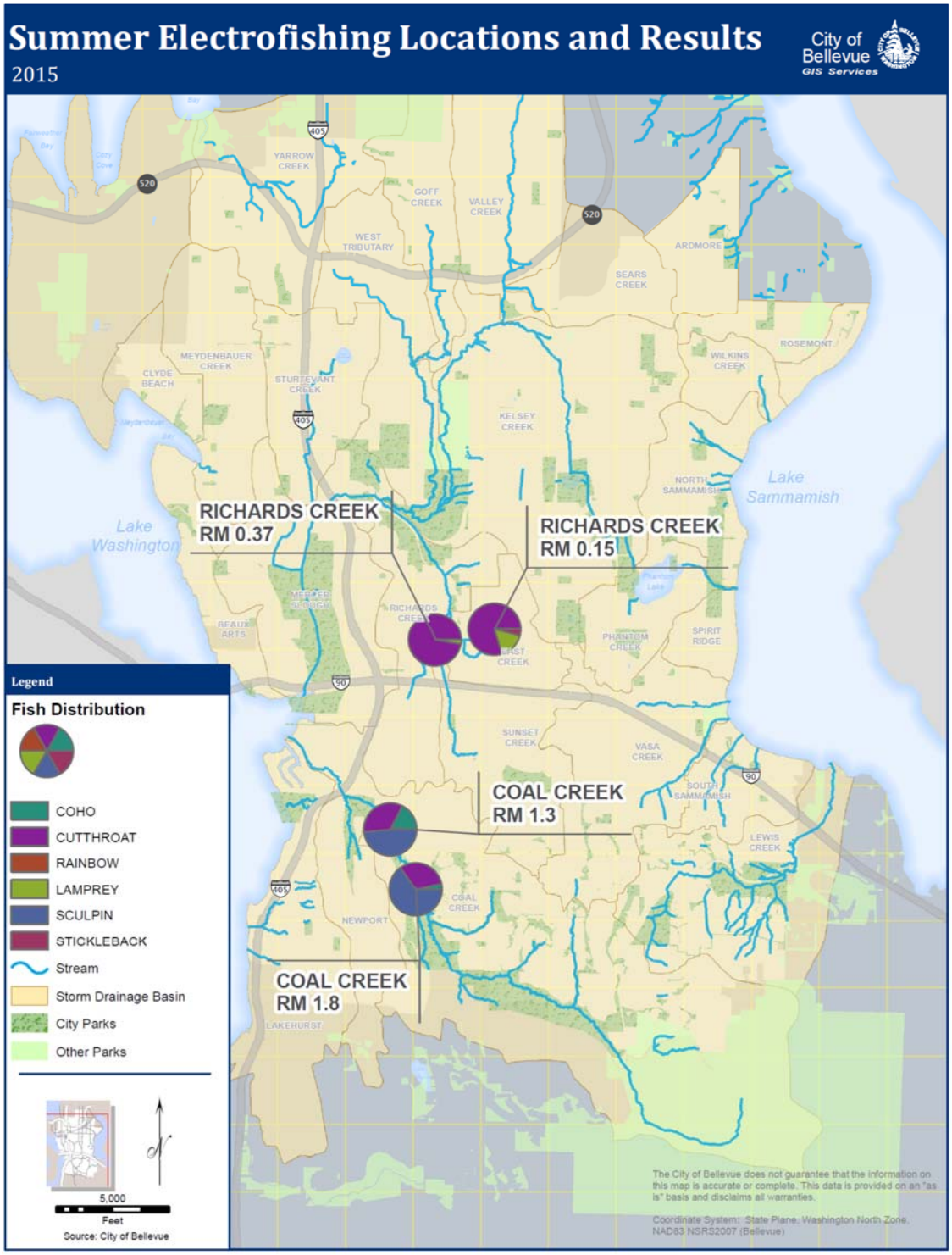

Figure 1. Map showing locations and results of electrofishing sites sampled in July 2015.

2.0 Methods

Electrofishing was performed on July 7, 8, and 9, 2015, in both Coal and Richard creeks (Figure 1). Methods of sampling in 2015 were similar to past efforts by the City. Electrofishing was conducted using a Smith-Root Backpack Electrofisher Model 12b. Settings on the electrofishing equipment for Coal Creek and Richards Creek were most effective at 200 volts (v), 70 Hertz (Hz), and 6 milliseconds (ms).

At all sites on both streams, block nets were placed at the downstream and upstream limits of each survey reach and a single pass was made by the electrofishing team. One of the field team members utilized the electrofisher backpack while two others used long-handled dip nets and followed closely alongside the electrofisher unit to capture stunned fish[1]. Other team members followed the electrofishing team with buckets of fresh stream water. Fish were tracked by habitat type (riffle or pool) and captured fish were placed in corresponding buckets. Captured fish were temporarily anesthetized on site using a dilute solution of MS-222 (Tricaine methanesulfonate) in water for identification and fork length measurements. Fish were then allowed to recover in fresh stream water supplied with an aerator until fully recovered. Once recovered, they were released upstream of the reach above the block net. Fish capture methods were conducted in accordance with the Washington State Scientific Collection Permit #15-279.

Temperature (° C), dissolved oxygen, and pH were recorded using an YSI 85 water quality probe deployed at each stream reach.

[1] Two netters were used throughout each reach. The team was comprised of a combination of experienced and inexperienced netters, including volunteers, who were consistently swapped out.

3.0 Results

3.1 Habitat and Water Quality Measurements

A summary description of the habitat attributes at sampling locations is presented in Table 1. Riffle, pool, and stream channel data for Coal and Richards creeks are presented in Table 2. Each stream had one survey reach composed of a single riffle and one survey reach with riffle/pool habitats (Table 2).

The two reaches entirely composed of riffle habitat were substantially different. On the Coal Creek Parkway riffle (RM 1.8), habitats had been recreated with several large boulder clusters that created microhabitats composed of small scour pools, cascades, and soft edge habitats. Water in the stream channel was deeper than most riffles, ranging from 0.5 to 1.3 feet deep (Table 2). Though two large woody debris complexes were anchored to support rather steep stream banks, most of the wood did not extend into the stream substrates. Most microhabitats were created by the large rock clusters.

The Richards Creek riffle (RM 0.15) was relatively straight and contained three evenly spaced grade and erosion control structures made of wood/rootwads. Each structure was composed of large logs anchored directly into the stream channel crossing the thalweg to flatten the grade of the stream. Rootwads were anchored along the stream bank adjacent to the logs that extended crosswise in the channel for stream bank erosion control. Small cascades and scour pools extended the length of the channel in the immediate vicinity of the logs. Stream bank rootwads created some edge habitats. Nearly all habitat complexity in this reach was associated with the grade structures. Between the grade structures, the stream was relatively slow flowing, with uniform depths and width. No cut bank habitats were present and riparian vegetation was composed primarily of grasses, with some planted vegetation that has not yet matured (e.g., young willows).

The riffle/pool survey reaches in both streams (Coal Creek RM 1.3 and Richards Creek RM 0.37) had the highest habitat complexity (Table 2). Both were dominated by narrow, but dense corridors of riparian vegetation that were a source of woody debris recruitment for pool creation within the stream channel and overhead shade. At Coal Creek, RM 1.3, a sedimentation pond was constructed (Anna's Pond) to act as a high water bypass and for the collection of excess sediments. Despite the pond construction adjacent to Coal Creek, riparian vegetation was extremely dense and extended for most of the length of the pond. Two pools created by natural LWD complexes were present in this survey reach and were the deepest observed during 2015 surveys. Mean depths were 1.8 feet with maximum depths of over 3 feet. Richards Creek at RM 0.37 was the smallest stream reach surveyed in 2015, flowing between two buildings in a business park complex. Similar to Coal Creek at Anna's Pond, the riparian zone, though limited by adjacent buildings, was extremely dense with substantial amounts of pool-forming wood within the stream channel and overhead. Both reaches had natural meanders creating cut banks that provided habitat for fish and variable wetted channel widths.

Table 1. Survey dates and site summary for 2015 electrofishing.

Date	Stream Name	River Mile (RM)	Reach Length (feet)	Site Description
July 7, 2015	Coal Creek	1.8	179	**Coal Creek Parkway Riffle/LWD CIP.** Located immediately downstream of Coal Creek Parkway; habitat improvements involve a recreated riffle with LWD complexes on the bank. The entire reach is considered a riffle, but has numerous microhabitats created by large boulder clusters throughout the reach (Photos 1–3). Both stream banks are relatively steep and substantial revegetation has occurred. At the upstream end of the survey reach is the Coal Creek Parkway crossing, where the grade of the stream beneath the road has been modified by a constructed weir to allow fish passage.
July 8, 2015	Coal Creek	1.3	186	**Anna's Pond Bypass CIP.** This sample reach runs the length of a created bypass pond (Photo 7). a dense riparian corridor is present for much of the sample reach, composed primarily of native trees and shrubs. The density of the vegetation canopy over the stream is high (>80 percent in most areas), with woody debris occurring within and throughout much of the survey reach. Riffle and pool habitats consist of deep pools (Photo 5) and broad shallow riffles (Photo 6).
July 9, 2015	Richards Creek	0.15	104	**Richards Creek Grade/Erosion Control CIP**. This survey reach consists of a series of three grade/erosion control structures anchored in the stream (Photos 9 and 10). Structures are made of LWD and rootwads, equally spaced in the stream channel. Survey reach is straight with relatively uniform depth. Entire survey reach is considered a riffle, though relatively slow moving and deeper than other riffles surveyed. Small microhabitats are associated with the grade structures. Very little habitat diversity not associated with the grade/erosion control structures. Bank vegetation is dominated by grasses; virtually no overhanging vegetation canopy exists.
July 9, 2015	Richards Creek	0.37	88	Smallest survey reach sampled that flows between low-rise buildings of a business park. Despite the proximity to a developed area, a narrow but dense riparian corridor is present. Substantial areas of wood within and over the stream channel are present. Stream channel is relatively narrow, but variable with small mid-stream gravel bars. Both riffle and pools are present with pools created by woody debris. Cut bank habitats with overhanging vegetation present on both banks for much of the survey reach (Photos 11 and 12).

Table 2. Stream channel data for Coal and Richards Creeks survey areas

Habitat Unit	Wetted Width (feet)	Wetted Depth (feet)	Length (feet)
Coal Creek (RM1.8)			
Riffle 1	15.74	0.73	178.8
Coal Creek (RM1.3)			
Pool 1	12.27	1.57	41
Riffle 1	17.83	0.4	80
Pool 2	11.0	2.1	14.5
Riffle 2	22.67	0.37	50
Richards Creek (RM0.15)			
Riffle 1	13.45	0.73	104
Richards Creek (RM0.37)			
Riffle 1	9.6	0.43	46
Pool 1	8.0	0.90	11
Pool 2	9.5	0.70	20
Riffle 2	6.0	0.70	10.8

Water quality parameters at all of the electrofishing stations showed typical values for urban streams during the summer. Temperature and dissolved oxygen values for all sites ranged from 14.7° C to 15.9° C and 9.1 milligrams per liter (mg/L) to 10.5 mg/L, respectively (Table 3). Although air temperatures were warm, with record-breaking levels experienced during the 2015 fish surveys, water temperatures at the four stream reaches were relatively good. However, as noted earlier, a fifth survey reach in Kelsey Creek was not surveyed this year to avoid potential stress on fish since water temperatures were consistently above 18° C. In addition, the survey reach at the second Richards Creek site was adjusted further downstream because the planned site had temperatures above 18° C. This original survey reach was an area of similar grade and erosion control structures, but flows were extremely low, contributing to high temperatures. The area selected for the survey was approximately 100 feet downstream where flows were higher and the overhead vegetation canopy was denser, providing shade and lower water temperatures.

Dissolved oxygen concentrations at the four survey reaches were all above 9 mg/L, which is well within the range for salmonids (Table 3).

Table 3. Water quality parameters for electrofishing sites during July 2015.

Site	Temperature (° C)	Conductivity (µs/cm)	pH	DO (mg/L)
Coal Creek (RM 1.8)	14.7	72	7.80	10.5
Coal Creek (RM 1.3)	15.9	705	7.91	9.1
Richards Creek (RM 0.15)	15.5	277	7.67	10.5
Richards Creek (RM 0.37)	15.8	286	7.55	10.5

3.2 Species Distribution and Density

Six species of fish were captured during the 2015 electrofishing surveys—cutthroat trout (*Oncorhynchus clarki*), juvenile coho salmon (*O. kisutch*), rainbow trout (*O. mykiss*), western brook lamprey (*Lampetra richardsoni*), threespine stickleback (*Gasterosteus aculeatus*), and torrent sculpin (*Cottus rhotheus;* young-of-the-year sculpin less than 30 millimeters (mm) long could not be identified to species; Figure 2).

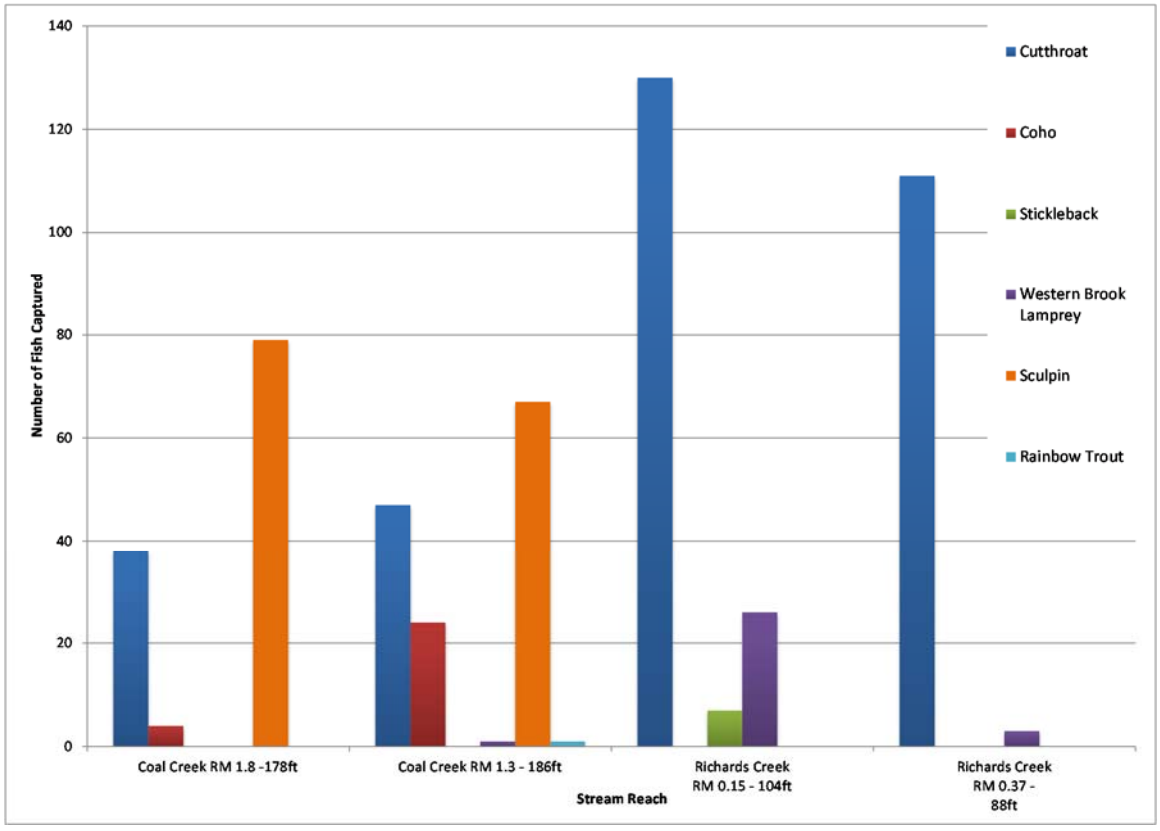

Figure 2. Species distribution by stream reach for 2015 sampling.

Trout species less than 80 mm in length are difficult to identify in the field as either rainbow or cutthroat trout. However, only one larger rainbow trout (134 mm) was captured in Coal Creek (RM 1.3) in 2015 and only a total of 2 (including this year) have been captured in the stream basins draining the City over the past 4 years. Therefore, for the purposes of this study, trout under 80 mm were considered cutthroat and recorded as such in the capture data. Of the non-salmonid species, threespine stickleback were only captured in Richards Creek at RM 0.15. Western brook lamprey were most abundant at this Richards Creek survey site, but were also found in lower numbers at the RM 0.37 site and in Coal Creek at RM 1.8. Other non-fish species captured during electrofishing included crayfish (*Pacifasticus leniusculus*) in Coal and Richards Creeks.

The highest densities of fish were captured in Richards Creek, with both sites having the highest abundances of cutthroat trout. Torrent sculpin was the dominant species at both Coal Creek sites, with moderate numbers of trout. Juvenile coho salmon were only captured in Coal Creek with the highest abundances of this species at RM 1.3. The highest diversity of fish was also found in Coal Creek at RM 1.3 with five species captured, compared with only two or three fish species captured at the other sites. (Figure 2).

The preponderance of cutthroat trout in Richards Creek was noteworthy, comprising 80 and 93 percent of total catch at the lower and upper survey reaches, respectively. In contrast, torrent sculpin was dominant in Coal Creek, comprising 48 and 65 percent of total catch, while absent in Richards Creek survey reaches. Cutthroat were second in abundance in Coal Creek and comprised similar proportions of total catch within the two survey reaches (31 and 33 percent of total catch; Figure 2).

Juvenile coho comprised 17.0 and 3.3 percent of the catch within the lower (RM 1.3) and upper (RM 1.8) Coal Creek reaches, respectively (Figure 2). Coho were absent in Richards Creek. The number of juvenile coho captured in 2015 represents average to above-average proportions of the species found in urban streams draining Bellevue over the past several years. In 2014, a relatively high proportion of juvenile coho were captured in Kelsey Creek (28.6 percent), representing the highest observed in recent years. The 2015 percentage of 17.0 percent in lower Coal Creek represents the second highest proportion of juvenile coho salmon catch, while the numbers found in the upper reach (3.3 percent of total catch) was within the average range observed in other streams in recent years (Figure 2). In 2012 and 2013, juvenile coho, when found, comprised 5 percent or less of total catch within a stream reach.

Also noteworthy was the relatively high proportion of western brook lamprey captured in the lower Richards Creek reach (16.0 percent of total catch). At the other survey reaches, this species comprised less than 3 percent of the total catch.

Table 4 shows the estimated density of fish species caught for each site. Fish density analysis was determined by normalizing the total fish count per linear foot surveyed for each reach[2]. The density of cutthroat trout was about five times higher in Richards Creek relative to Coal Creek. Trout densities were also quite similar in each of the streams, regardless of survey reach. Moderate and similar densities of sculpin were captured in the Coal Creek survey reaches.

[2] Comparison of relative abundance data between sites should be considered only on a gross level as differences in collection technique and netting efficiency can vary.

Table 4. Estimated density of fish species caught and ratio of coho to cutthroat for all sites.

Site	Fish Density (fish/linear foot)			Reach Length	Coho to Cutthroat Ratio
	Sculpin	Cutthroat	Coho		
Coal Creek RM 1.3	0.36	0.25	0.13	186	0.52
Coal Creek RM 1.8	0.44	0.21	0.02	179	0.095
Richards Creek RM 0.15	0	1.25	0	104	0
Richards Creek RM 0.37	0	1.26	0	88	0

Cutthroat densities in 2015 were similar to higher than those found in recent survey years. Richards Creek densities in 2015 were over 60 percent higher than those found in 2013 (0.78 fish per linear foot) at RM 0.9. Coal Creek was not surveyed in the past 3 years, but 2015 densities fell within the range found for other urban streams draining the City during this period (0.06 to 0.83 fish per linear foot; Hart Crowser 2012, 2013, 2014).

Juvenile coho salmon densities in Bellevue urban streams is still relatively low, but 2015 densities in Coal Creek were among the highest in recent years. In 2012, juvenile coho were captured in only one of four streams surveyed (West Tributary) with a density of 0.01 fish per linear foot. In 2013, coho were captured in two streams with similar low densities (0.01 and 0.04 fish per linear foot in Kelsey and Valley creeks, respectively). In 2014, a substantial increase in coho density was observed in Kelsey Creek with 0.05 to 0.24 fish per linear feet in two survey reaches. Coal Creek data from 2015 (0.02–0.13 fish per linear foot) show coho densities that are somewhat lower, but within the magnitude found in 2014. Similarly, the cutthroat to coho ratio in Coal Creek during 2015 (0.1 to 0.52) was substantially higher than that found in any streams during 2012 and 2013 and similar to that found Kelsey Creek in 2014 (0.1 to 0.42).

Surveys in 2015 found the highest densities of sculpin compared with any during the past three survey years. Prior to 2015, sculpin were last captured in Kelsey Creek in 2012 at a density of 0.02 fish per linear foot. Data from 2015 show an order of magnitude increase over previous findings.

3.3 Cutthroat Length Distribution and Habitat Use

As noted, similar numbers of cutthroat trout were captured in the survey reaches of each separate stream, though numbers were considerably different between streams, with abundances in Richards Creek much higher than Coal Creek (Table 5). Only trout over 80 mm were measured to reduce stress on fish due to high ambient air temperatures experienced during processing, so accurate size ranges and means could not be obtained in 2015.

Table 5. Number caught and length range for cutthroat across all sites sampled.

Site	Number of Cutthroat Trout	Length Range (mm)
Richards Creek RM 0.15	130	<80–152
Richards Creek RM 0.37	111	<80–183
Coal Creek (RM 1.3)	47	57–278
Coal Creek (RM 1.8)	38	<80–156

The majority of trout in Richards Creek were small, with only 20 and 13.5 percent of cutthroat measuring greater than 80 mm at RMs 0.15 and 0.37, respectively. Of the larger fish, most were under 110 mm at RM 0.15 with just one fish over 150 mm (Figure 3). Similar numbers of larger fish between 83 and 182 mm were captured at the RM 0.37 reach (Figure 4). Riffle habitats were predominant at both reaches (no pools were present at RM 0.15) and this is where most trout were captured. Only 12.6 percent of cutthroat at the RM 0.37 survey reach were captured in the two pools present at this site. Most of the fish in riffle habitats at both reaches were associated with cover. At RM 0.15, all cutthroat trout were closely associated with the three grade/erosion control structures composed of large wood and rootwads. This was not unexpected since the habitat between the structures had very little complexity; the stream channel was straight, with little wood, large rock, undercut habitats, or overhanging vegetation. The grade structures themselves created microhabitats composed of small cascades, scour pools, and edge habitats immediately adjacent to the wood and rootwads. At RM 0.37, most cutthroat captured in riffles were associated with undercut banks and wood laying over the stream channel.

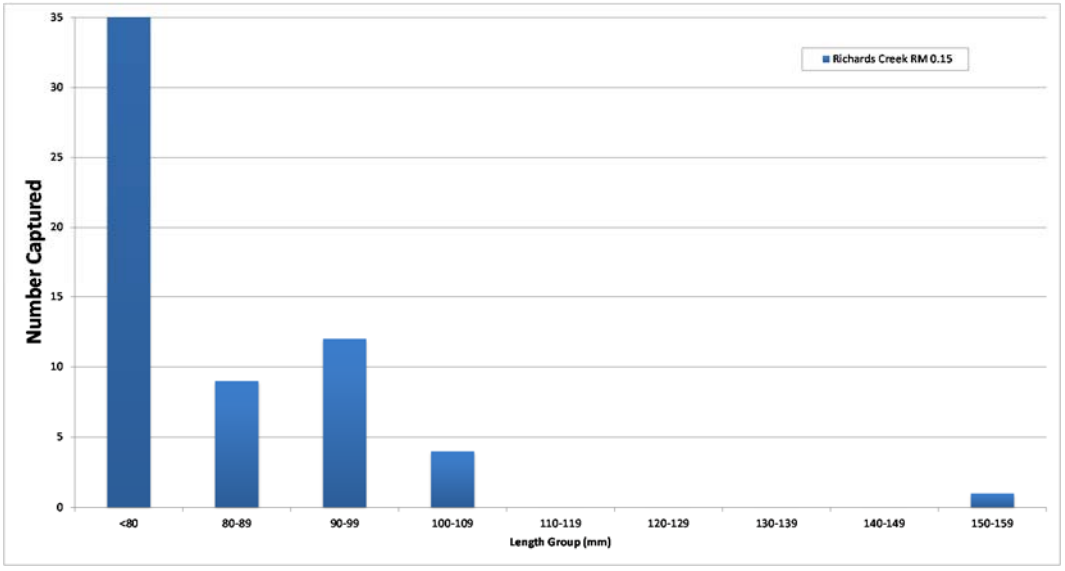

Figure 3. Length frequency distribution of cutthroat at Richards Creek (RM 0.15).

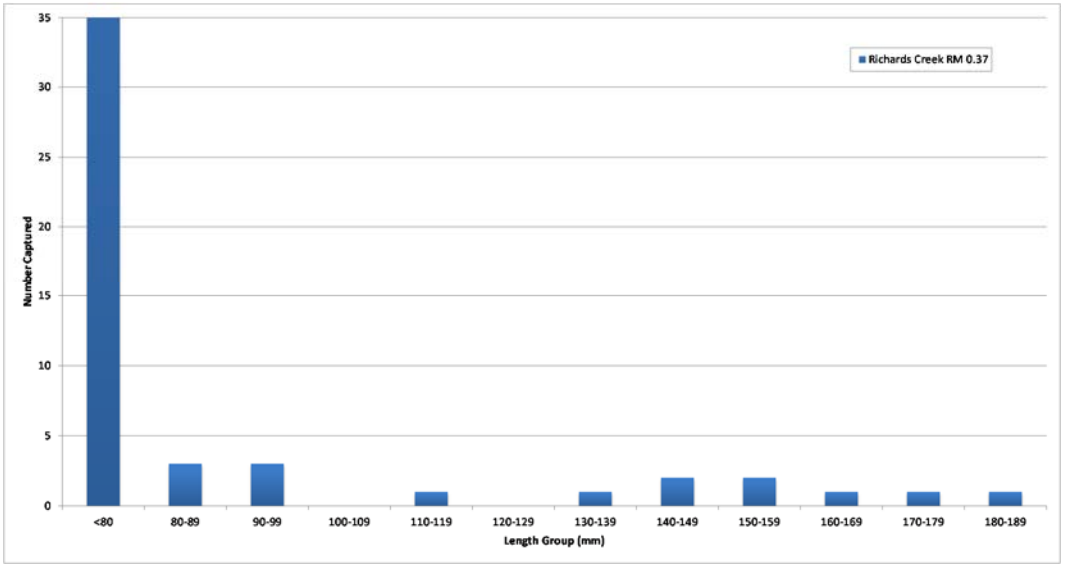

Figure 4. Length frequency distribution of cutthroat at Richards Creek (RM 0.37).

At the Coal Creek RM 1.3 survey reach, cutthroat abundance was much lower relative to Richards Creek, but fish were larger. Fifty-one percent of the fish were larger than 80 mm, with fish sizes spread relatively evenly to over 200 mm (Figure 5). In 2015, all cutthroat trout over 200 mm were captured in this reach. Of fish over 80 mm, 81 percent were associated with two pool habitats. Habitat complexity at the two pools was very good—mean depths ranged from 1.6 to 2.1 feet with one of the pools choked with wood and the other with large rock clusters. Maximum depths were greater than 3 feet. The RM 1.8 survey reach was considered all riffle habitat, but numerous small-edge, cascade, and scour-pool microhabitats formed by large rock clusters were present. In contrast to the RM 1.3 reach, only 16 percent of trout were larger than 80 mm and these consisted of fish with sizes that ranged between 115 and 155 mm (Figure 5).

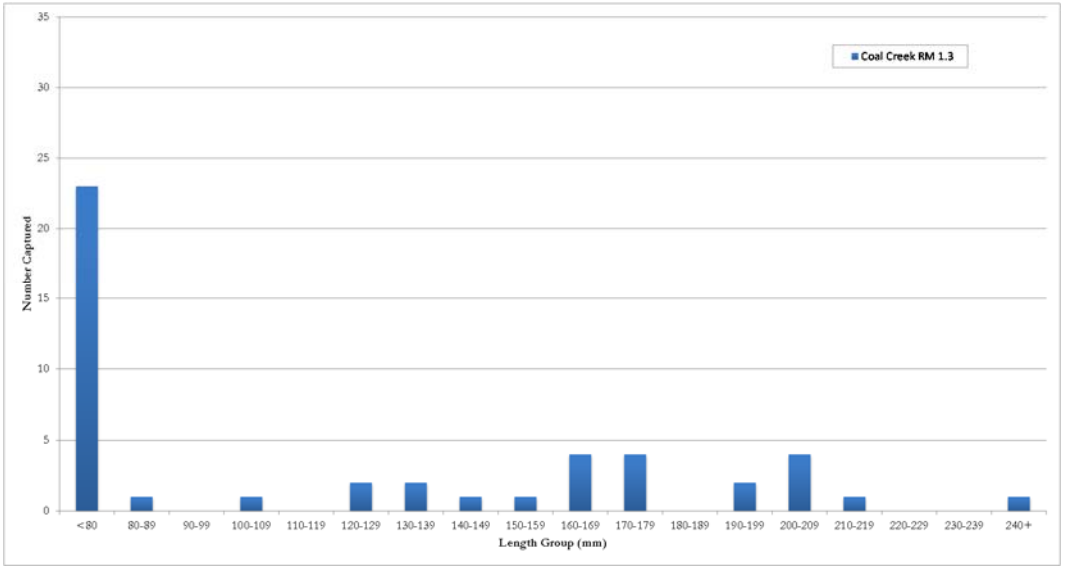

Figure 5. Length frequency distribution of cutthroat at Coal Creek (RM 1.3).

Length frequency distributions suggest that at least four year classes of cutthroat trout were present in Richards and Coal Creeks, particularly at the reaches with true riffle-pool habitats. Richards Creek size distributions at RM 0.37 suggest three or four year classes: young-of-year and juvenile fish under 100 mm in length, a subadult year class clustered in the 120 to 160 mm range, and an adult year class over 175 mm (Figure 4). At Coal Creek, RM 1.3, the same juvenile and subadult year classes were present, with the addition of a larger adult year class over 200 mm (Figure 5). At the two riffle-only survey reaches on both streams, fewer length distributions were found (Figures 3 and 6).

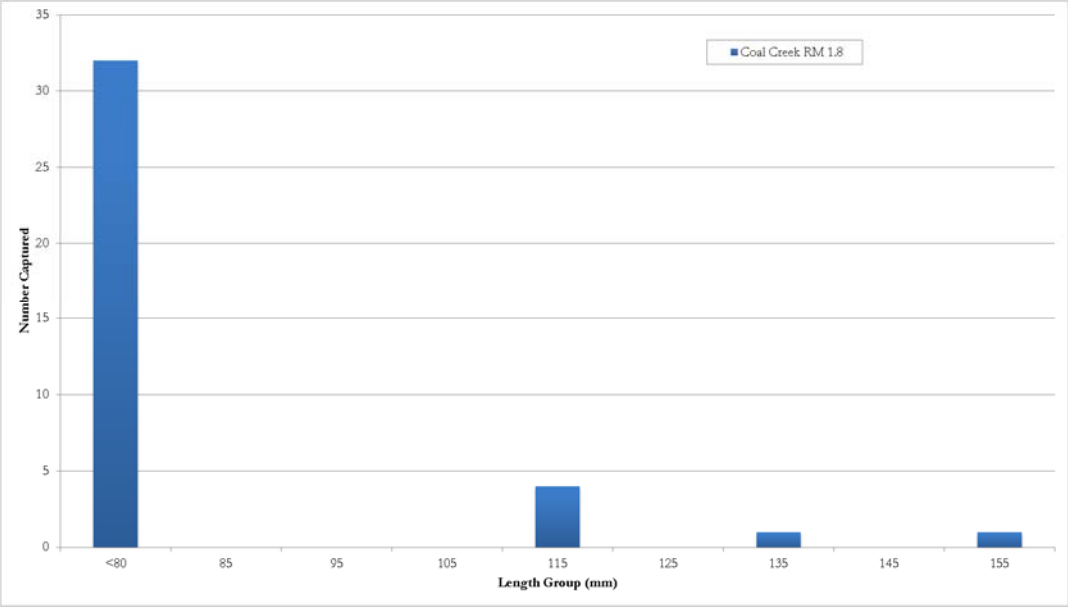

Figure 6. Length frequency distribution of cutthroat at Coal Creek (RM 1.8).

3.4 Sculpin Length Distribution and Habitat Use

Sculpin were only found in Coal Creek, with sizes ranging from less than 30 mm to 125 mm. Similar numbers and sizes were found in each stream reach (Table 6). Only sculpin over 30 mm were consistently measured to reduce stress on fish due to the higher ambient air temperatures experienced during sample processing, so accurate size ranges and means could not be obtained in 2015. Larger sculpin were successfully identified as torrent sculpin; smaller specimens were likely young juveniles of the same species, but species identification could not be confirmed in the field.

Table 6. Number caught and length range for sculpin across all sites sampled.

Site	Number of Sculpin	Length Range (mm)
Richards Creek RM 0.15	0	--
Richards Creek RM 0.37	0	--
Coal Creek (RM 1.3)	67	<30–125
Coal Creek (RM 1.8)	79	<30–122

The largest size group consisted of fish under 30 mm in length, comprising 31 and 47 percent of sculpin catch at RMs 1.3 and 1.8, respectively (Figures 7 and 8). Assuming these are torrent sculpin, data from British Columbia and Oregon suggests that these are young-of-the-year fish (Wydoski and Whitney 2003). At RM 1.3, nearly half of the fish were between 50 and 80 mm with the remaining 20 percent over 80 mm (Figure 7). In contrast, at RM 1.8, most fish were either less than 30 mm or greater than 70 mm (Figure 8). At RM 1.3 of the Coal Creek reach, which was composed of riffles and pools, only 31 percent of sculpin were captured in pool habitats, but most of these were larger fish over 60 mm. Young-of-the-year sculpin were captured in both habitats, but most were associated with riffles.

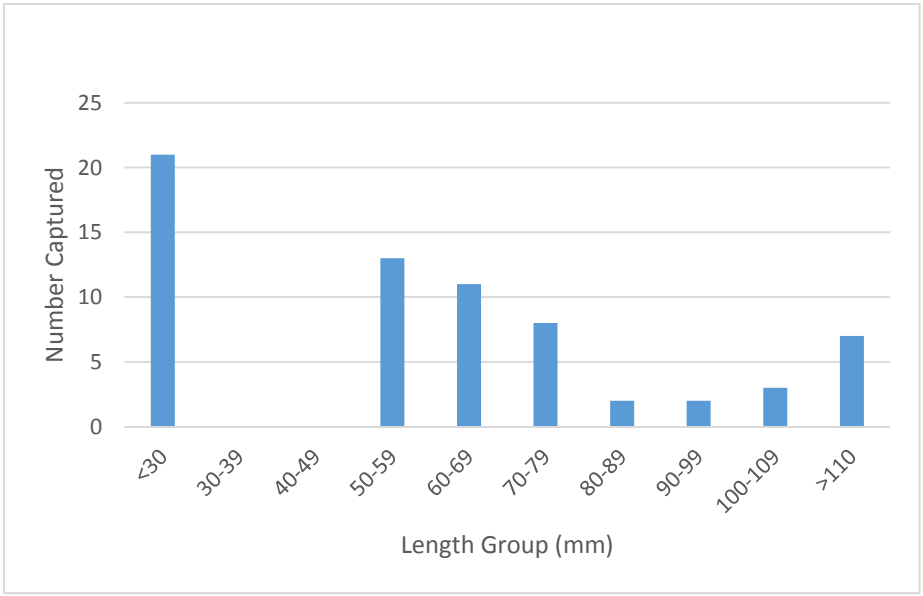

Figure 7. Length frequency distribution of sculpin at Coal Creek (RM 1.3).

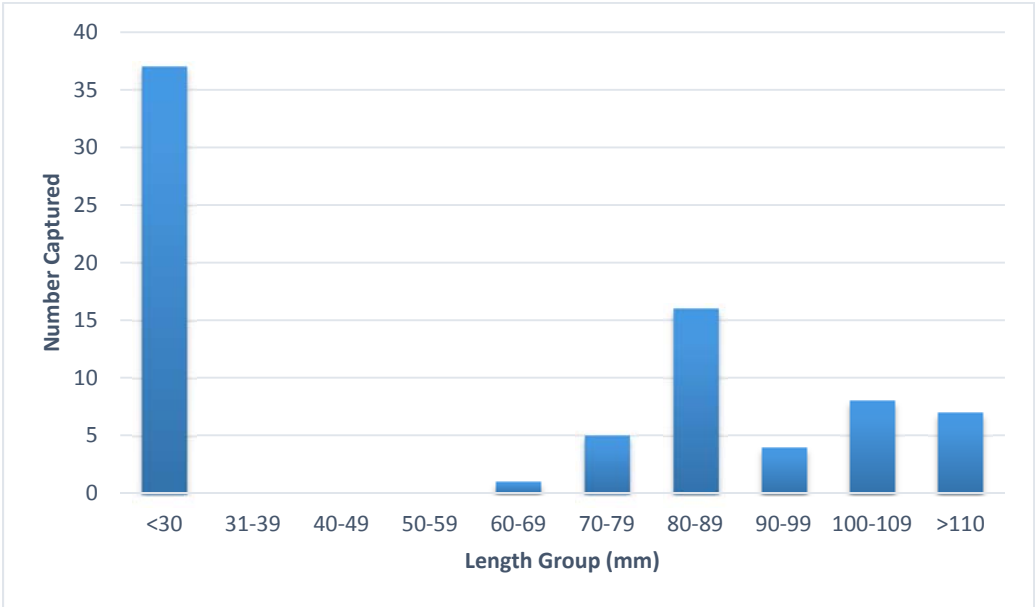

Figure 8. Length frequency distribution of sculpin at Coal Creek (RM 1.8).

3.5 Lamprey Length Distribution and Habitat Use

A total of 27 western brook lamprey were captured in Richards Creek, nearly 90 percent at RM 0.15. This habitat was unique relative to the other stream reaches surveyed, being composed of a slow-moving, but relatively deep riffle between the grade and erosion control structures placed in the reach. Sediments were composed of small gravel covered by a thin layer of fines. City of Bellevue employees observed adult lamprey spawning in this reach earlier in the spring (Devereaux, L., Biologist, City of Bellevue, personal communication, July 7, 2015). Lamprey length ranged from 65 to 145 mm with a mean length of 103.4 mm (Figure 9). Only three lamprey were captured at RM 0.37 and only one lamprey was caught in Coal Creek survey reaches.

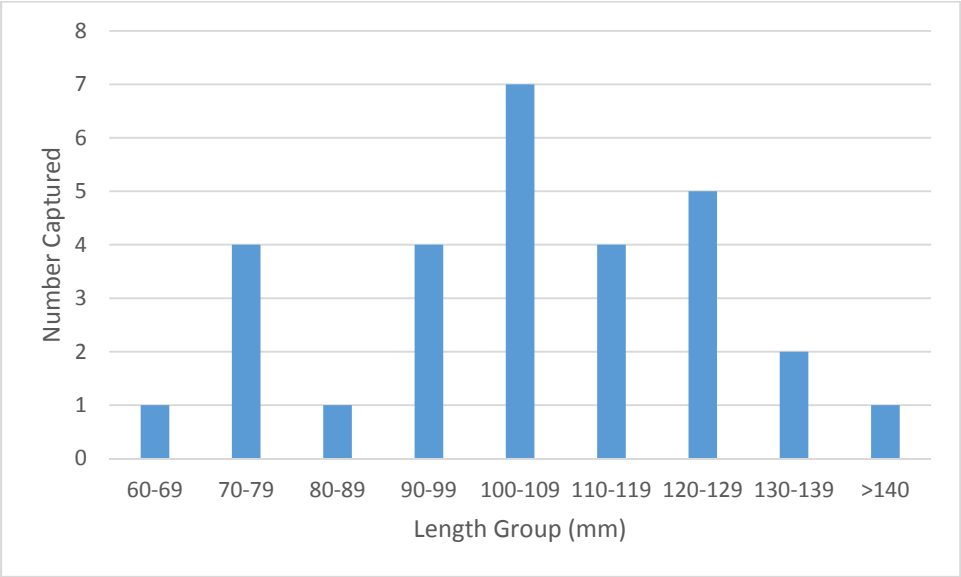

Figure 9. Length frequency distribution of lamprey at Richards Creek.

3.6 Coho Length Distribution and Habitat Use

A total of 28 juvenile coho salmon were captured in Coal Creek, the majority at RM 1.3 (24 specimens). All coho at RM 1.3 were captured in the two pools within the survey reach. The four coho captured at RM 1.8 were associated with deeper scour pools at the base of cascades near large rock clusters. Fish ranged in length from 65 to 100 mm with a mean length of 77.6 mm. Over 80 percent of all juvenile coho ranged from 60 to 90 mm, indicating a typical age 0 or 1+ year class (Figure 10). This size range is similar to lengths measured in previous surveys in 2012 (mean length 74.2 mm), 2013 (83.0 mm), and 2014 (71.1 mm).

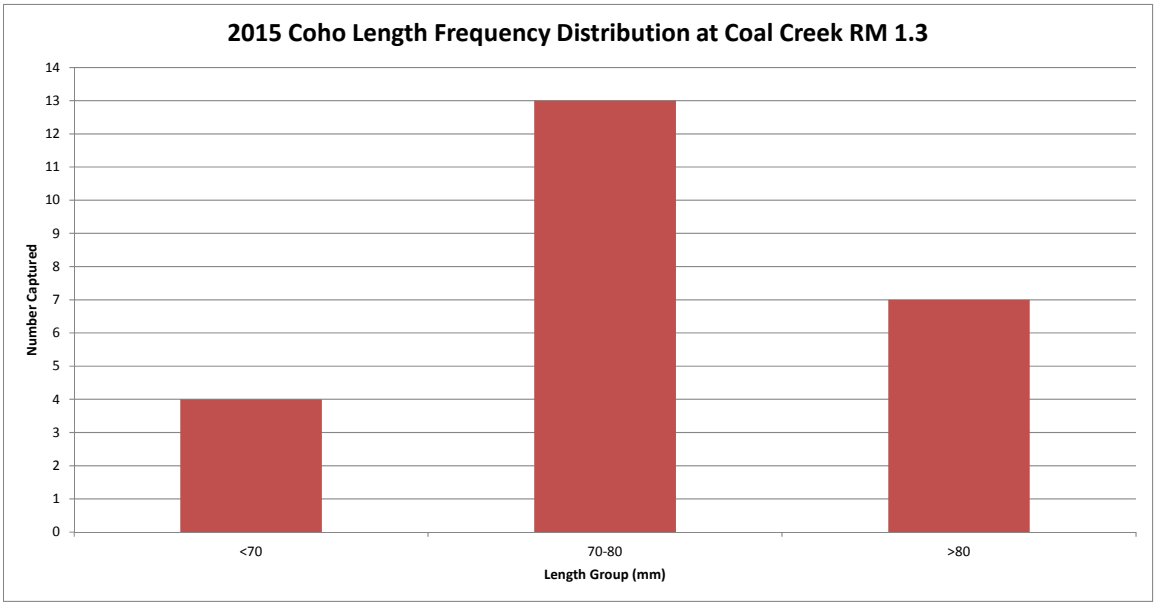

Figure 10. Length frequency distribution of coho at Coal Creek (RMs 1.3 and 1.8).

3.7 Other Fish Species

Rainbow trout and threespine stickleback were the other two species captured in 2015 stream surveys; however, both were rarely captured. One 134 mm rainbow trout was captured at survey reach RM 1.3 of Coal Creek in a pool that was occupied primarily by cutthroat trout and juvenile coho salmon. Seven threespine stickleback were captured in Richards Creek at survey reach RM 0.15. All of the specimens were juveniles under 20 mm in length.

3.8 Native and Non-Native Species

The diversity of fish captured during the 2015 survey was comparable to that found in 2014 and previous surveys with the exception of long-nosed dace (*Rhinichthys cataractae*). While specimens were often observed in recent surveys, they were not captured in 2015. This species was caught in small numbers in Richards Creek at RM 0.9 during 2013, but was not reported in Coal Creek in recent years. Torrent sculpin, which was the dominant species in Coal Creek in 2015, were largely absent in 2014, and observed in only the lowest reaches of Kelsey Creek (RM 0.2) in 2012. Many Puget Sound lowland streams contain other native species including, but not limited to, sculpin, dace, lamprey, largescale suckers, and possibly other salmonid species (Table 7). The greater abundances in coho salmon observed in both 2014 and 2015 are due to increased fish passage access and supplemental stocking of spawning adults. One of the objectives of the riffle reconstruction on Coal Creek RM 1.8 was to improve fish passage beyond Coal Creek Parkway.

No non-native fish species were captured in the 2015 fish surveys. Non-native species have been captured in several other urban streams in the City, as presented in Table 8.

Table 7. Native species documented in Bellevue streams during 1983, 1996–1997, 2002, 2007, and 2010–2015 summer fish surveys.

Species Name	Year / River Mile	Kelsey Creek									Valley Creek		Richards Creek			Yarrow Creek		Newport Creek	Vasa Creek	Coal Creek	
		0.2	1.06	1.4	1.8	2.1	2.59	3.81	3.83	3.97	0.2	0.82	0.15	0.37	0.9	1.13	1.8	0.06	0.39	1.3	1.8
Coho Salmon *(Oncorhynchus kisutch)*	1983	x			x	x															
	1996	x		x		x				x	x	x									x
	1997	x								x		x			x						
	2002					x															x
	2007		x			x					x	x									
	2010										x										
	2011							x	x												
	2012															x					
	2013									x	x										
	2014			x																	
	2015																			x	x
Cutthroat Trout *(Oncorhynchus clarki)*	1983	x			x	x															x
	1996	x		x		x	x			x	x	x			x			x			x
	1997	x								x		x			x						
	2002		x	x		x					x										x
	2007		x		x	x		x	x		x	x									
	2010			x	x	x					x										
	2011							x	x							x					
	2012	x		x																	
	2013									x	x				x		x	x			
	2014			x	x														x		
	2015												x	x						x	x
Rainbow Trout *(Oncorhynchus mykiss)*	1983	x			x	x															
	1996																				
	1997	x													x						
	2002																				
	2007																				
	2010																				
	2011																				
	2012																				
	2013																				
	2014																				
	2015																			x	
Sculpin *(Cottus spp.)*	1983																				x
	1996	x																			x
	1997	x										x			x						
	2002																				x
	2007																				
	2010																				
	2011																				
	2012	x																			
	2013																				
	2014																				
	2015																			x	x

Table 7 (cont'd)

Species Name	Year / River Mile	Kelsey Creek									Valley Creek		Richards Creek			Yarrow Creek		Newport Creek	Vasa Creek	Coal Creek	
		0.2	1.06	1.4	1.8	2.1	2.59	3.81	3.83	3.97	0.2	0.82	0.15	0.37	0.9	1.13	1.8	0.06	0.39	1.3	1.8
Three-spine stickleback *(Gasterosteus aculeatus)*	1983	x			x	x															
	1996																				
	1997														x						
	2002		x																		
	2007		x																		
	2010																				
	2011																				
	2012																				
	2013																				
	2014																				
	2015												x								
Western Brook Lamprey *(Lampetra richardsoni)*	1983																				
	1996						x								x						
	1997											x			x						
	2002		x								x										x
	2007		x		x			x	x		x										
	2010				x						x										
	2011																				
	2012	x		x																	
	2013									x	x				x						
	2014			x																	
	2015												x	x						x	
Largescale Sucker *(Catostomus macrocheilus)*	1983																				
	1996			x		x															
	1997																				
	2002																				
	2007		x																		
	2010																				
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				
Dace (longnose or speckled) *(Rhinichthys spp.)*	1983																				
	1996	x		x																	
	1997	x																			
	2002			x		x															
	2007		x		x	x															
	2010				x																
	2011																				
	2012	x		x																	
	2013														x						
	2014																		x		
	2015																				

Table 7 (cont'd)

Species Name	Year / River Mile	Kelsey Creek									Valley Creek		Richards Creek			Yarrow Creek		Newport Creek	Vasa Creek	Coal Creek	
		0.2	1.06	1.4	1.8	2.1	2.59	3.81	3.83	3.97	0.2	0.82	0.15	0.37	0.9	1.13	1.8	0.06	0.39	1.3	1.8
Trout Fry (<80 mm)	1983																				
	1996	x									x	x									
	1997	x								x		x			x						
	2002		x	x		x					x										x
	2007		x		x	x		x	x		x	x									
	2010			x	x	x					x										
	2011							x	x							x					
	2012																				
	2013									x	x				x			x			
	2014			x	x														x		
	2015																				

= did not sample
= sampled, no fish seen
x = sampled, fish seet

Table 8. Non-native species documented in Bellevue streams during 1983, 1996–1997, 2002, 2007, and 2010–2015 summer fish surveys.

Species Name	Year / River Mile	Kelsey Creek 0.2	1.06	1.4	1.8	2.1	2.59	3.81	3.83	3.97	Valley Creek 0.2	0.82	Richards Creek 0.15	0.37	0.9	Yarrow Creek 1.13	1.8	Newport Creek 0.06	Vasa Creek 0.39	Coal Creek 1.3	1.8
Bluegill (*Lepomis macrochirus*)	1983																				
	1996	x				x				x	x										
	1997																				
	2002					x															
	2007																				
	2010				x	x															
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				
Largemouth Bass (*Micropterus salmoides*)	1983																				
	1996																				
	1997									x											
	2002																				
	2007																				
	2010			x																	
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				
Pumpkinseed (*Lepomis gibbosus*)	1983																				
	1996																				
	1997																				
	2002					x															
	2007																				
	2010																				
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				
Crappie (black or white) (*Pomoxis spp.*)	1983																				
	1996																				
	1997																				
	2002																				
	2007																				
	2010			x	x																
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				

Table 8 (cont'd)

Species Name	Year / River Mile	Kelsey Creek									Valley Creek		Richards Creek			Yarrow Creek		Newport Creek	Vasa Creek	Coal Creek	
		0.2	1.06	1.4	1.8	2.1	2.59	3.81	3.83	3.97	0.2	0.82	0.15	0.37	0.9	1.13	1.8	0.06	0.39	1.3	1.8
Carp *(Cyprinus carpio)*	1983																				
	1996																				
	1997																				
	2002																				
	2007																				
	2010			x																	
	2011																				
	2012																				
	2013																				
	2014																				
	2015																				

= did not sample
= sampled, no fish seen
x = sampled, fish seen

4.0 Discussion and Recommendations for Future Actions

4.1 Discussion

Three of the four survey reaches involved sites where major CIPs have been previously undertaken (Table 1). The 2015 surveys represent initial sampling to determine the long-term effects of the CIPs on aquatic habitats and fish use. Results indicate relatively good fish use of habitats that have been modified in association with these CIPs. Continued surveys at the CIPs, and in other reaches on the same streams, will be necessary to determine if performance objectives for these long-term improvements are being achieved.

The reconstructed riffle on Coal Creek (RM1.8) had the highest abundance of torrent sculpin in 2015 or during any other recent survey. This and other freshwater sculpin species are important and considered sensitive indicator species relative to both water quality and optimal physical stream parameters. It would appear that the anchored LWD complexes on both stream banks provide important bank stabilization functions, but may provide less habitat to fish, since most of the wood does not extend into the stream channel substrates. Although numerous functional habitats were created by large rocks, extending the LWD into channel substrates may provide larger and additional microhabitats, cover, and pool-forming processes. The result may be the addition of deeper riffle areas and pools that attract higher densities of cutthroat trout and juvenile coho salmon.

High abundance of sculpin and trout were also observed in Coal Creek adjacent to Anna's Pond at RM 1.3. Though the sedimentation/high flow bypass pond is located adjacent to the survey reach, stream habitats were quite complex, consisting of substantial amounts of woody debris, boulder clusters, broad riffles, and dense riparian canopy providing shade. The two pools within the reach were the deepest observed in 2015. This likely contributed to this reach having the highest diversity of fish species (5), high abundance of torrent sculpin, and the highest density of juvenile coho salmon found in 2015.

The City is considering additional enhancements of the Anna's Pond site by anchoring LWD within the stream channel to increase habitat complexity. Given the current high riparian densities at this site, LWD supplementation is probably not necessary, but may be useful if placed at the north and south ends of the pond, where the stream is clearly visible. Supplementation anywhere else at the site would likely involve the removal of some existing vegetation and shade canopy, which may be detrimental to overall ecological functions. It may be more beneficial to monitor the riparian zone on the pond side for invasive vegetation (e.g., Himalayan blackberry or Japanese knotweed) which may take hold in the cleared area between the native vegetation and pond. Removing invasive vegetation and replanting with native species would contribute to the overall health of the riparian corridor and ensure that vital vegetation canopy and existing LWD recruitment are maintained in the area.

Perhaps surprisingly, the highest density of cutthroat trout was found at Richards Creek, RM 0.15, at the site of the grade and erosion control structures. As noted, these structures were composed of large logs and rootwads that were evenly spaced within the reach. Except for the structures themselves, very little habitat complexity was observed—no pools, no undercut banks or other edge habitats, a straight stream

channel, and very little overhanging vegetation or shade canopy. This stream reach did have a relatively high volume of slow-moving water (mean depth of 0.73 feet over a 104-foot reach) with microhabitats associated with the placed wood structures, and reasonable summer-time temperatures for a lower velocity habitat (15.5° C). This probably contributed to the higher abundances of trout, though all trout were associated with the three wood structures and none were captured between structures within the main stream channel. This site also had the highest proportion of young-of-the-year and smaller juveniles, with the lowest density of larger fish, despite the relatively large wetted width and water volume. This likely reflects the overall low habitat complexity; the site may not support older year classes of trout. In contrast, the Richards Creek stream reach at RM 0.37 was by far the smallest stream reach surveyed, yet contained several year classes of juvenile trout, adults over 180 mm, and virtually the same high trout density as site RM 0.15. This is likely the result of this reach containing substantial amounts of wood, riffle/pool habitats, cutbanks, and considerable shade from vegetation.

Richards Creek at RM 0.15 also had the highest density of western brook lamprey; spawning lamprey were observed earlier in the spring.

Juvenile coho salmon were only found in Coal Creek in 2015. The ratio of coho to cutthroat trout at the Anna's Pond reach (RM 1.3) was 0.52, which represents the highest ratio observed in recent years. In 2014, a coho-to-cutthroat-trout ratio of 0.42 was found at Kelsey Creek (Hart Crowser 2014). These higher ratios reflect the supplementation of adult coho in both streams. In 2013, 742 adult coho were released in Coal Creek, resulting in 152 identified redds and over 1,100 adults were released in Kelsey Creek, resulting in 113 redds. Similarly, in 2014, 1,573 adult coho were released in Coal Creek, resulting in 173 redds. In Kelsey Creek, 643 adults were released, but did not result in any documented redds. In 2014, only 15 non-hatchery adult coho were observed above Interstate 405.

Even with improved fish passage, the ratio of juvenile coho to cutthroat was low relative to healthy stream habitats. Lucchetti and Fuerstenberg (1993) reported that a coho-to-cutthroat ratio of >2 indicates excellent habitat, 1 to 2 indicates good habitat, and < 1 indicates urban impacts and/or limited access for anadromous fish. In healthy streams, juvenile coho account for 2 to 10 times the number of juvenile cutthroat. As urbanization continues, juvenile and adult resident cutthroat become more dominant and eventually surpass coho in both total numbers and biomass, which appears to be the case for these sites (Anderson 2011). However, both 2014 and 2015 survey results could be viewed as encouraging, since results in 2012 and 2013 found only a handful of coho with larger survey efforts. Further monitoring is needed to determine whether the increase in coho abundance observed in 2014 and 2015 represents an increasing trend in coho production. Also of interest is the ratio of adult coho to the number of redds observed and the number of wild non-supplemental adults that migrate up the basin.

4.2 Recommendations

It is recommended that the City continue studies on the reaches sampled this year and in previous years. Conducting additional surveys on the three 2015 reaches where capital projects were undertaken will be important to determine the long-term success of these projects relative to stream health and function, as well as on the effectiveness of future capital projects designed to improved fish habitat and passage. Data will also be useful in assessing the success of salmonid supplementation efforts. Continued studies to track the diversity, size, and abundance of native and non-native fish species for use as an indicator of overall stream health is also advised. Though not conducted in 2015, it is also advised that the City

continue stomach content studies to determine if New Zealand mudsnails are an increasing component of the diet of cutthroat trout and juvenile coho salmon. In addition, it is recommended that fish condition assessments, including weight and health observations, be included to evaluate interim impacts on fish health.

Below is a detailed list of recommendations for the City of Bellevue to facilitate these actions.

- Compare diversity, size, and abundance of fish species across all years for sites with historical data.
- Conduct electrofishing at low, middle, and upper reaches of creeks during the same sampling events to determine if salmonids and native fish are utilizing different habitats than in previous years. This may help determine more accurately the presence/absence of fish within a watershed.
- Determine fish condition index at electrofishing sites to assess relative health of priority fish species. The index could then be compared to other Western Washington urban streams where this particular data have been collected.
- Collect additional stream habitat data within survey reaches including large and small woody debris counts, percent canopy coverage and shading, cutbank lengths, boulder cluster counts, and substrate type. Annual survey observations strongly suggest that the presence of these stream and riparian habitat attributes affect the abundance and diversity of fish in survey reaches and should be quantified over time to assess changes and trends.
- Collect gut content data from priority salmonid species at current BIBI sites to determine if aquatic or terrestrial prey items dominate and to further investigate New Zealand mudsnail predation. These data will help determine prey species availability and use by salmonids. Data collected can also help determine if riparian and/or substrate improvements are necessary.
- Compare size of coho and cutthroat fish populations to other Puget Sound lowland reference streams.
- Continue a consistent electrofishing program that visits the same sites during the same time of year to increase robustness of data for determination of status and trends of priority fish species and to determine the prevalence of non-native species.
- Implement a study to evaluate selected electrofishing sites that have shown historical changes in species diversity and density. The study should include key water-quality parameters such as temperature and flow conditions; however, other parameters also should be considered for evaluation.
- Include adult coho escapement data in the status and trends database in order to associate coho presence or absence with run size. Continued monitoring is advisable for both juvenile abundance/habitat use and wild recruitment with an objective towards a sustainable run of wild coho salmon.

Data collected for native and non-native fish species presence, status, and trends in urban streams can be a useful tool in determining the health of urban streams. Changes in these attributes can also be used to determine if cumulative alterations in land use, habitat restoration activities, and supplementation efforts are influencing fish populations. However, fish use (or lack thereof) in urban streams can be due to many variables, including temporal and spatial changes, habitat type and condition, water quality, and climate. Changes to any one of these variables, without collecting data on each of them, make it difficult to determine what might be causing changes in fish densities and species composition. However,

collecting consistent data on habitat change, fish use, and diets (both temporally and spatially), would help ascertain if changes in fish populations and density are due to natural environmental changes, beneficial habitat modifications, or changes in land use. Implementing the recommendations mentioned above would help the City of Bellevue further answer these questions about its local, urban streams.

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Appendix A – 2015 Raw Data

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Date:	7/7/2015
Stream:	Coal Creek
Site:	Below Parkway
River Mile:	1.8
Latitute:	47.5578
Longitude:	-122.1685
Visibility:	Clear
Air:	18.6° C
Water:	Start 14.2° C, End 14.7° C
pH:	N/A
Turbidity	N/A
Conductivity:	72 µs/cm
DO:	10.54 mg/L
Total Reach Length:	178.8 ft
Riffle Length:	178.8 ft
Average Wetted Width:	15.74 ft
Average Wetted Depth:	0.73 ft
Electrofishing Setting:	200 v, 60 Hz, 6 mS
Start Time	8:45 AM
End Time	10:45 AM
Fishing Time:	3092 sec
Netter Success:	High/Variable

Sampling done by:
Kit Paulsen (Employee, Fish ID)
Jim Starkes (Consultant, Electrofishing)
Laurie Devereaux (Employee)
Sally (Volunteer)
Amber (Volunteer)
Ashley Mihle (Former Employee)
Haley Koesters (Watershed Planning Intern)
Keith Luu (Engineering Intern)
Meghan Veilleux (Engineering Intern)
Ken Mullins (Outreach Intern)
Emma Hewitt (Outreach Intern)

Fish #	Species	Length (mm)	Habitat Type
1	Cutthroat	<80	Riffle
2	Cutthroat	<80	Riffle
3	Cutthroat	<80	Riffle
4	Cutthroat	<80	Riffle
5	Cutthroat	<80	Riffle
6	Cutthroat	<80	Riffle
7	Cutthroat	<80	Riffle
8	Cutthroat	<80	Riffle
9	Cutthroat	<80	Riffle
10	Cutthroat	<80	Riffle
11	Cutthroat	<80	Riffle
12	Cutthroat	<80	Riffle
13	Cutthroat	<80	Riffle
14	Cutthroat	<80	Riffle
15	Cutthroat	<80	Riffle
16	Cutthroat	<80	Riffle
17	Cutthroat	<80	Riffle
18	Cutthroat	<80	Riffle
19	Cutthroat	<80	Riffle
20	Cutthroat	<80	Riffle
21	Cutthroat	<80	Riffle
22	Cutthroat	<80	Riffle
23	Cutthroat	<80	Riffle
24	Cutthroat	<80	Riffle
25	Cutthroat	<80	Riffle
26	Cutthroat	<80	Riffle
27	Cutthroat	<80	Riffle
28	Cutthroat	<80	Riffle
29	Cutthroat	<80	Riffle
30	Cutthroat	<80	Riffle
31	Cutthroat	<80	Riffle
32	Cutthroat	<80	Riffle
33	Cutthroat	156	Riffle
34	Cutthroat	119	Riffle
35	Cutthroat	130	Riffle
36	Cutthroat	110	Riffle
37	Cutthroat	110	Riffle
38	Cutthroat	116	Riffle
39	Coho	75	Riffle
40	Coho	77	Riffle
41	Coho	73	Riffle
42	Coho	71	Riffle

Fish #	Species	Length (mm)	Habitat Type
43	Sculpin (Torrent)	110	Riffle
44	Sculpin (Torrent)	77	Riffle
45	Sculpin (Torrent)	88	Riffle
46	Sculpin (Torrent)	85	Riffle
47	Sculpin (Torrent)	93	Riffle
48	Sculpin (juvenile)	27	Riffle
49	Sculpin (Torrent)	84	Riffle
50	Sculpin (Torrent)	83	Riffle
51	Sculpin (Torrent)	104	Riffle
52	Sculpin (Torrent)	110	Riffle
53	Sculpin (Torrent)	110	Riffle
54	Sculpin (Torrent)	104	Riffle
55	Sculpin (Torrent)	80	Riffle
56	Sculpin (Torrent)	103	Riffle
57	Sculpin (Torrent)	79	Riffle
58	Sculpin (Torrent)	74	Riffle
59	Sculpin (Torrent)	74	Riffle
60	Sculpin (Torrent)	110	Riffle
61	Sculpin (Torrent)	86	Riffle
62	Sculpin (Torrent)	68	Riffle
63	Sculpin (Torrent)	74	Riffle
64	Sculpin (Torrent)	83	Riffle
65	Sculpin (Torrent)	85	Riffle
66	Sculpin (juvenile)	27	Riffle
67	Sculpin (juvenile)	25	Riffle
68	Sculpin (juvenile)	26	Riffle
69	Sculpin (juvenile)	23	Riffle
70	Sculpin (juvenile)	25	Riffle
71	Sculpin (juvenile)	25	Riffle
72	Sculpin (juvenile)	22	Riffle
73	Sculpin (juvenile)	<30	Riffle
74	Sculpin (Torrent)	100	Riffle
75	Sculpin (Torrent)	82	Riffle
76	Sculpin (juvenile)	<30	Riffle
77	Sculpin (Torrent)	115	Riffle
78	Sculpin (Torrent)	80	Riffle
79	Sculpin (Torrent)	106	Riffle
80	Sculpin (Torrent)	80	Riffle
81	Sculpin (juvenile)	<30	Riffle
82	Sculpin (Torrent)	83	Riffle
83	Sculpin (Torrent)	108	Riffle
84	Sculpin (juvenile)	<30	Riffle

Fish #	Species	Length (mm)	Habitat Type
85	Sculpin (Torrent)	84	Riffle
86	Sculpin (juvenile)	<30	Riffle
87	Sculpin (juvenile)	<30	Riffle
88	Sculpin (juvenile)	<30	Riffle
89	Sculpin (juvenile)	<30	Riffle
90	Sculpin (juvenile)	<30	Riffle
91	Sculpin (juvenile)	<30	Riffle
92	Sculpin (juvenile)	<30	Riffle
93	Sculpin (Torrent)	108	Riffle
94	Sculpin (Torrent)	93	Riffle
95	Sculpin (Torrent)	86	Riffle
96	Sculpin (Torrent)	83	Riffle
97	Sculpin (Torrent)	84	Riffle
98	Sculpin (juvenile)	<30	Riffle
99	Sculpin (juvenile)	<30	Riffle
100	Sculpin (juvenile)	<30	Riffle
101	Sculpin (juvenile)	<30	Riffle
102	Sculpin (juvenile)	<30	Riffle
103	Sculpin (juvenile)	<30	Riffle
104	Sculpin (juvenile)	<30	Riffle
105	Sculpin (juvenile)	<30	Riffle
106	Sculpin (juvenile)	<30	Riffle
107	Sculpin (juvenile)	<30	Riffle
108	Sculpin (juvenile)	<30	Riffle
109	Sculpin (juvenile)	<30	Riffle
110	Sculpin (juvenile)	<30	Riffle
111	Sculpin (juvenile)	<30	Riffle
112	Sculpin (juvenile)	<30	Riffle
113	Sculpin (juvenile)	<30	Riffle
114	Sculpin (juvenile)	<30	Riffle
115	Sculpin (juvenile)	<30	Riffle
116	Sculpin (Torrent)	92	Riffle
117	Sculpin (Torrent)	120	Riffle
118	Sculpin (Torrent)	122	Riffle
119	Sculpin (Torrent)	95	Riffle
120	Sculpin (Torrent)	100	Riffle
121	Sculpin (Torrent)	96	Riffle

Date:	7/8/2015
Stream:	Coal Creek
Site:	Reach around Anna's Pond
River Mile:	1.3
Latitute:	47.5623
Longitude:	-122.1714
Visibility:	Clear
Air:	N/A
Water:	Start 14.7° C/ End 15.9° C
pH:	N/A
Turbidity	N/A
Conductivity:	705 µs/cm
DO:	9.08 mg/L
Total Reach Length:	185.5 ft
Electrofishing Setting:	200 v, 60 Hz, 6 mS
Start Time	9:20 AM
End Time	11:46 AM
Fishing Time:	N/A
Netter Success:	High/High

Sampling done by:
Kit Paulsen (Employee, Fish ID)
Jim Starkes (Consultant, Electrofishing)
Laurie Devereaux (Employee)
Stephanie (Employee)
Haley Koesters (Watershed Planning Intern)
Keith Luu (Engineering Intern)
Meghan Veilleux (Engineering Intern)
Ken Mullins (Outreach Intern)
Emma Hewitt (Outreach Intern)

Fish #	Species	Length (mm)	Habitat Type
1	Cutthroat	<80	Pool
2	Cutthroat	<80	Pool
3	Cutthroat	<80	Pool
4	Cutthroat	<80	Pool
5	Cutthroat	<80	Pool
6	Cutthroat	<80	Pool
7	Cutthroat	<80	Pool
8	Cutthroat	<80	Pool
9	Cutthroat	<80	Pool
10	Cutthroat	<80	Pool
11	Cutthroat	<80	Pool
12	Cutthroat	<80	Pool
13	Cutthroat	<80	Pool
14	Cutthroat	<80	Pool
15	Cutthroat	<80	Pool
16	Cutthroat	<80	Riffle
17	Cutthroat	<80	Riffle
18	Cutthroat	<80	Riffle
19	Cutthroat	<80	Riffle
20	Cutthroat	<80	Riffle
21	Cutthroat	<80	Riffle
22	Cutthroat	<80	Riffle
23	Cutthroat	<80	Riffle
24	Cutthroat	164	Pool
25	Cutthroat	278	Pool
26	Cutthroat	126	Pool
27	Cutthroat	81	Pool
28	Cutthroat	202	Pool
29	Cutthroat	191	Pool
30	Cutthroat	173	Pool
31	Cutthroat	154	Pool
32	Cutthroat	206	Pool
33	Cutthroat	120	Pool
34	Cutthroat	196	Pool
35	Cutthroat	144	Pool
36	Cutthroat	103	Pool
37	Cutthroat	175	Pool
38	Cutthroat	213	Pool
39	Cutthroat	160	Pool
40	Cutthroat	168	Pool
41	Cutthroat	202	Pool
42	Cutthroat	175	Pool

Fish #	Species	Length (mm)	Habitat Type
43	Cutthroat	134	Pool
44	Cutthroat	200	Pool
45	Cutthroat	179	Pool
46	Cutthroat	166	Pool
47	Cutthroat	134	Pool
48	Coho	69	Pool
49	Coho	73	Pool
50	Coho	97	Pool
51	Coho	88	Pool
52	Coho	79	Pool
53	Coho	65	Pool
54	Coho	74	Pool
55	Coho	71	Pool
56	Coho	73	Pool
57	Coho	85	Pool
58	Coho	75	Pool
59	Coho	87	Pool
60	Coho	77	Pool
61	Coho	71	Pool
62	Coho	80	Pool
63	Coho	79	Pool
64	Coho	67	Pool
65	Coho	73	Pool
66	Coho	78	Pool
67	Coho	76	Pool
68	Coho	100	Pool
69	Coho	66	Pool
70	Coho	91	Pool
71	Coho	83	Riffle
72	Sculpin (Torrent)	60	Pool
73	Sculpin (Torrent)	65	Pool
74	Sculpin (Torrent)	65	Pool
75	Sculpin (Torrent)	66	Pool
76	Sculpin (Torrent)	75	Pool
77	Sculpin (Torrent)	124	Pool
78	Sculpin (Torrent)	57	Pool
79	Sculpin (Torrent)	69	Pool
80	Sculpin (Torrent)	70	Pool
81	Sculpin (Torrent)	105	Pool
82	Sculpin (Torrent)	103	Pool
83	Sculpin (juvenile)	<30	Riffle
84	Sculpin (juvenile)	<30	Riffle

Fish #	Species	Length (mm)	Habitat Type
85	Sculpin (Torrent)	62	Riffle
86	Sculpin (juvenile)	<30	Riffle
87	Sculpin (juvenile)	<30	Riffle
88	Sculpin (juvenile)	<30	Riffle
89	Sculpin (juvenile)	<30	Riffle
90	Sculpin (juvenile)	<30	Riffle
91	Sculpin (Torrent)	70	Riffle
92	Sculpin (Torrent)	79	Riffle
93	Sculpin (Torrent)	76	Riffle
94	Sculpin (Torrent)	70	Riffle
95	Sculpin (Torrent)	59	Riffle
96	Sculpin (juvenile)	<30	Riffle
97	Sculpin (Torrent)	95	Riffle
98	Sculpin (Torrent)	76	Riffle
99	Sculpin (Torrent)	71	Riffle
100	Sculpin (Torrent)	60	Riffle
101	Sculpin (Torrent)	63	Riffle
102	Sculpin (juvenile)	<30	Riffle
103	Sculpin (Torrent)	86	Riffle
104	Sculpin (Torrent)	121	Riffle
105	Sculpin (Torrent)	77	Riffle
106	Sculpin (juvenile)	<30	Pool
107	Sculpin (juvenile)	<30	Pool
108	Sculpin (Torrent)	125	Pool
109	Sculpin (Torrent)	110	Pool
110	Sculpin (Torrent)	95	Pool
111	Sculpin (Torrent)	82	Pool
112	Sculpin (Torrent)	121	Pool
113	Sculpin (Torrent)	59	Pool
114	Sculpin (Torrent)	124	Pool
115	Sculpin (Torrent)	58	Riffle
116	Sculpin (juvenile)	<30	Riffle
117	Sculpin (Torrent)	63	Riffle
118	Sculpin (Torrent)	56	Riffle
119	Sculpin (Torrent)	56	Riffle
120	Sculpin (juvenile)	<30	Riffle
121	Sculpin (juvenile)	<30	Riffle
122	Sculpin (juvenile)	<30	Riffle
123	Sculpin (juvenile)	<30	Riffle
124	Sculpin (juvenile)	<30	Riffle
125	Sculpin (juvenile)	<30	Riffle
126	Sculpin (juvenile)	<30	Riffle

Fish #	Species	Length (mm)	Habitat Type
127	Sculpin (Torrent)	54	Riffle
128	Sculpin (Torrent)	56	Riffle
129	Sculpin (Torrent)	63	Riffle
130	Sculpin (Torrent)	115	Riffle
131	Sculpin (Torrent)	60	Riffle
132	Sculpin (juvenile)	<30	Riffle
133	Sculpin (Torrent)	58	Riffle
134	Sculpin (Torrent)	54	Riffle
135	Sculpin (Torrent)	58	Pool
136	Sculpin (Torrent)	58	Pool
137	Sculpin (Torrent)	103	Pool
138	Sculpin (juvenile)	<30	Pool
139	Rainbow Trout	134	Pool
140	Lamprey (WB)	157	Pool
141	Crayfish (Signal)	31	Pool

Date:	7/9/2015
Stream:	Richards/East Creek
Site:	Richards at Kamber
River Mile:	0.15
Latitute:	47.5871
Longitude:	-122.1618
Visibility:	Clear
Air:	N/A
Water:	Start 15.1° C/ End 15.5° C
pH:	N/A
Turbidity	N/A
Conductivity:	277.4 µs/cm (recorded as mS?)
DO:	10.45 mg/L
Total Reach Length:	104 ft
Riffle Length:	104f t
Average Wetted Width:	13.45 ft
Average Wetted Depth:	0.73 ft
Electrofishing Setting:	200 v, 60 Hz, 6 mS
Start Time	8:20 AM
End Time	9:30 AM
Fishing Time:	N/A
Netter Success:	High/High

Sampling done by:
Kit Paulsen (Employee, Fish ID)
Jim Starkes (Consultant, Electrofishing)
Laurie Devereaux (Employee)
Katie Jensen (Employee)
Haley Koesters (Watershed Planning Intern)
Keith Luu (Engineering Intern)
Meghan Veilleux (Engineering Intern)
Ken Mullins (Outreach Intern)
Emma Hewitt (Outreach Intern)
Ashley Mihle (Former employee)

Fish #	Species	Length (mm)	Habitat Type
1	Cutthroat	<80	Riffle
2	Cutthroat	<80	Riffle
3	Cutthroat	<80	Riffle
4	Cutthroat	<80	Riffle
5	Cutthroat	<80	Riffle
6	Cutthroat	<80	Riffle
7	Cutthroat	<80	Riffle
8	Cutthroat	<80	Riffle
9	Cutthroat	<80	Riffle
10	Cutthroat	<80	Riffle
11	Cutthroat	<80	Riffle
12	Cutthroat	<80	Riffle
13	Cutthroat	<80	Riffle
14	Cutthroat	<80	Riffle
15	Cutthroat	<80	Riffle
16	Cutthroat	<80	Riffle
17	Cutthroat	<80	Riffle
18	Cutthroat	<80	Riffle
19	Cutthroat	<80	Riffle
20	Cutthroat	<80	Riffle
21	Cutthroat	<80	Riffle
22	Cutthroat	<80	Riffle
23	Cutthroat	<80	Riffle
24	Cutthroat	<80	Riffle
25	Cutthroat	<80	Riffle
26	Cutthroat	<80	Riffle
27	Cutthroat	<80	Riffle
28	Cutthroat	<80	Riffle
29	Cutthroat	<80	Riffle
30	Cutthroat	<80	Riffle
31	Cutthroat	<80	Riffle
32	Cutthroat	<80	Riffle
33	Cutthroat	<80	Riffle
34	Cutthroat	<80	Riffle
35	Cutthroat	<80	Riffle
36	Cutthroat	<80	Riffle
37	Cutthroat	<80	Riffle
38	Cutthroat	<80	Riffle
39	Cutthroat	<80	Riffle
40	Cutthroat	<80	Riffle
41	Cutthroat	<80	Riffle
42	Cutthroat	<80	Riffle

Fish #	Species	Length (mm)	Habitat Type
43	Cutthroat	<80	Riffle
44	Cutthroat	<80	Riffle
45	Cutthroat	<80	Riffle
46	Cutthroat	<80	Riffle
47	Cutthroat	<80	Riffle
48	Cutthroat	<80	Riffle
49	Cutthroat	<80	Riffle
50	Cutthroat	<80	Riffle
51	Cutthroat	<80	Riffle
52	Cutthroat	<80	Riffle
53	Cutthroat	<80	Riffle
54	Cutthroat	<80	Riffle
55	Cutthroat	<80	Riffle
56	Cutthroat	<80	Riffle
57	Cutthroat	<80	Riffle
58	Cutthroat	<80	Riffle
59	Cutthroat	<80	Riffle
60	Cutthroat	<80	Riffle
61	Cutthroat	<80	Riffle
62	Cutthroat	<80	Riffle
63	Cutthroat	<80	Riffle
64	Cutthroat	<80	Riffle
65	Cutthroat	<80	Riffle
66	Cutthroat	<80	Riffle
67	Cutthroat	<80	Riffle
68	Cutthroat	<80	Riffle
69	Cutthroat	<80	Riffle
70	Cutthroat	<80	Riffle
71	Cutthroat	<80	Riffle
72	Cutthroat	<80	Riffle
73	Cutthroat	<80	Riffle
74	Cutthroat	<80	Riffle
75	Cutthroat	<80	Riffle
76	Cutthroat	<80	Riffle
77	Cutthroat	<80	Riffle
78	Cutthroat	<80	Riffle
79	Cutthroat	<80	Riffle
80	Cutthroat	<80	Riffle
81	Cutthroat	<80	Riffle
82	Cutthroat	<80	Riffle
83	Cutthroat	<80	Riffle
84	Cutthroat	<80	Riffle

Fish #	Species	Length (mm)	Habitat Type
85	Cutthroat	<80	Riffle
86	Cutthroat	<80	Riffle
87	Cutthroat	<80	Riffle
88	Cutthroat	<80	Riffle
89	Cutthroat	<80	Riffle
90	Cutthroat	<80	Riffle
91	Cutthroat	<80	Riffle
92	Cutthroat	<80	Riffle
93	Cutthroat	<80	Riffle
94	Cutthroat	<80	Riffle
95	Cutthroat	<80	Riffle
96	Cutthroat	<80	Riffle
97	Cutthroat	<80	Riffle
98	Cutthroat	<80	Riffle
99	Cutthroat	<80	Riffle
100	Cutthroat	<80	Riffle
101	Cutthroat	<80	Riffle
102	Cutthroat	<80	Riffle
103	Cutthroat	<80	Riffle
104	Cutthroat	<80	Riffle
105	Cutthroat	94	Riffle
106	Cutthroat	152	Riffle
107	Cutthroat	109	Riffle
108	Cutthroat	109	Riffle
109	Cutthroat	83	Riffle
110	Cutthroat	84	Riffle
111	Cutthroat	84	Riffle
112	Cutthroat	95	Riffle
113	Cutthroat	92	Riffle
114	Cutthroat	92	Riffle
115	Cutthroat	95	Riffle
116	Cutthroat	87	Riffle
117	Cutthroat	85	Riffle
118	Cutthroat	81	Riffle
119	Cutthroat	108	Riffle
120	Cutthroat	93	Riffle
121	Cutthroat	96	Riffle
122	Cutthroat	81	Riffle
123	Cutthroat	93	Riffle
124	Cutthroat	89	Riffle
125	Cutthroat	102	Riffle
126	Cutthroat	90	Riffle

Fish #	Species	Length (mm)	Habitat Type
127	Cutthroat	85	Riffle
128	Cutthroat	90	Riffle
129	Cutthroat	95	Riffle
130	Cutthroat	90	Riffle
131	Lamprey (WB)	78	Riffle
132	Lamprey (WB)	70	Riffle
133	Lamprey (WB)	120	Riffle
134	Lamprey (WB)	115	Riffle
135	Lamprey (WB)	105	Riffle
136	Lamprey (WB)	65	Riffle
137	Lamprey (WB)	90	Riffle
138	Lamprey (WB)	95	Riffle
139	Lamprey (WB)	115	Riffle
140	Lamprey (WB)	120	Riffle
141	Lamprey (WB)	130	Riffle
142	Lamprey (WB)	135	Riffle
143	Lamprey (WB)	80	Riffle
144	Lamprey (WB)	100	Riffle
145	Lamprey (WB)	110	Riffle
146	Lamprey (WB)	125	Riffle
147	Lamprey (WB)	90	Riffle
148	Lamprey (WB)	120	Riffle
149	Lamprey (WB)	110	Riffle
150	Lamprey (WB)	105	Riffle
151	Lamprey (WB)	125	Riffle
152	Lamprey (WB)	105	Riffle
153	Lamprey (WB)	105	Riffle
154	Lamprey (WB)	100	Riffle
155	Lamprey (WB)	100	Riffle
156	Lamprey (WB)	145	Riffle
157	Stickleback	<20	Riffle
158	Stickleback	<20	Riffle
159	Stickleback	<20	Riffle
160	Stickleback	<20	Riffle
161	Stickleback	25	Riffle
162	Stickleback	<20	Riffle
163	Stickleback	<20	Riffle

Date:	7/9/2015
Stream:	Richards Creek
Site:	Phase II
River Mile:	0.37
Latitute:	47.5856
Longitude:	-122.1643
Visibility:	Clear
Air:	N/A
Water:	Start 15.4° C/ End 15.8° C
pH:	N/A
Turbidity	N/A
Conductivity:	286 µs/cm (recorded as mS?)
DO:	10.51 mg/L
Total Reach Length:	87.8 ft
Electrofishing Setting:	200 v, 60 Hz, 6 mS
Start Time	10:15 AM
End Time	11:10 AM
Fishing Time:	N/A
Netter Success:	High/High

Sampling done by:
Kit Paulsen (Employee, Fish ID)
Jim Starkes (Consultant, Electrofishing)
Laurie Devereaux (Employee)
Katie Jensen (Employee)
Haley Koesters (Watershed Planning Intern)
Keith Luu (Engineering Intern)
Meghan Veilleux (Engineering Intern)
Ken Mullins (Outreach Intern)
Emma Hewitt (Outreach Intern)
Ashley Mihle (Former employee)

Fish #	Species	Length (mm)	Habitat Type
1	Cutthroat	<80	Riffle
2	Cutthroat	<80	Riffle
3	Cutthroat	<80	Riffle
4	Cutthroat	<80	Riffle
5	Cutthroat	<80	Riffle
6	Cutthroat	<80	Riffle
7	Cutthroat	<80	Riffle
8	Cutthroat	<80	Riffle
9	Cutthroat	<80	Riffle
10	Cutthroat	<80	Riffle
11	Cutthroat	<80	Riffle
12	Cutthroat	<80	Riffle
13	Cutthroat	<80	Riffle
14	Cutthroat	<80	Riffle
15	Cutthroat	<80	Riffle
16	Cutthroat	<80	Riffle
17	Cutthroat	<80	Riffle
18	Cutthroat	<80	Riffle
19	Cutthroat	<80	Riffle
20	Cutthroat	<80	Riffle
21	Cutthroat	<80	Riffle
22	Cutthroat	<80	Riffle
23	Cutthroat	<80	Riffle
24	Cutthroat	<80	Riffle
25	Cutthroat	<80	Riffle
26	Cutthroat	<80	Riffle
27	Cutthroat	<80	Riffle
28	Cutthroat	<80	Riffle
29	Cutthroat	<80	Riffle
30	Cutthroat	<80	Riffle
31	Cutthroat	<80	Riffle
32	Cutthroat	<80	Riffle
33	Cutthroat	<80	Riffle
34	Cutthroat	<80	Riffle
35	Cutthroat	<80	Riffle
36	Cutthroat	<80	Riffle
37	Cutthroat	<80	Riffle
38	Cutthroat	<80	Riffle
39	Cutthroat	<80	Riffle
40	Cutthroat	96	Riffle
41	Cutthroat	<80	Riffle
42	Cutthroat	178	Riffle

Fish #	Species	Length (mm)	Habitat Type
43	Cutthroat	146	Riffle
44	Cutthroat	136	Riffle
45	Cutthroat	90	Riffle
46	Cutthroat	<80	Riffle
47	Cutthroat	<80	Riffle
48	Cutthroat	<80	Riffle
49	Cutthroat	<80	Riffle
50	Cutthroat	<80	Riffle
51	Cutthroat	<80	Riffle
52	Cutthroat	<80	Riffle
53	Cutthroat	147	Riffle
54	Cutthroat	87	Riffle
55	Cutthroat	183	Riffle
56	Cutthroat	83	Riffle
57	Cutthroat	150	Riffle
58	Cutthroat	<80	Riffle
59	Cutthroat	<80	Riffle
60	Cutthroat	<80	Riffle
61	Cutthroat	<80	Riffle
62	Cutthroat	<80	Riffle
63	Cutthroat	<80	Riffle
64	Cutthroat	<80	Riffle
65	Cutthroat	<80	Riffle
66	Cutthroat	<80	Riffle
67	Cutthroat	<80	Pool
68	Cutthroat	<80	Pool
69	Cutthroat	<80	Pool
70	Cutthroat	<80	Pool
71	Cutthroat	<80	Pool
72	Cutthroat	90	Pool
73	Cutthroat	<80	Riffle
74	Cutthroat	<80	Riffle
75	Cutthroat	<80	Pool
76	Cutthroat	<80	Pool
77	Cutthroat	<80	Pool
78	Cutthroat	<80	Pool
79	Cutthroat	<80	Pool
80	Cutthroat	<80	Pool
81	Cutthroat	87	Pool
82	Cutthroat	164	Pool
83	Cutthroat	<80	Riffle
84	Cutthroat	<80	Riffle

Fish #	Species	Length (mm)	Habitat Type
85	Cutthroat	<80	Riffle
86	Cutthroat	<80	Riffle
87	Cutthroat	<80	Riffle
88	Cutthroat	<80	Riffle
89	Cutthroat	<80	Riffle
90	Cutthroat	<80	Riffle
91	Cutthroat	<80	Riffle
92	Cutthroat	<80	Riffle
93	Cutthroat	<80	Riffle
94	Cutthroat	<80	Riffle
95	Cutthroat	<80	Riffle
96	Cutthroat	154	Riffle
97	Cutthroat	117	Riffle
98	Cutthroat	<80	Riffle
99	Cutthroat	<80	Riffle
100	Cutthroat	<80	Riffle
101	Cutthroat	<80	Riffle
102	Cutthroat	<80	Riffle
103	Cutthroat	<80	Riffle
104	Cutthroat	<80	Riffle
105	Cutthroat	<80	Riffle
106	Cutthroat	<80	Riffle
107	Cutthroat	<80	Riffle
108	Cutthroat	<80	Riffle
109	Cutthroat	<80	Riffle
110	Cutthroat	<80	Riffle
111	Cutthroat	<80	Riffle
112	Lamprey	70	Riffle
113	Lamprey (WB)	75	Pool
114	Lamprey (WB)	95	Riffle
115	Crayfish	53	Riffle
116	Crayfish	30	Pool
117	Crayfish	55	Pool
118	Crayfish	50	Riffle
119	Crayfish	53	Riffle

Appendix B – Project Photos

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Photo 1. Coal Creek at RM 1.8 below Coal Creek Parkway

Photo 2. Engineered log jams for habitat and bank stability at Coal Creek, RM 1.8 below Coal Creek Parkway

Photo 3. Microhabitats in reconstructed riffle using large rock at Coal Creek, RM 1.8 below Coal Creek Parkway


Photo 4. Typical juvenile cutthroat trout in Coal Creek

Photo 5. Pool habitat on Coal Creek, RM 1.3, adjacent to Anna's Pond

Photo 6. Broad shallow riffle habitat on Coal Creek, RM 1.3, adjacent to Anna's Pond

Photo 7 Anna's Pond, engineered for high flow bypass and sedimentation adjacent to Coal Creek survey reach, RM 1.3


Photo 8. Rainbow trout captured in Coal Creek RM 1.3

Photo 9. Richards Creek, RM 0.15 and grade/erosion control structures composed of large woody debris

Photo 10. Individual grade/erosion control structure on Richards Creek, RM 0.15

Photo 11. Small, narrow stream reach on Richards Creek, RM 0.37

Photo 12. Small, narrow stream reach on Richards Creek, RM 0.37