



A Review of the City of Calgary Fish Habitat Enhancement Program

Introduction:

Following the 2013 flood, The City of Calgary undertook several projects to [repair and reinforce riverbanks](#) along the Bow and Elbow Rivers. These projects helped protect critical City infrastructure but had adverse effects on fish and sensitive fish habitat.

With support from both [The Government of Alberta](#) (AEP) and [Fisheries & Oceans Canada](#), (DFO) the City developed a plan to offset the loss of fish habitat and restore these vital habitat areas. Four projects have been proposed to offset the habitat loss:

- Phase 1 - **Quarry Park Side Channel [Project](#)** - 2017
- Phase 2 - **Bowmont West Side Channel [Project](#)** – 2018
- Phase 3 - **Elbow Park Gravel Bar Enhancement [Project](#)** – 2019
- Phase 4 - **Inglewood Bird Sanctuary Habitat Enhancement [Project](#)**

The program was developed in consultation with AEP and DFO to monitor gains made in fish habitat and increased productivity of key indicator species that represent the fishery management objectives of the region: brown trout, rainbow trout, and mountain whitefish. Local consulting engineers, Klohn Crippen Berger (KCB) were contracted to manage the monitoring program. The monitoring program consists of sampling at 1, 3- and 5-years post-construction:

Habitat Suitability Mapping and Modeling

An evaluation of change in habitat suitability was a key method used to assess progressive development and performance of the offset habitat relative to design expectations using a novel Habitat Suitability Index (HSI)

Biological Indicator Sampling

Biological data was collected through targeted sampling to provide the support that aquatic organisms and fish are using the new habitat. In addition to sampling fish populations, benthic invertebrates, periphytons, and macrophytes species were assessed.

Fall Spawning Survey

A fall spawning survey was conducted in November to assess seasonal habitat use. The occurrence of redd counts for fall spawning brown trout was assessed late in the fall before the onset of winter to optimize the redd counts that indicate the suitability of the habitat for spawning activities.



Discharge and Water Quality – Summer and Winter

Physical and chemical parameters were monitored to support the suitability of the new habitat within each project. Water depth, velocity, temperatures, oxygen content, pH, electrical conductivity, and oxidation-reduction potential were measured during summer and winter flow conditions.

Results:

The City of Calgary supplied the Quarry Park and Bowmont West - Monitoring Results Year 1 and 2^(1,2) for a review of the potential use of the data for inclusion in future Bow River fish population research initiatives.

Habitat Suitability Mapping and Modeling

Quarry Park – Although the projected increases in suitable habitat were not achieved, at 33% less than projected, the project does show improvements in suitable aquatic habitat to enhance fish use of the channels. Difficulty with establishing vegetation has reduced the sustainability values of the project. Replanting and increased watering have subsequently been made to the site that is hoped will show increases in habitat in future years.

Bowmont West – The projected increase in suitable habitat was exceeded by 42%. This substantial increase is probably contributed to differences between interpretation of the design hydraulics and what was constructed which affected model projections. Other contributions to the increase may well be enhanced excavation and an increase in bank cover and overhanging vegetation.

Biological Indicator Sampling

Quarry Park – July 2018 sampling showed a high relative population of longnose dace and juvenile brown trout. Although rainbow trout have been observed at the site, the absence of rainbow trout in the report is surprising (Table 1). The assessment suggests that the channels are most suitable as a fish nursery. A qualitative assessment of benthic invertebrate species showed an abundance of caddis (*Trichoptera spp.*), midge (*Chironomidae spp.*) larva, and mayfly (*Ephemeroptera spp.*) nymphs. Evidence of stonefly (*Plecoptera spp.*) nymph emergence was also observed.

Species	Scientific Name	Minimum Fork Length (mm)	Maximum Fork Length(mm)	Count	CPUE (fish/100 seconds)
Brown trout	<i>Salmo trutta</i>	39	76	14	0.74
Longnose dace	<i>Rhinichthys cataractae</i>	39	59	120	6.34
Longnose sucker	<i>Castostomus catostomus</i>	89	174	4	0.21
White sucker	<i>Castostomus commersoni</i>	102	123	2	0.11
Total				140	7.40

Table 1: Fish Capture Results from Quarry Park Side Channel (July 31, 2018)



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Bowmont West – August 2019 sampling resulted in the capture of 131 fish and seven different species from Channel 1 (Table 2). A high relative abundance of rainbow trout fry was supplemented with higher proportions of brown trout and longnose dace.

Species	Scientific Name	Minimum Fork Length (mm)	Maximum Fork Length(mm)	Count	CPUE (fish/100 seconds)
Longnose sucker	<i>Castostomus catostomus</i>	68	77	3	0.33
Longnose dace	<i>Rhinichthys cataractae</i>	42	76	28	0.81
Lake chub	<i>Couesius plumbeus</i>	34	48	10	0.33
White sucker	<i>Castostomus commersoni</i>	53	72	2	0.16
Rainbow trout	<i>Oncorhynchus mykiss</i>	32	55	42	3.09
Brown trout	<i>Salmo trutta</i>	45	65	14	0.81
Mountain whitefish	<i>Prosopium williamsoni</i>	79	79	1	0.00
Lake whitefish	<i>Coregonus clupeaformis</i>	0	0	0	0.00
Total				131	5.53

Table 2 - Fish Capture Results from Bowmont West Channel 1 (August 21, 2019)

Sampling from Channel 2 and 2A resulted in the capture of 89 fish and eight different species (Table 3). Mountain whitefish was the most prevalent species representing 78% of the catch. When data was pooled together there was some evidence of a potential loss of the larger rainbow trout, brown trout, and mountain whitefish age class.

Species	Scientific Name	Minimum Fork Length (mm)	Maximum Fork Length(mm)	Count	CPUE (fish/100 seconds)
Longnose sucker	<i>Castostomus catostomus</i>	462	463	2	0.14
Longnose dace	<i>Rhinichthys cataractae</i>	60	84	3	0.21
Lake chub	<i>Couesius plumbeus</i>	30	30	1	0.07
White sucker	<i>Castostomus commersoni</i>	71	92	3	0.21
Rainbow trout	<i>Oncorhynchus mykiss</i>	45	425	5	0.34
Brown trout	<i>Salmo trutta</i>	52	417	4	0.28
Mountain whitefish	<i>Prosopium williamsoni</i>	62	435	69	4.75
Lake whitefish	<i>Coregonus clupeaformis</i>	382	425	2	0.14
Total				89	6.13

Table 3 - Fish Capture Results from Bowmont West Channel 2 & 2A (August 22, 2019)

A qualitative assessment of benthic invertebrate species showed an abundance of caddis (*Trichoptera spp.*), midge (*Chironomidae spp.*) lava, and mayfly (*Ephemeroptera spp.*) nymphs. Evidence of stonefly (*Plecoptera spp.*) nymph emergence was also observed.

Fall Spawning Survey

Quarry Park – A total of 26 brown trout redds were recorded across the full length of the channel that supports the suitability of the site for fall spawning activities.



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Bowmont West – A total of 80 brown trout redds were recorded in channel 2 and 2A was considered relatively high for the Bow River. Channel 1 was blocked at the entrance rendering the flow to a trickle and no redds were observed.

Discharge and Water Quality – Summer and Winter

Quarry Park – the mean summer discharge rate was 4.5 cms which represent approximately 4.8% of the estimated flows in the Bow River. The winter flows were considerably lower at 1.5 cms.

The summer water quality data (Table 4) can be compared to the winter date (Table 5) on February 6, 2019, when air temperatures were at -20 °C. Although there was surface ice buildup across most of the channel, water continued to flow below the ice where brown trout redds had been previously observed.

Transect	T2
Temperature (°C)	18.20
Conductivity (µS/cm)	319
Dissolved Oxygen (mg/L)	11.36
pH	8.30
Oxidation Reduction Potential (mV)	-105.3

Table 4: - Water Quality Measurements in Quarry Park Side Channel, July 31, 2018

Transect	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	BR1
Temperature (°C)	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25	-0.25
Conductivity (µS/cm)	238	151		241	244	243	206
Dissolved Oxygen (mg/L)	15.24	10.31	15.59	16.85	15.25	22.51	15.96
pH	8.10	8.10	7.98	8.34	8.08	8.29	7.82
Oxidation Reduction Potential (mV)	142.2	77.1	106.4	98.0	93.3	91.9	131.9

Table 5 - Water Quality Measurements at various sites in Quarry Park Side Channel, February 6, 2019

Bowmont West – In Cannel 1, the mean summer discharge rate was 0.65 cms which represents approximately 0.6% of the estimated flows in the Bow River. Although Channel 2 was not monitored during this time, previous flow estimates had indicated approximately 19% of the Bow River flow went through Channel 2. The summer water quality data (Table 6) can be compared to the winter date (Table 7) on January 21, 2020, when air temperatures had been extremely cold for two weeks.

Although Channel 1 was frozen over, isolated deeper pools had flowing water. Channel 2 was free flowing with some ice shelf build up on the edge of the channel making it ideal for the preservation of brown trout eggs over the winter months.



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Transect	T1	T2	T3	T4
Temperature (°C)	16.86	16.35	16.77	16.76
EC (µS/cm)	265	257	258	261
DO (mg/L)	6.98	7.67	7.40	7.21
pH	6.54	6.22	6.15	6.68
ORP (mV)	111.7	113.8	54.8	27.7

Table 6 - Water Quality Measured at Bowmont West Channel (August 21, 2019)

Transect	T1	T2	T4	Bow River Mainstem
Temperature (°C)	0.14	0.00	0.07	1.17
EC (µS/cm)	203	186	231	267
DO (mg/L)	7.50	7.76	7.67	6.40
pH	8.28	8.45	8.30	8.19
ORP (mV)	224	224	239	229

Table 7 - Water Quality Measured at Bowmont West Side Channel (January 21, 2020)

Evaluation of Projects by Consulting Engineers

Quarry Park – Overall the monitoring data suggests that the habitat created in the side channel is suitable for and being used by fish, although the habitat value for the completed project was 33% lower than predicted, due primarily to a shortfall of habitat and bankside overhanging vegetation. Lack of bank cover would have influenced the retention of a resident fish population. Fish sampling and redd surveys indicate that the side channel offers suitable habitat for fish population recruitment. Evidence of benthic invertebrate and periphytic algae development suggests the channel is recovering quickly. Although further remediation of the side channel could improve the habitat and a subsequent increase in fish population the cost-benefit analysis would suggest no further excavation. Supplemental vegetation planting continues, that should contribute to net gains in a source of cover, integrity, and resilience of the aquatic ecosystem.

Bowmont West - Overall the monitoring data suggests that the habitat created in the side channel is suitable for and being used by fish. But the observed assessment in year 1 of the site was 42% higher than predicted in the project modeling due to the age class of fish, bank vegetation, overhanging cover, and a high level of spawning activity. Fish sampling and redd surveys indicate that the side channel offers suitable habitat for fish population recruitment during both the summer and winter.

Reviewer’s Evaluation of the Project

It is not for us to pass judgment on the design, analysis, or the evaluation of the projects, but rather to see if the data would be useful to integrate into a more extensive understanding of the Bow and Elbow River sports fishery dynamics.



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The project is unique in-so-far as the sites selected for the fish compensation initiative are spread across the entire City of Calgary Bow River and Elbow River watersheds. In addition, the sites are located above and below the Western Irrigation District Weir – Harvie Passage (HP) and the Bonnybrook Wastewater Treatment Plant (BWTP) that have historically had an impact on fish movement and aquatic food sources, respectively.

- **The Quarry Park Side Channel Project** is located below both HP and BWTP and is representative of a more abundant fish population that the Bow River is renowned for.
- **The Inglewood Bird Sanctuary Habitat Enhancement Project** is above BWTP and below HP.
- **The Elbow Park Gravel Bar Enhancement Project** is above both BWTP and HP and located in a City managed river flow source and primary brown trout spawning area.
- **Bowmont West Side Channel Project** is located above both the BWTP and HP. The site is located in close proximity to the Bearspaw Reservoir outflow and subject to water management discharge practices.

Historically the Western Irrigation District Weir presented a barrier to the free movement of fish across the City reach of the Bow River, but the development of the Harvie Passage Low Water Channel that was opened in 2011 and upgraded in 2018 eliminated this restraint. Over the past 20 years, BWTP practices have improved whereby less phosphate and other residues are discharged into the river. Both these improvements have and are expected to continue to have an impact on the fish population dynamics in the future.

Brown trout, rainbow trout, and to a lesser degree rocky mountain whitefish are the principal sport fishing targets in the Bow River. The City reach of the Bow River and the Elbow River are considered prime fall spawning sites for brown trout. But little is known of the rainbow trout spawning activity in the spring, although redds and fish have been observed in the main stem and tributaries of the Bow River. Fishing reports do indicate that the fishing effort and success are considerably lower above the BWTP and HP. Hopefully, the recent Alberta Environment & Parks creel surveys and fish population evaluation will shed more light on exactly what the difference could be.

The City of Calgary Fish Compensation Program reports from the first-year offset monitoring program for Quarry Park and Bowmont West support that habitat enhancement initiatives will improve suitable fish habitat for predominantly juvenile fish populations and to some degree, improve habitat for more mature resident populations of fish. What is also clear is that if suitable habitat is available brown trout will spawn there. This has been documented at both sites. What is a surprise is the lack of rainbow trout recorded in the Quarry Park side channel and a relatively high number of the same species at Bowmont West side channels. Improvements in fish habitat and vegetation



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planting at Quarry Park in 2019 should show improvements in suitability of habitat of this site at the three- and five-year data monitoring.

What is unclear is the impact of improved side-channel habitat on the improvement of cross-river fish populations. Fish will certainly gravitate to the most suitable habitat available, and for juvenile fish, suitable habitat protection from predators. For mature fish food source is most likely the driving force for residence. Therefore, improved access to the upper City reach of the Bow River through HP appears to support a thriving brown trout spawning population, but will they reside in the same area is unknown. Certainly, further investigation is needed to answer this question.

Water quality differences between Quarry Park and Bowmont Park are worthy of more investigation. A contaminant profile should be added to future investigations to determine what impact the City wastewater and surface runoff has on aquatic life. A more detailed seasonal analysis of benthic invertebrates should be considered.

Bow River water management policy has changed in recent years to enhance flood protection for the City of Calgary. Although the historical management practices have assisted in sustaining a world-class trout fishery, the modified water management operations during the spring runoff may well have altered the fishery and fish habitat. The free-flowing water management practice in May and June that now exists each year has impacted the ability of anglers to catch fish but offers a scouring of the riverbed that should enhance the aquatic habitat to balance the river's ecology.

Moving forward, the expansion of the City of Calgary Fish Compensation Program from two to four sites and a total of 5 years of monitoring data offer a unique opportunity for future long-term research initiatives that would give a unique understanding of the changing fish populations dynamics. An inter-discipline approach to future investigations would yield the most useful management tools to enhance fish populations.

Peter Crowe-Swords
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References:

1. Fish Habitat Offsetting Program – Phase 1: Quarry Park Offset Monitoring Years 1 and 2. May 2019. Klone Crippen Berger – For the City of Calgary
2. Fish Habitat Offsetting Program – Phase 2: Bowmont West Offset Monitoring Years 1 and 2. May 2019. Klone Crippen Berger – For the City of Calgary