Rip-Rap Repair, Structure Maintenance, and Creation of Fish Habitat in Pass (Norns) Creek 2015 - 2016

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Executive Summary

Pass (Norns) Creek is the first major tributary to the Columbia River below Hugh Keenleyside Dam adjacent to the town of Castlegar, BC. Pass Creek provides approximately 2.2 km of important spawning habitat for Rainbow Trout (*Oncorhynchus mykiss*), Kokanee (*Oncorhynchus nerka*), and Mountain Whitefish (*Prosopium williamsoni*) migrating from the Columbia River. Previous habitat restoration and creation efforts on the creek included rip-rap armoring along the streambank and the installation of artificial log jam structures to provide cover for rearing fish. In 2012, high flows damaged and dislodged some of these structures resulting in broken/loose cables and exposed nails, presenting a concern for public safety. The high flows also undermined the streambank adjacent to the Pass Creek Regional Exhibition Grounds, resulting in an exposed, failed bank prone to erosion and sedimentation. From 2013 to 2015, the Okanagan Nation Alliance (ONA) investigated the effects of the 2012 high flows and developed a number of projects aimed at addressing the failed bank, structures and lack of fish habitat along Pass Creek. In the summer of 2015, the ONA repaired the two eroded sections of rip-rap bank, removed damaged and hazardous log structures, and created additional fish habitat in Pass Creek.

With guidance and technical instruction from Deverney Engineering, the two failed sections of rip-rap bank were re-contoured from a 1:1 to a more stable 2:1 slope. A ground layer of geotextile fabric was laid beneath the rock to provide support and prevent further erosion of the bank. The ONA contracted Kabatoff Sand and Gravel for the installation of 18 loads of rock to armor the two exposed banks (rock volume $\approx$ 250 m^3). Small rip-rap material was used to strengthen weakened areas of the bank susceptible to erosion. As a supplementary fish habitat enhancement project, one load (14 m^3) of rock was placed along the toe of the bank in 9 small clusters (<2 m projected length) to provide low-flow fish habitat and deflect the thalweg from the repaired bank at low water levels. This additional work was funded by the Columbia Basin Trust.

In addition to these works, the ONA also contracted Kabatoff Sand and Gravel to remove two failed log-jam structures from the mainstream channel of Pass Creek. These structures were dislodged during the 2012 high flows and were left mid-channel, resulting in a potential obstruction that could alter flows. With the volunteer support from members of the Castlegar and District Wildlife Association, 54 exposed nails and 18 broken cables were removed from 10 remaining structures with in Pass Creek.

Preliminary observations indicate the repaired bank is stable and less susceptible to movement during high flows. The in-stream rock clusters added habitat complexity to Pass Creek and were utilized by Rainbow Trout Fry almost immediately following construction. By using boulders instead of logs for the structures, we aimed to provide more permanent habitat able to withstand all levels of flows within Pass Creek. Removal of dislodged structures, exposed nails and broken/loose cable will increase the habitat quality in Pass Creek.

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Introduction

Pass (Norns) Creek is the first major tributary to the Columbia River below Hugh Keenleyside Dam just north of Castlegar, BC (Figure 1a). The stream is accessible to fish from the confluence of Pass Creek with the Columbia River to a bedrock falls 2.2 km upstream Pass Creek. This section of stream provides important spawning habitat for Rainbow Trout (*Oncorhynchus mykiss*), Kokanee (*Oncorhynchus nerka*), and Mountain Whitefish (*Prosopium williamsoni*) migrating from the Columbia River. In 2011, 774 rainbow trout redds were identified in the accessible reach (Thorley and Baxter 2012). Due to its significance in supporting the local sport fishery, the area of Pass Creek accessible to fish is closed to fishing year round, making it an excellent candidate for habitat enhancement.

Pass Creek is bordered by the Pass Creek Regional Exhibition Grounds (on west bank of stream), and Regional Campground (on east bank of stream) owned by the Regional District of the Central Kootenay (RDCK; Figure 1b). These two venues are important areas for recreation and public use, as they promote education through informative signage along the walkways bordering Pass Creek. Many people use these areas to enjoy the outdoors and experience wildlife and it is an accessible area used to promote appreciation for fish and their habitats.

Previous habitat enhancement work included the construction of artificial log jams from 1998 – 2001 (McCleary 1999, Zimmer 2000, 2002). In total, 18 artificial log jams were constructed within Pass Creek Regional Park to Broadwater Road to provide additional habitat for Rainbow Trout and Kokanee. However, high flows in 2012 damaged some of these structures as well as two sections of rip-rap bank bordering the Pass Creek Regional Exhibition Grounds (Deverney 2014, Audy and Zimmer 2015). These bank failures resulted in an exposed the bank susceptible to erosion and sedimentation, posing a direct impact to the quality of habitat in Pass Creek. As well, the damaged log structures posed a potential obstruction to flows and a risk to existing downstream habitat structures.

To increase habitat quality and improve public safety, the Okanagan Nation Alliance took on three main projects in Pass Creek in 2015: the repair of eroded sections of rip-rap bank, removal of damaged and hazardous log structures, and the creation of fish habitat structures in Pass Creek. A riparian restoration project in the Pass Creek Regional Exhibition Grounds is also planned for the spring of 2016 in partnership with the RDCK and funded by the Columbia Basin Trust.

Figure 1: (a) Map of Pass Creek (identified in blue) in relation to Castlegar, BC and the Columbia River; (b) Main study site showing location of Pass Creek campground relative to repair site (identified in yellow) (source: Google Maps 2016).

Goals and Objectives

The ONA established three primary goals upon implementation of this project:

Goal 1: Stabilize and repair the rip-rap bank along the Pass Creek Regional Exhibition Grounds

Objective 1 – Provide better structure to failed bank with a 1:2 slope using 600-900 mm rock and add stability by filling gaps using 300 mm rock.

Objective 2 – Use an impermeable geotextile fabric beneath the newly placed rock to strengthen the soil foundation and increase bank protection, and reduce the potential for further erosion.

Goal 2: Remove hazards from dislodged fish habitat structures in Pass Creek

Objective 1 – Remove all exposed nails

Objective 2 – Remove broken or loosened cables from failed structures

Objective 3 – Remove two dislodged structures affecting flows within channel

Goal 3: Increase fish habitat complexity and availability

Objective 1 – Create nine boulder groyne structures to provide habitat for fry

Location of Works

The study area is an approximately 150 m segment of streambank located on the downstream north side of Pass Creek bordering the Pass Creek Regional Exhibition Grounds (Fig. 2). Rip-rap repair focused on two areas (Section 1 and Section 2) each approximately 11 m and 12 m in width, respectively.

Background on Study Site

In 2011, the bank of interest was armored with a 1:1 slope of rip rap in an attempt to reduce erosion and undercutting during freshet. However, as a result of the steep slope and improper rock placement, the bank was susceptible to failure during high flows (Norman Deverney, pers comm). As well, the area below the rip-rap bank provided little cover for fish, and this section of stream appeared to have limited in-stream habitat features.

In 2013, Audy and Zimmer (2014) conducted monitoring to assess the condition of the previously implemented habitat structures (Fig. 3). In total, 10 structures required maintenance to reduce public safety concerns (Sites 4, 6, 8, 9, 11, 12, 13, 14, 16, and 17). This would involve removal of cable and nails that may become hazards (Audy and Zimmer 2014).

Figure 2. Rip-rap and habitat enhancement site (in yellow), and focus areas Section 1 and 2 (in red) on the right bank of Pass Creek, bordering the Pass Creek Regional Exhibition Grounds (Source: Google Maps 2016).

Figure 3. Habitat structures assessed by Audy and Zimmer (2014) on Pass Creek.

Methods

The site was accessed through the Pass Creek Regional Exhibition Grounds. Selective brush above the rip-rap bank was removed in order to access the eroded areas of the bank. The existing rip-rap remained in the eroded areas was removed and the slope re-graded from a 1:1 to a 2:1 using a series 200 excavator. Once the desired slope was achieved, non-woven geotextile fabric was placed over the area to protect the mineral soil. Fabric was placed from bottom to top, downstream to upstream overlapping at least 0.3 m. Geotextile fabric was cut with excess to compensate for folds and slipping while rock was being placed.

Rocks were placed individually and in small groups by an excavator (Fig. 4a). Smaller rocks (> 0.24 m b-axis) were placed by hand to fill small gaps and ensure the geotextile fabric was completely covered by rock (Fig. 4b). Rocks were placed from bottom to top, and were not dropped from more than 0.3 m to avoid damaging the geotextile fabric. The largest rocks (1 m+ b-axis) were placed at the toe and mid-slope to increase stability. Smaller rocks (0.24 – 0.50 m b-axis) were then placed on top to protect the rest of the slope. Planning rock position prior to placement and individual placement creates a stronger structure more suitable for bank protection. Boulders were supplied and placed by Kabatoff Sand and Gravel Ltd. Rock material was previously approved for metal leaching/acid drainage, making it safe for aquatic use. All work on the rip-rap bank was conducted during the 2015 in-stream work window (July 15 – August 15) and was monitored by a qualified environmental technician.

Figure 4. (a) Excavator placing rip-rap on the right bank of Pass Creek at the Pass Creek Regional Exhibition. (b) Regional District of the Central Kootenay employees placing smaller rock in holes to cover all geotextile fabric and spaces in the rip-rap (pictures taken by Evan Smith, Okanagan Nation Alliance, July 2015).

Habitat structures that required removal from the stream were removed via excavator during the 2015 in-stream work window under supervision of a Biologist. Exposed nails on structures were hammered into the wood and loose or broken cables were cut using a cordless angle grinder or bolt cutters. All materials removed from the creek were taken off-site and disposed of in a waste management facility.

With additional funds from Columbia Basin Trust, rock habitat structures were created to increase habitat complexity in the reach and to deflect the thalweg from the rip-rap bank. The structures will help to reduce erosional force on the rip-rapped bank at lower water levels, and increase habitat for rainbow trout fry. The required boulder size was determined to be > 35 cm based on stream gradient and bank height (Ward 1997). Boulders were placed in the river via excavator from the top of bank during the instream work window (July 15 – August 15) to reduce impacts to rearing Rainbow Trout fry, and prior to the Kokanee spawning season. Work was conducted working downstream so changes in hydrology (thalweg) could be observed and taken into consideration before each subsequent structure was created.

Results

In total 18 loads of rock were used to repair the rip-rap bank. The majority of the rock was used to repair the two identified sections (Fig. 5 & 6). Remaining rock was used to strengthen areas of the rip-rap that appeared weakened or susceptible to erosion (Fig. 7). An additional load was placed at the toe of the bank to provide fish habitat and deflect the thalweg at low water levels.

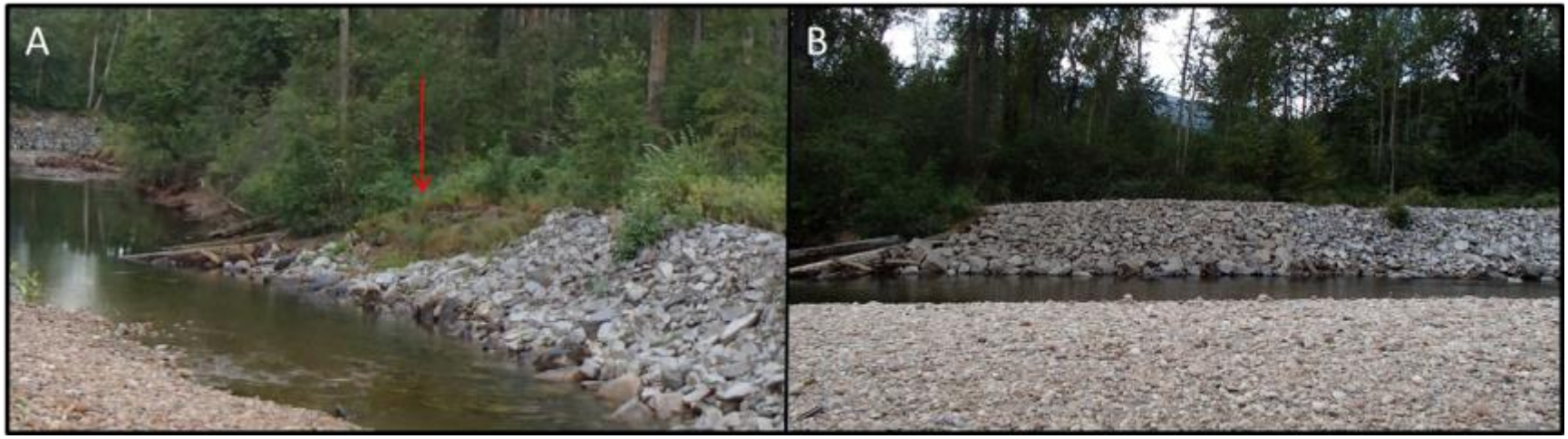

Figure 5. (A) Upstream view of Section 1 (indicated by the red arrow) before repairs were made. (B) View of Section 1 from across the stream after repairs were made pictures taken by Evan Smith, Okanagan Nation Alliance, July 2015).

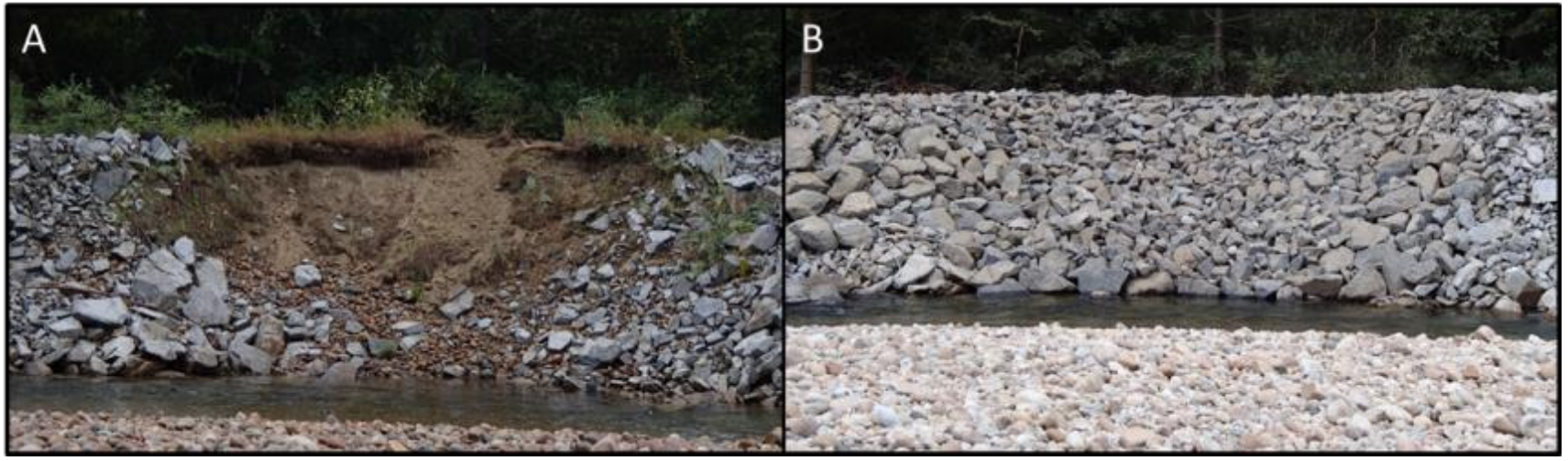

Figure 6. Before (A) and after (B) comparison of Section 2 along the rip-rap bank at pass creek (pictures taken by Evan Smith, Okanagan Nation Alliance, July 2015).

Figure 7. (Top) Before and after comparison of minor bank reinforcement along the toe of the rip-rap bank at Pass Creek. (Bottom) Before and after comparison of target bank stabilization conducted along the rip-bank at Pass Creek. Additional rock was placed at the bottom of this slope to support the top of the rip-rap bank; transforming it from a concaved bank to a 45 degree slope. (all pictures taken by Evan Smith, Okanagan Nation Alliance, July 2015).

In total, 54 nails and 18 pieces of cable were removed from structures 4, 6, 8, 9, 11, 12, 13, 14, 16 and 17 as recommended by Audy and Zimmer (2014). Structures 8 and 9 were removed from the stream with the excavator and placed on the bank, above the high water mark outside of the stream. A table describing the recommendations and treatment for each structure is provided in Appendix A.

With additional funding from the Columbia Basin Trust, nine rock cluster structures were created. These structures began upstream of the rip-rap bank of the Pass Creek Exhibition Grounds and continued about 100 m downstream at irregular intervals (Fig. 8). Components of these structures varied from ten to fifteen 0.35 m – 0.60 m b-axis rock to three to five 1 m+ b-axis rock. After construction, the rock clusters appeared to move the low-flow thalweg farther away from the rip-rap bank during low water (pers. obs.).

Figure 8. Examples of rock groyne fish habitat structures created to deflect the thalweg at low flows from the rip-rap bank and provide fish habitat at Pass Creek, flow direction indicated with yellow arrow (all pictures taken by Evan Smith, Okanagan Nation Alliance, July 2015).

Discussion

Preliminary observations indicate newly placed rip-rap is stable and will be able to protect the bank during high flows. Rock placement ensured all elements were tightly interlocked, ensuring new rock to be less susceptible to movement. Following placement, a stability test was conducted by the environmental monitor and the newly placed rip rap was more stable than rip rap placed previously. This can likely be attributed to the decrease in slope from 1:1 to 2:1.

The removal of exposed nails and broken/loose cable has improved safety in Pass Creek for recreationalists. With the volunteer help of the Castlegar and District Wildlife Association hazards were removed quickly and efficiently. Monitoring of these failed structures should take place following high-flow events to identify exposed hazards. The in-stream rock clusters increased interstitial spaces and habitat complexity. These features allow Rainbow Trout fry to escape predators, while the resulting pools downstream of the structures provide fish with resting areas (Fig. 9). After installation, Rainbow Trout fry were observed using the new rock clusters (Fig. 10). These structures have already begun to provide habitat for Rainbow Trout fry.

Figure 9. Rock structures created along the rip-rap bank in the Pass Creek Regional Exhibition Grounds creating pools and cover for rainbow fry (picture taken by Evan Smith, Okanagan Nation Alliance, July 2015).

Figure 10. Rainbow Trout fry using a recently constructed fish habitat structure in the Pass Creek Fairgrounds on the right bank of Pass Creek (picture taken by Evan Smith, Okanagan Nation Alliance, July 2015).

Recommendations

To ensure the rip-rap bank can withstand freshet and high flows, monitoring should occur every spring and after a flood. Weaknesses in the bank should be recorded and repairs made before further damage occurs. Though still intact, parts of the bank are still near a 1:1 slope. To avoid future repairs, we recommend re-contouring the entire bank to a 2:1 slope.

Continual monitoring of large woody debris and rock structures should occur to determine their stability and functionality every few years, particularly after significant flow events (>1 in 10 year flows). Additional hazards may appear as structures are affected by floods and high freshets. Since the rock structures have yet to withstand freshet, monitoring in the spring of 2016 should occur and any movement of the structures should be documented, and associated hazards assessed. Monitoring will also provide information that will improve design and construction of similar structures in the future.

Acknowledgements

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Appendix A: Recommendations from Audy and Zimmer (2014) regarding fish structures and maintenance activities

Table 1. Description of monitoring conducted on 18 large-woody debris (LWD) habitat structures and a Newbury Weir in 2013 and action taken in 2015 based on the recommendations (table adapted from Audy and Zimmer 2014).

Structure	Rating	Comments	Maintenance Required?	Recommendations	Action Taken in 2015
Structure 1	M	cables have loosened, but are otherwise good; 2 boulders buried	No	stable and functioning	none
Structure 2	25	boulders buried; cables are in good condition; SWD accumulation underneath	No	stable and functioning	none
Structure 3	75	buried log and rootwad; affected by high water; however, structure creates a deep pool with structure 4	Yes	stable and functioning	none
Structure 4	50	candidate for maintenance; boulders (3) are no longer attached; rotated and snapped cables	Yes	remove broken cables; additional rock recommended for placement upstream, along eroding bank	Broken cables removed and additional rock placed upstream of structure during rip-rap repair
Structure 5	50	3 buried logs; a lot of accumulated SWD; loose cable at end of structure	Yes	consider repositioning structure	cable removed from structure
Structure 6	M	relatively stable; large dogwood growing over part of structure; exposed nails are a hazard	Yes	stable and functioning; remove exposed nails	nails removed

Structure 7	100	structure originally placed to encourage sediment deposition and channel narrowing.	Yes	stable and functioning	none
Structure 8	100	displaced structure, origin unknown; could potentially reposition this structure; exposed nails are a hazard	Yes	consider relocating structure; remove exposed nails	structure relocated to top of bank (decommissioned), nails removed
Structure 9	100	displaced structure; loose cables on one log;exposed nails are a hazard	Yes	consider relocating structure; remove exposed nails	cable and nails removed
Structure 10	100	displaced structure	Yes	consider relocating	structure relocated to bank (decommissioned) and nails and cable removed
Structure 11	M	SWD accumulating throughout structure; structure looks as though it's been pulled away from bank or significant erosion has occurred; 1 cable starting to fray; exposed nails a hazard	Yes	remove broken cables and exposed nails	nails and cables removed
Structure 12	M	broken cables; SWD accumulating; exposed nails are a hazard	Yes	remove broken cables and exposed nails	cables and nails removed
Structure 13	25	broken cables (2); 1 very loose cable; exposed nails are a hazard	Yes	remove broken cables and exposed nails	cables and nails removed
Structure 14	M	front rootwad is buried; cables appear to be secure; exposed nails are a hazard	Yes	stable and functioning; remove exposed nails	nails removed

Structure 15	N	LWD stacked on top of structure appears to be in good shape and functional	No	stable and functioning; no maintenance required	none
Structure 16	M	buried cable; broken cable	Yes	remove broken cable	cable removed
Structure 17	25	buried cables; one cable loop no longer holding anything	Yes	remove loose cable	cable removed
Structure 18	75	Lots of sediment buildup; buried boulders and logs; cottonwood down upstream of structure, enhancing effect of structure	No	Stable and functioning; no maintenance required	None
Newbury Weir	75	Has been scoured down to native rock (cobbles); angular material has moved downstream 10-25 m	No	Still functioning as fry and juvenile cover; continue to monitor	None