3299 / WP#T-1263

Routine Effectiveness Evaluation

Off-channel ponds and debris structures

FRBC ACTIVITY NUMBER: **725138**
Funded by Forest Renewal BC

MARCH 2002

Prepared for:

Ministry of Water, Land and Air Protection
104-3220 Eby Street
Terrace , BC V8G 5K8

Submitted to:

Kitsumkalum Band Council
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Prepared by:

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1 Introduction

Biolith Scientific Consultants Ltd. was contacted by Triton Environmental Consultants Ltd. on behalf of the Kitsumkalum Band Council to conduct a Routine Effectiveness Evaluation on three restoration projects completed in 2001 on the Copper River.

1.1 Project proponent, partners and funding source

The proponent for the Copper (Zymoetz) River watershed restoration program is the Kitsumkalum Band Council, working in conjunction with the B.C. Ministry of Water, Land and Air Protection with funding provided by Forest Renewal B.C. (FRBC).

1.2 REE scope and purpose

This report provides a summary of the results of a Routine Effectiveness Evaluation (REE) of watershed restoration works at two off-channel sites, Site 77 and 3 km, and an instream project in the Copper (Zymoetz) River watershed near Terrace, B.C. The purpose of this REE was to evaluate the effectiveness of the restoration works approximately four months to one year after completion. The key issues examined included:

- present condition of restoration works,
- assessment if the restorative works were effective in meeting project objectives,
- maintenance requirements on sites,
- further enhancement opportunities,
- success and failures of these projects and lessons for future restoration projects.

1.3 Watershed description and works to date

The Lower Copper River is the priority key unit for watershed restoration in the Copper watershed contained in the Kalum Forest District. The Copper River watershed drains approximately 3000 km^2 and was negatively altered by past development including powerline, pipelines, road construction and forestry harvesting activities. These activities over the past 35 years in conjunction with large floods has caused substantial channel changes and impacted fish habitat, particularly access to off-channel habitat. Major projects completed to date include a large, excavated side channel on the Copper River floodplain (Site 9), a smaller groundwater fed off-channel between 2 and 3 km, debris catchers located in the Copper River mainstem at 3 km and a fish access channel and culvert replacement at 27.8km (Site 77). The Site 9 Side Channel was not included under the scope of the REE.

1.4 Site Description and Objectives

1.4.1 Site 77

The main objective for Site 77 was to provide permanent access for juvenile coho into existing habitat (Triton 2000; Triton 2001). This project involved the replacement of two perched metal culverts and one collapsed wooden box culvert with a new, 1500 mm diameter metal culvert in 1999. The intent was to allow juvenile coho to enter 1000 m^2 of off-channel habitat isolated by the Forest Service Road (FSR) from the Copper River.

Another objective at Site 77 was to position the new culvert and new outlet channel to capture the entire outflow of water from the off-channel ponds instead of letting the water drain through the road material via a buried log box culvert (Triton 2000). This increased the likelihood of access for juvenile coho during moderate and low water conditions (Triton 2000). A third objective at Site 77 was the construction of a 50 m long armored channel below the new culvert on the existing gravel bar to the Copper River, in order to enhance access for juvenile coho during moderate and low water conditions (Triton 2000a).

1.4.2 Off-Channel Site at 3 km

Prior to initial construction in 2000, Site 3km was an ephemeral, groundwater channel with poor fish access from the Copper River. In 2000 a 180 m long channel was excavated to provide off-channel rearing and overwintering habitat. Five ponds were added in 2001 to provide additional rearing and overwintering habitat for juvenile coho.

Site objectives for 3 km off-channel project were:

- To develop an existing ephemeral channel with poor fish access into productive off-channel spawning and rearing habitat for coho salmon, Dolly Varden char and trout.
- To address the loss of fish habitat due to berm removal and channel infilling at adjacent Site 9.

1.4.3 Debris Catchers

Three debris catchers, called DC1 to DC3, were constructed along an eroding bank, 350m in length and 3 m high, located adjacent to 3 km along the Copper FSR. The channel is eroding the west bank and migrating at 3 to 4 m per year southwards into the Hydro ROW adjacent to the site (Triton 2001). Basic debris catcher design is comprised of one horizontal cross beam, anchored to the bank, and 4 or 5 'rack or trash logs' anchored to the cross beam and positioned pointing upstream into the Copper River. The concept behind the catchers is that they will accumulate small woody debris on the upstream face, slow the water velocity and enable substrate deposition in back eddies immediately upstream and downstream of the structure (Triton 2001). Initial construction of the catchers was completed in fall 2000 with additional logging debris added to the structures

in May 2001. Since construction the catchers and have only experienced two high water run-off events in summer.

Site objectives for the Debris Catcher Project were:

- To test the durability of large log and boulder debris catchers in a large river subject to occasional large floods (100 year flood of approximately 3000 m^3/s),
- To test the effectiveness of these structures in substantially reducing the rate of gravel bank erosion and lateral channel migration which may protect the remaining second-growth riparian vegetation immediately downstream

Secondary objectives included:

- The intent to improve fish habitat by providing wood cover and scour pool formation.

1.5 Study area

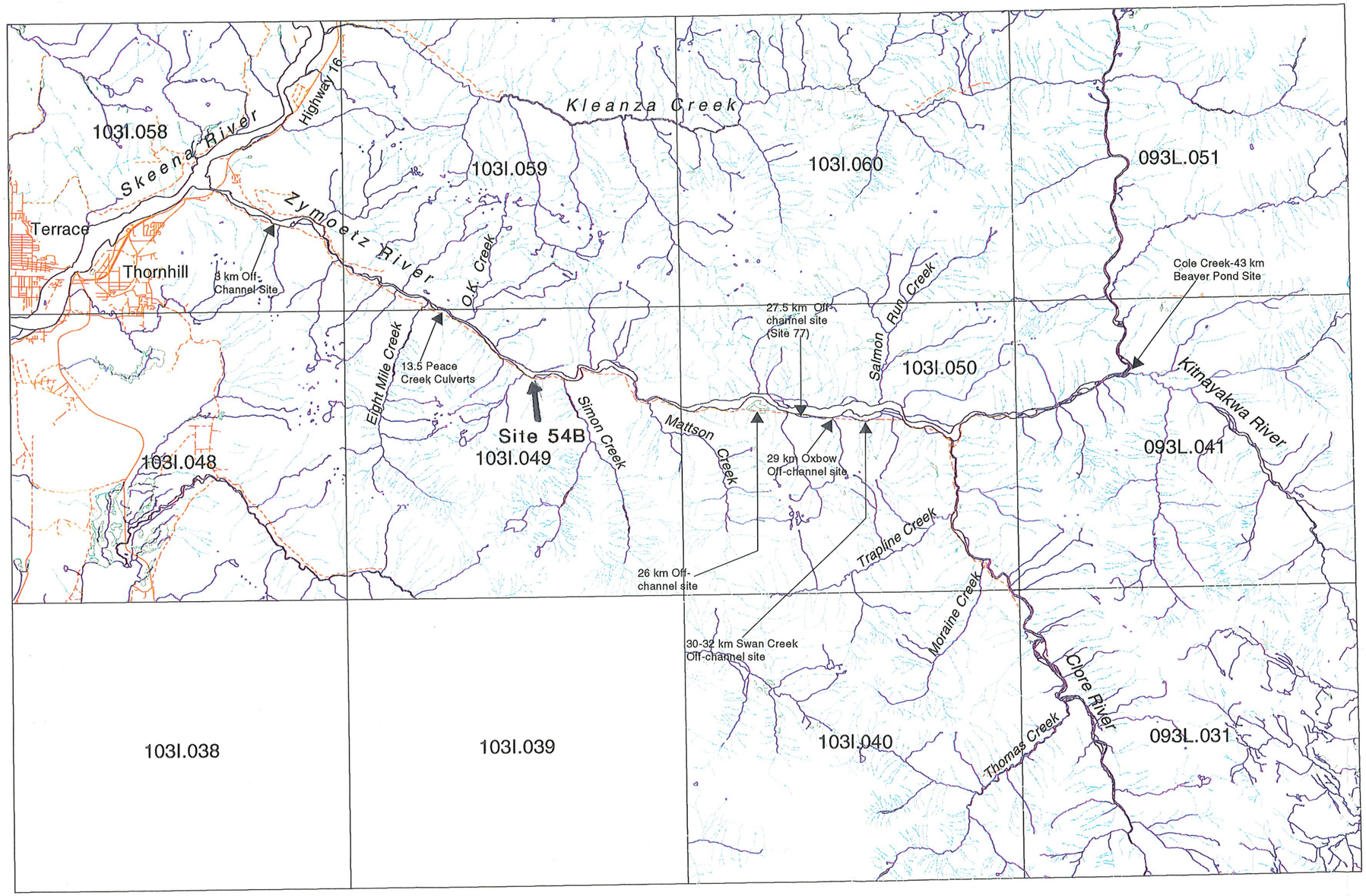
A map of the study area is provided in Figure 1. Site 77 is located adjacent to reach 5 of the Copper while the 3 km site is between 2 and 3 km on the Forest Service Road.

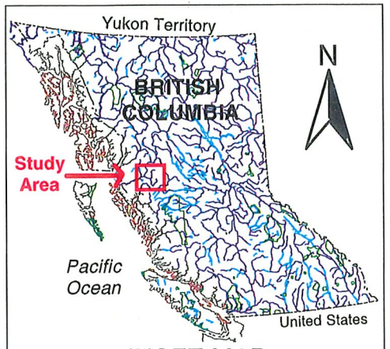
2 Methods

Methods used in performing the REE were outlined in the draft document (April 30, 2001) Appendix A: Guidelines for Instream Routine Effectiveness Evaluation and Appendix B: Guidelines for Off-Channel Routine Effectiveness Evaluation (MWLAP 2001). Since the REE guidelines fish access did not exist prior to this study, the guidelines for off-channel evaluations were used at Site 77. A field visit occurred to evaluate the physical and biological performance at each site.

LOWER COPPER RIVER WRP ASSESSMENT SITES

Overview Map





INSET MAP

LEGEND

- Gravel Roads
- Paved Roads
- Rivers/Streams
- Lakes
- Indefinite/Intermittent Streams
- Marshes/Swamps
- Glaciers

2000 0 2000 4000 Meters

1:175,000

Source: Digital TRIM 1:20,000,
Projection : UTM

Date: April 3, 2000
Created by: SM

TRITON
Environmental Consultants Ltd.

Map#: 2675.06.299

FIGURE 2.

3 Results and Discussion

The field visit to Site 77 and 3 km projects was on March 15, 2002, during low water, late winter conditions. Two biologists, Glenn Grieve (Biolith) and Doug Webb, and Shawn Giesbrecht (Triton) visited the sites, took photographs, recorded measurements of physical parameters and conducted fish sampling using roe-baited minnow traps under ice. The REE of the debris catchers was performed by Steve Jennings and Shawn Giesbrecht (Triton) on March 9, 2002, during winter conditions.

3.1 Site 77

3.1.1 Performance Summary

The Site 77 off-channel site was rated three for overall performance which implies that the site has not become less productive or less stable overall (Figure 2). Overwintering habitat conditions were adequate with abundant cover, adequate depth and good physical conditions. The new culvert was functioning well and fish passage is possible when not frozen. Fishing under ice at two pond sites above the culverts produced 12 juvenile coho that appeared to be 2+ years in age, ranging in fork lengths from 68 to 105 mm. Juvenile coho captured before the replacement of the culverts in 1999 were considered to be 3+ years of age, with fork lengths ranging from 160 to 180 mm. The fish captured in 1999 were likely prevented from migrating downstream by the dispersed flow and perched culverts. The culvert and new channel built in 2001 enabled the smaller, and therefore younger fish, into the off-channel habitat from the river. The project was successful in meeting the primary objective of providing access to juvenile coho.

3.1.2 Biological objectives

Even though 60 cm of snow and 14 cm of ice covered the outlet channel and pond, the site met the biological objectives of providing overwintering habitat for juvenile coho and fish passage.

3.1.3 Physical condition

Fish access did not exist during the inspection due to 10 cm of ice in the channel. However, the culvert appeared to provide good physical characteristics to allow access for juvenile coho during flowing conditions in the Copper River. Dissolved oxygen (DO) concentrations and water temperature could not be determined in either the culvert or the channel below as there was no liquid water. Dissolved oxygen in the pond ranged from 4.8 to 11.2 mg/L which is adequate to good for overwintering fish. The outlet channel was physically intact was not challenged by high water in the Copper River since construction. Water temperature was less than 1 degree Celcius.

3.1.4 Overall rating

The overall rating for the culvert and channel was meeting expectations for off-channel habitat. The results of the quantitative evaluation on the REE Form are summarized in Figure 2. The need for additional cobble armouring along the outlet channel between the pond and the culvert inflow reduced the overall physical rating to 2.

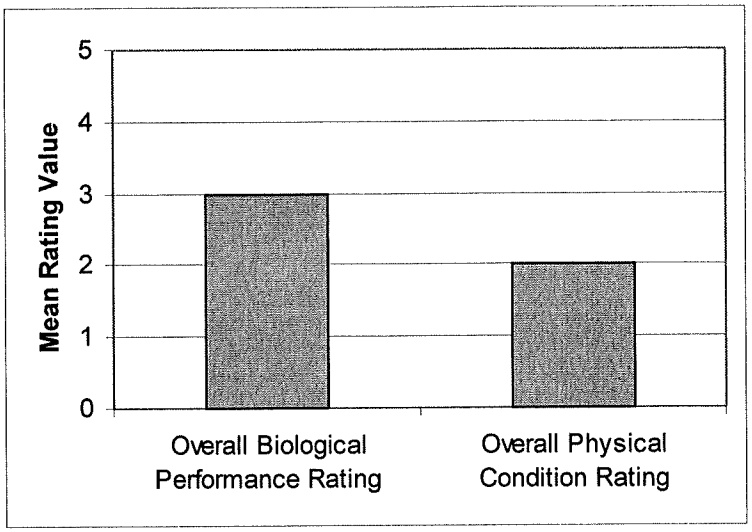


Figure 2. Summary of performance and condition ratings for the access project at Site 77.

3.1.5 Project maintenance

1. Routine monitoring of Site 77 is recommended in 2002 to confirm fish access throughout this system and stability of the outlet channel after over topping flows in spring runoff.
2. A truckload of pit run gravel could be deposited into the channel immediately downstream from the culvert and spread downstream to fill interstitial spaces in the porous cobble and encourage the formation of a few refuge pools.
3. The beaver grating intended (Triton 1999) for the upstream end of the culvert should be installed.

3.1.6 Future Opportunities

No additional opportunities exist at this site.

3.2 3 km pond site

3.2.1 Performance Summary

Overall performance was rated at 2, with the site not fully meeting expectations mainly due to the variable water table and drying of the channel between ponds in the winter. The pond habitat appeared to be functioning well. Fishing under ice at three of the four ponds produced 39 juvenile coho that appeared to be 2+ years in age, ranging in fork lengths from 72 to 118 mm and six cutthroat trout juveniles ranging in fork length from 83 to 90 mm. Compared to pre-construction when no fish habitat existed, the project was successful in providing rearing habitat for juvenile coho.

All of the large woody debris placed into the channel appeared to have remained in place. The lack of ice in the pond at the headwaters of the channel, along with up to 1 m of water depth below the ice in some places, and the presence of significant numbers of fish suggested that there was adequate flow of water through this system. The protective berm made from the excavated spoil, was not eroded or disturbed.

3.2.2 Biological objectives

The presence of a significant number of overwintering juvenile coho indicated that the main objective of this project had been successfully met. The presence of overwintering cutthroat trout juveniles indicate that the expectations have been exceeded. As the area was covered with 20 cm to 60 cm of snow and 5 cm of ice evaluation of the other biological parameters was challenging. The lack of water in the channel where fish spawned over the past two years indicated poor incubating conditions and likely poor egg survival which decreased the biological performance score.

3.2.3 Physical condition

Dissolved oxygen (DO) concentrations and water temperature were moderate (10.6 mg/l, 3.4 °C) at the headwater pond and were progressively lower downstream (5.2 mg/l, 1.2. °C at pond 4). This was not unexpected in a groundwater channel with relatively little flow during winter seasons. The presence of apparently healthy, juvenile fish indicate that the low values were not likely a negative impact on survival. Water flow was minimal between ponds. No re-vegetation was apparent but snow cover would hide grass. The channels connecting the ponds and the watered channel at Site 9 were dry although there may have been some sub-surface flow.

3.2.4 Overall rating

Overall, the performance of this structure was slightly lower than expectations due to the dewatering. The results of the quantitative evaluation on the REE Form are summarized in Figure 3.

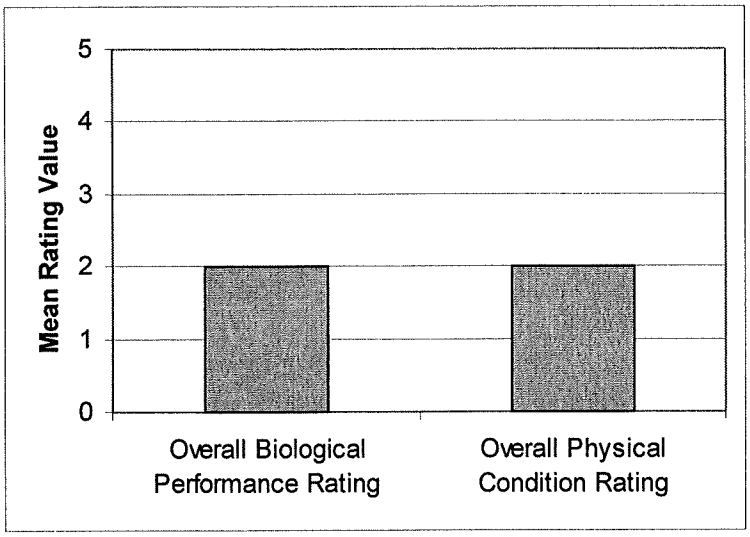


Figure 3. Summary of performance and condition ratings for the off-channel project at the 3 km Site.

3.2.5 Project maintenance

1. This site should be monitored during the fall of 2002 to evaluate the spawning habitat conditions and success.
2. The site should be re-vegetated with local deciduous shrubs for cover.

3.2.6 Future Opportunities

No other opportunities for further work were identified.

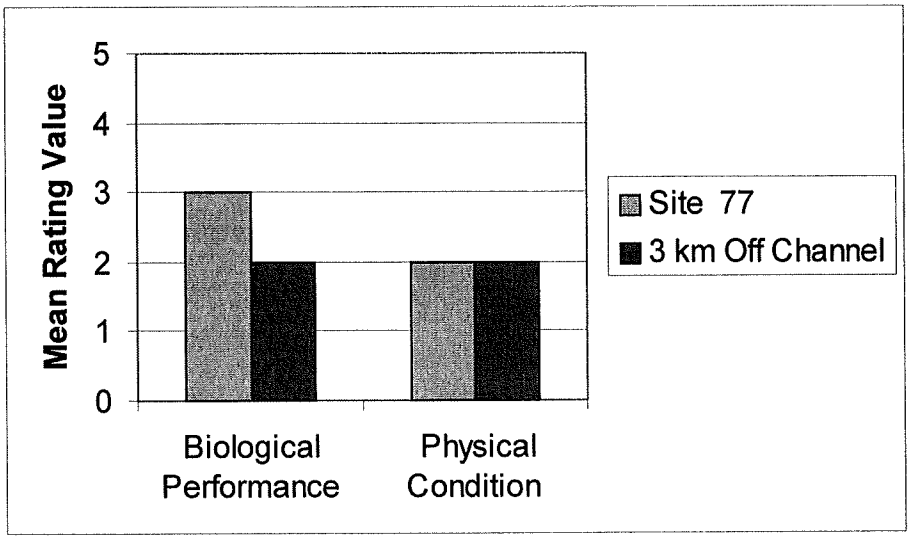


Figure 4. Summary of performance and condition rating for Site 77 and 3 km sites.

3.3 Debris Catchers

3.2.1 Performance Summary

Summary REE records are presented in Appendix A. Overall physical and biological performance summaries are illustrated in Figure 5. The three catchers are performing adequately and no significant change in structural condition or stability was observed since construction.

A minor change in the stream thalweg and the riffle upstream of DC1 was noted. Prior to construction the riffle upstream of DC1 flowed straight from the mid-channel bar onto the catcher. Since then the riffle has progressed upstream, almost parallel to the bank, and the stream thalweg now curves from the riffle, along the bank and onto the debris catcher causing erosion to the banks immediately upstream of the catcher. This change was not anticipated and the rate of erosion should be monitored, especially following a high flow event to ensure erosion does not compromise DC 1. The erosion rate of the banks was estimated at 2 to 4m per year but appears to have slowed since construction 1 year ago. We anticipate that the angle of repose of the bank will change from near vertical presently (see photos) to a 30 to 50 degree angle seen in other similar banks along the river. Small woody debris collected on DC1 (upstream most catcher) and the structures appear functional in intercepting instream debris. Additional woody debris was added in May 2001 to each catcher to increase the obstruction of water flowing through each structure. The woody debris persisted over the past 10 months on each structure.

3.2.2 Biological objectives

Since construction the thalweg has progressed to the center of the channel at low flows (3 m approximately) and scoured a deep run off the point of DC1. This deep run provids some holding habitat for adult salmon but limited rearing and overwintering habitat for juvenile fish. Sediment from the scouring action at DC1 was deposited downstream of DC1 creating a small riffle and the bed between these 2 catchers is beginning to form a pool/riffle/pool sequence.

3.2.3 Physical condition

All three catchers appear in excellent condition and no change was noted on DC2 and 3. On DC1 the outermost log (river side) has shifted down in the channel resulting from the scour created by the structure. Measurements listed below were taken from the channel bottom to the top of log and can be compared to future monitoring. Measurements include:

- Channel bottom to the top of the butt of the outermost rack log, 4.85m
- Channel bottom to the top of the butt of the crossbeam log, 3.85m.

The use of knots in the steel cable instead of cable clamps is one concern. One cable underneath of DC1 tied to a boulder has frayed to the knot and may potentially fail. This boulder should be re-attached to the cable with a clamp.

3.2.4 Overall rating

Overall, the performance of this structure was meeting expectations. The results of the quantitative evaluation on the REE Form are summarized in Figure 5.

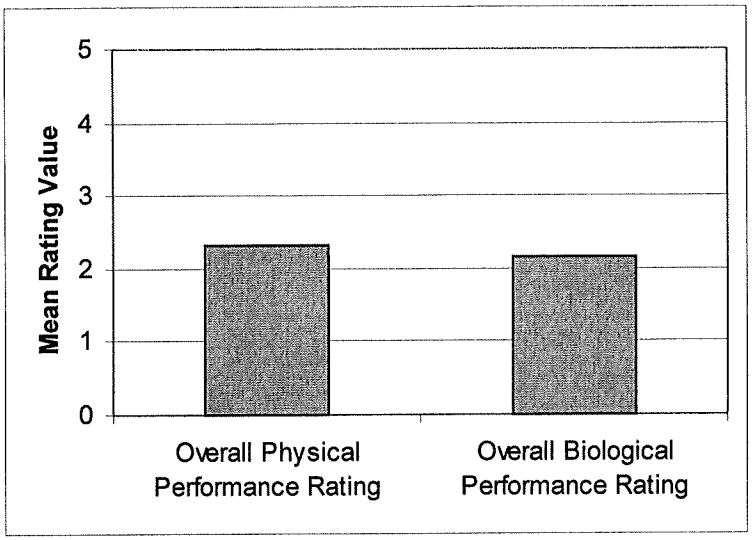


Figure 5. Summary of performance and condition ratings for the off-channel project at the Debris Catcher Site.

3.2.5 Project maintenance

Routine maintenance is required on all three catchers. Several cables on each catcher had slackened off due to settling of the structures and require tightening. It is recommended that some of the knots used to tie the cables be reinforced with cable clamps to ensure structural stability during peak flows.

3.2.6 Future Opportunities

No future opportunities for restoration were identified.

4 Conclusions and Recommendation

A summary table of maintenance works is listed below in Table 1 to guide future activities.

Site 77

The culvert and lower channel did not provide access for juvenile coho at the time of this evaluation due to ice over. The presence of 2 year old juvenile coho above the road

indicated that access had been restored. Further evaluation through another REE at moderate and high water conditions, along with two improvements including the installation of beaver grating and addition of gravels downstream of the culvert were recommended.

3 km Site

The excavated off-channel habitat is meeting expectations regarding provision of rearing habitat for juvenile coho. Another REE during the late fall adult coho immigration was recommended to evaluate the success of this channel in providing spawning habitat. Accelerated re-vegetation of the berm was also recommended.

Debris Catchers

The constructed debris catchers are meeting the primary objectives of reducing the rate of bank erosion and appear able to withstanding average river flows although have not been tested against a bankfull flood. The biological attributes of the Debris Catchers will become more apparent in future REE's as scour and the formation of pool/riffle sequencing will continue and improve. We recommend routine maintenance of tightening and cable clamp reinforcement to the cables.

Table 1. Summary of remedial works recommended for Site 77, 3 km Site projects.

Priority	Watershed	Distance	Site ID	Maintenance Score	Problem/Fix	Estimated Cost	Person Days Required	Materials and equipment Required	Prescription Required
1	Copper		Debris Catchers 1 to 3	2.5	Tighten cables and reinforce cable knots with clamps	$1000 to $1500	2	5/8' Cable, staples and clamps, cut-off saw hand tools	No
2	Copper	At culvert inlet	Site 77	2	Armouring 10m channel upstream of culvert	$500	2	locally available cobble	No
3	Copper	both sides of channel on berm	3 km	2	Limited re-vegetation for stream cover. Plant with deciduous shrubs.	$500	2	locally available plants, grass seed, hand tools	No
4	Copper	at culvert mouth	Site 77	2	Add load of gravel to channel	$400	2	load of pea or pit run gravel	No
5	Copper	at head of culvert	Site 77	2	Missing beaver guard	$400	1	metal grate	No

5 References

Ministry of Water, Land, and Air Protection. 2001. Draft document (April 30, 2001) Appendix B: Guidelines for Off-Channel Routine Effectiveness Evaluation. Produced by the B.C. Ministry of Water, land and Air Protection and part of Schedule A: Watershed Restoration Program Standards Agreement.

Triton Environmental Consultants Ltd. 2000a. Copper River: 1999/2000 Monitoring and Works Summary. Report prepared for Skeena Cellulose Ltd.

Triton Environmental Consultants Ltd. 2000b. Copper River Culvert Replacement (Site 77). A two page report prepared for the 1999-2000 Compendium of WRP Aquatic Rehabilitation Projects.

Triton Environmental Consultants Ltd. January, 2001a. Copper River WRP: 2000 - 2001 Instream Works Summary Report

Triton Environmental Consultants Ltd. 2001b. Copper River Groundwater Channel at 3 km. Prepared for the 1999-2000 Compendium of WRP Aquatic Rehabilitation Projects.

Form 1: Routine Effectiveness Evaluation Restoration Summary - Off-Channel Component

Appendix A. Routine effectiveness evaluation for off-channel development at 3 km and Site 77.

FRBC Activity No. 25138
Project Name: 3 km Off-Channel Site
Development constructed September, 2000

Watershed: Copper (Zymoetz) River
Sub-watershed NA
Date: March 22, 2002

Survey Crew: SG DW GG
Weather / Flow: sunny / low
Forest District: Kalum

						Targets		Biological Performance Objectives					Physical Condition								Overall				
Stream	Reach	Distance	Site ID #	Off-Channel Type	Site Objective	Species	Lifestage	Overwinter	Rearing	Spawning	Incubation	Overall Rating	Dissolved Oxygen	Nutrients	Intake Integrity/Function	Flow	Outflow Integrity/Function	Berm Condition	Revegetation	Overall Rating	Structural Condition	Structural Stability	Maintenance	Photos	Comments
Copper River	1	3 km	3km Off channel	GF/ SF	Primary - Rearing and overwintering Secondary - spawning	Co	JUV	2.5	3	2	2	2	2	2	2	2	3	3	2	2	3	3	2	5 to 8	Do ranged from 5.2 to 10.6mg/L
Copper River	5	28 km	Site 77	SF	Provide access to overwintering habitat	Co	JUV	3	3	n/a	n/a	3	2	4	n/a	3	2	3	3	2	3	3	2	4	Fish captured under ice. DO ranged from 4.8 to 11.2 mg/L Monitor beaver activity above road. No evidence now. REE again after high water event

SF - surface fed

Form 1: Routine Effectiveness Evaluation Restoration Summary - Instream Structure Component

Appendix B. Routine effectiveness evaluation for Debris Catchers

FRBC Activity No. 25138
Project Name: Debris Catchers
Development constructed August, 1999 and Completed Nov., 2001

Watershed: Copper (Zymoetz) River **Survey Crew: SG SJ**
Sub-watershed NA **Weather / Flow: sunny / low**
Date: March 16, 2002 **Forest District: Kalum**

					Physical							Biological								Overall						
Stream	Distance	Site ID #	Structure Type	Site Objective	Pool	Riffle	Gravel Bar	Stream Bank	Stream Cover	Nutrient	Overall Rating	Species	Life Stage	Overwintering	Rearing	Holding	Spawning	Incubation	Overall rating	Structural Condition	Structural Stability	High Flow Function	Low Flow Function	Maintenance Reccomendations	Photo Numbers	Comments
Copper R.	3 km	DC1	LWD -DC	Primary - deflect flow from eroding bank and collect debris. Secondary - scour pools and provide cover for fis	3	na	na	2.5	3	na	3	SA	JUV	2.5	3	2.5	na	na	2.5	3	3	3	2.5	2	10, 11	SWD has accumulated on this structure.
Copper R.	3 km	DC2	LWD -DC		2	na	na	3	3	na	2	SA	JUV	2	3	2.5	na	na	2	3	3	3	2.5	2	12, 13	
Copper R.	3 km	DC3	LWD -DC		2	na	na	3	3	na	2	SA	JUV	2	3	2	na	na	2	3	3	3	2.5	2	14	

Appendix C. Photographs

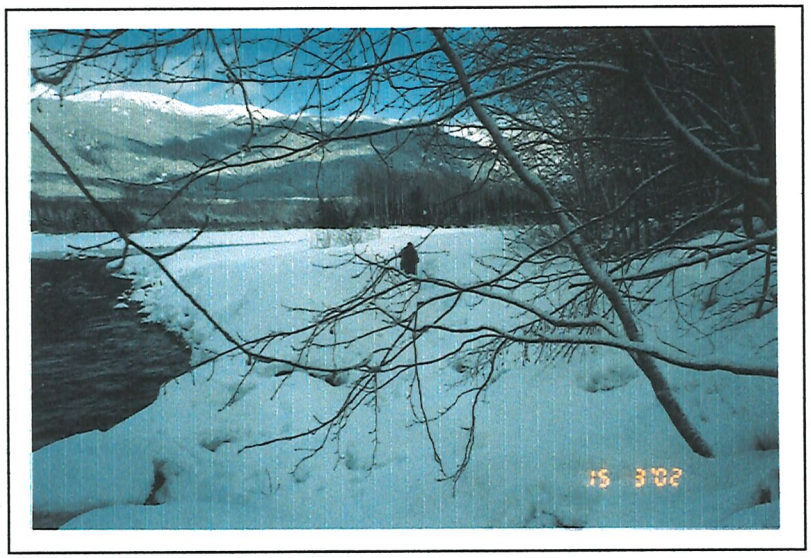


Photo 1. Looking upstream in the lower channel of Site 77 from the Photo Reference point on the bank near the mouth

Photo 2. Looking at the outlet of the new culvert at Site 77.

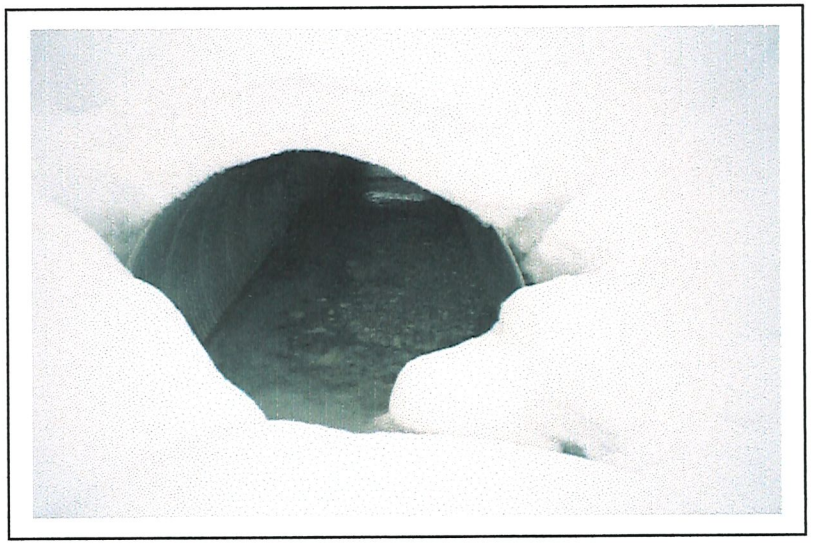


Photo 3. Looking at the culvert inlet at Site 77. Gravels have infilled the bottom of the culvert for 6m.

Photo 4. Looking upstream at off-channel habitat made accessible from the Copper River. Coho juveniles were capture in minnow traps under the ice.

Photo 5. Looking upstream in the excavated channel at 3 km from approximately 40 m below Pool 1.

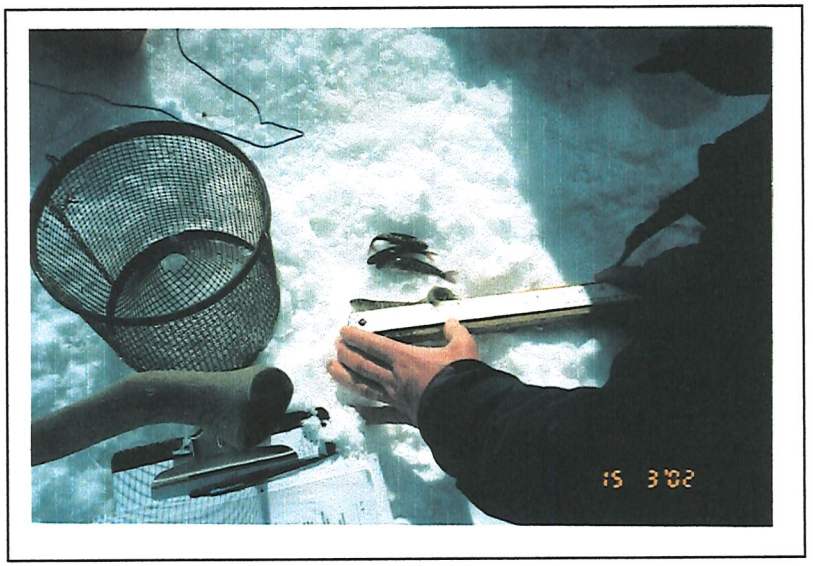


Photo 7. Some of the coho and cutthroat trout juveniles captured in Pool 4.

Photo 6 Looking downstream Pool 4 in the excavated off-channel development at 3 km. Note the large woody debris. Juvenile coho and cutthroat trout were captured in minnow traps under the ice in this pool.

Photo 8. Looking downstream toward the mouth of the new off-channel habitat. This channel drains into a spawning channel where the person on the left is standing.

Photo 9. Looking upstream at the Copper River mainstem from Debris Catcher 1 at the thalweg eroding the gravel bar.

Photo 11. Looking underneath Debris Catcher 1 at a frayed cable attached to a boulder that required re-attachment.

Photo 10. Looking downstream at Debris Catcher 1. Small woody debris is accumulating at the base of the structure.

Photo 12. Looking downstream at Debris Catcher 2 and 3. Note how the thalweg has been pushed into the center of the channel and away from the eroding bank.

Photo 13. Looking upstream at the backside of Debris Catcher 2. The structure has remained stable with minor shifting.

Photo 14. Looking downstream at Debris Catcher 3. Additional woody debris was loaded onto the structure in May 2001.