Restoration of a Mountain Bike Trail, Three Blind Mice Trail Network, Penticton, British Columbia

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Abstract

Mountain biking is a growing recreational activity in many areas of British Columbia which can have negative environmental effects on the landbase. The purpose of this project was to restore a segment of decommissioned mountain bike trail in the Three Blind Mice trail network in Penticton, BC. The goals of the restoration treatment were to discourage riding on that trail segment, reduce soil erosion potential and establish vegetation cover. The trail segment to be restored was 41 m long with an average slope of 9% on a loamy sand soil. The restoration treatment included blocking the trail access, decompacting the trail tread surface and planting native vegetation. The restoration was successful in discouraging trail use and decompacting the surface to promote infiltration and reduce soil erosion potential. Vegetation establishment was partially successful with over-winter mortality of some of the transplanted species, specifically grass and herbs. Introduced agronomic species colonized the restored trail tread which has benefits related to soil stability, but may make it difficult for native species to colonize the treated area.

Acknowledgements

Thanks to Laura Harp and Brent Tibben of the Penticton Area Cycling Association for assistance in identifying a suitable project site. Field assistance decompacting and revegetating the trail tread was provided by Camilla Freestone and Elizabeth Welch.

1.0 Introduction and Background

Mountain biking is a popular recreational activity in British Columbia. This activity has an impact on the land base through the creation and use of trails. Trail use can cause soil erosion and disturbance of vegetation cover and disturb local wildlife and potentially cause conflict with other trail users (hikers, equestrians). There have been a number of reviews of the potential environmental effects of mountain biking (Marion and Olive 2006, Marion and Wimpey 2007, Pickering et al. 2010, Quinn and Chernoff 2010). The primary environmental impacts of mountain bike trails are:

- Soil compaction and erosion (rutting etc)
- Water quality degradation (due to soil erosion and sedimentation, presence of people)
- Vegetation loss and compositional change (invasive species)
- Disruption of wildlife

To limit environmental damage, properly located and constructed trails are essential (Marion and Wimpey 2007, Pickering et al. 2010). The primary resource on environmentally friendly trail construction is published by the International Mountain Biking Association (2004). There is little available literature on the deactivation and restoration of mountain bike trails. The most direct information comes from the International Mountain Biking Association (No Date) webpage which provides an outline of steps to follow when decommissioning and restoring mountain bike trails. There is a more extensive restoration manual available for hiking and wilderness trails (Therrell et al. 2006). Extensive searches did not identify any published peer-reviewed or grey literature assessing the efficacy of restoration treatments on mountain bike trails and few related to hiking trails (Therrell et al. 2006).

This project is focussed on restoration of soil function and vegetation cover to a decommissioned trail segment with the primary goal of reducing erosion and sedimentation hazard. There are numerous factors that influence the impact of trails on the environment. Soil texture controls the cohesion and erosion potential of soil,with finer textured (silt) and non-cohesive (sands) soil at highest risk. Locations with frequent and high intensity rainfall are also at higher risk of surface erosion, especially where the trail slope gradients are steep. The frequency and intensity of trail usage may also be a factor influencing the rates and types of trail degradation.

The objectives of this project were to work with the local trail users group (Penticton and Area Cycling Association [PACA]) to restore a section of mountain bike trail in the Three Blind Mice trail network near Penticton, BC (Figure 1). PACA members identified the trail segment for restoration. The segment of trail to be addressed is the lower end of Chute Out (Figure 2), which had recently been re-routed and built to a higher standard (International Mountain Biking Association 2004). Deactivation and restoration of the old trail surface will reduce soil erosion

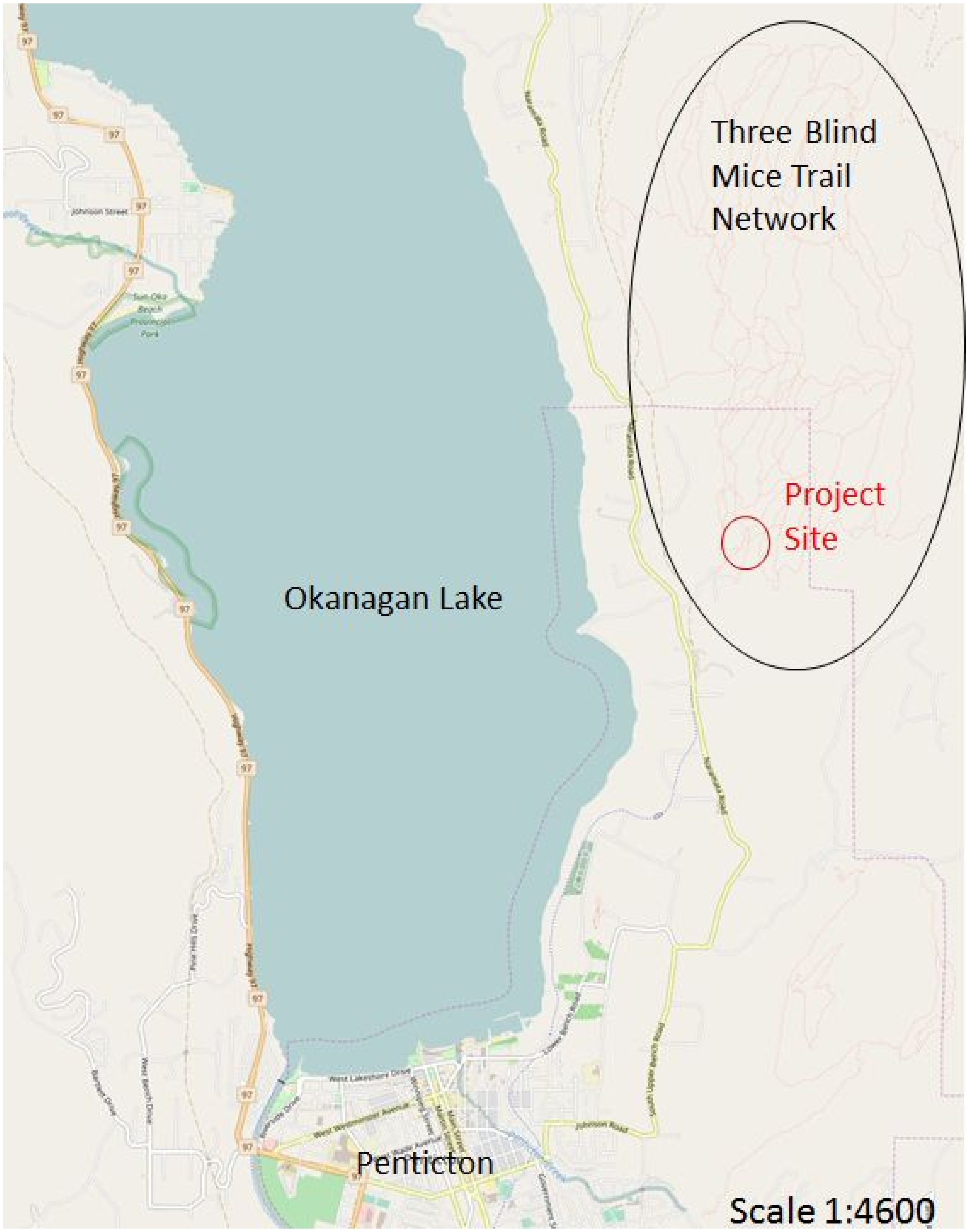

Figure 1. Location of project site (red circle) and Three Blind Mice trail network (dashed red lines within black circle) north of Penticton, British Columbia (Source: Openstreetmap.org).

Figure 2. Detailed location map of project site at downslope end of Chute Out trail. Note this map pre-dates the construction of the new trail alignment through the project site and shows the decommissioned section of trail to be restored.(Source: Trailforks.com)

potential and help ensure riders are re-routed onto the improved trail. It is hoped that establishing native plants will reduce the incidence of invasive species colonizing the disturbed trail surface and reduce soil erosion potential.

2.0 Methods

This section will provide an overview of the project site and describe the restoration and monitoring methods used to complete the project.

2.1 Project Area Description

The study area is located within the Three Blind Mice trail network near Penticton, BC (Figure 1) in the Okanagan Valley. The trail network includes over 160 km of trails that are used for mountain biking, hiking, trail running and horseback riding. As well, there is a disc golf course located adjacent to the restoration site. The area is designated as a recreation/forest reserve of the City of Penticton with the purpose of acting as a carbon offset for future development (Swanson 2016).

The trail network area has a history of selective harvesting of Douglas fir in the early to mid-1900's. There is no active forest harvesting currently in the project area. The area is under tenure for range use resulting in cattle grazing throughout the area. The movement of cattle has contributed to the dispersal of agronomic and invasive species throughout the trail network.

The project site is a decommissioned segment of the lower end of Chute Out (Figure 2) uphill from the main Three Blind Mice trailhead at Riddle Road. The restoration site location is at latitude 49.545° N and longitude 119.555° W with an elevation of 578 m above sea level. The orientation of the site is WSW with an aspect of 250°.

The trail segment to be restored is 41 m long with an average slope of 9%. This trail segment was decommissioned when a new bypass was constructed to reduce the speed of riders and create a safer transition as they approached the junction with the Roller Coaster trail (Figure 3).

2.1.1 Weather and Climate

Meteorological monitoring at the project site was beyond the scope of this project so examination of climate and weather data for the site is based on the long term record for the Penticton Airport which has the longest data record in the area. It is likely that the data from the airport is broadly representative of the project site, however, there are a few factors that may result in differences. First, the project site is about 200 m higher in elevation which may result in slightly lower temperatures under some conditions. In addition, the airport is on flat ground between Okanagan and Skaha lakes, and therefore temperatures are likely moderated due to the proximity of the water bodies and exposure to the prevailing N/S winds. At the project site, the aspect and shelter from the wind may result in higher temperatures on sunny days.

The climate of the project area is dominated by hot summers and cool winters (Figure 4). Summer daytime temperatures often exceed 30°C in July and August, while winter temperatures are only infrequently below -5°C. Precipitation is low, averaging only 346 mm/yr (Environment Canada 2014). The wettest months of the year are May and June, while September is the driest non-winter month (Figure 5). The combination of high summer temperatures and little rainfall results in significant soil moisture deficits, seasonal drought and plant water stress.

Figure 3. Satellite image showing project site and segment of trail for restoration. Note this image pre-dates the construction of the new trail alignment. (Source: Google Earth)

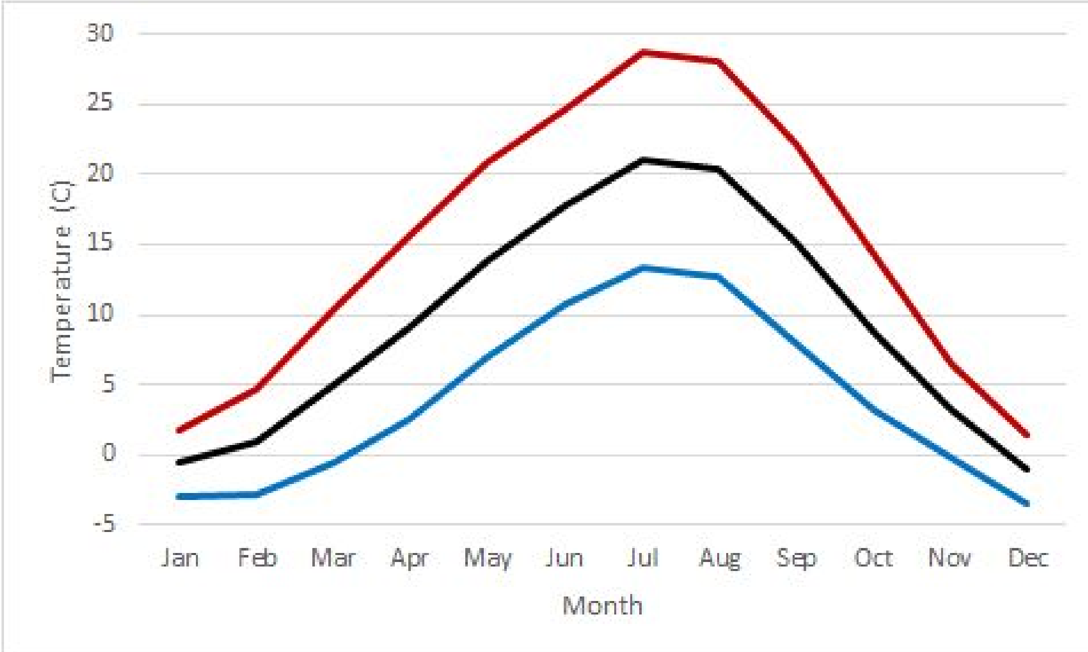

Figure 4. Long-term climate normals (1981-2010) maximum (red), minimum (blue) and mean (black) monthly temperatures for Penticton Airport (Source: Environment Canada 2014).

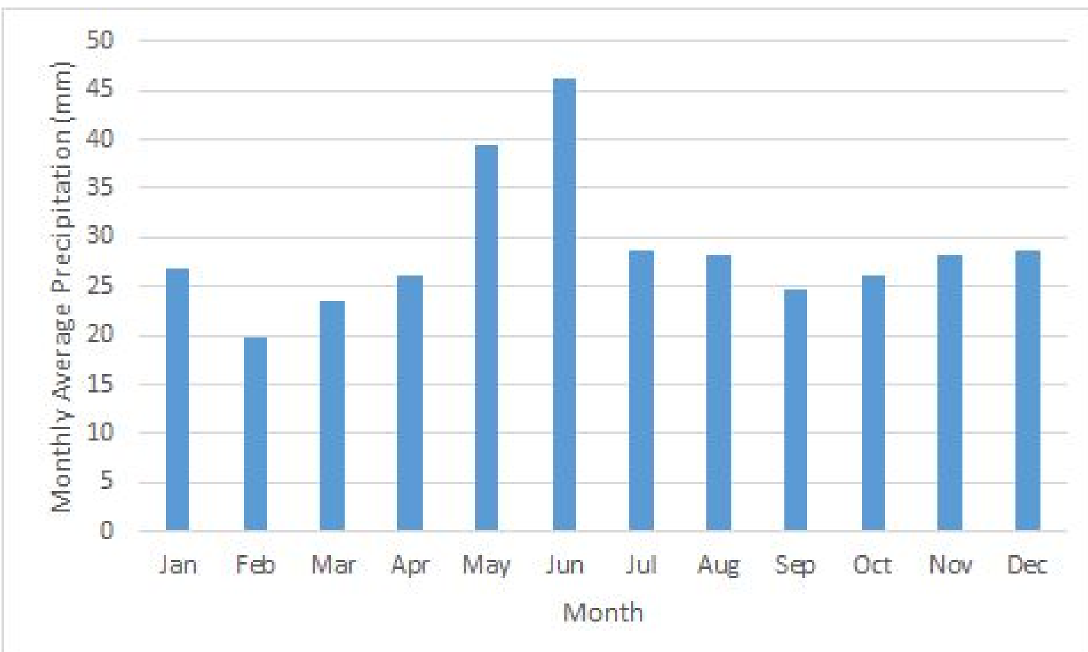

Figure 5. Long-term climate normals (1981-2010) mean monthly precipitation (rain + snow) for Penticton Airport (Source: Environment Canada 2014).

Temperature conditions during the period of this project are shown in Figure 6. On-site restoration activities occurred during September 2016 followed by periodic field visits through June 2017. This period coincided with warm temperatures (Figure 6) and dry conditions (Figure

7) which necessitated manual irrigation of the plantings at the site to reduce mortality due to water stress. The winter of 2016/17 was colder with more precipitation than average. For the period of September 1, 2016 through June 30, 2017, precipitation at Penticton was 399.7 mm, which is higher than average.

2.1.2 Geology

The project site is underlain by Okanagan Complex Metamorphic Complex bedrock, specifically mylonite (Okulitch 2013). Bedrock outcrops are common within the trail network, but at the project site there is no exposed bedrock at the surface.

The bedrock is overlain by a combination of glacial and postglacial sediments. Glacial fluvial outwash sediments are present on the valley sides. The project area is on a flat site at the outlet of a gully that does not currently have an active flowing channel. The surficial materials underlying the trail segment being restored appear to be of fluvial origin washed down the gully. This assessment is based on lack of coarse fragments noted in the soil pit (see below) as compared with the surrounding hillslopes.

2.1.3 Vegetation Community

The vegetation community was described in June 2017.This delay was due to the fact that much of the vegetation was dead and not easily identifiable during the restoration treatments in September 2016. The disturbed nature and ongoing grazing use of the restoration site has resulted in a vegetation community dominated by agronomic species. The vegetation noted at the site includes the trail tread and the surrounding vegetation community. For this reason the herb layer is divided into the native vegetation and introduced species. Plant identification follows Parish et al. (1996):

Canopy (<5% cover): *Pinus ponderosa*

Sub-canopy (<5% cover): *Pinus ponderosa, Pseudotsuga menziesii*

Shrub layer (<20% cover): *Mahonia aquifolium, Symphoricarpos albus, Rosa acicularis, Amelanchier alnifolia, Artemesia tridentata, Chrysothamnus nauseosus, Rhus radicans*

Herb layer (20%): *Gaillardia aristata, Agropyron spicatum, Potentilla fruticosa, Achillea millefolium, Elymus repens*

Introduced (agronomic) species (40%): *Agropyron cristatum, Phleum pratense, Dactylis glomerata, Bromus tectorum, Centaurea stoebe, Trifolium pratense, Medicago sativo, Verbascum thapsus*

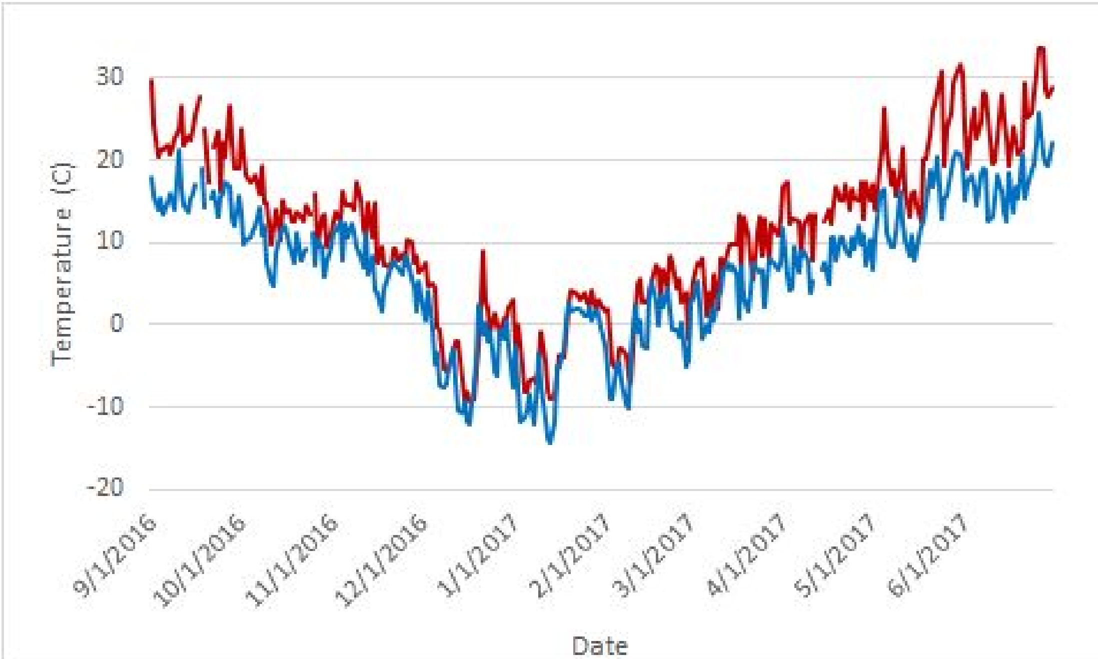

Figure 6. Daily maximum and minimum temperatures for Penticton Airport, September 1, 2016 - June 30, 2017 (Source: Environment Canada 2017).

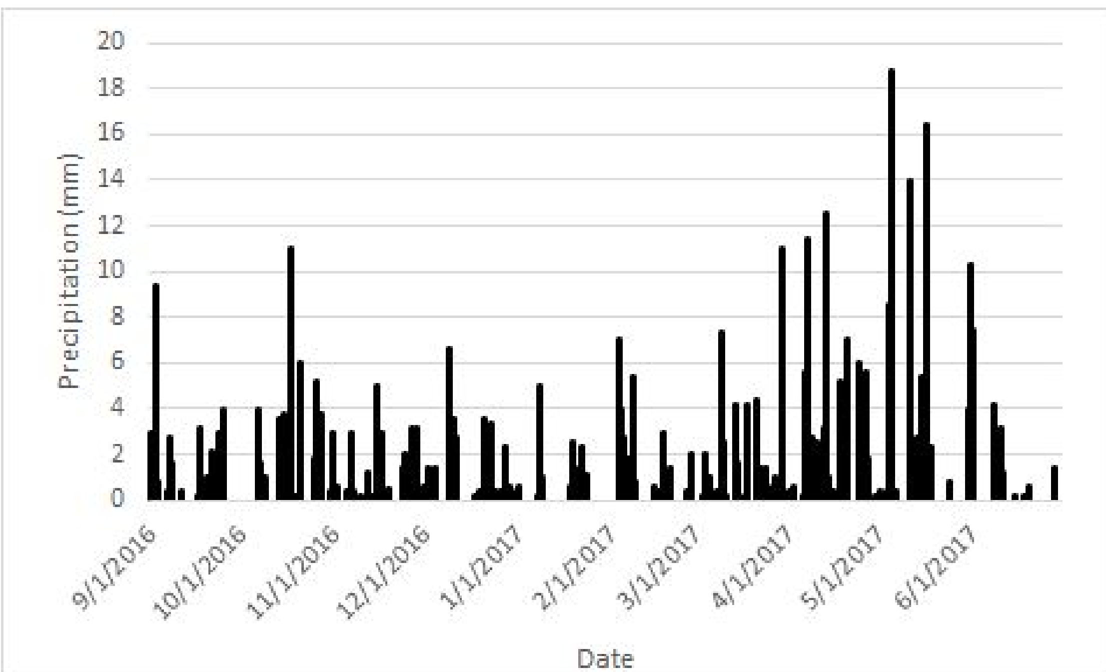

Figure 7. Daily precipitation (rain + snow) for Penticton Airport, September 1, 2016 - June 30, 2017 (Source: Environment Canada 2017).

There was no moss or lichen cover within the immediate vicinity of the trail tread. Prior to the restoration treatment, there was almost no vegetation cover on the trail tread and limited debris (wood, rocks).

The canopy vegetation on the adjacent hillslopes was dominated by ponderosa pine. Stand structure surveys in the Three Blind Mice trail network measured ages of canopy pines between 80-115 years old and 12-25 m tall (Swanson 2016).

The biogeoclimatic ecosystem classification for the project area is PPxh1 (Okanagan Very Dry Hot Ponderosa Pine Variant) (Lloyd et al. 1990, Swanson 2016). This is the hottest and driest forested ecosystem in British Columbia (Lloyd et al. 1990).

2.1.4 Soils

A soil pit was completed in June 2017 adjacent to the restored trail tread (Figure 8). At the time of the measurements, the soils were very dry. The soil properties described were:

- No organic horizon present
- 0-4 cm, Ah/Ap, sandy loam, no coarse fragments, large number of grass roots, pale beige
- 4-15 cm, Ahe/Ap, sandy loam, no coarse fragments, few roots, light brown
- 15-31 cm, Bm1, sandy loam, organic enriched, minor gravel (~10%), few roots, brown
- 31-44 cm, Bm2, sandy loam, organic enriched, no gravel, small pieces of charcoal, few roots, med-dark brown
- 44-60 cm, C, loamy sand, no roots, no coarse fragments, little organic matter

The field observations agree with the soil mapping which is for a well-drained sandy loam classified as an Orthic Eutric Brunisol and named the Rockface soil series (Agriculture and Agri-Foods Canada 2013). Swanson (2016) reported that the project area should have significant (30-50%) coarse fragment content which was not noted the in the soil pit. The difference between the mapping and the field data is related to the source of the fine sediment washed down the gully and deposited on the surface of the glacial fluvial terrace.

The coarse texture of the soils on this site make them at low risk for significant compaction but at high risk of surface erosion due to the lack of cohesion between the grains (Hillel 1982).

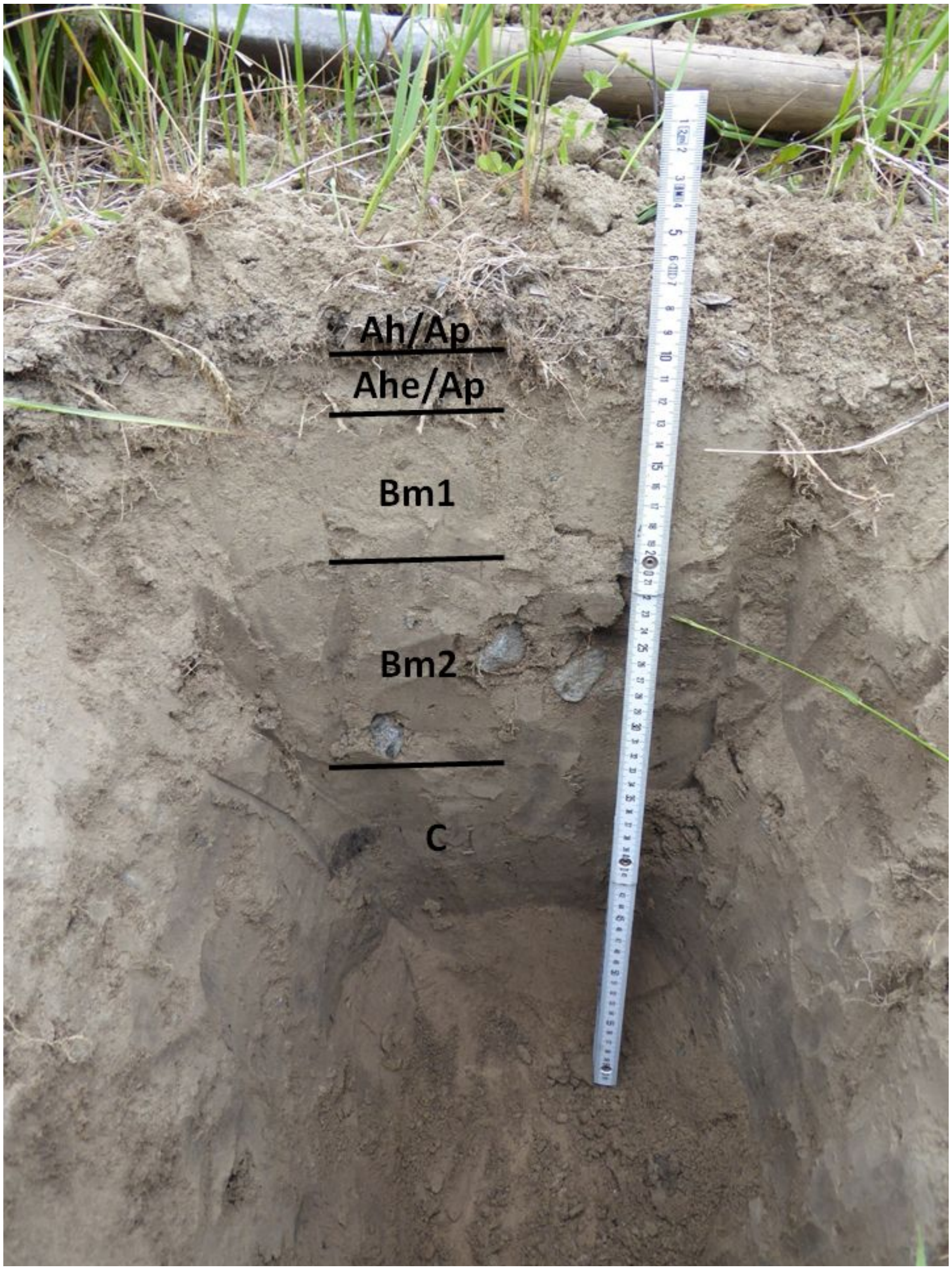

Figure 8. Soil pit with horizons shown. See section 2.1.4 for horizon descriptions. (Photo: T. Redding)

2.2 Restoration Methods

Prior to this project, no restoration work had been carried out on this trail segment (Figures 9 & 10). The field work to carry out the restoration treatments was completed in September 2016. Restoration of the trail tread followed the process outlined by IMBA (No Date), Therrell et al. (2006) and PCTA (2011) included the following steps:

1. Create smooth intersection between old and new trail segments
2. Break up old trail tread (e.g., physically decompact trail surface)
3. Control erosion (e.g., break-up surface, organic matter amendment, water flow barriers)
4. Plant (transplant) vegetation
5. Disguise/block corridor
6. Education on restoration (e.g., signs)

Step 1. The intersection of the trails had been not been blocked prior to the initiation of this project (Figure 11) and there was evidence (tire tracks) of continued use of the trail segment. To make it obvious which trail to follow, logs and rocks were placed across the intersection (Figure 11). The obstacles served a dual purpose of re-routing and bike traffic along with creating a catch-basin feature to contain sediment eroded from the lower ends of the Chute Out trail.

Step 2. The tread of the old trail was manually decompacted using a shovel and rake (Figure 12). The decompaction is intended to reduce the soil density, to improve drainage and facilitate root penetration. If the soil is not decompacted, there is a greater potential for surface erosion (Marion and Wimpey 2007). The sandy nature of the soil means the amount of compaction was limited. The sandy soil and few coarse fragments meant relatively easy manual decompaction. Improved drainage will act to reduce the potential for soil erosion.

Step 3. To control erosion, a barrier was placed at the intersection with the upslope trail to slow water movement, encourage infiltration and contain any sediment washing in at the intersection (Figure 11). Along the trail tread, the soil was decompacted manually through digging and then raked to break-up large peds and clods. Once the soil was decompacted, rocks and organic matter consisting of branches, wood, cones and pine needles were placed on the surface. These materials act as water flow barriers, camouflage the decompacted trail tread and add habitat diversity to the ground surface. These additions of plant matter covered approximately 30% of the decompacted soil surface and act as a source of organic matter to the soil as they break down.

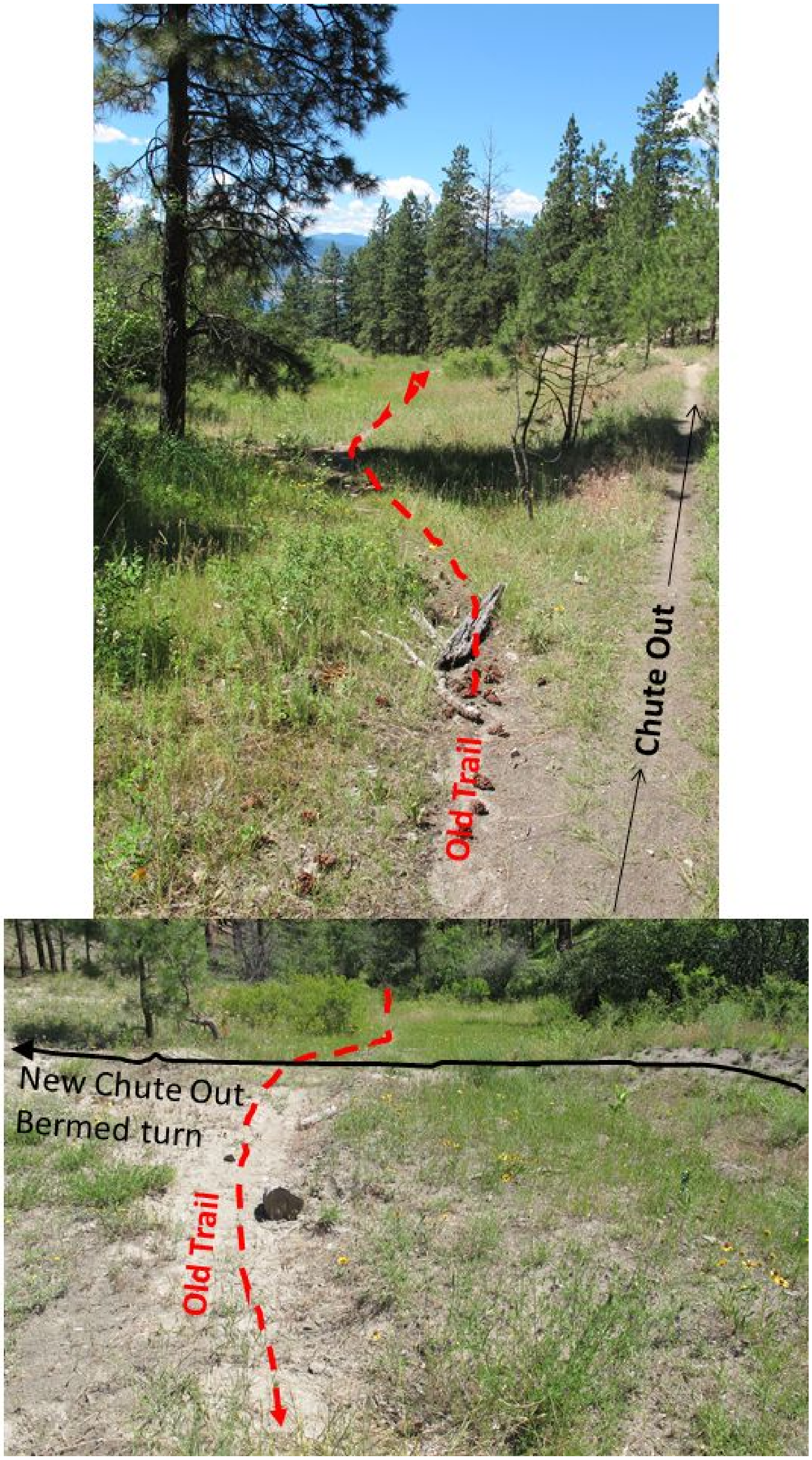

Figure 9. Pre-restoration site photos showing orientation of decommissioned trail segment and newly constructed trail. Top image shows intersection where new trail segment diverges from segment being restored. Bottom image shows path of section being restored and crossing of the newly constructed Chute Out s-curves and berms. (Photos: T. Redding)

Figure 10. Pre-restoration photos of trail tread. Note slight depression of the tread relative to surrounding ground surface and small accumulations of sediment. A few large pieces of wood have been scattered through the area to discourage trail use. (Photo: T. Redding)

Figure 11. Junction between decommissioned and new segments of Chute Out. Upper photo shows intersection prior to restoration and the lower photo shows post-restoration treatment with organic material spread over the decompacted trail tread. In lower photo note the presence of logs and rocks to disguise and discourage use of the trail and capture and store any sediment running down Chute Out.. (Photos: T. Redding)

Figure 12. Decompaction of trail tread. The trail tread was manually decompacted by digging followed by raking to break-up large clods. (Photo: T. Redding)

Step 4. Native vegetation was transplanted onto the trail tread following the manual decompaction (Figure 13). Plants were taken from adjacent undisturbed sites, with the areas they were removed from re-covered with soil and organic litter. The species transplanted included rose, oregon grape, bluebunch wheatgrass, saskatoon berry, rabbitbrush and yarrow. Plants were spaced between 2-2.5 m along the decompacted tread. Given the dry conditions, plants were manually irrigated with approximately 1L each of water at the time of planting and twice more at weekly intervals late September and early October 2016. It was difficult to determine the success of the transplants during fall 2016 as they went dormant soon after planting.

Step 5. As covered above, the trail junction was blocked using wood and rocks (Figure 11). In addition, wood and rocks were placed on the decompacted trail tread (Figure 13) to disguise the feature, act as a water diversion feature, sediment collection and provide a diversity of habitat for plants and animals.

Step 6. Given the small section of trail restored at this time no educational signs have been developed.

2.3 Monitoring

Following restoration treatments, the site was visited a number of times in the fall of 2016 and spring of 2017 to assess the success of the restoration activities. These visits included visual assessment of changes in the site conditions and inspection of the health and vigour of the transplanted material.

3.0 Results & Discussion

In fall 2016 and spring 2017, repeat visits were undertaken the to the site to assess the success of the restoration actions. The restoration treatment was largely successful from the perspective of discouraging use, preventing soil erosion and revegetating the former trail tread.

The logs and rocks placed across the intersection with the new Chute Out trail were successful in collecting and containing sediment running down the trail tread (Figure 14). There was no evidence of surface erosion on the decompacted section of trail tread.

The barrier at the trail intersection combined with the planting and placement of debris has discouraged people from riding the restored trail segment. There has been no evidence of bike tracks along the restored section following the restoration treatments in fall 2016 or in spring 2017. There was evidence of ground squirrel activity over the winter period (Figure 15). Evidence of recent cattle use was present in fall 2016 and spring 2017 was present in the form of tracks, trampling and fresh droppings.

Plant cover of the trail tread increased from pre-restoration to post-restoration. Canopy cover increased from <5% pre-restoration to approximately 40% post-restoration (Figure 13). Increased vegetation cover will assist with reducing erosion potential by protecting the soil surface from raindrop impacts and the roots holding soil in place. As plants are established they will provide increased inputs of organic matter that will improve water holding capacity of the soils to further support plant growth.

Figure 13. Changes in vegetation cover from fall 2016 (left image, immediately post-transplanting) to spring 2017. (Photo: T. Redding)

Figure 14. Junction between Chute Out and restored trail in June 2017. Note the thick vegetation cover along the restored trail tread. Also note the accumulation of sediment at the junction that was deposited following snow melt and spring rain storms. (Photo: T. Redding)

Figure 15. Piles of sediment from ground squirrel activity during winter 2016/17. Note agronomic grasses growing along former trail tread and through sediment pile. (Photo: T. Redding)

The survival of the transplanted native plants was less than hoped. While the oregon grape, saskatoon, rabbitbrush and rose all appeared to survive, none of the bunch grasses or yarrow were alive as of early June 2017. There are a few potential reasons for the lack of success in transplanting the grasses and yarrow. The dry fall, even with the added irrigations, followed by a colder than normal winter may have been too hard for the plants when combined with the shock of transplanting. Ground squirrels grazing under the snowpack during the winter may have damaged some transplants.

In spring 2017, the decompacted trail tread held more agronomic species than had been present in the fall. It is possible that the decompaction treatment allowed dormant seeds in the soil to germinate during the wet spring of 2017. Seeds may also have blown into the site during the fall 2016 or been brought in by cattle or ground squirrels. Given the high density of agronomic species present pre-restoration, it is likely that they will continue to form a large portion of the vegetation cover on the restored trail segment.

4.0 Conclusions

The purpose of this project was to restore a section of mountain bike trail in the Three Blind Mice trail network near Penticton, BC. The restoration was carried out with the support of the Penticton Area Cycling Association which identified the trail segment for treatment. The restoration project met the goals by eliminating use of the trail segment, reducing erosion hazard and capturing sediment being transported from the trail upslope. This assists the cycling club in meeting their environmental goals as part of the trail network management agreement with the City of Penticton and the BC Ministry of Forests, Lands and Natural Resources.

The restoration project will be used as a field trip for students studying Environmental Science at Okanagan College in Penticton. The students will combine learning about the local ecosystems with discussion of the restoration and introduction to simple monitoring techniques. It would be useful to work with PACA to develop a trail monitoring and restoration program that could involve students.

Low survival of the transplanted native plants (especially grasses and herbs) was disappointing. In future efforts in this area, transplanting may need to be carried out in the early spring to increase the potential for survival. At this time of year the soil is generally at its highest moisture content, and May and June are the rainiest months of the year (Figure 5). As well, off-site sources of native plant material or seed should be considered if sufficient funds can be obtained. These plants may be more amenable to planting as compared to transplanting locally sourced plants which have their roots disturbed. While the proliferation of agronomic species is unfortunate, it was inevitable given the high density of these species already present in the project area and their ability to colonize disturbed sites. These agronomic species do play a positive role in stabilizing the soil and disguising the restored trail surface.

While overall this project was successful in meeting the objectives in terms of soil stabilization, there are a number of improvements that could be made in future trail restoration efforts in this area. Systematic vegetation monitoring pre- and post-restoration should be completed to quantify the success of revegetation. It would have been helpful to mark the individual plants that were transplanted on the decompacted trail tread. Given the climate and growing conditions at the site, this means that vegetation enumeration can probably only be carried out in the late spring, leaving a year-long gap between assessments of success. This may prove challenging for some types of project funding which have shorter work windows.

On sites with a higher compaction potential, pre- and post-restoration measurements of soil bulk density could be used to assess the success of decompaction treatments (Therrell et al. 2006). In conjunction, soil properties such as bulk density, organic matter content, infiltration rates could be measured on and adjacent to trail treads to examine the effects of the trail and any restoration treatments on soil function. Understanding these differences could be helpful in locating and constructing future trails based on soil properties. Long-term trends in soil properties could also be monitored following construction of new trails to better understand when the trail tread becomes “hardened” (Marion and Wimpey 2007). These types of measurements could be easily carried out by students as part of a class project.

There is a need for formal assessments of the efficacy of different trail restoration methods on meeting the restoration goals for decommissioned mountain bike trails. This is true for both soil and vegetation related objectives. There is no available peer-reviewed or grey literature on the success of mountain bike trail restoration to help guide future efforts. It is important to test and refine the few guidelines that exist (e.g., International Mountain Bike Association No Date) and clarify where under what conditions they are most effective. While techniques applied to restoring hiking trails can be applied (e.g., Therrell et al. 2006, PCTA 2011), some effects of mountain biking are very specific (e.g., steep slopes, drops, speed, skidding) and need to be examined in greater detail.

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