Accepting Beavers and Enhancing Wetlands

Final Report

Prepared for: National Wetland Conservation Fund
Habitat Conservation Trust Foundation
City of Fernie
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Date: January 31, 2019

The Elk River Watershed Alliance gratefully acknowledges the financial support of Environment and Climate Change Canada, Habitat Conservation Trust Foundation and the City of Fernie. In-kind services and consultation were provided by Align Surveys Ltd., the Fur-Bearers of Alberta, Cows and Fish, BC Wildlife Federation, Foothills Silviculture, Taylor MacDonald Construction Ltd., Valley Vitals and Wildsight Elk Valley Branch.

Elk River Alliance

Executive Summary

Wetlands and the habitats they provide are critical for humans and wildlife alike. They provide numerous ecological services, such as filtering water, moderating the effects of droughts and floods, and providing critical habitat for countless species, including many species at risk in North America, such as Great Blue Heron and Western Painted Turtles (Alberta Government, 2013). Often wetlands form naturally on their own, but where conditions are suitable, beavers will often help speed up the process and construct wetlands, making beavers a keystone species (Wright *et al.,* 2002; Beavers and Wetlands, 2012). The tree felling and flooding of streams that are needed to produce these wetlands is often seen as a nuisance activity from humans, and actions have been taken to prevent their activities.

In an effort to promote beavers as an important component of the watershed and increase human understanding and appreciation for beavers and the services they provide to us, the Elk River Alliance (ERA) completed the "Accepting Beavers and Enhancing Wetlands" project. "Accepting Beavers and Enhancing Wetlands" is a community-based wetland project aimed at developing strategies to live harmoniously with beavers by using specific techniques relevant to our local watershed to improve wetland health and inspire public action demonstrating acceptance of beavers and enhancing healthy wetland form and function.

The two primary goals of this project were:

1) Enhance and protect healthy wetland characteristics created by beaver activity in Fernie wetlands by:
    a. Installing beaver pond leveling devices that will maintain acceptable water levels and reduce the negative effects of beaver activity on human property (e.g. property flooding, tree felling);

    Achieved: Pond levelling devices were installed in beaver dams in the McDougall and West Fernie wetlands on October 27, 2017.

    b. Removing invasive species from the sensitive upland zone to increase biodiversity;

    Achieved: While installing tree fencing students removed invasive species including Canada thistle and spotted knapweed.

    c. Improving the habitats for blue-listed species (e.g. Western painted turtles listed in the Species At Risk Act).

    Achieved: a nesting site with protective fencing and a basking platform was installed in the West Fernie wetland in June with the help of students from Jaffray Elementary/Jr. Secondary School and Isabella Dickens Elementary School.

2) Increase public awareness, understanding and appreciation of local wetland form and function by:
    a. Assessing the health of the wetland ecosystem;

    Achieved: A survey and wetland health assessment was completed in June 2018 with both wetlands being found to be Functional at Risk

b. Hosting a BCWF Wetlandkeeper course to educate residents and engage future volunteers;

Achieved: Ten community members participated the in BCWF Wetlandkeeper course October 12-14, 2017. Members learned valuable information on wetland health assessments and participated in wetland construction in Hosmer.

c. Engaging youth to steward the wetland;

Achieved: Youth were involved in numerous stewardship activities, including tree wrapping, turtle nesting site development and the installation of basking platforms.

d. Partnering with the Fernie Trails Alliance to improve the recreational trail

Not Achieved: Funding not obtained.

e. Installing interpretive signs educating community about the values of wetlands and habitat they provide for species at risk.

Achieved: Interpretive signs were installed in the McDougall, West Fernie and Annex Park wetlands.

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Background

Beavers have a history and reputation amongst many residents in the Elk Valley as being problem rodents. A common perception is that they should be hunted and their habitat drained. Wetlands have historically had a similarly negative reputation; they have been drained for railway and road construction, and mined and used for fill to raise elevation for developing commercial property. Beaver dams have been removed to drain surface water thought to be flooding basements, and riverine wetlands were isolated from the main Elk River channel. The Upper Kootenay Ecosystem Enhancement Plan (2014) states that wetlands in the region, including the Elk Valley, have experienced impacts from intensive land development, forestry, mining, and recreational use.

These views and subsequent actions towards beavers and wetlands are ceasing to be the norm as research illustrates the importance of beaver dams in increasing species richness (Wright, *et al.,* 2002) and creating critical habitat for numerous species of fish and waterfowl (McCall *et al.,* 1996; France, 1997; Brown *et al.,* 1996). Further, research has shown that trapping as a form of beaver management is ineffective because beavers regularly move back into suitable environments (Houston, 1998). The current best management practice is to mitigate beaver activities in a non-destructive manner that maintains the critical wetlands that beavers create (Taylor and Singleton, 2014; Simon, 2006). These mitigation steps include pond levelers or flow devices, caged culverts, and fenced trees, depending on the type of problematic beaver activity a site is experiencing.

Pond levelers are flow devices constructed and installed in beaver dams that allow water to flow through the dam. This ensures that flooding upstream of the dam is reduced while maintaining the wetland created by the beaver dam, along with the associated ecological services. There are several different varieties of pond level control devices that have been designed, providing an environmentally friendly, humane and cost-effective solution to mitigate flooding from beavers over the long term (Callahan, 2003; Lisle, 2003). Culvert caging or exclusion stops beavers from blocking culverts with sticks and mud by providing a barrier that separates beavers from the culvert, and may be used in conjunction with a flow tube (Simon, 2006). Fencing of trees protects specific trees or species of trees from being felled by beavers.

Both the City of Fernie and the Regional District of the East Kootenays (RDEK) expressed concern regarding problematic flooding resulting from beaver activity occurring in the McDougall and West Fernie Wetlands, respectively. In order to address these concerns, a multifaceted approach was designed that utilized current mitigative structures, engaged and educated community members, and improved existing qualities of the wetlands (e.g. habitat for species at risk, etc).

Description of Activities Completed

Restoration Activities

In order to complete the goals of this project, community members joined in numerous wetland restoration and enhancement activities. These included floodwater reduction through the installation of two pond levelers, wrapping trees to discourage felling, removing garbage and invasive plant species, and improving turtle nesting and basking habitat. These activities are documented below.

Floodwater Reduction

To determine the best beaver mitigation strategies available, ERA consulted with wildlife conflict managers and riparian habitat specialists from the Alberta Fur-Bearers and the Cows and Fish Alberta Riparian Habitat Management Society. Training sessions for beaver management at the BCWF Wetland Institute in September 2017 were also attended. From these consultations, and training sessions, the strategy to construct and install a 12" diameter corrugated pond-leveling device in the problematic beaver dam was developed.

ERA then applied for and received a notification for *Changes in and About a Stream* in accordance with the BC Government Water Sustainability Act from Front Counter BC.

ERA contractors and Align Surveys Ltd. conducted a site assessment and surveyed McDougall Wetland site to assess the elevations of the beaver dam, culverts at nearby road and the pond at the golf course in order to determine the appropriate elevation for the pond leveler installation (Appendix A). During the site assessments, the watercourse was tracked through the wetland and the appropriate elevation was determined to maintain quality beaver habitat (above 0.7m depth near the dam). The elevation of the water levels during the assessment did not show any signs of flooding at the golf course. Elevations were not taken at the West Fernie Wetland as previous "beaver baffles" had been installed 10 years prior at an appropriate level, but are now dysfunctional due to clogging.

Pond levelers were constructed and transported with the in-kind services and rentals provided from Taylor-MacDonald Ltd. Construction, following similar guidelines modified from methods described in Lisle, 2003. Seven community volunteers assisted in installing the pond levelers on October 27, 2017.

In each dam, a 20 m long, 20 cm diameter corrugate pipe was used to allow water to bypass the beaver dam in high water. In order to install the leveler, dam material such as sticks and mud were removed from the dam to create an opening in which the tube would fit. The leveler was then inserted into the dam at an elevation that would maintain adequate water levels but would allow excess water to drain from the wetland. Six-foot-long T-posts were used to stabilize the leveler and were tied to the pipe using wire to keep it in place in the event of a large flood. The primary modification that was made from the guidelines (Hood and Yarney, 2015) was to place the cage on its side at the McDougall Wetland as it fit best in this location given the slope

leading up to the beaver dam (Figure 1a).

Figure 1. a) Upstream and b) downstream view of the pond leveler installed in the McDougall Wetland beaver dam.

The water levels behind each of the dams in the McDougall Wetland and West Fernie Wetland have been monitored during the 2018 spring freshet. Despite high water in May and early June, flooding of upstream land was not observed. In both wetlands, water levels have been maintained above the minimum depth of 0.7 m that is required for beaver survival. Further, maintaining the highest water level possible will result in the healthiest wetland and the greatest amount of water stored for later release in the event of a summer drought. It appears that the installation of the pond levelers at the McDougal and West Fernie wetlands is an ideal solution where upstream property will not experience seasonal flooding while the wetlands maintain acceptable, healthy water levels protecting habitat for beavers and other wildlife. A letter of support of the project is included from Ray Bryant, superintendent at the Fernie Golf Course, outlining the appreciation for the project to find a middle ground where wetland health could be maintained while reducing problematic flooding (Appendix B).

Tree Wrapping and Wetland Cleanup

In order to discourage felling and help prevent bank erosion, 35 cottonwood trees along the West Fernie dike were wrapped with stucco fencing. Twenty-three grade 9 students from the Fernie Academy assisted in this project as part of the Know Your Watershed student action initiative June 1, 2017 (Figure 2). Students learned about beaver biology and behavior, and learned several mitigation strategies that are utilized to discourage beaver felling. Students also learned about different invasive species at the wetland (e.g. Spotted Knapweed, Canada Thistle, etc.) and removed these from site, along with garbage. To continue this work, 22 grade 5/6 students from Isabella Dickens Elementary School wrapped an additional 20 cottonwood trees on June 12, 2018.

Figure 2. Students from the Fernie Academy wrap trees in the West Fernie Wetland to discourage felling.

Turtle Enhancements

ERA and volunteers conducted enhancements to the West Fernie wetland for Western painted turtles. Western painted turtles had previously attempted to nest in an area of gravel deposited halfway between the water's edge of the wetland and the highway. An improved nesting site was installed closer to the water on June 4, 2018 by 18 grade 6 students from Jaffray Elementary/Jr. Secondary School. Students dug an area 2 m by 1 m by 0.5 m deep, laying weed barrier on the bottom, and filling in the area with a sandy loam that was donated from Foothills Silviculture.

The enhancements were continued on June 12, 2018 with the help of 23 grade 6 students from Isabella Dickens Elementary School and 2 community volunteers. Students fenced off the nesting site to keep turtles from accessing the highway, and then installed a basking platform constructed from two logs attached to each other with chain and affixed to the shore with a piece of rebar. These enhancements have been monitored and ten Western painted turtles have been observed basking on the platform at a single time (figure 3).

Figure 3. Western painted turtles basking on installed basking platform on south-facing slope in the West Fernie Wetland.

Education and Outreach

ERA partnered with BC Wildlife Federation and the College of the Rockies Fernie Campus to deliver the BCWF "Wetlandkeepers" course (Figure 4). Ten participants from the Elk Valley and Cranbrook region attended the course October 12-14, 2017 with a special focus on beaver activities and their positive impacts on wetlands. This educational opportunity also assisted ERA in securing volunteer support for wetland conservation activities in the region.

Figure 4. Wetlandkeeper students from the a) West Fernie Wetland and b) McDougall Wetland. Students braved the elements to learn about vegetation surveys, wetland soil and hydraulic dynamics.

To further educate members of the public who did not have the opportunity to participate in the BCWF Wetlandkeeper course, 7 articles were written and published in the Fernie Free Press and Elk Valley Herald newspapers, and on-line through E-KNOW and Fernie.com websites under the theme 'Wild about Wetlands.' Articles were entitled: "Beavers: Friend or Foe? (Nov 2017), "Transforming Old Gravel Pits into Wetlands requires a Team Effort" (Jan. 2018), "Celebrating and Creating Wetlands: World Wetland Day" (Jan. 2018), "Wetland and Species at Risk" (Mar. 2018), "Wetland Plants Perfect for Water" (Mar. 2018), "Wetlands Are Flood Solutions" (Mar. 2018), "Many Hands Help Restore Wetlands" (May 2018).

Three interpretive signs were developed and installed in the McDougall, West Fernie and Annex Wetlands. The interpretive signs outlined the important roles the beavers play in preserving wetland health, and why wetlands are important to humans and other wildlife. The interpretive signs were installed in October, 2018. The Annex Park sign was developed using text provided by the 2016 Fernie Secondary School Grade 8/9 Class. Copies of the signs are attached (Appendix C).

A Beaver Buddy interpretive program was developed for kindergarten through grade 3 students with themes taken from the school curriculum. The program was delivered to approximately one hundred students throughout the Valley attending Isabella Dickens Elementary School, The Fernie Academy and Frank J. Mitchell Elementary School on June 18, 19 and 20, 2018 (Figure 5). The program will continue to be offered to teachers through the Columbia Basin Environmental Education Network. A letter of support from Jane Fraser whose class received the program on June 18, 2018 is attached (Appendix D).

Figure 5. A class of grade one students from Isabella Dickens Elementary School enjoying the Beaver Buddy program.

Wetland Survey and Health Assessment

ERA and community volunteers initiated a wildlife and vegetation survey and a wetland health assessment during the BCWF Wetlandkeeper Course, but due to unanticipated weather it was not possible to fully inventory species at that time. A full survey and wetland health assessment was completed in June 2018. The wetland polygons surveyed are seen in Figure 6. The results of the vegetation survey are listed in Tables 1-4.

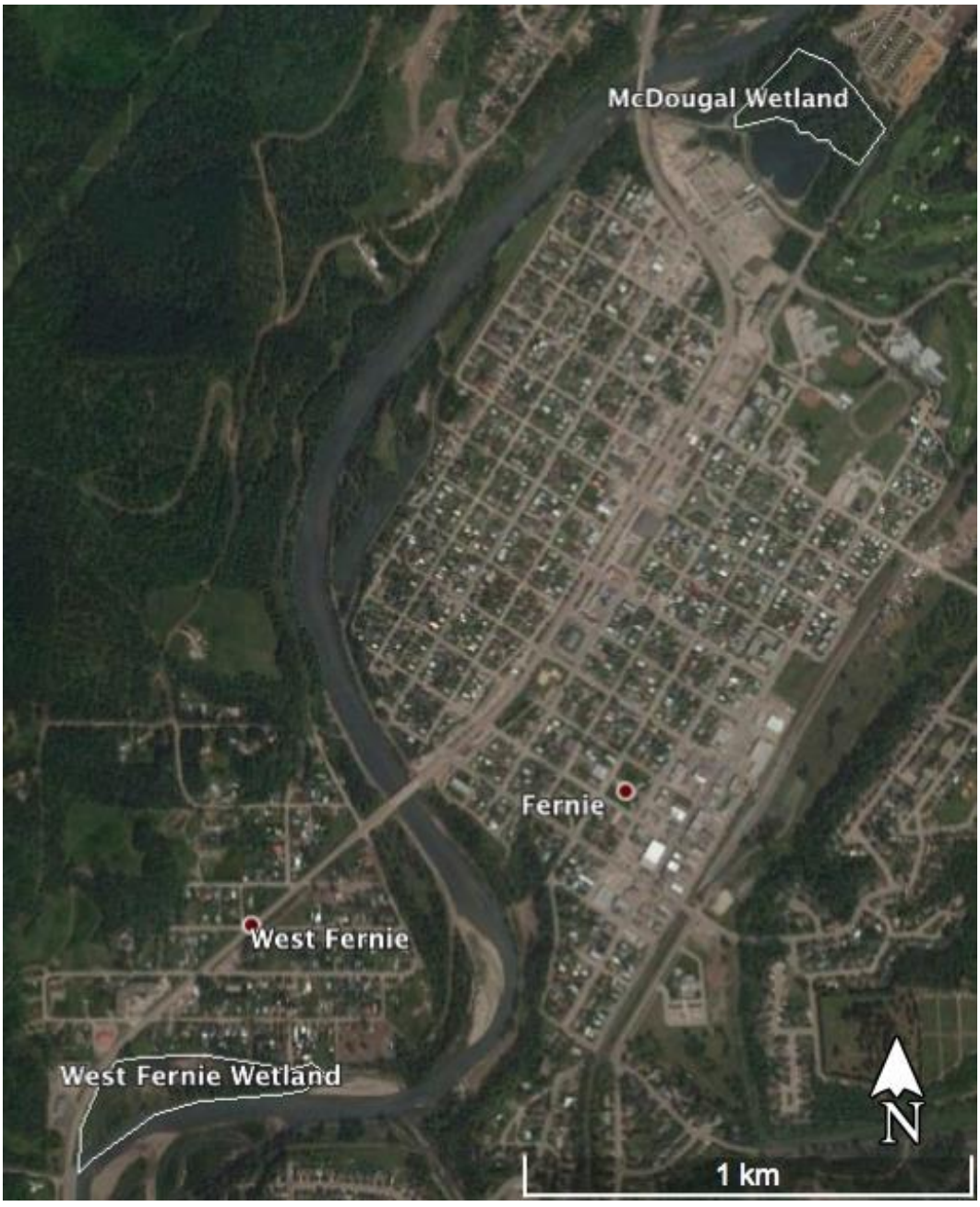


Figure 6. Areal view of both wetland polygons surveyed.

West Fernie Wetland Health Assessment

The West Fernie Wetland scored a total of 42 out of 63 points in the Wetland Health Assessment, giving it a health rating of Functional at Risk, as it is healthy but with problems. This rating occurred because while the site is generally very healthy, the human activity surrounding the wetland has resulted in pressure on the wetland. This has occurred from residential properties backing onto the wetland introducing non-native, non-wetland plants into the wetland, along with its proximity to the highway making it susceptible to invasive species (currently minimal species found on site). The West Fernie Wetland is at present a healthy, functional wetland, but requires monitoring and efforts to ensure that human activity does not negatively impact it in the future. This will be critical as it becomes more popular for recreational purposes. Species observed in the West Fernie Wetland are listed in Tables 1 and 2 below and shown in Figure 7.

Table 1. West Fernie Wetland Wildlife Survey

Common Name	Scientific Name
Red Wing Blackbird	*Agelaius phoeniceus*
Violet Green Swallow	*Tachycineta thalassina*
Black Capped Chickadee	*Poecile atricapillus*
Merganser	*Mergus serrator*
Mallard	*Anas platyrhynchos*
Canada Geese	*Branta canadensis*
Moose	*Alces alces andersoni*
Beaver	*Castor canadensis*
Western Painted Turtle	*Chrysemys picta*
Common Garter Snake	*Thamnophis sirtalis*

Table 2. West Fernie Wetland Vegetation Survey

Common Name	Scientific Name
Black Cottonwood	*Populus balsamifera ssp. trichocarpa*
Englemann Spruce	*Picea engelmannii*
Shining Willow	*Salix lucida*
Mountain Alder	*Alnus tenuifolia*
Red Osier Dogwood	*Cornus stolonifera*
Saskatoon	*Almelanchier alnifolia*
Black Hawthorn	*Crataegus douglasii*
Prickly Rose	*Rosa acicularis*
Mountain Ash	*Sorbus scopulina*
Soopolallie	*Sheperdia canadensis*
Common Snowberry	*Symphoricarpos albus*
Black Twinberry	*Lonicera involucrata*
Burdoch*	*Arctium lappa*
Meadow Buttercup	*Ranunculus acris*
Purple Vetch	*Vicia americana*
Common Dandelion	*Taraxicum officianale*
Yellow Salsify*	*Tragopogon dubius*
Yarrow	*Achillea millefolium*
Queen Anne's Lace*	*Daucus carota*
Creeping Thistle*	*Cirsium arvense*
Common Duckweed	*Lemna minor*
Broadleaf Plantain	*Plantago major*
Field Mint	*Menthe arvensis*
Self-heal	*Prunella vulgaris*
Red Clover	*Trifolium pratense*
Alfalfa	*Medicago sativa*
Common Hound's Tongue	*Cynoglossum officinale*
Common Horsetail	*Equisetum arvese*
Small-flowered Forget-Me-Not	*Myosotis laxa*
Milfoil	*Myriophyllum Sp.*
Yellow Toadflax*	*Linaria vulgaris*
Fireweed	*Chamaenerion angustifolium*
False Solomon's Seal	*-Maianthemum racemosa*
Common Red Paintbrush	*Castilleja miniata*
Orchard Grass	*Dactylis glomerata*
Cattail	*Typha latifoia*
Bur-reed	*-Sparganium emersum*
Mare's Tail	*Hippuris vulgaris*
Mosses	

* Non-native species

Figure 7. Western painted turtle observed on a north-facing slope in amongst some reeds (prior to turtle enhancement).

McDougall Wetland Health Assessment

The McDougall wetland received a score of 50 points out of a possible 63, putting it on the cusp between Proper Functioning and Functional at Risk. This rating occurred because of its proximity to urbanized land use. Vegetation in the wetland has been altered due to human activity, which may lead to the wetland becoming impacted further. Currently, the alterations have not impacted the function of the wetland. However, the results from the water monitoring (see below) are of concern as they draw attention to the large amount of *E.coli* that is washed into the wetland from upstream sources during rain events. The wetland provides natural filtration of parasites, but as upstream development and forestry activities continue filtration processes may become overwhelmed. Maiden Lake, the adjacent water body that receives its inflow from the same location, does not benefit from the natural filtration services provided by the McDougall Wetland. Therefore, the outflow from Maiden Lake flows back into the Elk River with minimal filtration. Further studies should investigate the potential environmental and health impacts associated with this, particularly considering that Maiden Lake for recreation with a beach where people of all ages swimming in the water. Species observed in the McDougall Wetland are listed in Tables 3 and 4 below.

Table 3. McDougall Wetland Wildlife Survey

Common Name	Scientific Name
Great Blue Heron	*Ardea herodias*
Red Wing Blackbird	*Agelaius phoeniceus*
Beaver	*Castor canadensis*
Moose	*Alces alces andersoni*

Table 4. McDougall Wetland Vegetation Survey

Common Name	Scientific Name
Black Cottonwood	*Populus balsamifera ssp. trichocarpa*
Englemann Spruce	*Picea engelmannii*
Shining Willow	*Salix lucida*
Red Osier Dogwood	*Cornus stolonifera*
Black Hawthorn	*Crataegus douglasii*
Lilac	*Syringa vulgaris*
Mountain Sweet-Cicely	*-Osmorhiza berteroi*
Cow Parsnip	*Heracleum lantum*
Rosey Twisted Stock	*Streptopus roseus*
Meadow Rue	*Ranunculus acris*
Meadow Buttercup	*Ranunculus acris*
Soopolallie	*Sheperdia canadensis*
Common Snowberry	*Symphoricarpos albus*
Purple Vetch	*Vicia americana*
Queen Anne's Lace*	*Daucus carota*
Creeping Thistle*	*Cirsium arvense*
Field Mint	*Menthe arvensis*
Red Clover	*Trifolium pratense*
Alfalfa	*Medicago sativa*
Black Twinberry	*Lonicera involucrata*
Mountain Ash	*Sorbus scopulina*
Cattail	*Typha latifoia*
Coon's Tail	*Ceratophyllum demersum*
Sedges	*Carex spp.*
Common Spike Rush	*Eleocharis palustris*

* Non-native species

Water Monitoring

ERA conducted water quality measurements and sampling on June 20, 2018 to reflect early season high flow conditions, and September 18 to reflect low flow conditions. Measurements were taken at two locations in the West Fernie Wetland; one at the culvert leading into the wetland from the golf course, and one at the very end before the water drains into the Elk River (Figure 8).

Figure 8. Aerial view of locations sampled in the McDougall Wetland. WM1 represents the upstream location at the culvert, and WM2 represent the downstream location above the inflow from Maiden Lake.

Measurements were taken at mid- to late afternoon to reduce time-of-day effects, with the downstream site tested first. Parameters that were measured *in situ* included the following: water and air temperature, pH, dissolved oxygen, conductivity and turbidity. Water samples were collected and sent to Maxxam Analytics, Inc. for laboratory analysis of the following parameters: nutrients, metals, physical properties and coliforms. Only results that illustrated a variation either temporally or spatially have been discussed in our analysis.

Currently it is not feasible to draw significant conclusions from this study due to the limited sample size. The water quality data provide some insight into the condition of the water quality that may affect wetland biota, and to help demonstrate the functionality of the McDougall wetland in providing natural water treatment services prior to the runoff being discharged into the Elk River. It should be noted that there are no specific water quality guidelines for wetlands in British Columbia. Therefore, water quality results are compared to the British Columbia Ministry of Environment's Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture (BCMOE, 2018) and Recreational Water Quality Guidelines (BCMOE, 2017).

Not assessed during this study is the presence of pesticides in runoff coming from the Fernie Golf Course. As this may have significant impacts on downstream aquatic systems, and also enters into Maiden Lake without filtration, future studies should investigate the presence and impacts of these chemicals.

Weather Data

Weather data was acquired from Environment Canada through MacHydro. Daily high temperatures throughout the summer showed that June was the second coolest month with an average temperature of 14.5 °C (Figure 9). June was also the driest month, with a total of 24 mm of rain falling (Figure 10). July and August saw hot temperatures, with the average monthly temperatures around 19.0 °C and 17.2 °C, respectively, and total precipitation around 29.8 mm and 51.6 mm, respectively. September was the coolest, wettest month, with an average temperature of 11.03 °C and 81.9 mm of rain falling throughout the month.

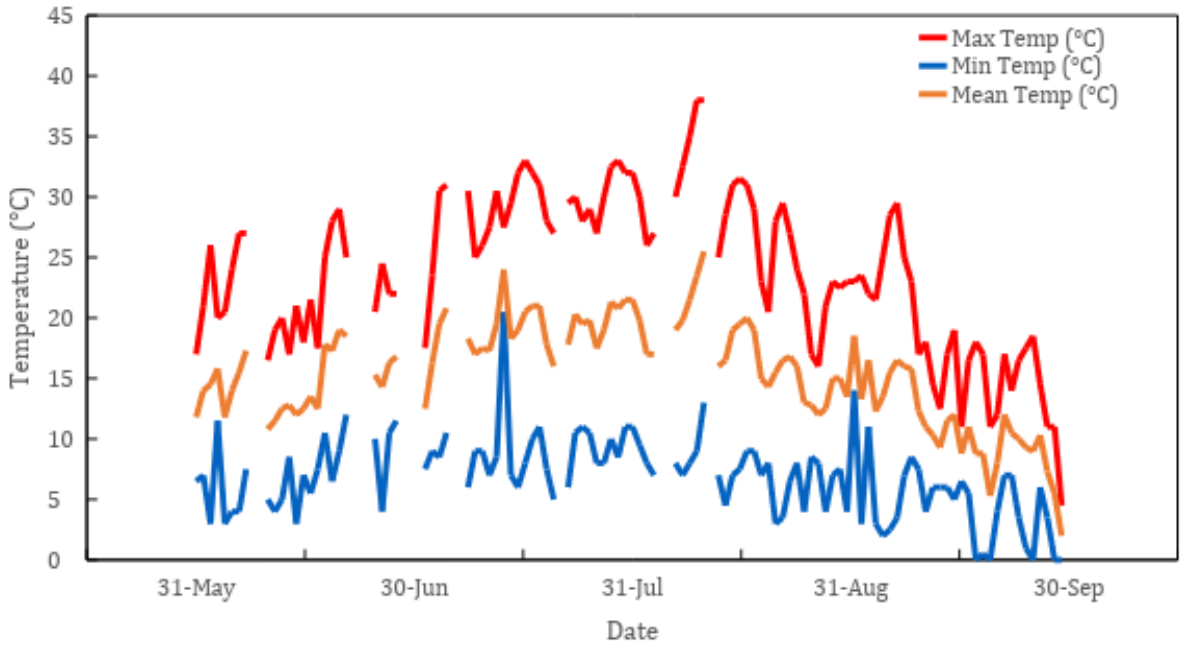


Figure 9. High (red), mean (orange) and low (blue) temperatures recorded from June to September 2018 in Fernie, BC.

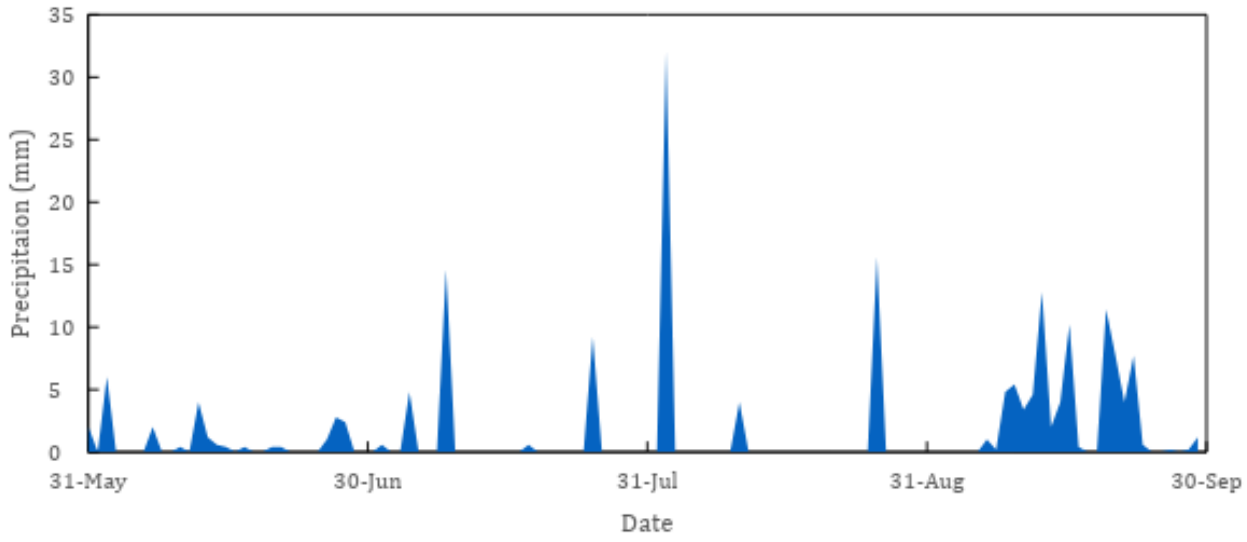


Figure 10. Precipitation from June to September 2018 recorded in Fernie, BC.

Overall Analysis

Water and air temperatures, pH and DO were comparable between both locations during site visits. Specific conductivity and turbidity were notably higher during the late season testing at the outflow of the wetland. This is likely the result of the rain events leading up to the sample collection as water-logged soil was notably mixed with the water at the downstream location. This was also reflected in the greater number of dissolved solids found at the downstream site in late season measurements.

Greater differences were observed in laboratory results during late season testing than during early season. This seasonal variability in water quality is likely the result of a combination of anthropogenic activities (i.e. fertilizer application, logging road usage, etc.) and the limited rain events until early September 2018, resulting in increased concentrations of tested chemicals being transported through surface runoff in September.

Nutrient Analysis

Nitrate and nitrite concentrations in July samples were below detectable limits in upstream as well as downstream locations (Table 5). September nitrate and nitrite concentrations were higher than in July at the upstream location, but concentrations at the downstream location continued to be below detection. Total Kjedlahl nitrogen (TKN) is the total concentration of organic nitrogen (amino acids and proteins) and ammonia nitrogen. TKN concentrations were similar at upstream and downstream sites in July but downstream concentrations were somewhat higher in September (Table 5). These findings suggest that a) nutrients, likely from fertilizer application at the golf course throughout the summer, enter the upstream sampling site via runoff during fall rains; and, b) plants and microorganisms in the wetland are utilizing the nutrients, thus reducing inorganic nitrogen and increasing organic nitrogen as measured by TKN. The nitrite concentrations at the inflow in September were at the long-term Water Quality Guideline

maximum (BCMOE, 2018). However, in order to confirm this exceedance, 5 samples must be taken within a 30-day period. The short-term maximum nitrite concentration is 0.006 mg/L.

Phosphorus concentrations were measured as orthophosphate, an inorganic form of phosphorus, and total phosphorus, which includes organic phosphorus. July orthophosphate concentrations were four times higher at the upstream site than at the downstream site (Table 5). July total phosphorus concentrations were similar upstream and downstream. Late season orthophosphate concentrations were similar at the upstream and downstream locations. Total phosphorus concentrations were somewhat higher downstream in September. The reasons for the seasonal variations in orthophosphate and total phosphorus concentrations are unknown. Removal of orthophosphate (which is the most bioavailable form of phosphorus) via uptake by algae and aquatic plants in the wetland may explain the difference between upstream and downstream concentrations in the spring samples. However, there was no difference between upstream and downstream orthophosphate in September, possibly because of the influx of additional orthophosphate via runoff from the rains that month.

Table 5. Nutrients tested at the McDougall Wetland at the upstream (1) and downstream (2) sites

Measured Parameter	MW1 July	MW2 July	MW1 Sept	MW2 Sept
Nitrate (NO_3; mg/L)	<0.013	<0.013	0.32	<0.13
Nitrate + Nitrite (N; mg/L)	<0.0042	<0.0042	0.079	<0.0042
Nitrite (NO_2; mg/L)	<0.0099	<0.0099	0.020*	<0.0099
Total Kjeldahl Nitrogen (mg/L)	0.177	0.134	0.21	0.49
Orthophosphate (P; mg/L)	0.016	0.0039	0.0046	0.0040
Total phosphorus (P; mg/L)	0.0066	0.0076	0.011	0.032

* sample was above the long-term maximum level, but below the short-term maximum level outlined by BC Water Quality Guidelines for aquatic health, wildlife and agriculture.

The results provide some evidence that the wetland is functioning to help remove excess nutrients from the water prior to its discharge into the Elk River. This is a very important function because excess nutrients entering the Elk River may lead to large increases in growth of attached algae on river gravels, cobbles and boulders. This increased algal growth can alter or degrade fish habitat.

Wetlands have been studied for their capacity to filter water, removing unwanted chemicals and excess nutrients, and are often constructed to help treat stormwater runoff prior to it reaching a larger body of water. This filtration occurs because wetlands are one of the most biologically productive ecosystems; the high degree of primary production is able to utilize and remove excess nutrients and can break down contaminants into harmless byproducts (Kadlec and Wallace, 2009). Wetlands have been found to be extremely proficient at removing nutrients from eutrophic water sources (Wu *et al.* 2010). The reduction of nitrate and nitrite in the upstream versus downstream samples in September and the reduction of orthophosphate in the upstream versus downstream samples in July provide an indication of filtering mechanisms as water as it moves through the McDougall Wetland.

Pathogenic Microorganism Analysis

The B.C. government uses *E. coli* as an indicator of faecal contamination in fresh water bodies (BC MOE, 2017). Due to hold time restrictions for laboratory analysis of *E. coli*, samples were analyzed at the Calgary Maxam location, generating results in MPN (most probable number) as the Alberta standard. Therefore, samples were compared to the Environmental Quality Guidelines for Alberta Surface Waters (2018) as opposed to the British Columbia Ministry of Environment's Water Quality Guidelines for Aquatic Life, Wildlife & Agriculture.

E. coli is a microorganism that is found in the intestinal tract of many warm-blooded species, and can be a pathogen to humans. Water bodies can be contaminated with *E. coli* from stormwater runoff as a result of agriculture, wild and domesticated animals, and sewage (Edberg *et al.* 2000). *E. coli* has been shown to cause numerous gastrointestinal disorders when consumed, and has been linked to illness in swimmers (Wade *et al.,* 2003).

The upstream sample site location illustrated greater levels of both *E. coli* and total coliforms than the downstream location at both times of year (Table 6). The later season results were drastically higher than early season, with the total coliforms registering as above the detectable limits of 2400MPN/100mL at the upstream location in September. The number of *E. coli* found at the upstream site exceeded the 100 MPN/100mL maximum outlined in Alberta (Alberta Government, 2018) by 590 MPN/100mL. While a minimum of weekly sampling is recommended to evaluate the presence of *E. coli,* this exceedance is excessive and warrants future investigation.

Table 6. Pathogenic Microorganisms tested at the McDougall Wetland at the upstream (1) and downstream (2) sites

Measured Parameter	MW1 July	MW2 July	MW1 Oct	MW2 Oct
E-coli (MPN/100mL)	4.1	2.0	690*	17
Total Coliforms (MPN/ 100mL)	1,200	1,000	>2400**	2000

*sample for *E.coli* is above the recommended limit of 100MPN/10mL outline by the Environmental Quality Guidelines for Alberta Surface Waters.
** sample for total coliforms exceeded the maximum detection limit of 2400 MPN/100mL

While the upstream location is not currently utilized for swimming, the water does mix with the water in Maiden Lake, which is utilized as a recreational swimming area. This would suggest that a) the water from the wetland that is reaching the outlet at Maiden Lake is being filtered of faecal contaminants and related microorganisms, and; b) any runoff from the golf course that is bypassing the wetland and being transported directly into Maiden Lake likely contains *E. coli* concentrations significantly higher than the allowable amount for recreational beaches outlined by BC MOE (2017). Similar to how nutrients are removed from water through wetlands, pathogens can be removed as well. The mechanisms by which pathogens are removed vary between different pathogens, and also between different wetlands. The primary removal mechanisms are plant root filtration, predation by larger microbes, sedimentation and starvation (Carvalho *et al.,* 2016). Other factors that influence the mechanism and rate of pathogen removal include vegetation quantity and type, sunlight, pH, flow and retention, and temperature

variations. Further testing is required to address the potential for contamination in and surrounding Maiden Lake and if it is safe to be used as a swimming location in its current state.

Metal Analysis

All metals tested were beneath the BC Water Quality Guidelines for aquatic health, wildlife and agriculture. Metals where one of more samples were above detectable limits are illustrated in Table 7. Early season measurements showed a trend towards marginally decreased concentrations at the downstream site compared to the upstream site; however, this trend is reversed in the September water quality tests. This is likely the result of the rain events that preceded the sample collection. Prior to the collection date, rain was recorded for 11 consecutive days with a total of 48.8 mm of rain falling. As a result, turbidity increased in the second sampling. As metals absorb into solids and the water quality samples were not filtered prior to testing, the results are likely a reflection of the increased turbidity. Further tests would be required to determine with greater certainty. However, as none of the metals exceeded BC Water Quality Guidelines, there is currently no reason to believe that excessive concentrations of any metal are reaching or leaving the wetland.

Table 7. Metals tested at the McDougall Wetland at the upstream (1) and downstream (2) sites

Measured Parameter	MW1 July	MW2 July	MW1 Oct	MW2 Oct
Aluminum (Al)	<0.050	<0.050	<0.050	0.054
Barium (Ba)	0.145	0.126	0.115	0.199
Boron (B)	<0.010	<0.010	<0.010	<0.010
Iron (Fe)	0.131	0.103	0.098	0.608
Silicon (Si)	2.47	2.11	2.98	4.59
Strontium (Sr)	0.219	0.202	0.198	0.248
Calcium (Ca)	0.050	58.9	48.3	75.9
Manganese (Mg)	0.0068	<0.0030	0.0344	0.395
Magnesium (Mg)	12.2	12.0	9.33	15.8
Potassium (K)	0.64	0.49	1.20	2.61
Sodium (Na)	2.38	2.30	2.52	2.61
Sulphur (S)	3.63	3.30	3.55	3.57

Trail Improvements

Funding for the wetland trail improvements was not received, and as such no alterations to the tail have occurred. However, ERA and the Fernie Trails Alliance (FTA) are looking at other options to enhance the trail, particularly the areas in depressions that tend to be muddy in early spring and late fall. FTA is actively sourcing funding to create a bridge over the West Fernie Wetland and is engaging ERA in consultations to ensure minimal environmental impacts.

Community Consultation and Next Steps

Throughout this project, ERA engaged with community members to ensure that the project met the intended goals, and also to determine future steps needed to improve wetland form and function in the Elk Valley. ERA has been in consultation with Fernie Golf and Country Club superintendent and City of Fernie Officials since the beginning of the project to better understand the issue of flooding on the golf course and ensure a beneficial solution could be found. Further, ERA has engaged community and advocated to help determine future steps to ensure wetland health. ERA has presented to the Sparwood District council and begun taking steps in developing stormwater wetlands, and is consulting on beaver mitigation in Hosmer. ERA will also be looking into the potential for investigating the *E. coli* concentrations surrounding and in Maiden Lake, as well as assessing the water for the presence and concentrations of pesticides.

References

Alberta Government. 2013. *Alberta Wetland Policy*. Retrieved March 2, 2018 from http://aep.alberta.ca/water/programs-and-services/wetlands/documents/AlbertaWetlandPolicy-Sep2013.pdf

Alberta Government. 2018. Environmental Quality Guidelines for Alberta Surface Waters. Retrieved October 1, 2018 from https://open.alberta.ca/dataset/5298aadb-f5cc-4160-8620-ad139bb985d8/resource/38ed9bb1-233f-4e28-b344-808670b20dae/download/environmentalqualitysurfacewaters-mar28-2018.pdf.

Beavers and Wetlands. 2012, Spring. *Ottawa-Carleton Wildlife Centre Newsletter*. Retrieved March 10, 2018 from http://wildlifeinfo.ca/newsletters/spring12.pdf

Beusen, A.W. 2014. *Transport of nutrients from land to sea: global modeling approaches and uncertainty analysis.* Doctorate Degree. Utrecht University, Netherlands.

British Columbia Ministry of Environment and Climate Change Strategy (BCMOE). 2017. *B.C. Recreational Water Quality Guidelines: Guideline Summary*. Water Quality Guideline Series, WQG-02. Prov. B.C., Victoria B.C.

British Columbia Ministry of Environment and Climate Change Strategy (BC MOE). 2018. *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report*. Water Quality Guideline Series, WQG-02. Prov. B.C., Victoria B.C.

Brown D.J., W.A. Hubert and S.H. Anderson. 1996. *Beaver ponds create wetland habitat for birds in mountains of southeastern Wyoming*. Wetlands 16: 127–133.
Callahan M. 2003. *Beaver management study*. Association of Massachusetts Wetland Scientists Newsletter. 44:12-15.

Correll, D.L. 1998. The Role of Phosphorus in the Eutrophication of Receiving Waters: A Review. Journal of Environmental Quality. 27:261-266.

Diaz, R. J. and R. Rosenberg. 2008. *Spreading dead zones and consequences for marine ecosystems*. Science 321: 926–929.

Edberg, S.C., E.W. Rice, R.J. Karlin, and M.J. Allen. 2000. *Escherichia coli: the best biological drinking water indicator for public health protection*. Symposium Series (Society for Applied Microbiology). 29: 106S-116S.

Fish and Wildlife Compensation Program (FWCP) and Columbian Basin Trust (CBT). 2014. *Upper Kootenay Ecosystem Enhancement Plan*. Retrieved March 7, 2018 from http://fwcp.ca/app/uploads/2015/07/fwcp-kootenay-ecosystem-enhancement-plan-sept-2014.pdf

France, R.L. 1997. *The importance of beaver lodges in structuring littoral communities in boreal*

headwater lakes. Canadian Journal of Zoology 75: 1009–1013.

Hallegraeff, G.M. 1993. *A review of harmful algal blooms and their apparent global increase*. Phycologia. 32: 79–99.

Hood, G.A. and N. Yarmey. 2015. *Mitigating Human-Beaver Conflicts through Adaptive Management*. Unpublished Report for Beaver County. Camrose (AB): pp. 70.

Houston, A.E. 1998. *The beaver–a southern native returning home*. Proceedings of the 18th Vertebrate Pest Conference. 18:12-17.

Kadlec, R. H. and Wallace, S. D. 2009. *Treatment Wetlands 2nd Ed.* CRC Press.

Lisle, S. 2003. *The use and potential of flow devices in beaver management*. Lutra. 46(2): 211–216.

McCall, T.C., T.P. Hodgman, D.R. Diefenbach, and R.B. Owen. 1996. *Beaver populations and their relation to wetland habitat and breeding waterfowl in Maine.* Wetlands 16(2): 163-172.

Simon, L.J. (2006). *Solving Beaver Flooding Problems through the Use of Water Flow Control Devices*. Proceedings of the 22nd Vertebrate Pest Conference, University of California, Davis. 51:174-180. Retrieved March 7, 2018 from http://www.martinezbeavers.org/wordpress/wp-content/docs/174%20Simon.pdf

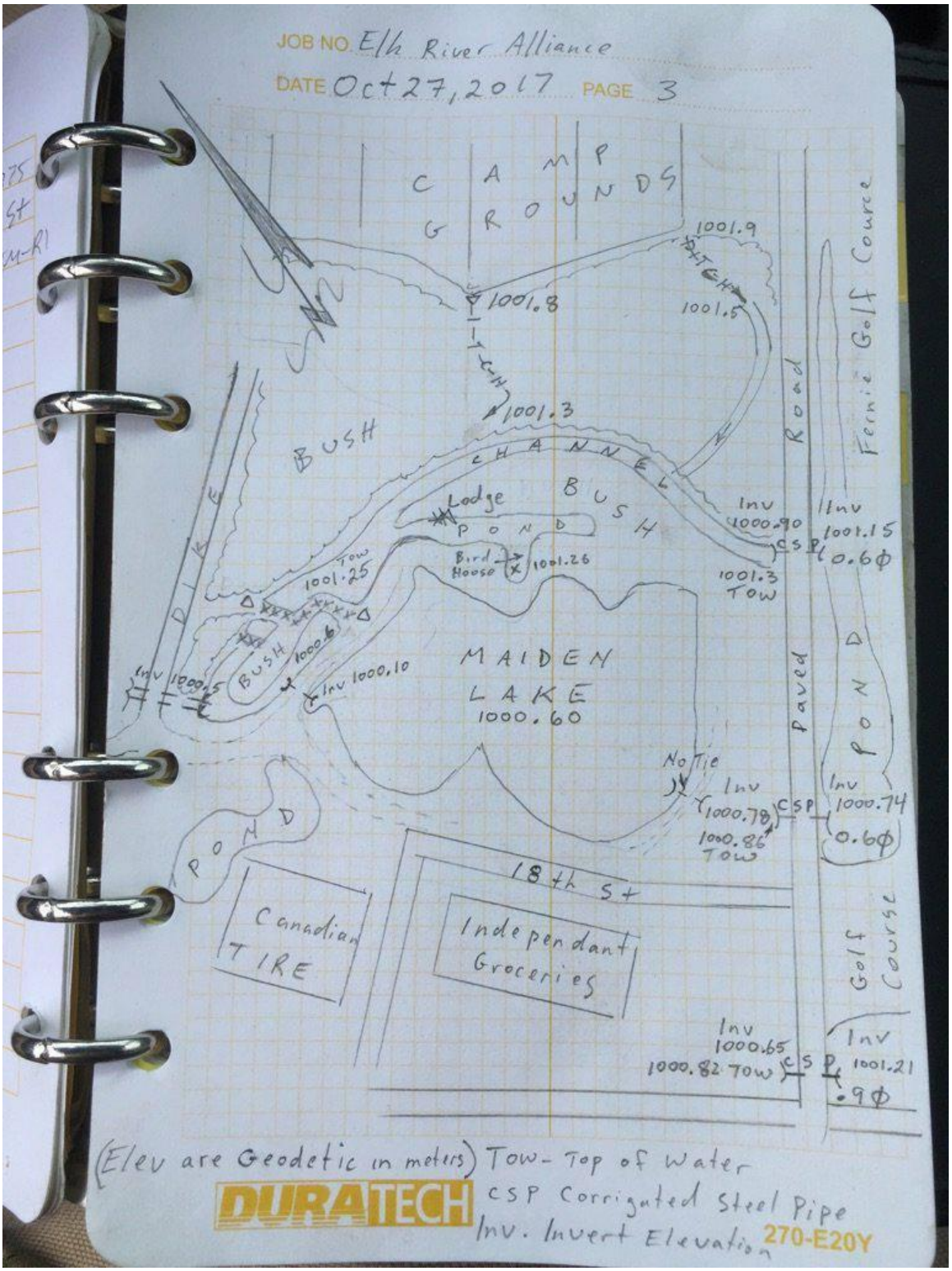
Taylor, J.D. and R.D. Singleton. 2014. *The evolution of flow devices used to reduce flooding by beavers: a review*. Wildlife Society Bulletin. 38: 127–133.

Wade, T.J., N. Pai, J.N. Eisenberg, and J.M. Jr. Colford. 2003. *Do U.S. Environmental Protection Agency water quality guidelines for recreational waters prevent gastrointestinal illness? A systematic review and meta-analysis.* Environmental Health Perspective. 111(8): 1102–1109.

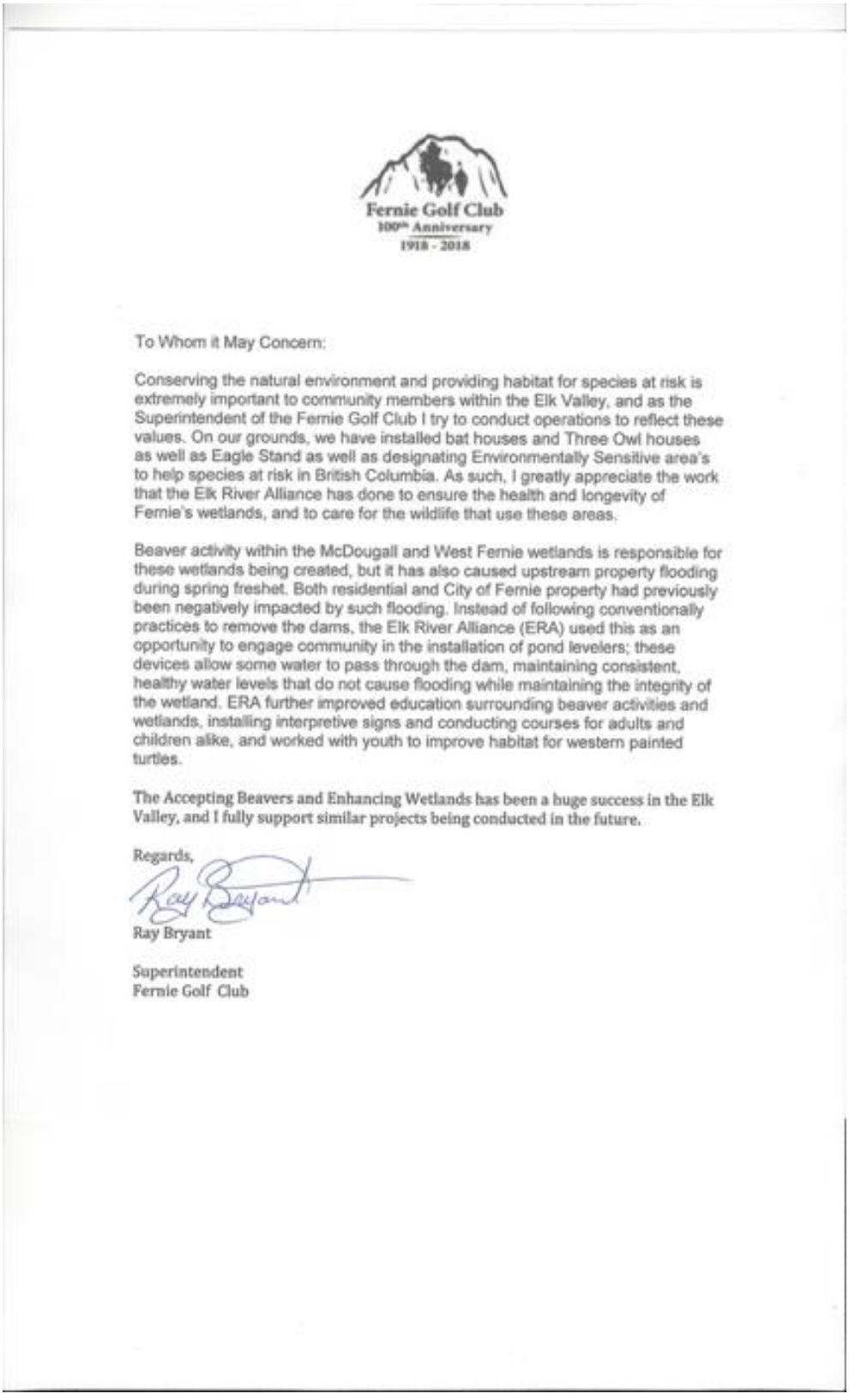
Wright, J.P., C.G. Jones, and A.S. Flecker. 2002. *An ecosystem engineer, the beaver, increases species richness at the landscape scale*. Oecologia. 132(1): 96-101.

Wu, H., P. Huang, and J. Wang. 2010. *Treatment of Eutrophic-lake Water by Free Water Surface Wetland.* International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering. 4(7): 290-293.

Appendix A. Survey Information McDougall Wetland



Appendix B. Letter of Support – Beaver Mitigation



Fernie Golf Club
100th Anniversary
1918 - 2018

To Whom it May Concern:

Conserving the natural environment and providing habitat for species at risk is extremely important to community members within the Elk Valley, and as the Superintendent of the Fernie Golf Club I try to conduct operations to reflect these values. On our grounds, we have installed bat houses and Three Owl houses as well as Eagle Stand as well as designating Environmentally Sensitive area's to help species at risk in British Columbia. As such, I greatly appreciate the work that the Elk River Alliance has done to ensure the health and longevity of Fernie's wetlands, and to care for the wildlife that use these areas.

Beaver activity within the McDougall and West Fernie wetlands is responsible for these wetlands being created, but it has also caused upstream property flooding during spring freshet. Both residential and City of Fernie property had previously been negatively impacted by such flooding. Instead of following conventionally practices to remove the dams, the Elk River Alliance (ERA) used this as an opportunity to engage community in the installation of pond levelers; these devices allow some water to pass through the dam, maintaining consistent, healthy water levels that do not cause flooding while maintaining the integrity of the wetland. ERA further improved education surrounding beaver activities and wetlands, installing interpretive signs and conducting courses for adults and children alike, and worked with youth to improve habitat for western painted turtles.

The Accepting Beavers and Enhancing Wetlands has been a huge success in the Elk Valley, and I fully support similar projects being conducted in the future.

Regards,

Ray Bryant

Superintendent
Fernie Golf Club

WHY ARE WETLANDS IMPORTANT?

What is a wetland?

Wetlands are areas where the ground is covered by water for all or part of the year. Three things make up a wetland: soggy soil, water and water-loving plants. There are many different kinds of wetlands including swamps, marshes, bogs, fens and shallow water. The Annex pond is a constructed wetland to store and treat stormwater and has a marsh along the edge of its shallow waters.

How plants help wetlands

Wetland plants prefer soggy, wet soils. Look for plants in four wetland zones:
- **riparian zone** where shrubs and trees grow in the drier upland;
- **emergent zone** where sedges and rushes live on the edge;
- **submerged zone** where plants live under the shallow water;
- **floating zone** where plants drift on top of the water.

Plant roots help the wetland hold soil in place. They also filter pollutants and store excessive nutrients before entering the Elk River. To identify wetland plants remember:

Sedges have edges, Rushes are round, Grasses have joints right down to the ground... and Cattails are flat!

Who needs wetlands?

Invertebrates, fish, amphibians, reptiles, birds and mammals all depend on the Annex wetland for habitat. Animals at this wetland such as mayflies, toads, long-toed salamanders, moose and beavers all use this wetland as a safe place to live and reproduce. Wetland plants provide them food and a place to hide. All living things are equally important and each play a role in ensuring a healthy wetland.

Why care for wetlands?

Wetlands have disappeared near towns and cities across Canada having been filled in, drained, and developed over. But wetlands are also important to communities They provide free services like filtering storm water pollutants before entering the Elk River. The Annex Pond stores spring runoff, slowly releasing it into the river. We need to protect the few wetlands remaining in the Elk Valley.

Thank you to the Fernie Secondary School (FSS) Grade 8/9 Class (2016) for writing the text for this sign.

www.elkriveralliance.ca

Elk River Alliance

This project was undertaken with the financial support of

Environment and Climate Change Canada

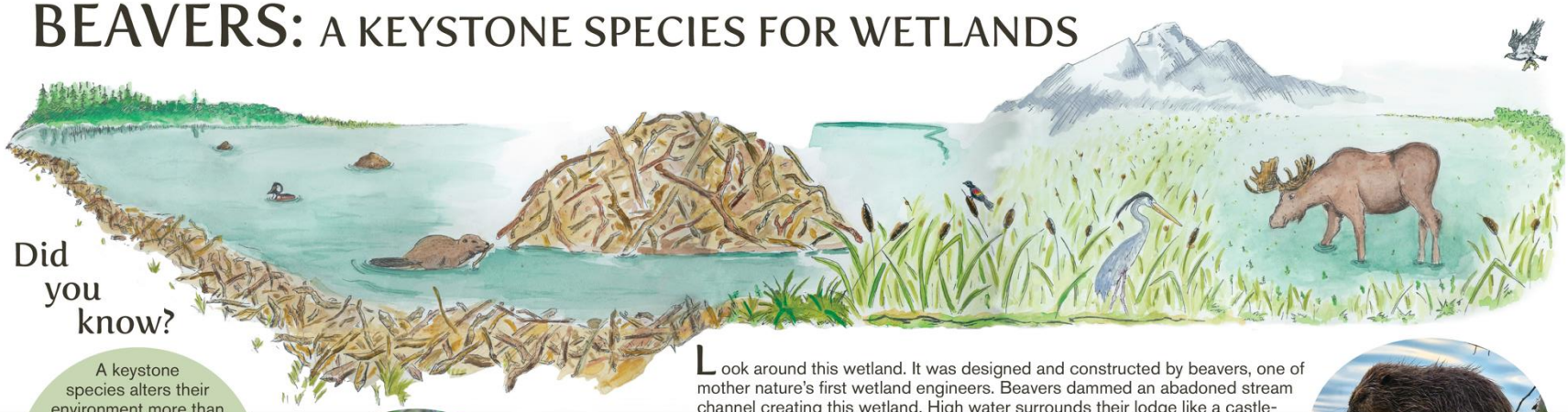
Fernie City of Fernie British Columbia

Teck

BCWF BC Wildlife Federation Wetland Education Program

Habitat Conservation Trust Foundation

BEAVERS: A KEYSTONE SPECIES FOR WETLANDS



Did you know?

A keystone species alters their environment more than you would expect. Beavers play a critical role in maintaining wetland ecosystems. Without beavers, numerous wetland plants and animals would not survive here.

Look around this wetland. It was designed and constructed by beavers, one of mother nature's first wetland engineers. Beavers dammed an abadoned stream channel creating this wetland. High water surrounds their lodge like a castle-moat, protecting it from predators. Beavers create their own ideal home and in turn habitat for many other species.

How do other species benefit from wetlands?

Aquatic insects feed on increased decaying matter improving biodiversity and their abundance.

Birds rest, feed and raise their young here. Do you know that great blue heron is a species at risk that use Fernie's wetlands?

Small mammals like muskrats, and larger ones like moose, also benefit from the denser vegetation that provides food and shelter.

Amphibians and reptiles like the still water and abundant insects. If you're lucky, maybe you'll see a Western painted turtle basking during your visit!

Predators like hawks, bears and owls find prey around wetlands. Make lots of noise so you don't surprise them!

Fish depend on water stored in the wetland that is slowly released back to the Elk River in late summer.

We also benefit from countless wetland services, including flood control, drought mitigation, and clean, filtered water.

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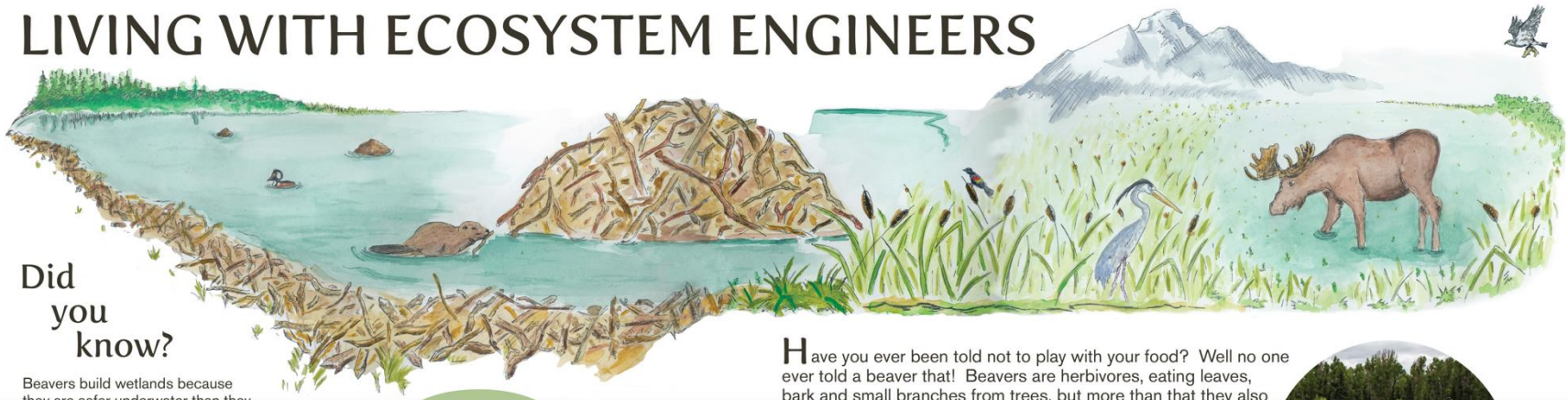
LIVING WITH ECOSYSTEM ENGINEERS



Did you know?

Beavers build wetlands because they are safer underwater than they are on land. Look at their many underwater adaptations.

Have you ever been told not to play with your food? Well no one ever told a beaver that! Beavers are herbivores, eating leaves, bark and small branches from trees, but more than that they also build with plants! Beavers use their large front teeth, wedging out chunks to fell trees. Knawed into smaller pieces this material is used to build dams.

Deep water behind the dam protects their underwater entrance and stores food for winter. This creates a wetland ideal for beavers and countless other wildlife. However, sometimes people don't appreciate their efforts.

Beaver activity can be responsible for flooded property, blocked culverts and the loss of valuable trees. Get to know these four-legged furry engineers, and develop techniques to live harmoniously with them. Look around Fernie for these innovative beaver-baffling structures:

Fencing protects mature trees critical for bank stabilization.

Irregular shaped fencing upstream of culverts keeps beavers from blocking them.

Photo: Cows and Fish

Pond levellers reduce seasonal flooding while maintaining appropriate water levels for the beavers and wetland to thrive.

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BCWF BC Wildlife Federation Wetlands Education Program

Habitat Conservation Trust Foundation

Appendix D. Letter of Support – Education Program

Ecole Isabella Dicken Elementary School
1302 2nd Avenue
Fernie, British Columbia
V0B 1M0

July 14th, 2018

To Whom It May Concern:

On June 18th, my Kindergarten students had the privilege and unique opportunity to participate in a new, educational program developed by the Elk River Alliance entitled Beaver Buddies.
The presentation was aimed to increase knowledge and appreciation of beavers in our watershed. Having lived in Fernie for close to twenty years, I knew there were beavers, but knew very little about them or their impact on Fernie's wetland. The presentation provided valuable information in an interesting and age appropriate manner. The presenter used hands-on materials, visuals, puppets, and an elaborate costume to make her presentation come alive. Students were actively engaged in the presentation. I particularly liked the fact that it was place-based, immersing students in local opportunities and experiences while learning about beavers in their natural habitat.
Beaver Buddies was by far one of my favourite programs offered to Fernie students without prohibitive bussing costs. Whether offered by CBEEN's Wild Voices for Kids or by The Elk River Alliance, it is a program worthy of funding and support.
I am enclosing some pictures from our day and would be available to answer any questions that you might have.

Sincerely,

Jane Fraser
Isabella Dicken Elementary School
Kindergarten Teacher.