NCC Land Stewardship Activities F17

FWCP Project No. W-F17-05

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Executive Summary

The purpose of the agreement (FWCP Project No. W-F17-05) and “NCC Land Stewardship Activities F17” project is to provide resources to enable NCC to continue restoring habitat on conservation properties in the South Selkirks and East Kootenay.

Five projects were undertaken as part of the “NCC Land Stewardship Activities F17” agreement, which took place between May 10, 2016 and March 31, 2017. Funding in the amount of $15,000 was designated to continue ecosystem restoration activities, specifically Bull Trout Enhancement and planning for the restoration of Rare Dry Interior Cedar-Hemlock Ecosystems on Darkwoods as described in the Property Management Plan; $15,000 of funding was allocated to invasive plant treatments on NCC properties in the Canadian Rocky Mountain Program Area; $15,000 was designated for ecosystem restoration on NCC’s Kootenay River Ranch property; and $5,000 allocated for the wetland creation plan on NCC’s Cherry Meadows property.

From the removal and management of invasive species along several NCC properties in the Canadian Rockies ecoregion, floral species restoration on NCC’s Kootenay River Ranch and Darkwoods conservation properties, to the creation of wetland habitat in Cherry Meadows, the funding provided by FWCP has allowed NCC to undertake a series of tasks and measures that seek to mitigate these and other threats to the local ecology, and the ecoregion as a whole.

Nature Conservancy of Canada

The Nature Conservancy of Canada (NCC) is a private non-profit organization working for the direct protection of natural habitats and wild spaces across this country. Since 1962, NCC and our partners have protected over 2.8 million acres of ecologically significant land and water for its intrinsic value and for future generations. Almost 1 million of these protected acres are located in British Columbia. It is the goal of NCC to protect, manage, and where appropriate, restore natural areas so they can sustain the ecosystems and species that define them.

Within the Columbia Basin, NCC provides protection for over 190,000 acres of land, including landscapes such as: at-risk grasslands, unusual geological formations, montane regions and precious valley bottom habitat. NCC’s properties in the Basin conserve vital habitat for several species at risk (e.g. Badger, Grizzly Gear, Mountain Caribou, Bull Trout and Rocky Mountain Bighorn Sheep).

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Task 1: Darkwoods Ecosystem Restoration for Rare Dry Interior Cedar-Hemlock Ecosystems

Introduction

The Darkwoods Management Plan (2011) identifies Dry ICH Forests as a Biodiversity Target that has been degraded range-wide by forest harvesting, range activities, and fire suppression. Detailed restoration planning requires setting priorities among biodiversity targets in space and time, and requires complete baseline information at both landscape and stand levels. The funding provided by the Fish and Wildlife Compensation Program (FWCP) is to identify species at risk and focal species within a 250 hectare area of ICHxw and ICHdw immediately adjacent to the Creston Valley Wildlife Management Area and the Kootenay River. This project will recommend actions to maintain or enhance habitat values during ecosystem restoration activities that may include prescribed fire and/or thinning treatments.

Goals & Objectives

The funding provided by the Fish and Wildlife Compensation Program (FWCP) was to continue to identify species at risk, focal species, and recommendations for restoring/maintaining these rare ecosystems as described in the Darkwoods Property Management Plan.

Objectives	Status	Comments
Conduct surveys for rare and endangered species	Complete	The BC CDC provided a list of rare and endangered species that were encountered during 2016 surveys.
Provide prescription for restoration treatment	Complete	Prescription prepared by NCC's South Selkirk Project Manager with experience in restoration and forestry operations.
Conduct stand treatment that benefits the dry ICH zone	Complete	5 ha were treated by Wildhorse Forestry
Monitor results of treatment	On-going	Early snow fall restricted access to the remote site and follow up site surveys are planned for early summer 2017, and will be on-going.

Study Area

Primarily east, northeast and southerly aspect face units at low to middle elevations near the lake. These units are identified as a high priority for treatment, to promote their own resilience, and to reduce the risk of fire spreading from this hot dry low elevation zone to higher elevations.

Methods

BC Conservation Data Centre Surveys

Botany surveys were conducted by August 18-20, 2016 by BC CDC botanist and contractors. Implementation of a continued ecology sampling program is planned for 2018 and 2019.

Prescription and Rationale for Treatment

Logging and silvicultural practises prior to NCC purchasing Darkwoods in 2008 left large areas of unnaturally dense young stands of conifers that provide lower habitat value for a range of species throughout the property. In the recently completed Darkwoods Property Management Plan, NCC has prioritized the restoration of fire maintained ecosystems in the dry portions of the Interior Cedar Hemlock zone (ICHdw and ICHxw).

NCC recognizes that climate change, especially in the low elevation forests, will likely mean that some species found at any given site may become maladapted to conditions in the coming decades or centuries. In fire maintained ecosystems, the goal is to promote open stands of thick barked species capable of surviving low severity fires, higher summer temperatures and lower moisture availability. By reducing the density of young trees and keeping widely spaced Ponderosa Pine, Western Larch and Douglas fir, trees will grow faster and develop thicker bark with fewer ladder fuels. It is anticipated that when the stand burns at some point in the coming decades, whether it be a prescribed fire or wildfire, it will be a low severity ground fire rather than a catastrophic high severity wildfire.

The target ecosystem is an old growth stand with a stocking density lower than the 600 – 800 stems per hectare (sph) resulting from this trial. If stocking was reduced further at this stage of stand development, the risk is that the remaining trees would keep their lower branches for longer thereby increasing the fire hazard in the medium term. As the forest continues to develop and the canopy closes, a further spacing treatment may be required once self-pruning has taken place. While the next treatment may yield some commercial sized timber, this is not an objective of this trial and any revenue would be used to offset treatment costs.

Restoration Treatment

In an effort to reduce the density of conifers, maintain more deciduous trees and palatable shrubs, and create larger gaps, a local forestry contractor was hired to reduce the stocking of conifers from over 4,000 sph to 600 – 800 sph. The prescription recommended removing all competing conifers and larch within 3.5 meters of a healthy Ponderosa, Douglas Fir or Larch but did not remove any deciduous trees or shrubs.

Results

Botany Surveys

Table 1. B.C. Conservation Data Centre: Plant Observation Form for Red or Blue-listed species

	1	2	3	4	5	6	7	8
Taxon name	*Impatiens ecornuta*	*Impatiens ecornuta*	*Impatiens ecornuta*	*Impatiens ecornuta*	*Mertensia paniculata* var. *borealis*	*Mertensia paniculata* var. *borealis*	*Pinus albicaulis*	*Ahtiana sphaerosporella*
Source of Report	Observation form/photo	Observation form/photo	Observation form/photo	Observation form/photo	Observation form	Observation form	Observation form/photo	Observation form/photo
Location	Wetland fringe at the bottom of Mosquito	Wetland fringe at the bottom of Mosquito	Wetland fringe at the bottom of Mosquito	Wetland fringe at the bottom of Mosquito	Blaze Creek FSR	Laib Creek	Mt. McGregor	Mt. McGregor

	Management area	Management area	Management area	Management area				
Habitat type	Wetland	Wetland	Wetland	Wetland	Forest	Forest	Forest	Forest
Habitat	cattail	cattail	cattail	cattail	roadside thicket, upper montane/subalpine	roadside thicket, upper montane/subalpine	subalpine grassland	*Pinus albicaulis*
Associated spp.	*Impatiens capensis, Typha latifolia, Carex retororsa & Scutellaria lateriflora*	*Impatiens capensis, Typha latifolia, Carex retororsa & Scutellaria lateriflora*	*Impatiens capensis, Typha latifolia, Carex retororsa & Scutellaria lateriflora*	*Impatiens capensis, Typha latifolia, Carex retororsa & Scutellaria lateriflora*				
(yyyy/mm/dd)	08/18/2016	08/18/2016	08/18/2016	08/18/2016	08/20/2016	08/20/2016	08/19/2016	08/19/2016
Zone	11	11	11	11	11	11	11	11
Easting	524978	525023	525085	525220	509634	502891	511651	511576
Northing	5449014	5448825	5448571	5448469	5448950	5466439	5465582	5465507
Source for coordinate	GPS	GPS	GPS	GPS	GPS	GPS	GPS	GPS
Waypoint numbers (if applicable)								
# of Individuals (exact)								
# of Individual (range estimates)	1- 50	1- 50	1- 50	1- 50	1- 50	1- 50	50-250	1-50
Area Occupied: Length (m)								
Area Occupied: Width (m)								
Area Occupied (m²)	15	15	5000	500	500	100	400	5
Description of Area Occupied	among typha in marshy thickets	among typha in marshy thickets	among typha in marshy thickets	among typha in marshy thickets	smaller meadow	isolated small habitat	discrete wetland & pond area	foot of slope only
Condition of Population (& potential threats to plants within occupied area)	no threats	no threats	no threats	no threats	no threats	no threats	drying trend would eliminate site	no threats
Overall Quality of Occurrence	Excellent	Excellent	Excellent	Excellent	Good	Fair	Good	Fair
Elevation (m)	553	555	554	550	1638	1407	2196	2221
Slope (%)	0	0	0	0	25	0	15	15

Restoration Treatment

In the fall of 2016, NCC carried out a trial restoration project in a stand that was logged and planted in 2003 in the ICHdw to assess the costs and challenges of these treatments. The trial took place on a south facing slope above Cultus Creek adjacent to areas known to support high numbers of ungulates during the winter months. Slashing contractors completed approximately 5 hectares of the treatment in October, 2016 (Figure 1).

Figure 1. Treatment area outlined in purple; the area shaded red was completed in 2016.

Prior to treatment, the stand was stocked with over 4,000 stems per hectare of Grand Fir, Larch, Douglas Fir, Western White Pine and Ponderosa pine that had become impenetrable for large ungulates and would have developed into a stand vulnerable to high severity fire (Figure 2).

Figure 2. Densely stocked conifer plantation prior to treatment.

The early snow in late October blocked access over Porcupine Pass, so no post treatment stand surveys were completed.

However, stocking was clearly reduced (Figure 3) and the crew leader reported elk sign in the treatment area immediately following completion. A full assessment of the trial will be completed in the summer of 2017.

Figure 3. Post treatment spacing in treatment unit.

Recommendations

Further surveys for rare and endangered species by BC CDC staff and contractors will continue until 2018.

This successful pilot project indicates that this type of work can be cost effective and logistically feasible. An expanded restoration program is planned for 2017 in similar habitats in the ICHdw and ICHxw above Kootenay Lake. We have identified and prioritized an additional 24.2 hectares for treatments.

Treating five hectares required 12 person days to complete, at a total cost of just under $5,000. This initial trial suggests that this type of treatment will cost approximately $1000/ha, recognizing that every treatment area is different and costs could be higher or lower depending of access, age of stand, size of trees, stocking, and other variables. NCC is currently prioritizing other areas for similar treatments, but it is clear that there is a great deal of work to be done in the coming years, and this project will help in planning future restoration work.

Task 2: Darkwoods Bull Trout Enhancement Project

Introduction

In the Cultus Creek watershed, Eastern Brook Trout populations currently overlap with Bull Trout spawning habitat in Cultus and Laib Creeks. Negative effects of competitive interactions between introduced Brook Trout and native salmonid populations are well documented via introgressive hybridization (Kanda et al. 2011), competition and predation (Peterson et al. 2008). Suppression or eradication of Brook Trout has been shown to increase imperiled Bull Trout abundance by 10-fold in Oregon stream systems (Buktenica et al. 2013). This project will examine whether it is feasible to remove invasive Brook Trout within habitat overlaps of Bull Trout in order to conserve Bull Trout populations by reducing hybridization potential and interspecies competition. This project will involve electrofishing where habitats overlap to determine the relative abundance of Bull and Brook Trout, along with removal of the Brook Trout captured. The relative abundance of Brook Trout will be tracked in subsequent years of fish removal to quantify the efficacy of the technique.

Goals & Objectives

The funding provided by the Fish and Wildlife Compensation Program (FWCP) was to map and provide a summary report of actions implemented related to restoring Aquatic Conservation Targets as described in the Darkwoods Property Management Plan.

Objectives	Status	Comments
Review of Brook Trout eradication methodology used and its applicability to Laib Creek	Complete	See *Laib Creek Brook Trout Eradication Feasibility Sampling 2016*
Determine basic population dynamics of Brook Trout (and native species if possible) in an index section of Laib Creek	Complete	See *Laib Creek Brook Trout Eradication Feasibility Sampling 2016*
Determine the capture probability, efficiency, relative abundance and density of Brook Trout in an index section of Laib Creek	Complete	See *Laib Creek Brook Trout Eradication Feasibility Sampling 2016*
Conduct removal of any Brook Trout encountered during project sampling	Complete	See *Laib Creek Brook Trout Eradication Feasibility Sampling 2016*

Study Area

Laib Creek is a 15.7 km long 3rd order stream. Laib Creek drains into Cultus Creek which enters Kootenay Lake approximately 5.5 km downstream. Two sites were targeted for Brook Trout eradication feasibility monitoring.

Methods

For detailed methods see Appendix 1: *Laib Creek Brook Trout Eradication Feasibility Sampling 2016, prepared by Amec Foster Wheeler Environment and Infrastructure.*

Results

For detailed results see Appendix 1: *Laib Creek Brook Trout Eradication Feasibility Sampling 2016, prepared by Amec Foster Wheeler Environment and Infrastructure.*

Recommendations

The overarching objective of determining if an expanded program for Eastern Brook Trout eradication feasibility on the Darkwoods Conservation Area is likely not feasible due to complexities between species interactions, prohibitively high cost, catchability due to rugged terrain, and accessibility to remote sites.

Further recommendations suggested by the author of *Laib Creek Brook Trout Eradication Feasibility Sampling 2016* are provided below.

The following are recommendations based on the results of this project:

1. Determine management objectives for Brook Trout in Laib Creek.

2. Conduct post-treatment monitoring in Laib Creek to determine dynamics of fish recolonization.

3. Collect additional DNA samples from Brook Trout and native salmonid species in overlapping sections of Laib Creek and conduct genetics analysis on DNA samples from those also collected in treatment reach to determine if pure Brook Trout stock or if any hybrids are present.

4. Conduct age analysis on otolith structures collected to help identify age and growth information for the Brook Trout population in Laib Creek if further suppression efforts are undertaken. These parameters are required to compare age-at-maturity and growth rates between native and non-native populations to aid in suppression activities (e.g., interval between removals). Brook Trout may have a competitive advantage if they mature earlier and occur in higher densities than native salmonid species.

Map

For detailed map see page 2 in Appendix: *Laib Creek Brook Trout Eradication Feasibility Sampling 2016, prepared by Amec Foster Wheeler Environment and Infrastructure.*

Task 3: Invasive Plant Management

Introduction

The invasion of noxious weeds has numerous negative impacts on natural ecosystems. Invasive plants threaten the health of Canada's limited native grasslands, may displace or extirpate endangered plant and animal species, negatively impact wildlife habitats, reduce productivity in forestry, agriculture and fisheries, and overall contribute negatively to functioning ecosystems.

Invasive plants pose the second largest threat to native biodiversity after the threat of residential development. NCC, with the assistance of our partners, having removed the primary threat of development, is placing a priority on the management of invasive species on private conservation properties.

Goals & Objectives

The funding provided by the Fish and Wildlife Compensation Program (FWCP) was for invasive plant treatments on NCC properties in the Canadian Rocky Mountain Program Area. The treatments were directed to address the priorities outlined in the Invasive Plant Management Plan developed for the Canadian Rocky Mountain Program Area and regional invasive plant councils/committees (i.e., Central Kootenay Invasive Species Society and East Kootenay Invasive Species Council).

The project's intent was to address the threat posed by invasive species to biodiversity targets on NCC's conservation lands. The Invasive Species Council (ISC) of BC defines the term invasive species as any non-native organism that causes economic or environmental harm and can spread quickly to new areas of BC. The ISC defines an invasive plant as any invasive plant that has the potential to pose undesirable or detrimental impacts on people, animals or ecosystems. Invasive plants can establish quickly and easily on both disturbed and un-disturbed sites, causing widespread negative economic, social and environmental impacts. At a regional level, high priority invasive plants (Early Detection Rapid Response [EDRR]) have been identified by the East Kootenay Invasive Species Council (EKISC) and the Central Kootenay Invasive Species Society (CKISS) for survey and treatment.

Spotted knapweed
(*Centaurea maculosa*)

Hound's tongue
(*Cynoglossum officinale*)

Canada thistle
(*Cirsium arvense*)

Objectives	Status	Comments
To conduct invasive plant management and control activities on high priority sites on NCC's properties, including: Frog Bear Conservation Corridor, Columbia Lake Lot 48, Marion Creek Benchlands, Pine Butte Ranch, Kootenay River Ranch, Thunder Hill Ranch, Elk Valley Heritage Conservation Area, and the Mount Broadwood Heritage Conservation Area.	Complete	Completed by EKISC and CKISS
The Central Kootenay Invasive Species Society (CKISS) and East Kootenay Invasive Species Council (EKISC) entered all treatment record and survey data completely and accurately into the IAPP system by December 31st, 2016.	Complete	See extract below from both CKISS (Table 1) and the EKISC (Table 2)
Where survey data are not available, CKISS and EKISC will conduct multi-species inventory and mapping of high priority invasive plants as required.	Complete	See extract below from both CKISS (Table 1) and the EKISC (Table 2)
Conduct annual inventory throughout the Frog Bear Conservation Corridor and promote the use of standardized inventory methodology and data forms that are based on the provincial Invasive Alien Plant Program (IAPP) standards. Inventory should focus on detecting EDRR species, those that are not known in the area and on observing changes in distribution/density or area of established invasive species.	Complete	See extract below from both CKISS (Table 1) and the EKISC (Table 2)
Based on inventories and regional priorities, the CKISS and EKISC shall implement an integrated management approach to treat high priority invasive plants and/or sites applying the most suitable tools for the particular situation.	Complete	Additionally, CKISS surveyed for aquatic invasives, including Bullfrogs and maintained the mussel substrate sampler at Tye on Darkwoods.

Study Area

The Canadian Rocky Mountains ecoregion extends over a large portion of the Rocky Mountains in southeastern British Columbia, and includes NCC's Elk-Flathead, Rocky Mountain Trench, and South Selkirk Natural Areas.

Methods

All invasive plant management activities were conducted as per the guidelines established by the *Invasive Alien Plant Program (IAPP) Reference Guide (2013)* and the *Invasive Plant Pest Management Plan for the Southern Interior of British Columbia (FLNR-PMP 738-0024-14/19)*. All inventories, mechanical and chemical treatment data collected in 2016 have been entered into the IAPP database.

Priority areas and target invasive plants were identified in collaboration with NCC's Stewardship Coordinator, Canadian Rocky Mountains and the South Selkirk Program Manager and the *2014 Invasive Plant Program Summary Report*. Additional stakeholders, private landowners, NCC staff, and invasive species specialists were also consulted as required.

Results

At several conservation properties, mechanical treatments were the most effective management option. Some sites were close to water which precluded the use of herbicides along the riparian zone.

Visual surveys at all sites will provide a more accurate inventory of weed populations for future planning and management. In addition, biological control (biocontrol) insects were surveyed, collected, and distributed at appropriate locations. This long-term management tool is useful for areas that will not be visited regularly or where herbicide treatment is not possible.

Grass seed was spread at most sites when feasible and if there was a good chance of seed establishment. If this seed successfully germinates at the site, it will provide competition for the undesirable invasive weeds, as well as increase biodiversity and forage value.

Recommendations

Annual invasive species management and monitoring funds have significantly improved NCC's ability to track and treat invasive species on conservation lands. It is recommended that annual monitoring and treatments continue. In 2016-2017 an assessment of IAPP sites on NCC lands should be conducted and reported on to determine the efficacy of treatments as well as the scope of the issue.

The development of Best Management Practices when working on NCC lands continues to be developed in consultation with local Invasive Plant Councils. NCC will participate in invasive plant treatment planning meetings with both the EKISC and CKISS in 2017 to further develop strategic plans for invasive plants on NCC priority properties. Additionally, NCC will continue to develop Operational Weed Management Plans for newly acquired conservation lands, including the recently added Luxor Linkage in the East Kootenay.

Table 2. Summary of invasive plant surveys, mechanical, herbicide, and biorelease treatments conducted by CKISS on Frog-Bear Conservation Area in 2016.

2016 Survey Extract Gravel Pit/Bat House/Tye Beach							
Site ID	**UTM Easting**	**UTM Northing**	***Invasive Plant***	**Survey Date**	**Estimated Area**	**Distribution**	**Density**
301301	528566	5453114	***Spotted knapweed (CENT BIE)***	24/05/2016	0.3250	7 | continuous uniform occurrence of well-spaced individuals	2 | 2-5 plants/m2 (Med)
301301	528566	5453114	***Sulphur cinquefoil (POTE REC)***	24/05/2016	0.3250	2 | few sporadically occurring individuals	3 | 6-10 plants/m2 (High)
301301	528566	5453114	***Yellow hawkweed (HIER PRA)***	24/05/2016	0.3250	5 | a few patches or clumps of a species	4 | >10 plants/m2 (Dense)
301303	528552	5453134	***Scentless chamomile (MATR PER)***	24/05/2016	0.0500	5 | a few patches or clumps of a species	3 | 6-10 plants/m2 (High)
301306	528571	5453036	***Oxeye daisy (LEUC VUL)***	25/09/2016	2.5000	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
301306	528571	5453036	***Spotted knapweed (CENT BIE)***	24/05/2016	1.6000	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
301306	528571	5453036	***Spotted knapweed (CENT BIE)***	25/09/2016	2.5000	5 | a few patches or clumps of a species	4 | >10 plants/m2 (Dense)
301306	528571	5453036	***Yellow hawkweed (HIER PRA)***	24/05/2016	1.6000	4 | several sporadically occurring individuals	2 | 2-5 plants/m2 (Med)
301306	528571	5453036	***Yellow hawkweed (HIER PRA)***	25/09/2016	2.5000	2 | few sporadically occurring individuals	4 | >10 plants/m2 (Dense)
301312	528649	5453084	***Spotted knapweed (CENT BIE)***	24/05/2016	0.2000	4 | several sporadically occurring individuals	2 | 2-5 plants/m2 (Med)
301312	528649	5453084	***Sulphur cinquefoil (POTE REC)***	24/05/2016	0.2000	5 | a few patches or clumps of a species	3 | 6-10 plants/m2 (High)
301312	528649	5453084	***Yellow hawkweed (HIER PRA)***	24/05/2016	0.2000	4 | several sporadically occurring individuals	2 | 2-5 plants/m2 (Med)
301313	528698	5452893	***Spotted knapweed (CENT BIE)***	26/05/2016	0.3600	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
301313	528698	5452893	***Sulphur cinquefoil (POTE REC)***	26/05/2016	0.3600	5 | a few patches or clumps of a species	3 | 6-10 plants/m2 (High)
301314	528512	5453180	***Spotted knapweed (CENT BIE)***	26/05/2016	0.1000	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
301314	528512	5453180	***Sulphur cinquefoil (POTE REC)***	26/05/2016	0.1000	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
301314	528512	5453180	***Yellow hawkweed (HIER PRA)***	26/05/2016	0.1000	5 | a few patches or clumps of a species	2 | 2-5 plants/m2 (Med)
301320	529711	5450143	***Canada thistle (CIRS ARV)***	26/05/2016	1.3000	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)
301320	529711	5450143	***Canada thistle (CIRS ARV)***	25/09/2016	1.3000	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
301320	529711	5450143	***Common tansy (TANA VUL)***	26/05/2016	1.3000	5 | a few patches or clumps of a species	4 | >10 plants/m2 (Dense)
308754	515224	5464088	***Common tansy (TANA VUL)***	28/08/2016	0.0400	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
308754	515224	5464088	***Spotted knapweed (CENT BIE)***	28/08/2016	0.0400	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)
318992	514979	5463629	***Spotted knapweed (CENT BIE)***	28/08/2016	0.0160	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
318993	515037	5463671	***Common tansy (TANA VUL)***	28/08/2016	0.1200	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
318993	515037	5463671	***Spotted knapweed (CENT BIE)***	28/08/2016	0.1200	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
318994	515157	5463800	***Hawkweed species (HIER SPP)***	28/08/2016	0.0800	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
318994	515157	5463800	***Oxeye daisy (LEUC VUL)***	28/08/2016	0.0800	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
318994	515157	5463800	***Spotted knapweed (CENT BIE)***	28/08/2016	0.0800	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
318994	515157	5463800	***St. John's wort/Saint John's wort/ Goatweed (HYPE PER)***	28/08/2016	0.0780	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
318996	515495	5463808	***Spotted knapweed (CENT BIE)***	28/08/2016	0.0500	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)

Survey Extract--Midgley/TopazFRS/NewingtonFSR							
316588	525525	5443357	***Spotted knapweed (CENT BIE)***	27/08/2016	1.6000	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
316589	525724	5445224	***Common tansy (TANA VUL)***	06/06/2016	0.2500	5 | a few patches or clumps of a species	3 | 6-10 plants/m2 (High)
316589	525724	5445224	***Hawkweed species (HIER SPP)***	08/06/2016	0.2500	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)
316589	525724	5445224	***Oxeye daisy (LEUC VUL)***	06/06/2016	0.2500	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
316589	525724	5445224	***Spotted knapweed (CENT BIE)***	28/08/2016	1.6000	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)
316589	525724	5445224	***Sulphur cinquefoil (POTE REC)***	06/06/2016	0.2500	5 | a few patches or clumps of a species	1 | <= 1plant/m2 (Low)
316853	525709	5445114	***Hawkweed species (HIER SPP)***	08/06/2016	0.0300	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)
316853	525709	5445114	***Oxeye daisy (LEUC VUL)***	08/06/2016	0.0300	1 | rare individual, a single occurrence	1 | <= 1plant/m2 (Low)
316853	525709	5445114	***Spotted knapweed (CENT BIE)***	08/06/2016	0.0300	2 | few sporadically occurring individuals	1 | <= 1plant/m2 (Low)
316853	525709	5445114	***St. John's wort/Saint John's wort/ Goatweed (HYPE PER)***	08/06/2016	0.0200	4 | several sporadically occurring individuals	1 | <= 1plant/m2 (Low)

2016 Mechanical Treatment Extract							
Site ID	**UTM Easting**	**UTM Northing**	**Invasive Plant**	**Treatment Date**	**Treatment Comments**	**Method**	**Area**
301320	529711	5450143	**Canada thistle (CIRS ARV)**	08/06/2016	Dead headed some Canada thistle flowering heads within the PFZ while inspecting post-chemical treatment efficiency	Dead-heading	0.0010
308754	515224	5464088	**Spotted knapweed (CENT BIE)**	30/07/2016	Tye Beach community weed pull, approx 6 people pulling for 2 hours throughout beach shore area.	Hand pulling	0.0500

2016 NCC Invasive Plant Chemical Treatment/Chemical Monitoring											
Chemical Treatment Extract (All)											
Site ID	**Area**	**UTM Easting**	**UTM Northing**	**Invasive Plant**	**Treatment Date**	**Herbicide**	**Method**	**Area Treated**	**Amount of Mix Used**	**Application Rate**	**Delivery Rate**
301320	**Bat House**	529711	5450143	**Canada thistle (CIRS ARV)**	26/05/2016	Banvel VM	Hand Gun	1.0500	420.00000	3.00	400
301303	**Gravel Pit**	528552	5453134	**Scentless chamomile (MATR PER)**	24/05/2016	Milestone	Hand Gun	0.0500	20.00000	0.50	400
301306	**Gravel Pit**	528571	5453036	**Spotted knapweed (CENT BIE)**	24/05/2016	Milestone	Hand Gun	0.6250	250.00000	0.50	400
301301	**Gravel Pit**	528566	5453114	**Spotted knapweed (CENT BIE)**	24/05/2016	Milestone	Hand Gun	0.3250	130.00000	0.50	400
301313	**Gravel Pit**	528698	5452893	**Spotted knapweed (CENT BIE)**	26/05/2016	Milestone	Hand Gun	0.3750	150.00000	0.50	400
301306	**Gravel Pit**	528571	5453036	**Spotted knapweed (CENT BIE)**	25/09/2016	Clearview	Hand Gun	0.7500	300.00000	0.23	400
301306	**Gravel Pit**	528571	5453036	**Spotted knapweed (CENT BIE)**	28/09/2016	Tordon 22K	Hand Gun	2.0000	800.00000	2.25	400
301312	**Gravel Pit**	528649	5453084	**Sulphur cinquefoil (POTE REC)**	24/05/2016	Milestone	Hand Gun	0.2000	80.00000	0.50	400
301314	**Gravel Pit**	528512	5453180	**Yellow hawkweed (HIER PRA)**	26/05/2016	Milestone	Hand Gun	0.1000	40.00000	0.50	400
316588	**Midgley**	525525	5443357	**Spotted knapweed (CENT BIE)**	27/08/2016	Tordon 22K	Hand Gun	1.3750	550.00000	2.25	400
316589	**Midgley**	525724	5445224	**Spotted knapweed (CENT BIE)**	28/08/2016	Tordon 22K	Hand Gun	1.3750	550.00000	2.25	400

Topaz/Midgely Chemical Treatment Extract											
Site ID	Jurisdictions	UTM Northing	Invasive Plant	Treatment Date	Treatment Paper File ID	Method	Area Treated	Amount of Mix Used	Application Rate	Delivery Rate	Dilution Percent
316588	Ministry of Forests, Lands and Natural Resource Operations (100%)	5443357	**Spotted knapweed (CENT BIE)**	27/08/2016	FLNRO 2016	Hand Gun	1.3750	550.00000	2.25	400	0.5625
316589	Ministry of Forests, Lands and Natural Resource Operations (100%)	5445224	**Spotted knapweed (CENT BIE)**	28/08/2016	FLNRO 2016	Hand Gun	1.3750	550.00000	2.25	400	0.5625

Chemical Monitoring Extract											
Site ID	Area	Herbicide	Treatment Method	Treatment Date	Treatment Paper File ID	Inspection Date	Primary Surveyor	Efficacy Rating	Estimated Area	Distribution	Density
301320	**Bat House**	Banvel VM	Hand Gun	26/05/2016	NCC 2016	08/06/2016	JENNFER VOGEL	90% to 99% efficacy	1.3000	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)
301306	**Gravel Pit**	Milestone	Hand Gun	24/05/2016	NCC 2016	08/06/2016	JENNFER VOGEL	80% to 89% efficacy	2.5000	5 | a few patches or clumps of a species	4 | >10 plants/m2 (Dense)
316589	**Midgley**	Tordon 22K	Hand Gun	28/08/2016	FLNRO 2016	06/09/2016	DAVID DEROSA	90% to 99% efficacy	1.6000	6 | several well-spaced patches or clumps	2 | 2-5 plants/m2 (Med)

2016 NCC Invasive Plant Biological Treatment/Biological Dispersal												
Biological Treatment Extract												
Site ID	Site Created Date	UTM Zone	UTM Easting	UTM Northing	Invasive Plant	Estimated Area	Distribution	Density	Treatment Date	Treatment Comments	Release Quantity	Biologic al Agent
308754	10/09/2015	11	515224	5464088	Spotted knapweed (CENT BIE)	0.0400	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)	19/08/2016	Bio agents were released on August 19, 2016 but a survey was not completed at the time. A plant survey was completed on August 28. Site is very windy and has no structure	100	CYPH ACH
318992	12/12/2016	11	514979	5463629	Spotted knapweed (CENT BIE)	0.0160	7 | continuous uniform occurrence of well-	3 | 6-10 plants/m2 (High)	28/08/2016	Bio agents were released on August 19, 2016 but a survey was not completed at the time. A plant survey was completed on August 28 and this date is entered as the release date	100	CYPH ACH

							spaced individuals			due to IAPP restrictions on a release date coming before a survey date		
318993	12/12/2016	11	515037	5463671	Spotted knapweed (CENT BIE)	0.1200	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)	28/08/2016	Bio agents were released on August 19, 2016 but a survey was not completed at the time. A plant survey was completed on August 28 and this date is entered as the release date due to IAPP restrictions on a release date coming before a survey date	100	CYPH ACH
318994	12/12/2016	11	515157	5463800	Spotted knapweed (CENT BIE)	0.0800	7 | continuous uniform occurrence of well-spaced individuals	3 | 6-10 plants/m2 (High)	28/08/2016	Bio agents were released on August 19, 2016 but a survey was not completed at the time. A plant survey was completed on August 28 and this date is entered as the release date due to IAPP restrictions on a release date coming before a survey date	100	CYPH ACH
318996	12/12/2016	11	515495	5463808	Spotted knapweed (CENT BIE)	0.0500	8 | continuous occurrence of a species with a few gaps in the distribution	3 | 6-10 plants/m2 (High)	28/08/2016	Bio agents were released on August 19, 2016 but a survey was not completed at the time. A plant survey was completed on August 28 and this date is entered as the release date due to IAPP restrictions on a release date coming before a survey date	100	CYPH ACH

Table 3. Summary of invasive plant herbicide treatments in IAPP format conducted by EKISC in the East Kootenay in 2016.

Property	Site ID	UTM Easting	UTM Northing	Invasive Plant	Treatment Date	Herbicide	Method	Area Treated	Amount of Mix Used	Application Rate	Delivery Rate
Elk Valley	230836	650129	5499006	Common tansy (TANA VUL)	29/08/2016	Tordon 22K	Hand Gun	0.0107	4.50000	2.25	420
	230836	650129	5499006	Wormwood (ARTE ABS)	29/08/2016	Tordon 22K	Hand Gun	0.0012	0.50000	2.25	420
	270709	650488	5500420	Spotted knapweed (CENT BIE)	29/08/2016	Milestone	Hand Gun	0.0833	20.00000	0.50	240
	270710	650637	5500344	Spotted knapweed (CENT BIE)	29/08/2016	Tordon 22K	Hand Gun	0.0095	4.00000	2.25	420
	270716	650370	5500302	Burdock species (ARCT SPP)	29/08/2016	Milestone	Hand Gun	0.0292	7.00000	0.50	240
	270716	650370	5500302	Canada thistle (CIRS ARV)	29/08/2016	Milestone	Hand Gun	0.0292	7.00000	0.50	240
	270716	650370	5500302	Spotted knapweed (CENT BIE)	29/08/2016	Milestone	Hand Gun	0.0583	14.00000	0.50	240
	276031	650573	5500405	Spotted knapweed (CENT BIE)	29/08/2016	Milestone	Hand Gun	0.0208	5.00000	0.50	240
	276031	650573	5500405	Spotted knapweed (CENT BIE)	29/08/2016	Tordon 22K	Hand Gun	0.0286	12.00000	2.25	420
	276031	650573	5500405	Yellow/common toadflax (LINA VUL)	29/08/2016	Tordon 22K	Hand Gun	0.0071	3.00000	2.25	420
	295816	650519	5500572	Spotted knapweed (CENT BIE)	29/08/2016	Milestone	Hand Gun	0.0208	5.00000	0.50	240
	295855	650717	5500509	Hound's-tongue (CYNO OFF)	29/08/2016	Tordon 22K	Hand Gun	0.0021	0.90000	2.25	420
	295855	650717	5500509	Spotted knapweed (CENT BIE)	29/08/2016	Tordon 22K	Hand Gun	0.0043	1.80000	2.25	420
	295855	650717	5500509	St. John's wort/Saint John's wort/ Goatweed (HYPE PER)	29/08/2016	Tordon 22K	Hand Gun	0.0007	0.30000	2.25	420
	317453	648405	5496654	Spotted knapweed (CENT BIE)	29/08/2016	Tordon 22K	Hand Gun	0.0048	2.00000	2.25	420
	317453	648405	5496654	St. John's wort/Saint John's wort/ Goatweed (HYPE PER)	29/08/2016	Tordon 22K	Hand Gun	0.0167	7.00000	2.25	420
	317453	648405	5496654	Sulphur cinquefoil (POTE REC)	29/08/2016	Tordon 22K	Hand Gun	0.0024	1.00000	2.25	420
Luxor	316717	556077	5622317	Dalmatian toadflax (LINA DAL)	06/08/2016	Lontrel	Hand Gun	0.0020	0.40000	0.70	200
	316717	556077	5622317	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Hand Gun	0.0380	7.60000	0.70	200
	316718	556726	5622846	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.5000	100.00000	0.70	200
	316719	556665	5622993	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.1900	38.00000	0.70	200
	316720	556584	5622977	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.2000	40.00000	0.70	200
	316721	556344	5622635	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.0400	8.00000	0.70	200
	316722	556396	5622842	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.0500	10.00000	0.70	200
	316723	556455	5622910	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.0250	5.00000	0.70	200
	316724	555940	5622552	Spotted knapweed (CENT BIE)	06/08/2016	Lontrel	Boomless Nozzle	0.0500	10.00000	0.70	200
Lot 48	303131	582347	5570411	Diffuse knapweed (CENT DIF)	17/08/2016	Milestone	Hand Gun	0.0600	12.00000	0.40	200
	303131	582347	5570411	Spotted knapweed (CENT BIE)	17/08/2016	Milestone	Hand Gun	0.0900	18.00000	0.40	200
KRR	296198	588768	5548294	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0500	10.00000	0.20	200
	296199	588465	5549358	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.1250	25.00000	0.20	200
	296210	587956	5549020	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0750	15.00000	0.20	200
	296211	587867	5548775	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0100	2.00000	0.20	200
	296214	588046	5549171	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0550	11.00000	0.20	200
	302964	589226	5550179	Diffuse knapweed (CENT DIF)	31/08/2016	Clearview	Boomless Nozzle	0.1200	24.00000	0.20	200
	302964	589226	5550179	Spotted knapweed (CENT BIE)	31/08/2016	Clearview	Boomless Nozzle	1.0800	216.00000	0.20	200
	309732	587891	5548457	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0500	10.00000	0.20	200

	318109	589522	5542780	Diffuse knapweed (CENT DIF)	06/07/2016	Clearview	Boomless Nozzle	0.5750	115.00000	0.20	200
	318110	589988	5543156	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.3500	70.00000	0.20	200
	318111	589707	5543696	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.3000	60.00000	0.20	200
	318112	589773	5544403	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.2250	45.00000	0.20	200
	318113	589302	5545289	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.2000	40.00000	0.20	200
	318114	589966	5543730	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.1750	35.00000	0.20	200
	318115	589518	5544966	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.1500	30.00000	0.20	200
	318116	590088	5544182	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.0500	10.00000	0.20	200
	318117	589417	5544325	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.0500	10.00000	0.20	200
	318118	589362	5544197	Spotted knapweed (CENT BIE)	06/07/2016	Clearview	Boomless Nozzle	0.0500	10.00000	0.20	200
	318123	589085	5547277	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.2000	40.00000	0.20	200
	318124	588709	5549422	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.1250	25.00000	0.20	200
	318125	588650	5548604	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0750	15.00000	0.20	200
	318126	588736	5548831	Spotted knapweed (CENT BIE)	27/06/2016	Clearview	Boomless Nozzle	0.0250	5.00000	0.20	200
Marion	302968	578681	5566504	Spotted knapweed (CENT BIE)	28/06/2016	Milestone	Boomless Nozzle	0.1750	35.00000	0.40	200
	302970	577985	5565358	Spotted knapweed (CENT BIE)	03/08/2016	Milestone	Hand Gun	0.0750	15.00000	0.40	200
	318121	579318	5565152	Spotted knapweed (CENT BIE)	28/06/2016	Milestone	Boomless Nozzle	0.2250	45.00000	0.40	200
Mt Broadwood	242761	648065	5460673	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	2.5806	400.00000	0.14	155
	242767	644757	5459084	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	2.1500	430.00000	0.14	200
	242786	646396	5459282	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	0.3548	55.00000	0.14	155
	276384	645215	5469090	Spotted knapweed (CENT BIE)	13/09/2016	Milestone	Boomless Nozzle	0.5161	80.00000	0.29	155
	309801	646285	5459178	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	0.1935	30.00000	0.14	155
	309801	646285	5459178	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	0.3226	50.00000	0.14	155
	309801	646285	5459178	Yellow/common toadflax (LINA VUL)	12/08/2016	Clearview	Boomless Nozzle	0.3226	50.00000	0.14	155
	318328	643690	5458748	Burdock species (ARCT SPP)	12/08/2016	Clearview	Boomless Nozzle	0.1419	22.00000	0.14	155
	318328	643690	5458748	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	0.5677	88.00000	0.14	155
	318331	646434	5459047	Spotted knapweed (CENT BIE)	12/08/2016	Clearview	Boomless Nozzle	0.4839	75.00000	0.14	155
	318341	643527	5464973	Spotted knapweed (CENT BIE)	13/09/2016	Clearview	Boomless Nozzle	0.0968	15.00000	0.14	155
	318375	644953	5467466	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.0323	5.00000	0.29	155
	318384	644088	5465563	Spotted knapweed (CENT BIE)	13/09/2016	Clearview	Boomless Nozzle	0.0129	2.00000	0.14	155
	318387	644183	5465698	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.3548	55.00000	0.29	155
	318388	644497	5466460	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.3355	52.00000	0.29	155
	318389	644642	5467069	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.1935	30.00000	0.29	155
	318391	644516	5466624	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.1290	20.00000	0.29	155
	318392	644737	5467493	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.1290	20.00000	0.29	155
	318394	644126	5465638	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.0129	2.00000	0.29	155
	318395	644755	5467349	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.0129	2.00000	0.29	155
	318396	644066	5465594	Spotted knapweed (CENT BIE)	14/09/2016	Milestone	Boomless Nozzle	0.0129	2.00000	0.29	155
Thunderhill	243650	579233	5561946	Burdock species (ARCT SPP)	04/08/2016	Milestone	Hand Gun	0.0150	3.00000	0.40	200

	243650	579233	5561946	Diffuse knapweed (CENT DIF)	04/08/2016	Milestone	Hand Gun	0.0150	3.00000	0.40	200
	243650	579233	5561946	Spotted knapweed (CENT BIE)	04/08/2016	Milestone	Hand Gun	0.1200	24.00000	0.40	200
Pine Butte	296119	580965	5499461	Spotted knapweed (CENT BIE)	17/09/2016	Milestone	Boomless Nozzle	0.0750	15.00000	0.40	200
	296119	580965	5499461	Sulphur cinquefoil (POTE REC)	17/09/2016	Milestone	Boomless Nozzle	1.4250	285.00000	0.40	200
	296123	579973	5499478	Spotted knapweed (CENT BIE)	24/08/2016	Milestone	Boomless Nozzle	0.0725	14.50000	0.40	200
	296123	579973	5499478	Sulphur cinquefoil (POTE REC)	24/08/2016	Milestone	Boomless Nozzle	1.3775	275.50000	0.40	200
	296125	580978	5499985	Sulphur cinquefoil (POTE REC)	07/08/2016	Milestone	Boomless Nozzle	0.6500	130.00000	0.40	200
	303194	580449	5500554	Sulphur cinquefoil (POTE REC)	25/08/2016	Milestone	Boomless Nozzle	1.4750	295.00000	0.40	200
	318065	580829	5499790	Sulphur cinquefoil (POTE REC)	21/09/2016	Milestone	Boomless Nozzle	1.5000	300.00000	0.40	200
	318092	579762	5498439	Chicory (CICH INT)	07/08/2016	Milestone	Hand Gun	0.0015	0.30000	0.40	200
	318092	579762	5498439	Spotted knapweed (CENT BIE)	07/08/2016	Milestone	Hand Gun	0.1485	29.70000	0.40	200
	318093	580378	5498536	Spotted knapweed (CENT BIE)	07/08/2016	Milestone	Boomless Nozzle	0.1000	20.00000	0.40	200

Table 4. East Kootenay conservation properties and associated land managers which were prioritized for invasive plant management in 2016 (NCC properties highlighted in green).

Property	Land Manager	Area Treated (ha)	Manual/ Biocontrol/ Inventory $
Armstrong	TNT	0.175	
Big Ranch	TNT	5.288	
Bummer's Flats	TNT/MFLNRO	2.615	1710.00
Cherry Creek	TNT	0.450	In-Kind
Columbia Lake East	MFLNRO	2.125	
Columbia Lake East Provincial Park	BC Parks	0.225	
Columbia Lake Westside	TNT	1.015	
Dry Gulch Provincial Park	BC Parks	0.875	
Earl Ranch	MFLNRO	0.175	
Elk Valley	NCC	0.337	
Hoodoos	NCC/TNT	0.900	
Kikomun Provincial Park	BC Parks	7.512	
Kootenay River Ranch	NCC	4.115	
Lot 48	NCC	0.150	
Lower Norbury Creek	TNT	3.650	
Luke Creek	NCC	Inventory	250.00
Luxor Linkage	NCC	1.095	500.00
Marion Creek	NCC	0.566	750.00
Mt. Broadwood/ Wigwam	NCC	18.176	
Norbury Provincial Park	BC Parks	0.062	250.00
Pine Butte	NCC	6.925	
Red Barn	MFLNRO	0.600	
Sheep Mountain (Cutts)	TNT/MFLNRO	4.000	
Starr	MFLNRO	1.150	
Sun Lakes	MFLNRO	0.150	
Thunder Hill	NCC	0.850	
Wasa Provincial Park	BC Parks	0.152	
Wasa Slough	TNT	0.020	500.00
Wycliffe	MFLNRO	3.730	

Task 4: Kootenay River Ranch Ecosystem Restoration

Background

NCC has been progressively implementing recommendations, guided by a Vegetation Management Plan (2007) from the Kootenay River Ranch Property Management Plan (2010). The objective of ecosystem restoration is to re-create open habitats, encourage the development of mature, large-diameter trees, and affect a shift in species composition towards plant communities that were historically characteristic of the site. Using a variety of innovative silvicultural techniques, approximately 300 hectares have been treated to date with another 140 hectares of follow-up maintenance treatments conducted to restore ecosystems that are resilient to climate change. Completion of treatments on Treatment Unit 8A would result in approximately a contiguous 190ha of area restored to open forest conditions and available for a prescribed burn regime.

Goals & Objectives

Map and summary report of actions completed to restore open forests and grassland on Kootenay River Ranch.

Objectives	Status	Comments
Work with professional forester to develop treatment options and oversee implementation.	Complete	Prescription considers possible future logical burn boundary for prescribed fire.
Work with forestry contractors to implement ER prescription.	Completed	Slashing treatments for approx. 20 ha were conducted during winter season.
Work to keep costs low by exploring revenue recovery options.	On-going	Discussions for possible timber harvest to further restoration goals on-going with Canfor representatives.
Work with professional forester to develop treatment options and oversee implementation.	Complete	Prescription considers possible future logical burn boundary for prescribed fire.

Study Area

Kootenay River Ranch (KRR) is a long, narrow 1,340ha (3,311ac) property located between Canal Flats and Skookumchuck, BC. The property lies east of the Kootenay River and either straddles or is adjacent to Highway 93/95 for approximately 11 km.

Methods

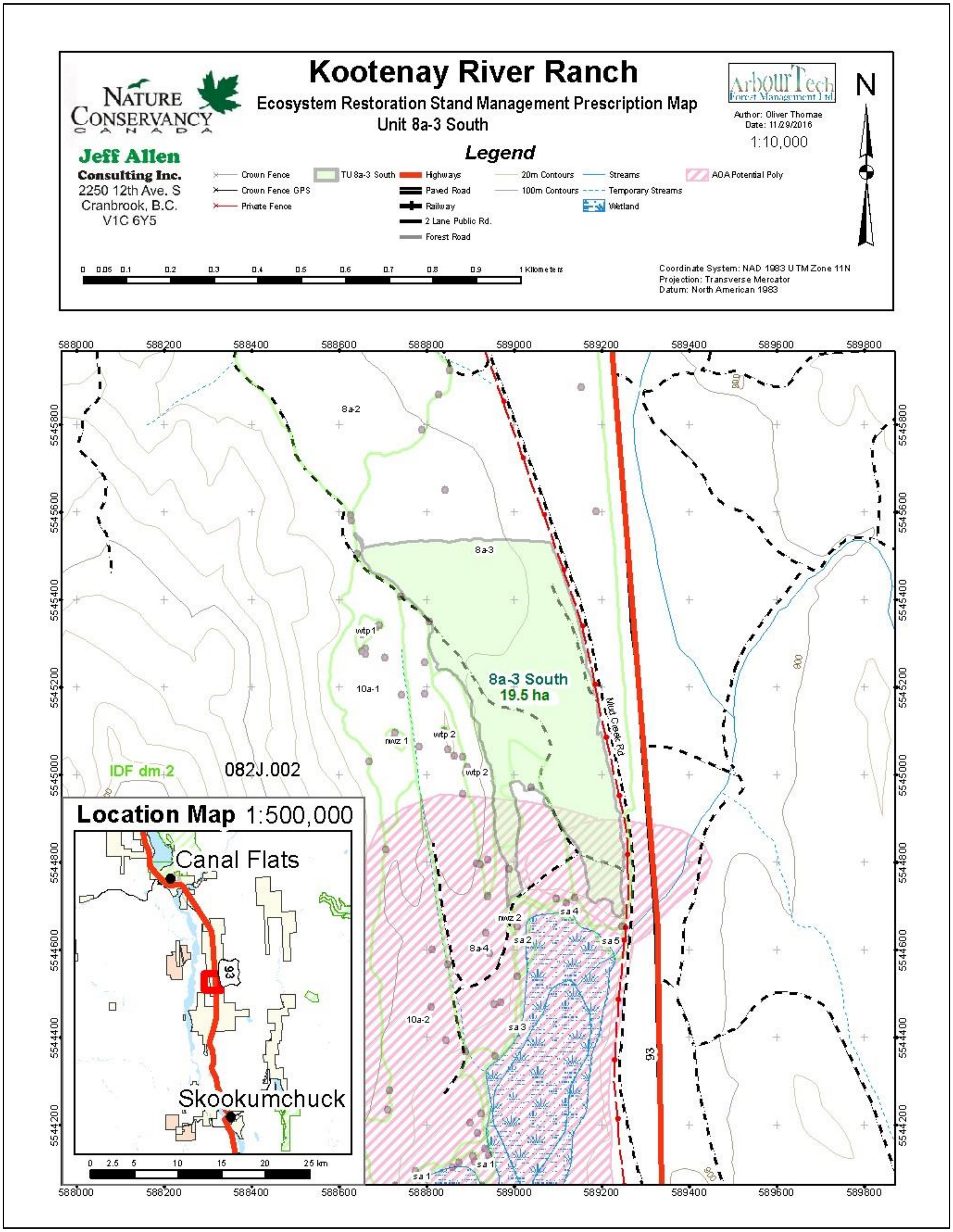
A restoration forester prepared a detailed habitat restoration prescription for implementation.

A forestry contracting firm conducted slashing treatments using a combination of chainsaws and brushing equipment.

Results

Approximately 19.5 ha were treated to an Open Forest condition (see Map).

Map


Kootenay River Ranch
Ecosystem Restoration Stand Management Prescription Map
Unit 8a-3 South
Nature Conservancy Canada
Jeff Allen Consulting Inc.
2250 12th Ave. S
Cranbrook, B.C.
V1C 6Y5
ArbourTech Forest Management Ltd
Author: Oliver Thomae
Date: 11/29/2016
1:10,000
N
Legend
Crown Fence
Crown Fence GPS
Private Fence
TU 8a-3 South
Highways
Paved Road
Railway
2 Lane Public Rd.
Forest Road
20m Contours
100m Contours
Streams
Temporary Streams
Wetland
AOA Potential Poly
0 0.05 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 Kilometers
Coordinate System: NAD 1983 UTM Zone 11N
Projection: Transverse Mercator
Datum: North American 1983
8a-2
8a-3
8a-3 South
19.5 ha
Mud Creek Rd
wtp 1
wtp 2
10a-1
nwz 1
nwz 2
IDF dm 2
082J.002
sa 1
sa 2
sa 3
sa 4
sa 5
8a-4
10a-2
93
Location Map 1:500,000
Canal Flats
Skookumchuck
0 2.5 5 10 15 20 25 km

Recommendations

A total of 322 ha of restoration treatments have now been accomplished on Kootenay River Ranch. The Vegetation Management Plan recommends treating a total of approximately 919 ha in order to achieve ecosystem restoration goals by providing grassland and open forests that are resilient to climate change, provide habitat for species at-risk, and reduce the probability of a catastrophic wildfire in the region. Continued treatments are recommended to achieve these goals and also provide a burn unit with fire guards for a possible prescribed burn in the future.

Task 5: Cherry Meadows Wetland Creation Project

Introduction

Wetland and stream restoration projects are proposed to help compensate for similar habitats that were inundated by reservoirs constructed along the Columbia River in the Kootenay Region. A wetland restoration project was identified on the Cherry Meadows property. It is very possible to restore this human-altered wet meadow so it looks and functions like a natural ecosystem supporting a variety of wetlands and related terrestrial habitats. In order to proceed with a wetland creation project, NCC worked with Thomas Biebighauser and Robin Annschild to develop a detailed project and design for the Cherry Meadows wetlands.

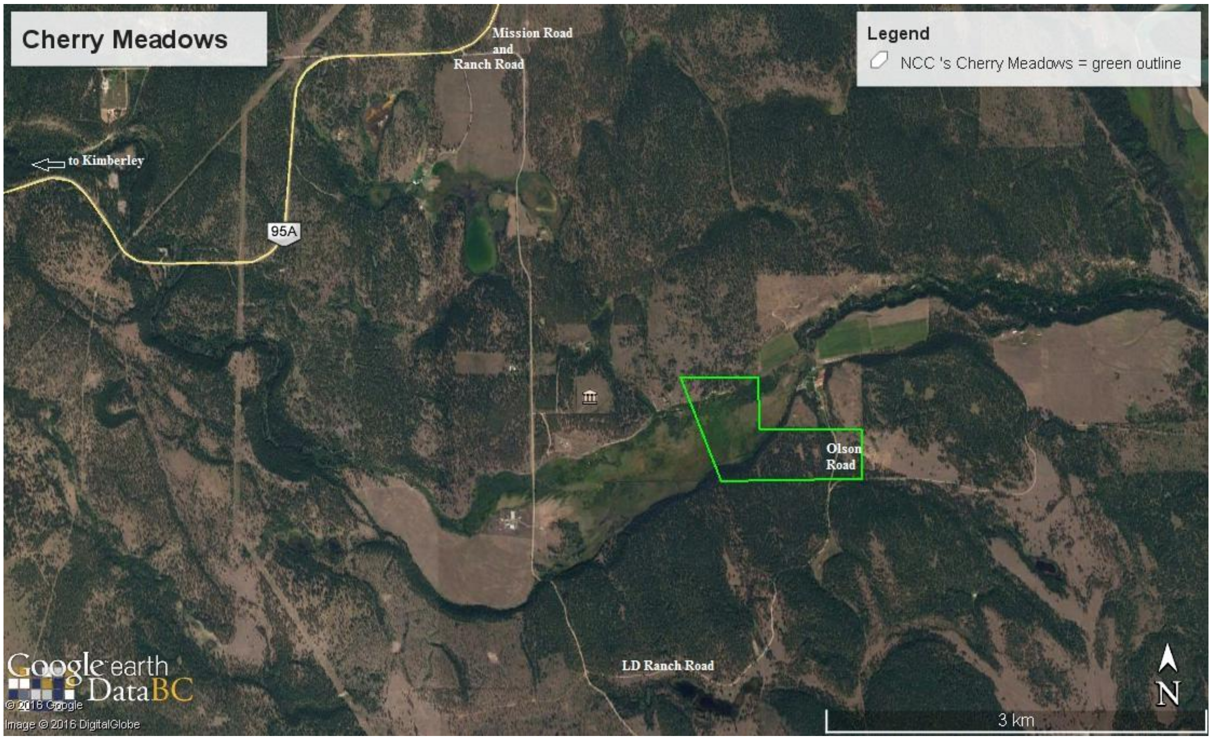
Goals & Objectives

Summary report of wetland creation prescription and recommendations provided by wetland specialist.

Objectives	Status	Comments
Identified wetland restoration projects at Cherry Meadows	Complete	See *Cherry Meadows Wetland Restoration Project* report in Appendix
Designed and marked wetland restoration projects at Cherry Meadows	Complete	See *Cherry Meadows Wetland Restoration Project* report in Appendix
Prepared an itemized budget for implementing wetland restoration projects at Cherry Meadows	Complete	See *Cherry Meadows Wetland Restoration Budget* in Appendix
Prepared a detailed report with photos and recommendations for the restoration of wetlands at Cherry Meadows	Complete	See *Cherry Meadows Wetland Restoration Project* report in Appendix

Study Area

The 70 hectare (172.5 acre) Cherry Meadows property is located approximately 15 km east of Kimberley on the benchlands west of the Kootenay River. The property is located immediately north of the St. Mary's Reserve 10 kilometers north of Cranbrook.



Methods

Wetland restoration projects were identified in the old farm fields at Cherry Meadows. The areas selected were drained using ditches, showing they were once wetlands. Most of the wetland restoration sites were also shallow basins that had been modified by filling and draining. The following types of wetlands would be restored: Emergent, Ephemeral, and Wet-Meadow.

Sites were selected for wetland restoration where slopes were gradual, groundwater was near the surface, and soil texture was high in clay. Slopes were measured using a laser level. Each wetland restoration site was selected to have no more than a 50cm change in elevation from upper to lower edge.

For a more detailed description of Methods see *Cherry Meadows Wetland Restoration Project* report in Appendix.

Results

The Cherry Meadows Wetland Restoration Project would restore over 40-acres of emergent, ephemeral, and wet-meadow wetlands by filling ditches, removing fill, and reshaping natural contours on the landscape. The project would restore key features of natural wetlands, including flow from springs, the elevation of groundwater, presence of shallow water depressions, hydric soils, non-compacted soils, tufts, mounds, ridges, and native wildflowers, shrubs, and trees that were present before drainage took place.

Thirteen wetland projects were identified over the Cherry Meadows project area. These thirteen wetland design forms are available upon request.

Recommendations

Based on the findings and report by Thomas Biebighauser and Robin Annschild, NCC will pursue additional funding through the National Wetlands Conservation Fund, and other partners including FWCP in 2017 to implement the project. NCC recognizes the support for wetland creation and enhancement from FLNRO-FWCP and we hopeful that this initiative will be funded in 2017/18.

Map

See *Cherry Meadows Wetland Restoration Project* report in Appendix.

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Kanda, N.,R.F. Leary and F.W. Allendorf. 2002. Evidence of Introgressive Hybridization between Bull Trout and Brook Trout. Transactions of the American Fisheries Society 131:772-782.

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Acknowledgements

The Nature Conservancy of Canada would like to acknowledge the financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders.

Appendices

Appendix 1. *Laib Creek Brook Trout Eradication Feasibility Sampling 2016, prepared by Amec Foster Wheeler Environment and Infrastructure.*

Appendix 2. *Cherry Meadows Wetland Restoration Project Report, prepared by Thomas Biebighauser and Robin Annschild*

Appendix 3. *Cherry Meadows Wetland Restoration Budget, prepared by Thomas Biebighauser and Robin Annschild*

Nature Conservancy of Canada

Laib Creek Brook Trout Eradication Feasibility Sampling – 2016

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
Suite 601E, 601 Front St.
Nelson, BC

21 November 2016

FINAL

Laib Creek Brook Trout Eradication Feasibility Sampling

2016

FINAL

Submitted to:

The Nature Conservancy of Canada
#200-825 Broughton St., Victoria, British Columbia

Submitted by:

Amec Foster Wheeler Environment & Infrastructure
Suite 601E, 601 Front St., Nelson, British Columbia

21 November 2016

VE52564.2016

IMPORTANT NOTICE

Suggested Citation: Amec Foster Wheeler. 2016. Laib Creek Eastern Brook Trout Eradication Feasibility Sampling. Report Prepared for the Nature Conservancy Canada. 12 pp. + 2 App.

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Acknowledgements

The following people are gratefully acknowledged for assistance and information contributions during this study:

Nature Conservancy of Canada

Adrian Leslie, South Selkirk Project Manager, Nelson, BC

The following employees of **Amec Foster Wheeler Environment & infrastructure Ltd.** contributed to the collection of data and preparation of this report:

Louise Porto, MSc., R.P.Bio.	Senior Aquatic Habitat Biologist, Author
Crystal Lawrence, BSc., R.P.Bio.	Aquatic Biologist, Author
Matthew Yuen	GIS

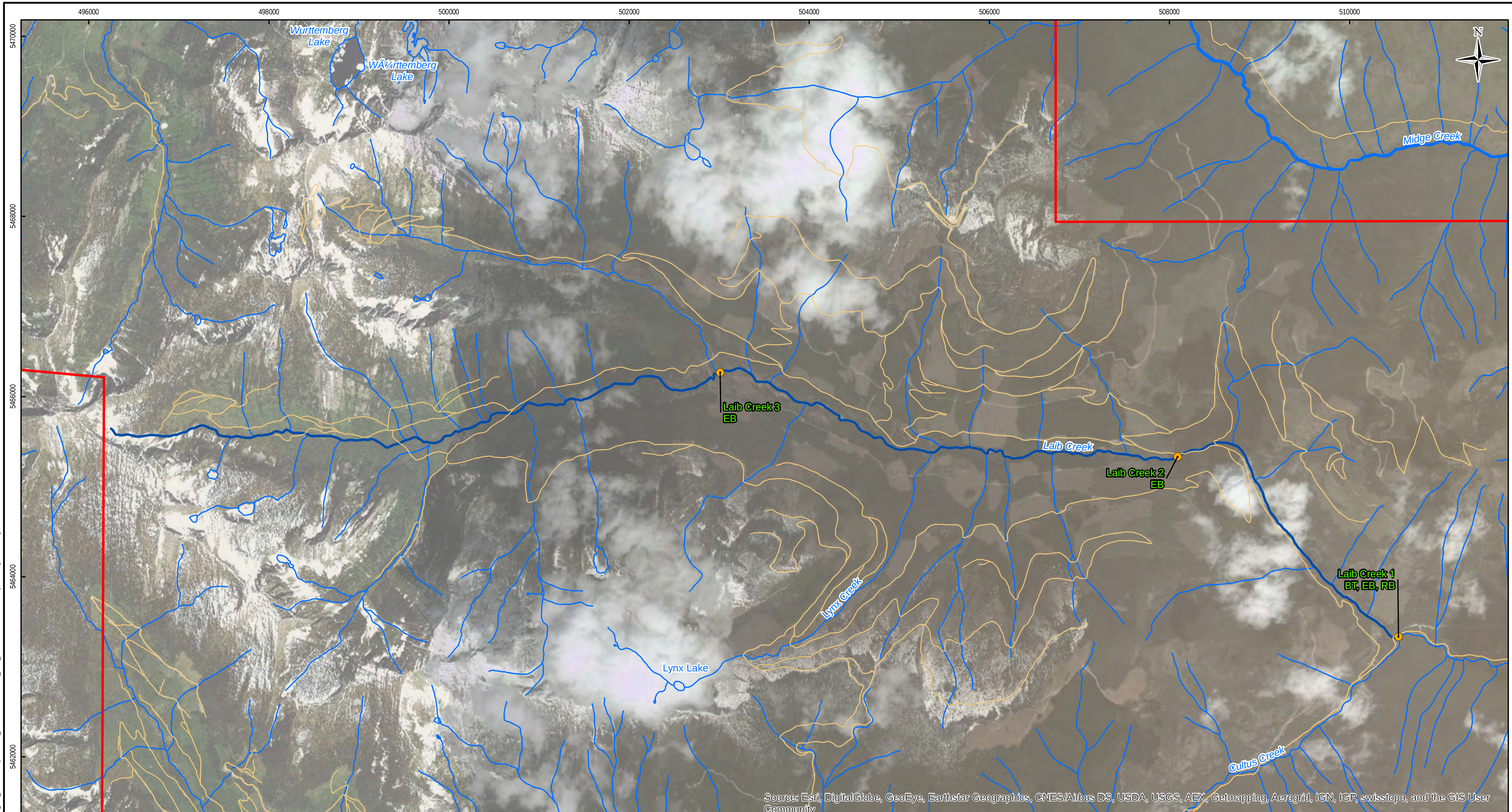
1 INTRODUCTION

Darkwoods Conservation Area (herein referred to as Darkwoods) is a 55,200 ha property in the West Kootenay District of the Southern Selkirk Mountain's Nelson Range situated in the triangle between Nelson, Salmo and Creston and bordered by West Arm Provincial Park, the Midge Creek Wildlife Management Area, and the Creston Valley Wildlife Management Area (NCC 2010). The property was purchased in 2008 by the Nature Conservancy of Canada (NCC) in partnership with the Fish and Wildlife Compensation Program (FWCP) – Columbia Basin and covers 12.5% of the South Selkirk Natural Area (SSNA), a 400,000 ha area that contains diverse ecosystem types and ecologically sensitive areas, the highest density of nesting ospreys (*Pandion haliaetus*) in Canada and threatened mountain caribou (*Rangifer tarandus caribou*) (NCC 2010; FWCP 2012). There are over 130 small lakes and interconnecting streams that are home to native Bull Trout (*Salvenlinus confluentus*), Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) and Rainbow Trout (*Oncorhynchus mykiss*) as well as non-native Eastern Brook Trout (*Salvelinus fontinalis*) (herein referred to as Brook Trout).

Native fish populations are a biodiversity target on the Darkwoods property, but there is limited knowledge of occurrence, distribution and abundance (Irvine 2014). To fill some of these data gaps, sampling was conducted in 2015 to identify fish species presence within the Cultus Creek watershed including Laib Creek (Amec Foster Wheeler 2016). At that time, Brook Trout, Bull Trout and Rainbow Trout were captured in the lowest approximately 100 m of the creek immediately upstream of the confluence with Cultus Creek while only Brook Trout were found in sample sites further upstream (Amec Foster Wheeler 2016). Brook Trout are a non-native species that may displace or hybridize with native Bull Trout due to competitive interactions (e.g., Rieman et al. 2006, Peterson et al. 2008, Warnock and Rasmussen 2013). Isolated Bull Trout populations are at risk of local extinction from their displacement by Brook Trout and/or sterilization by the creation of hybrids of the two species (Rieman et al. 2006). Prevention and management of Brook Trout invasions is a focus of native fish conservation plans in western Canada and the United States.

The overall objective of this project was to conduct a preliminary evaluation for the feasibility of suppressing or eradicating Brook Trout from Laib Creek. Specific objectives included:

1. Review of Brook Trout eradication methodology used and its applicability to Laib Creek;
2. Determine basic population dynamics of Brook Trout (and native species if possible) in an index section of Laib Creek;
3. Determine the capture probability, efficiency, relative abundance and density of Brook Trout in an index section of Laib Creek; and,
4. Conduct removal of any Brook Trout encountered during project sampling.



Legend

- Highway
- Existing Road
- Laib Creek
- Streams
- Waterbody
- Darkwoods Property Boundary
- Site Name

EB = Eastern Brook Trout
RB = Rainbow Trout
BT = Bull Trout

Scale: 1:40,000

0 0.5 1 2

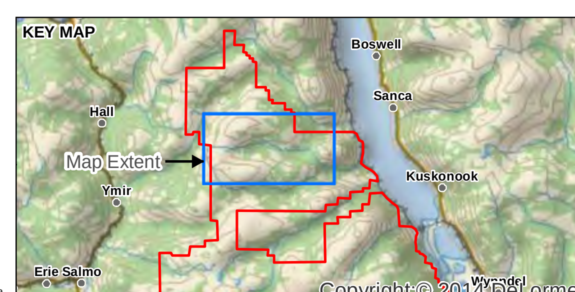
Kilometers

Reference:

DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)

Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)

KEY MAP



CLIENT:

Nature Conservancy Canada

PROJECT:

Darkwoods

TITLE:

Overview of Laib Creek within the NCC Darkwoods Conservation Area

DATE:	ANALYST:	QA/QC:	
November, 2016	MY	LP	Figure 1

GIS FILE: 02-01-005_Laib_Creek

JOB No: VE52564

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

amec foster wheeler

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2 METHODS

2.1 Study Area and Site Selection

Laib Creek is a 15.7 km long 3rd order stream. Laib Creek drains into Cultus Creek which enters Kootenay Lake approximately 5.5 km downstream. Two sites were targeted for Brook Trout eradication feasibility monitoring: Laib_Creek_1 and Laib_Creek_2. Preliminary sampling occurred at these sites in October 2015 (Amec Foster Wheeler 2016).

Laib_Creek_1 is located immediately upstream of the confluence with Cultus Creek and extends upstream to the Porcupine Forest Service Road Bridge. The site length in 2016 was 40 m, stream width was approximately 5 m and habitat was step-pool with large boulder substrate.

Laib_Creek_2 is located approximately 4 km upstream of the confluence with Cultus Creek, upstream of the Laib Road Bridge. The site length in 2016 was 75 m, stream width was approximately 12 m and the habitat was riffle-pool with cobble/boulder substrates (**Appendix A**, **Plate 1** to **Plate 3**). Abundance sampling occurred only in Laib_Creek_2 in 2016 and is herein referred to as the treatment reach.

2.2 Fish Capture & Processing

The following methods were used to evaluate fish abundance at the treatment site (i.e., Laib_Creek_2). Abundance sampling had been proposed for Laib_Creek_1, but abundance sampling was discontinued because of the low fish density encountered.

Fish sampling was conducted by a two-person crew equipped with a Smith-Root LR-24 backpack electrofisher. Electrofisher settings were determined based on the current conductivity and kept consistent for the duration of sampling. One crew member operated the electrofisher and the other member was responsible for netting stunned fish. An initial electrofishing survey was conducted on August 8, 2016 (Day 1) to collect samples for the mark-recapture portion of the study. Stunned fish were transferred to a bucket and allowed to recover prior to processing. Fish processing included recording the fish species, fork length (to nearest mm) and weight (to nearest g). The left pelvic fin was then removed to identify the fish as “marked”; the fin tissue was preserved in ethanol to facilitate future DNA analysis. Fish were transferred to live-wells and held in the stream overnight.

The following day, a block net was installed at the downstream end of the treatment site. Block net panels were 4 m in length and 1.5 m in height with approximately 1 mm (stretched measure) nylon mesh. Panels were secured together with zap straps to create a continuous barrier across the width of the channel; the ends of the nets were tied to a tree on either bank. Rebar was used to keep the top of the net above the water surface and provide additional support against the current. Large cobbles and small boulders were placed along the bottom of the entire net along the upstream side to secure it in place and prevent fish passage underneath. A block net was not installed at the upstream end of the site due to a lack of nets. An upstream end point was chosen where Brook Trout habitat was limited and few fish had been captured during the preliminary fish capture pass.

Marked fish that had been held overnight were released into the site and allowed to disperse for approximately 30 minutes. Three backpack electrofishing removal passes were performed, keeping electrofishing settings and effort as consistent as possible between each subsequent pass. Following each pass, fish were inspected for a mark (pelvic fin removed), marked fish were noted and new fish were processed as above. All fish were then euthanized, inspected for sexual maturity and otoliths were removed for future aging, if warranted.

Water temperature (°C), pH and conductivity (µs) were measured using a handheld Oakton Mult-Parameter PCTestr 35. The accuracy of the meter for temperature is ±0.5°C, pH is ± 0.1 and conductivity is ± 1%.

2.3 Data Analysis

Fish sampling data was digitized and reviewed for data entry errors. Catch-per-unit-effort (CPUE) was calculated for each species at each location by comparing the number of fish captured to the number of electrofishing seconds used. Descriptive statistics including mean and standard deviation were used to explore length and weight data using Excel. Length-weight was plotted in Excel and a 3^{rd} order polynomial trendline was fit to the data. Length data was converted to a relative frequency histogram by evaluating the number of fish at each 10 mm length increment by the total number of fish captured.

Total abundance (N) was calculated using the Lincoln-Peterson model with Chapman correction as outlined in Krebs (2015):

$$N = [(M+1)\ (C+1) / R+1]\ - 1$$

Where:

N = the size of the population at time of marking;

M = the number of marked individuals in the first sample;

C = the total number of individuals captured in the second sample;

R = the number of marked individuals in the second sample (i.e., recaptures).

Upper and lower 95% confidence intervals (CI) were calculated as outlined in Krebs (2015) using binomial methods as the fraction of marked animals to total number captured in second sample (R/C) was >0.10.

The numbers of marked fish recovered during sampling were used to estimate capture efficiency, which was defined as the proportion (or percentage) of fish in a given area that are captured during sampling (Peterson et al. 2004). Capture efficiency was calculated as: E = (R/M)*100 %

3 RESULTS

All fish capture, site location and effort data is provided in **Appendix B**.

3.1 Capture and Abundance

Fish captures and effort are summarized in **Table 3.1-1**: Triple Pass Depletion and Mark-Recapture of Brook Trout within the treatment site (Laib_Creek_2), 8-9 August 2016. Fish capture at Laib_Creek_1 was too low to conduct an abundance survey at the time of sampling therefore only one electrofishing pass and no marking was conducted at this site (**Table 3.1-1**: Triple Pass Depletion and Mark-Recapture of Brook Trout within the treatment site (Laib_Creek_2), 8-9 August 2016).

A total of 21 Brook Trout were captured during the first survey within the treatment reach (i.e., Laib_Creek_2); no other fish species were captured. Fifteen of the Brook Trout were marked and released into a 75 m treatment site after being held overnight to facilitate the mark-recapture abundance estimate. During the triple pass depletion electrofishing survey that followed, a combined total of 29 Brook Trout were captured in the treatment site of which eight fish had marks. **Table 3.1-1**: Triple Pass Depletion and Mark-Recapture of Brook Trout within the treatment site (Laib_Creek_2), 8-9 August 2016 summarizes the number of marked and total number of Brook Trout captured during three consecutive electrofishing passes.

The abundance of Brook Trout in the treatment area was 52 (32-107 95% CI) and fish density was 0.06 fish/m^2. The overall capture efficiency using triple pass depletion methods was 53%, whereas the capture efficiency using only a single pass was 40%.

Table 3.1-1: Triple Pass Depletion and Mark-Recapture of Brook Trout within the treatment site (Laib_Creek_2), 8-9 August 2016

Site Name	Depletion Pass	Electro-fishing Seconds	Fish Capture									
			Brook Trout			Bull Trout		Rainbow Trout		Total	
			Catch	Marks	CPUE	Catch	CPUE	Catch	CPUE	Catch	CPUE
Laib_Creek_1	N/A	624	3	0	0.005	1	0.002	1	0.002	5	0.008
Laib_Creek_2	N/A	2,314	21	0	0.009	0	0	0	0	21	0.009
Laib_Creek_2 Treatment	1	835	15	6	0.018	0	0	0	0	15	0.018
Laib_Creek_2 Treatment	2	754	10	2	0.013	0	0	0	0	10	0.013
Laib_Creek_2 Treatment	3	765	4	0	0.005	0	0	0	0	4	0.005

Note: CPUE = Catch-per-unit-effort and was calculated as the number of fish captured per second of electrofishing effort.

3.2 Length, Weight, and Age

Captured Brook Trout ranged from 49 to 225 cm FL and 0.8 to 119 g in weight (**Figure 3.2-1**). The average length of Brook Trout captured within the treatment site (n=42) was 111.2 mm (SD±34.7) and the average weight was 19.3 g (SD±25.0).

The length frequency distribution suggests the population within the treatment site primarily consists of an age class of fish between 71 and 140 mm fork length (**Figure 3.2-2**). Given the other sizes observed, it is likely that this is the age-1 cohort and the one smaller fish is representative of the age-0 cohort while those >161 are the age-2 and older fish (**Figure 3.2-2**). Otoliths were removed from 3 fish >168 mm fork length, but have not be aged at this time to confirm age class estimations. One male (200 mm fork length) and two females (168 mm and 201 mm fork length) were identified by the presence of mature gonads. The fecundity of one female Brook Trout (201 mm fork length) was 245 eggs with an average diameter of 2.5 mm (**Appendix B**, **Plate 4**).

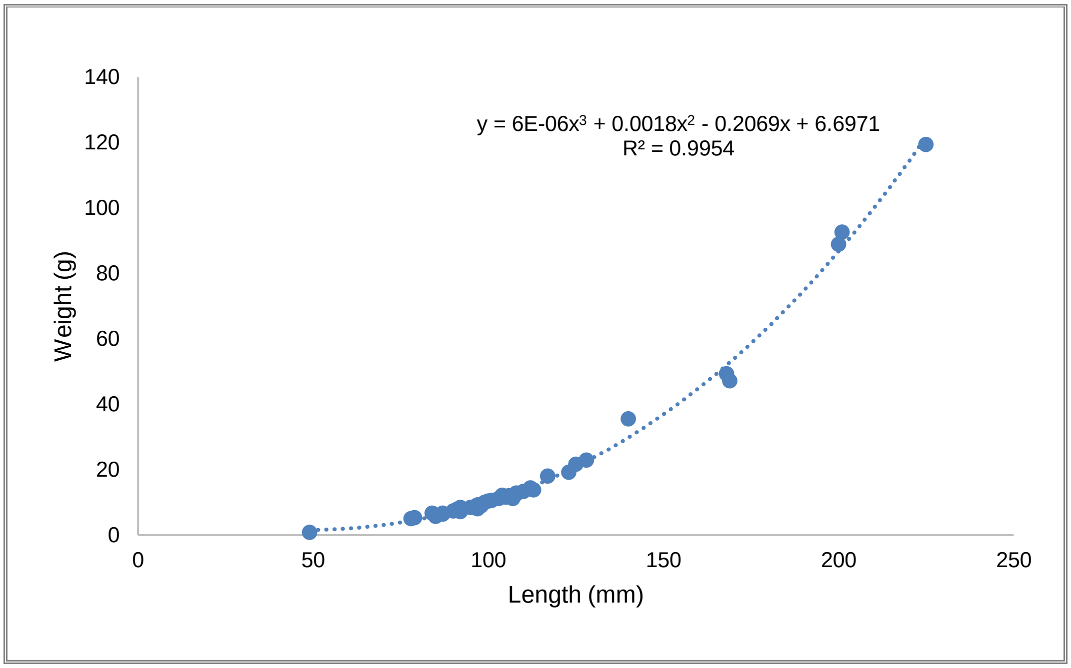

Figure 3.2-1: Length-weight Relationship of Brook Trout Captured within the Treatment Site (Laib_Creek_2), August 2016

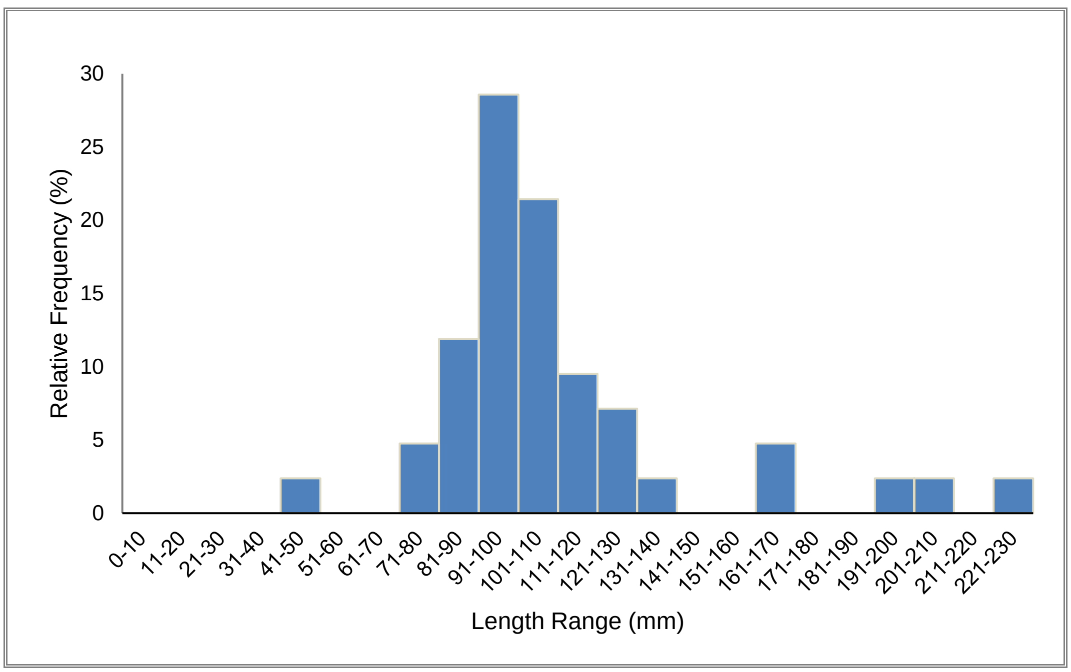

Figure 3.2-2: Relative Length Frequency Histogram of Brook Trout Captured within the Treatment Site (Laib_Creek_2), August 2016

4 DISCUSSION

The present study was undertaken as a first step to understand fish population dynamics in Laib Creek, while removing Brook Trout from the treatment area. During this study, Brook Trout were observed in low densities (0.06 fish/m^2) with an estimated abundance of 52 individuals in the 900 m^2 treatment site. Upstream abundances may also be similar based on catch-rates observed in 2015 (Amec 2015). Observed densities of Brook Trout have ranged from 0.8-11.3 fish/m^2 prior to undertaking suppression programs in small rocky mountain streams (e.g., Thompson and Rahel 1996, Peterson et al. 2004). Capture efficiency of Brook Trout in Laib Creek was 0.53 and was within the range observed during suppression studies conducted in high elevation streams (e.g., 0.25-0.97 Peterson et al. 2004). The majority of individuals captured in 2016 were likely age-1 fish with few sexually mature adults and only one YOY observed.

Although native Bull Trout and Rainbow Trout were observed in the confluence area of Laib Creek during sampling conducted in 2015 and 2016, Brook Trout were the only species found above 4 km. However, areas of Laib Creek between 0.5 and 4 km were inaccessible from the road and could not be sampled therefore fish distribution in this section is unknown. The steep, step-pool habitats of Laib Creek in this section may be a migration barrier (A. Leslie, pers. comm., 2016). It is unknown at this time whether Brook Trout have displaced native salmonids from these upper sections or if they were introduced because the area was fishless due to the likely migration barrier. Genetics testing of samples collected in 2016 may help identify if there are any Bull Trout x Brook Trout hybrids to help confirm if native Bull Trout were ever present in the upstream reaches of Laib Creek.

Brook Trout eradication and suppression programs can be onerous, and have encountered mixed success. Successful non-native control programs typically result in a pulse of recruitment by native trout, but the pulse may be absent or undetectable unless several successive years of suppression have occurred (references cited in Peterson et al. 2008). Consistent, repeated suppression is required to interrupt the recruitment cycle by removing adults prior to spawning and removing age-0 fish after they are large enough to be effectively captured by electrofishing, since Brook Trout populations can quickly recover when suppression ceases especially when movement from untreated stream reaches is possible (Peterson et al. 2008, Shepherd et al. 2014).

Peterson et al. (2008) use field data and matrix population models for small central rocky mountain streams with mean summer temperatures of 8-12°C (similar to Laib Creek) to evaluate the effectiveness of Brook Trout suppression. They found that the most effective treatment was 3 years of single pass electrofishing suppression treatment followed by no more than 2-3 years without suppression. Lower frequency, single pass suppression efforts were generally preferred, but effectiveness depends on capture efficiency, Brook Trout immigration rates, and local demographic parameters. For example, electrofishing suppression was most cost effective when travel time was <4 hours and capture efficiency was high (>0.6) over all levels of Brook Trout immigration. However, two pass electrofishing was recommended when travel time was high and capture efficiency is low (Peterson et al. 2008).

Eradication of a non-native Brook Trout population from a 15 km section of stream in Oregon was successful and resulted in an approximately 10-fold increase in imperiled Bull Trout abundance (Buktenica et al. 2013). However, the effort required was large, including installation of barriers to prevent Brook Trout re-introduction, and culling using both electrofishing and a piscicide treatment (Buktenica et al. 2013). Total effort was approximately 138 person days per kilometre of stream treated. Shepherd et al. (2014) successfully eradicated Brook Trout from small rocky mountain streams (wetted widths 1.2-2.6 m) over a period of 4-8 years (total of 10.8 km) using multiple EF passes per treatment. Efforts included between 64 and 171 person-days per treatment reach and the costs ranged from $3,500-$5,500/km of stream; costs were higher for larger streams because they required more removal efforts. Effort included using 2-3 person crews whom camped near the treatment sites to eliminate travel.

Although sampling biases occurred during the present program (e.g., no upper block net to prevent immigration into or out of the treatment area, short time period for dispersion of marked fish) and the small size of the treatment area may not demonstrate any direct effect of removal, the objectives of this project were met and information can be used to generate a suppression program, if warranted. However, it is likely that suppression efforts in Laib Creek will be high. Laib Creek is approximately 15.7 km long and the extent and source (for example, upstream lake or lakes) of the Brook Trout invasion in unknown. Travel time to the Laib Creek treatment reach, the first direct access to Laib Creek upstream of the confluence, took approximately 2 hours from Nelson, BC. Total effort to conduct triple-pass electrofishing removal (includes set up of one block net and fish processing) with a two-person crew in the 75 m treatment section required approximately 7 hours exclusive of travel time. This resulted in the removal of 29 Brook Trout. Other factors that increase the effort required to eradicate Brook Trout from Laib Creek include stream width >3 m, large woody debris and step-pool habitats that decrease catchability and accessibility issues.

Future management of non-native Brook Trout in Laib Creek (and perhaps in other watersheds on the Darkwoods property) requires consideration of whether this species needs to be eradicated or supressed from upper watershed areas when native species may not be present. The suppression of Brook Trout may be warranted in areas directly overlapping with native species or directly upstream of these areas to prevent Brook Trout immigration and potential displacement and hybridization with native species.

5 RECOMMENDATIONS

The following are recommendations based on the results of this project:

1. Determine management objectives for Brook Trout in Laib Creek.
2. Conduct post-treatment monitoring in Laib Creek to determine dynamics of fish recolonization.
3. Collect additional DNA samples from Brook Trout and native salmonid species in overlapping sections of Laib Creek and conduct genetics analysis on DNA samples from those also collected in treatment reach to determine if pure Brook Trout stock or if any hybrids are present.
4. Conduct age analysis on otolith structures collected to help identify age and growth information for the Brook Trout population in Laib Creek if further suppression efforts are undertaken. These parameters are required to compare age-at-maturity and growth rates between native and non-native populations to aid in suppression activities (e.g., interval between removal). Brook Trout may have a competitive advantage if they mature earlier and occur in higher densities than native salmonid species (Rieman et al. 2006).

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Appendix A

Photographs

Plate 1: Laib Creek treatment site downstream blocknet, 9 August 2016. Photo taken facing downstream.

Plate 2: Laib Creek treatment site, 9 August 2016. Photo taken facing upstream.

Plate 3: Laib Creek treatment site, 9 August 2016. Photo taken facing downstream.

Plate 4: Mature female Brook Trout sampled from the Laib Creek treatment site, 9 August 2016.

Appendix B

Fish Capture Data

Field Site Name	Water Temperature (°C)	Conductivity (μs)	pH	Survey Method	Date	Start Time	Date	End Time	EF Volts	EF Seconds	EF Pass	Common Name	Length (mm)	Weight (g)	Sex	DNA	Otolith	Marked and Released	Recaptured Mark	Comments
Laib_Creek_1	11.7	76	8.8	EF	8-Aug-16	12:20	8-Aug-16	12:50	600	624	-	Eastern Brook Trout	118	15.5	Unknown	Yes	1	-	-	Photo of dorsal
Laib_Creek_1	11.7	76	8.8	EF	8-Aug-16	12:20	8-Aug-16	12:50	600	624	-	Rainbow Trout	96	9.7	Unknown	No	0	-	-	
Laib_Creek_1	11.7	76	8.8	EF	8-Aug-16	12:20	8-Aug-16	12:50	600	624	-	Bull Trout	151	30.7	Unknown	No	0	-	-	
Laib_Creek_1	11.7	76	8.8	EF	8-Aug-16	12:20	8-Aug-16	12:50	600	624	-	Bull Trout	131	22.6	Unknown	No	0	-	-	
Laib_Creek_1	11.7	76	8.8	EF	8-Aug-16	12:20	8-Aug-16	12:50	600	624	-	Bull Trout	55	1.3	Unknown	No	0	-	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	225	119.4	Unknown	Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	201	92.6	Female	Yes	Yes	Yes	-	Photo 87; 245 eggs, 2.5mm egg diameter
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	200	88.9	Male	Yes	Yes	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	128	22.9		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	169	47.1		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	123	19.2		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	95	8.4		Yes	No	-	-	Mortality
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	110	13.3		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	106	12.1		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	108	12.5		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	107	11.2		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	112	14.4		Yes	No	-	-	Mortality
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	97	8		Yes	No	-	-	Mortality
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	87	6.7		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	87	6.4		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	92	8.4		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	99	10		Yes	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	49	0.8		No	No	Yes	-	
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	117	18		Yes	No	-	-	Mortality
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	84	6.7		Yes	No	-	-	Mortality
Laib_Creek_2	12.3	78	8.9	EF	8-Aug-16	14:15	8-Aug-16	16:22	700	2314	-	Eastern Brook Trout	85	5.7		Yes	No	-	-	Mortality
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	79	5.3		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	140	35.5		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	96	8.4		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	104	12.2		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	125	21.6		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	92	7.3		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	90	7.4		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	92	7.2		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout	100	10.4		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	10:30	9-Aug-16	11:15	700	835	1	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	101	10.6		Yes	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	105	11.6		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	108	12.8		Yes	No	-	-	

Field Site Name	Water Temperature (°C)	Conductivity (µs)	pH	Survey Method	Date	Start Time	Date	End Time	EF Volts	EF Seconds	EF Pass	Common Name	Length (mm)	Weight (g)	Sex	DNA	Otolith	Marked and Released	Recaptured Mark	Comments
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	98	8.9		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	78	5		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout				-	-	-	Yes	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	103	11.2		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	112	14		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	12:15	9-Aug-16	12:55	700	754	2	Eastern Brook Trout	113	13.8		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	13:15	10-Aug-16	13:47	700	765	3	Eastern Brook Trout	96	8.6		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	13:15	10-Aug-16	13:47	700	765	3	Eastern Brook Trout	97	9.2		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	13:15	10-Aug-16	13:47	700	765	3	Eastern Brook Trout	91	7.9		No	No	-	-	
Laib_Creek_2	10.1	80	8.9	EF	9-Aug-16	13:15	10-Aug-16	13:47	700	765	3	Eastern Brook Trout	168	49.3	Female	No	Yes	-	-	

Cherry Meadows
Wetland Restoration Project
The Nature Conservancy of Canada


This wetland was made by beaver damming a drainage ditch at Cherry Meadows


Northern Leopard Frog

Thomas R. Biebighauser
Robin Annschild
June 6, 2016

Contents

Introduction

The Cherry Meadows Wetland Restoration Project would restore over 40-acres of productive wetlands to improve habitat for wildlife on the Cherry Creek floodplain near Kimberley, British Columbia. Actions would be taken to improve habitat for waterfowl and rare species by filling ditches and restoring natural landscape depressions at Cherry Meadows. This major project would control erosion, recharge groundwater, increase wildlife habitat diversity, and greatly improve opportunities for viewing wildlife. The restored wetlands would look and function like natural ecosystems, requiring little, if any maintenance.

Over 40-acres of large wetlands would be restored at Cherry Meadows to provide habitat for Cinnamon Teal and a diversity waterfowl species.

Background

Located in the Rocky Mountain Trench near Kimberley, BC, Cherry Meadows is characterized by large open meadows surrounded by forests of ponderosa pine. Mowed walking trails wind through old fields bordering Cherry Creek (Nature Conservancy Canada, 2016).

Wildlife found at Cherry Meadows include badger, grizzly bear, black bear, white-tailed deer, elk, beaver, muskrat, mink, weasel, wood duck, hooded merganser, bufflehead, mallard, geese, and west slope cutthroat trout (Nature Conservancy Canada, 2016). Mule deer and moose move through the area (Walter Latter, 2016).

Scattered small existing wetlands at Cherry Meadows are likely supporting western painted turtle, western toad, great blue heron, common nighthawk and the short-eared owl. Sandhill cranes, a locally rare species, use the property and one pair has nested in the area. Flammulated owls and Lewis's woodpeckers have been detected nearby (Nature Conservancy Canada, 2016).

Cherry Meadows is dominated by dense growths of reed canary grass, a nonnative species that took over the fields after they were farmed. The reed canary grass is preventing wildflowers, shrubs, and trees from growing on the site.

Cherry Meadows was once a natural mosaic of wet-meadow, ephemeral, emergent, shrub, and forested wetlands that were hydrologically connected. Most of the 49-acres of farm fields at Cherry Meadows were artificially created by the draining and filling of these wetlands.

The old farm fields at Cherry Meadows were intensively examined by Thomas R. Biebighauser, Robin Annschild (Wetland Restoration Consulting), and Richard Klafki (Nature Conservancy Canada) from May 16 -18, 2016. The locations of drainage ditches, filled wetlands, moved streams, sloped lands, and compacted soils were identified during this visit.

This aerial photograph shows Cherry Meadows when it was intensively farmed. The red arrow points to a tractor cutting hay. The photograph was provided by Carol and Walter Latter, who once owned the property. The date the aerial photograph was taken is unknown.

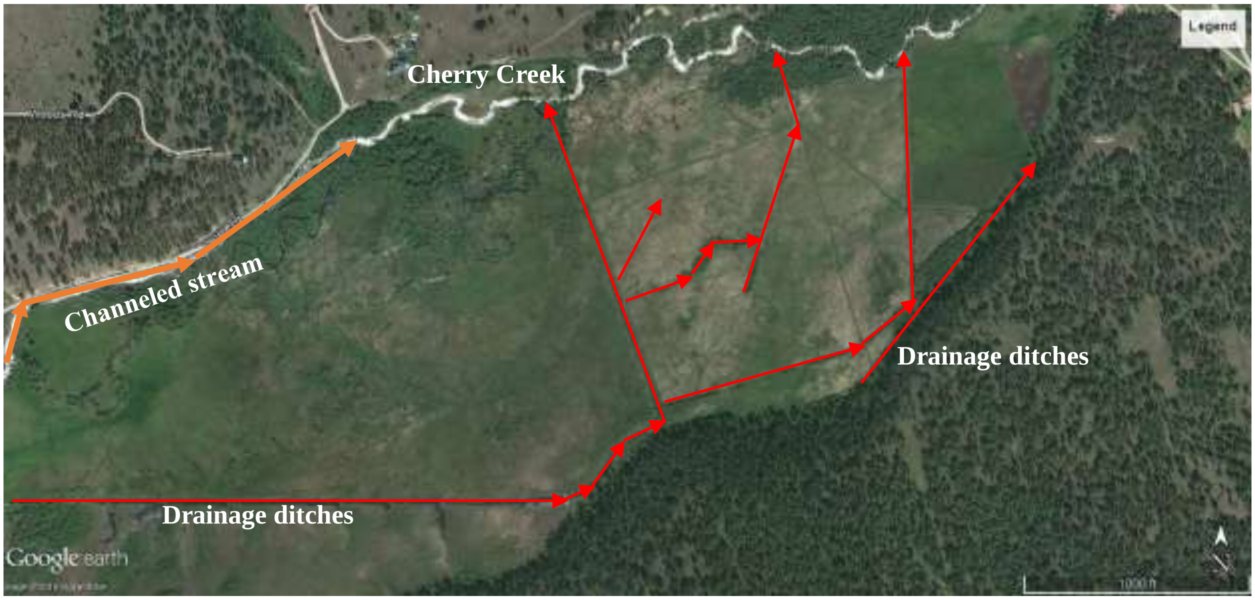
Deep ditches, like the one shown, were dug to divert runoff from Cherry Meadows.

The wetlands and steams once present at Cherry Meadows were greatly affected by the following human activities:

1) A deep and long ditch was dug along the base of the mountain to divert runoff. Water from the mountainside at one time flowed onto the valley in a sheet-like pattern, saturating soils and supporting a diversity of wetlands and streams. The ditch, dug years ago, is still drying the large field.
2) Deep and long ditches were dug along the West and East sides of the property. Peter Wood dug the West ditch using dynamite. The ditches have eliminated water standing in wetlands, and have lowered the elevation of groundwater over Cherry Meadows. The deep ditches, dug years ago, are still drying the wetlands today.
3) A series of shallow ditches, not mapped, are draining Cherry Meadows.
4) Wetland depressions were filled with soil to dry them for farming. The land surfaces were then smoothened for farming, creating conditions for growing crops.
5) The surface of the land was sloped so runoff would flow into dug ditches, further drying them for farming.
6) The pits and mounds formed by generations of trees falling over and the ridges and depressions formed by the flow of Cherry Creek across the floodplain were filled and leveled to create smooth surfaces for farming.
7) Drainage structures made from wood, stone, and clay tile were buried in the ground to dry soils for farming.
8) Head-cuts were formed by the construction of ditches. These head-cuts are causing erosion, and a deepening and widening of the ditches. The head-cuts are eliminating surface water, and are further drying the fields by lowering the elevation of groundwater.
9) The soils at Cherry Meadows have been compacted by livestock and by rubber-tired tractors. Because these soils contain a high percentage of clay, they have remained compacted. Plant growth, along with plant and animal diversity are greatly reduced

because of the compaction. Animals that survive by digging burrows are less likely to do this in the compacted soils. The compacted soils also prevent water from soaking into the ground.

10) Cherry Creek was moved and straightened on the property located immediately upstream from Cherry Meadows. The channeling of Cherry Creek has caused head-cuts to form, and trees and shrubs to fall into the stream. The soil being washed into Cherry Creek is being deposited downstream, in part at Cherry Meadows.



This map shows the primary ditches dug to drain wetlands at Cherry Meadows. A Lidar image would show many more ditches compared to this aerial photograph.

The red line on this photo shows one of many ditches dug at Cherry Meadows to drain wetlands so they could be farmed. The ditches continue to remove standing water, and lower the elevation of groundwater.

The red line on this photo shows one of the main ditches dug to dry wetlands at Cherry Meadows. The ditches continue to function though dug years ago.

The red line shows the center of a diversion ditch, dug along the base of the mountain at Cherry Meadows. The ditch is one of many dug to drain the wetlands once present on the site, and continue to divert runoff from Cherry Meadows

This photo shows another diversion ditch at Cherry Meadows.

Wetlands would be restored at Cherry Meadows from large fields that were leveled and filled for farming. These old fields are dominated by reed canary grass, and support a low diversity of plants and animals.

Purpose and Need

The Cherry Meadows Wetland Restoration Project would restore over 40-acres of emergent, ephemeral, and wet-meadow wetlands by filling ditches, removing fill, and reshaping natural contours on the landscape. The project would restore key features of natural wetlands, including flow from springs, the elevation of groundwater, presence of shallow water depressions, hydric soils, non-compacted soils, tufts, mounds, ridges, and native wildflowers, shrubs, and trees that were present before drainage took place.

The wetlands would be restored to provide habitat for waterfowl, along with a diversity of animals and plants. The following species of waterfowl would benefit from restoring the wetlands:

1) American Goldeneye
2) American Wigeon
3) Bufflehead
4) Cinnamon Teal
5) Canada Goose
6) Greater Scaup
7) Green-Winged Teal
8) Hooded Merganser
9) Lesser Scaup
10) Mallard

11) Northern Shoveler
12) Pintail
13) Redhead
14) Ruddy Duck
15) Wood Duck

Features would be restored in and around the wetlands to support a diversity of amphibians, birds, fish, invertebrates, mammals, and reptiles once present in the valley. The wetlands would be built to provide habitat suitable for use by the following rare species:

- Bald Eagle
- Northern Leopard Frog
- Monarch Butterfly
- Sandhill Crane
- Trumpeter Swan
- Western Painted Turtle
- Western Toad

Restoring the wetlands would greatly increase wildlife viewing opportunities, control erosion, clean runoff, and restore a diversity of attractive, flowering plants. The erosion being caused by head-cuts in ditches would be controlled. The elevation of groundwater would be restored, as would the flow of water from springs to recharge groundwater, form streams, and restore a diversity of wetland types.

Wetland Restoration Design

Wetland restoration projects were identified in the old farm fields at Cherry Meadows. The areas selected were drained using ditches, showing they were once wetlands. Most of the wetland restoration sites were also shallow basins that had been modified by filling and draining. The following types of wetlands would be restored: Emergent, Ephemeral, and Wet-Meadow.

Sites were selected for wetland restoration where slopes were gradual, groundwater was near the surface, and soil texture was high in clay. Slopes were measured using a laser level. Each wetland restoration site was selected to have no more than a 50cm change in elevation from upper to lower edge.

Soil texture on each wetland restoration site was determined using a 122cm long tile probe, and a 122cm long, open-face soil auger. The elevation of groundwater at each location was determined by digging test holes using a soil auger. The elevation of groundwater in the test holes was measured when dug, and again the following day.

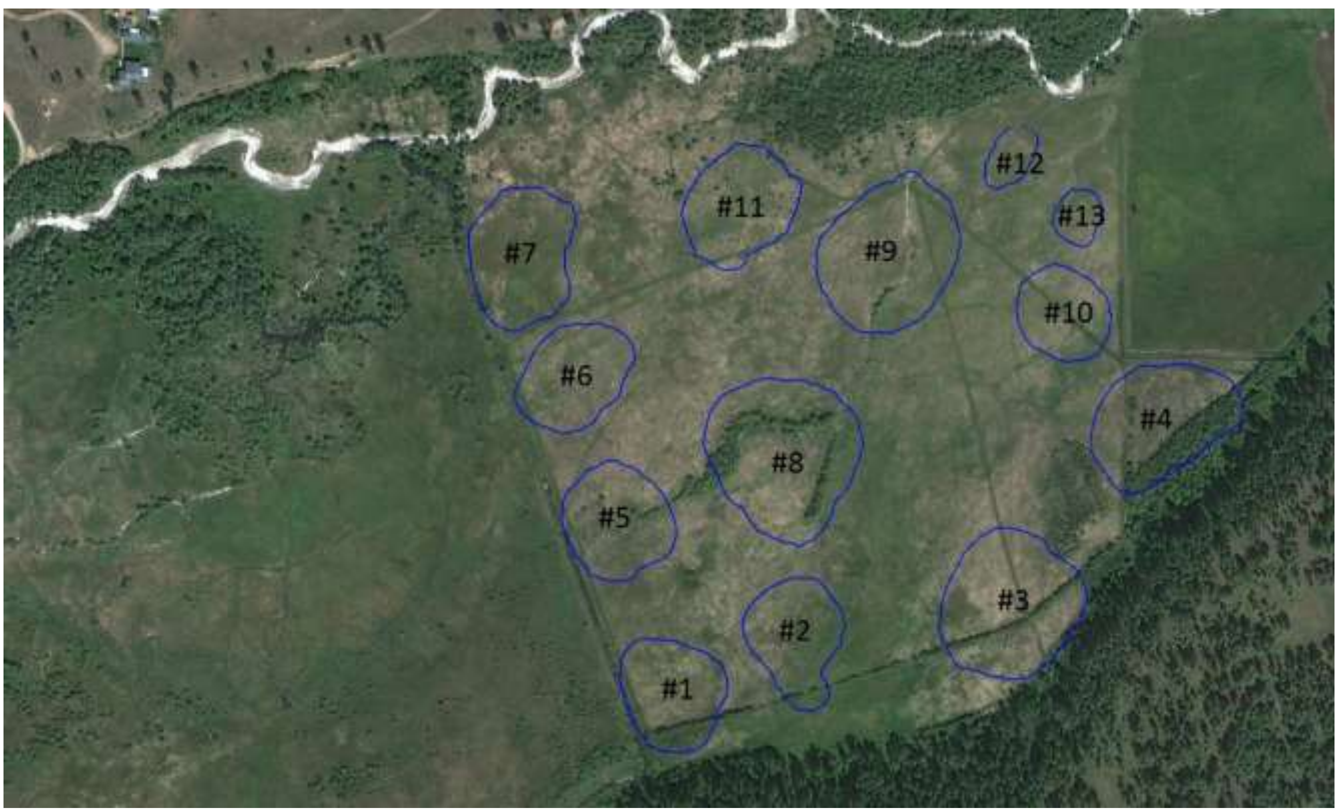
One can see water in some of the ditches at Cherry Meadows. This is largely due to the ditches removing water from the ground. Some of the ditches have been blocked by beaver. However, the soils in the pasture fields are not saturated because the ditches are doing their job: removing water from the surface and the ground. This project would restore the historic elevation of groundwater by filling ditches and restoring natural contours on the land.

A soil auger was used to measure soil texture and to determine the elevation of groundwater at each wetland restoration site.

A long wooden stake was placed in the center of each wetland that was designed. A GPS was used to record the coordinates of each stake.

The perimeter of each designed wetland was marked using brightly colored plastic ribbon. A GPS was used to map the perimeter of each planned wetland.

Planned Emergent and Ephemeral Wetland Restoration Areas at Cherry Meadows.



Each blue polygon shows where an emergent or ephemeral wetland would be restored at Cherry Meadows. Wet-meadow wetlands would be restored between the emergent and ephemeral wetlands; and are not shown on the map.

Emergent and Ephemeral Wetland Areas.

Wetland Number	Type	Area (m^2)	Perimeter (m)
1	Emergent	15,040	260
2	Emergent	4,873	274
3	Emergent	8,784	341
4	Emergent	7,306	324
5	Emergent	5,383	258
6	Emergent	4,989	262
7	Emergent	6,368	304
8	Emergent	10,300	375
9	Ephemeral	8,989	349
10	Ephemeral	3,764	222
11	Ephemeral	5,565	281
12	Ephemeral	1,242	135
13	Ephemeral	1,137	125
Not Numbered	Wet-Meadow	88,134	
Total		161,874	

The wetlands were designed in existing basins that were filled and smoothed for agriculture, and where wetland construction would facilitate the disabling and filling of drainage ditches.

There are a number of reasons why the construction of a number of wetlands of various shapes and sizes is recommended at Cherry Meadows, instead of building one large dam surrounding the fields:

1. The change in elevation from upper to lower edge is too great.
2. The depth of the water would be too great, providing habitat to fish, not waterfowl and rare species of wildlife.
3. The dam would be expensive to build and to maintain.
4. The dam would appear unnatural.
5. The area would become dominated by cattails and reed-canary grass.

Wet-meadow wetlands would be restored as part of this project. Wet-meadow wetlands are also called wet-prairies. They contain a wide diversity of wildflowers, sedges, and rushes. Wet-meadows provide valuable habitat to waterfowl for nesting. Frogs and toads forage in wet-meadows. Frog and toad juveniles depend on wet-meadows for their survival. The wet-meadows to be restored would provide critical habitat to Sandhill Cranes for nesting and feeding.

Some claim that beaver alone can restore the drained wetlands at Cherry Meadows. They see beaver building dams across some of the ditches, and wrongfully assume the small ponds they make resemble the natural wetlands once present on the site. Here are some reasons why beaver would not be able to restore wetlands on their own:

1. Water does not flow in the ditches all year. Beaver generally dam streams that contain a perennial flow.
2. The shear stresses of water in the ditches can be so high during a flood that beaver are unable to maintain their dams.
3. Beaver are not able to block the flow of water being carried beneath the surface in buried drainage structures made from wood, rock, clay tile, and plastic pipes
4. Beaver do not remove the large quantities of soil used to fill wetlands.
5. Beaver are not able to flood areas where slopes have been increased using tractors and heavy equipment to direct water into ditches.
6. Beaver may not be allowed to dam ditches bordering private land, as their activities would flood private land.
7. The large old fields dominated by reed canary grass do not offer beaver the food they need to survive, so they cannot be expected to live in large numbers at Cherry Meadows.

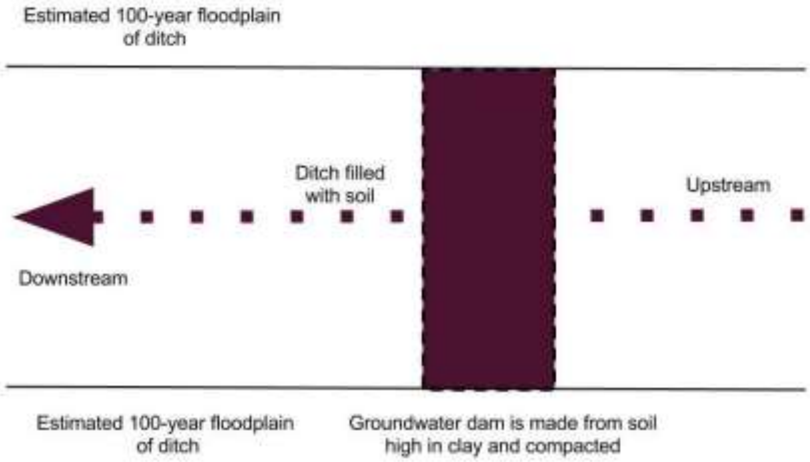
A variety of techniques would be used to restore wetlands at Cherry Meadows. The techniques have been developed by Tom Biebighauser who has restored over 1,800 wetlands in 23-States, Canada, New Zealand, and Taiwan. Tom Biebighauser has published 4-books describing the techniques to be used, and instructs an average of 1,000 people a year who work as engineers, biologists, botanists, landscape architects, and landowners, in how to use these practices.

Detailed *Wetland Design Forms* were completed for each wetland restoration project. These are available by contacting the authors.

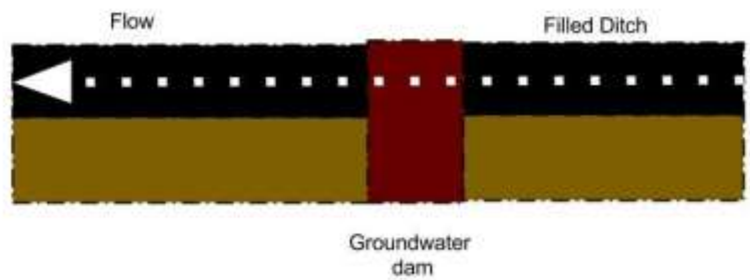
Beaver made this small wetland by blocking a drainage ditch at Cherry Meadows. The ditch remains functional as drainpipes were installed in each beaver dam. The dams are also leaking because the beaver are no longer maintaining them.

Here are the main techniques that would be used to restore wetlands at Cherry Meadows:

1) Groundwater Dams: Underground dams would be placed at strategic locations to restore the elevation of groundwater in wetlands and streams. A groundwater dam is a band of compacted clay soil, formed underground, that interrupts permeable layers of soil and drainage structures. Groundwater dams would be placed in ditches, and along the lower edges of wetlands to be restored. Groundwater dams are not visible, and require no maintenance.



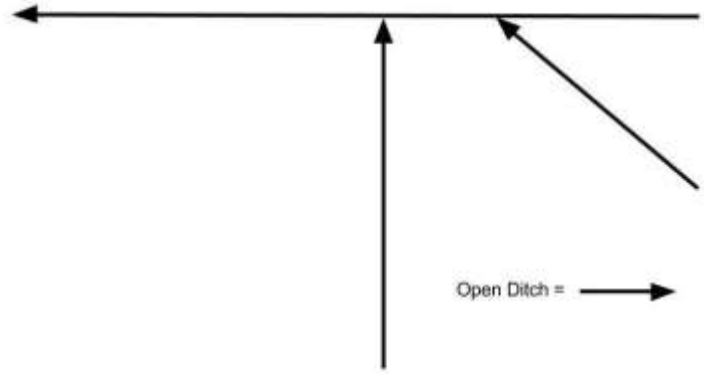
How a groundwater dam is used to control the flow of water in a filled ditch (plan view)



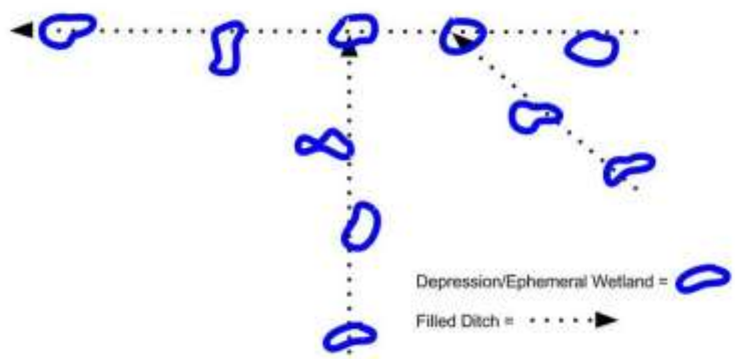
Groundwater dam used to control the flow of water in a filled ditch (profile view)

2) Ditch filling: Ditches would be filled with soil of similar soil texture and compaction rates as what is generally present on either side of the ditch. Some of the soil used to fill the ditches would be obtained from the piles of soil present along the edge of the ditch. However, additional soil would be needed because the ditches and piles of soil must be cleaned of plants and roots before they are used. Water would continue to flow in the filled ditches if the soil used to fill the ditches were mixed with plants and organic material.

Great care would be used when filling ditches near springs to make sure the flow from the spring is maintained. While ditches near springs would be filled, the soils near where the spring emerges would be loosened and shaped to maintain flow.

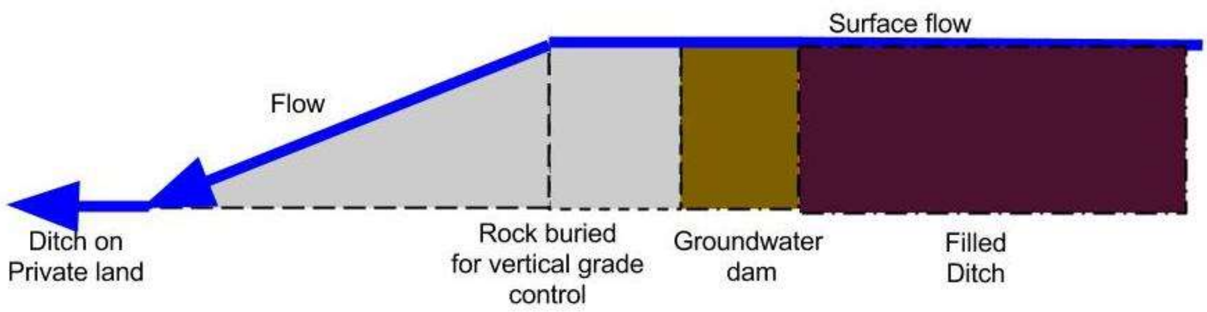


Open drainage ditches-typical plan view

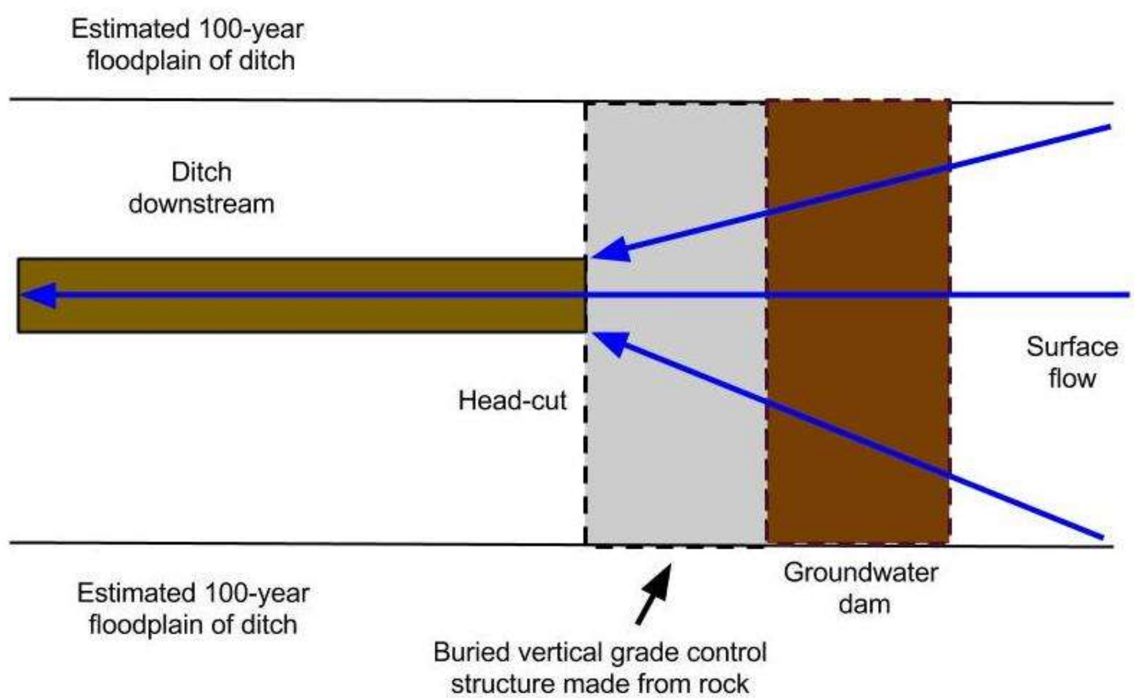


Filled drainage ditches-typical plan view

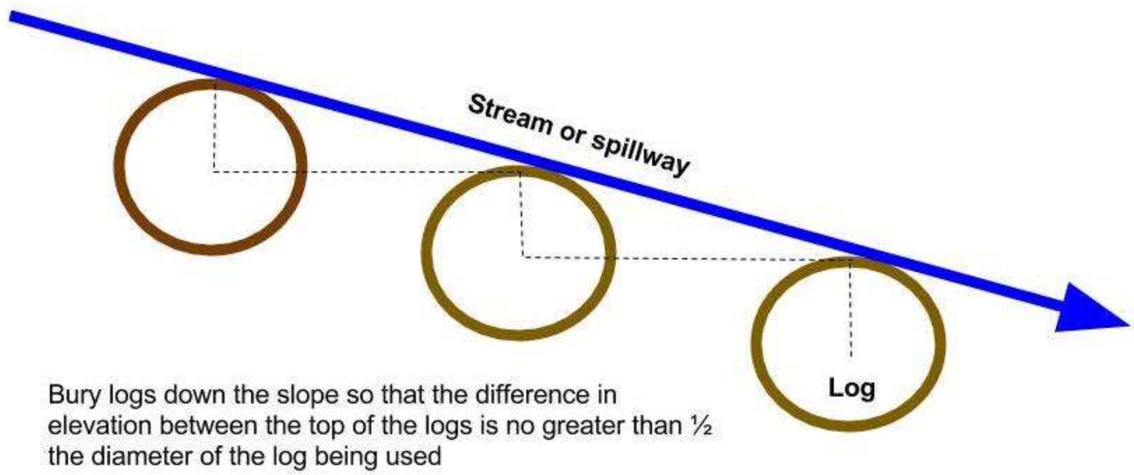
3) Vertical Grade Control: Vertical grade control structures would be used to control head-cuts that threaten restored wetlands. These structures, made from rock or large diameter logs, would be buried underground, and across the 100-year floodplain where water leaves the wetland. The structures would protect the wetlands and streams from being destroyed by head-cuts located downstream from the wetland.



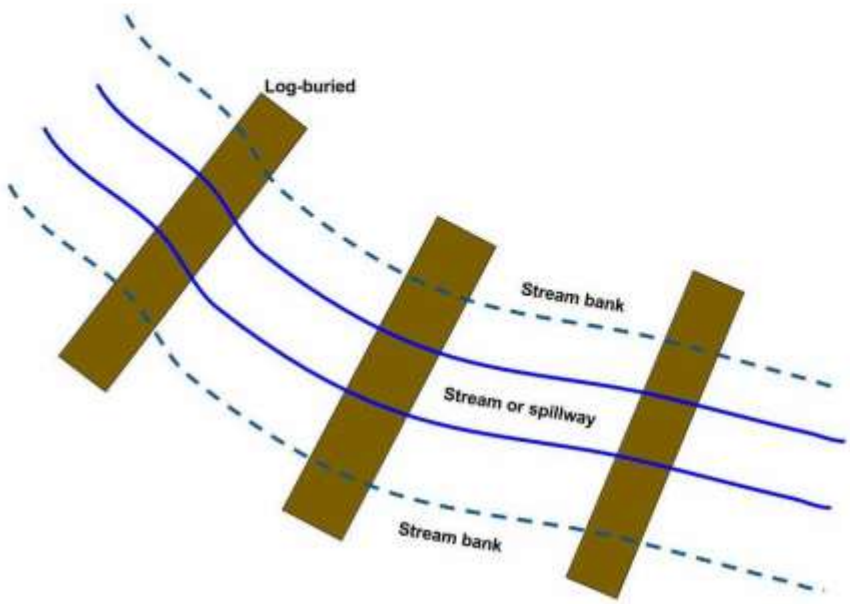
Constructed spillway using rock for vertical grade control to transition water from a restored wetland or stream into a ditch (typical profile view)



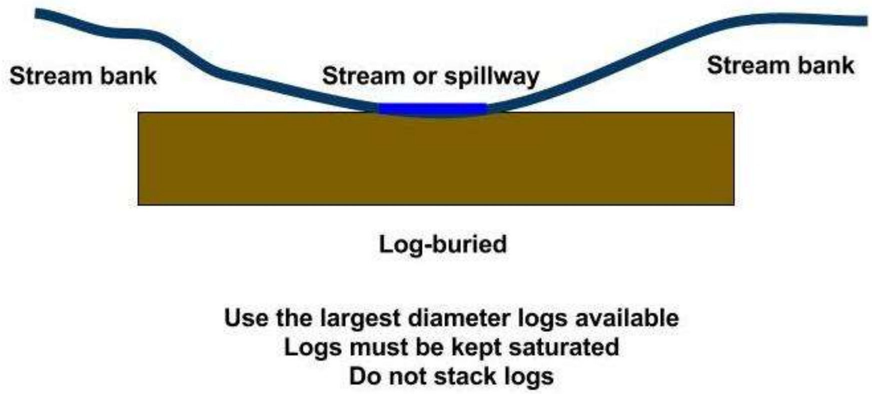
Constructed spillway using rock for vertical grade control to transition water from restored wetland or stream into a ditch (typical plan view)



Constructed spillway using large diameter logs for vertical grade control to transition water from a restored wetland or stream into a ditch (typical side profile view)



Constructed spillway using logs for vertical grade control to transition water from restored wetland or stream into a ditch (typical plan view)



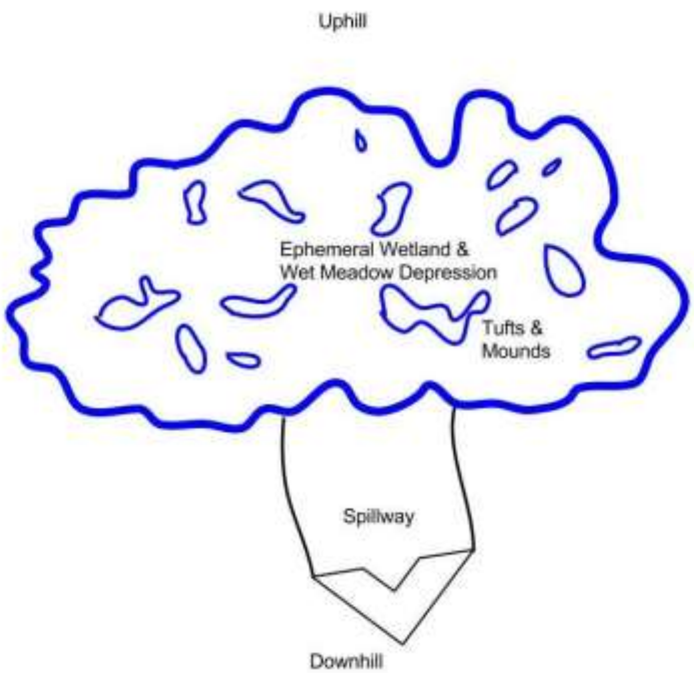
Constructed spillway using large diameter logs for vertical grade control to transition water from a restored wetland or stream into a ditch (typical front profile view)

4) Spillways: Naturally appearing and functioning spillways would be used to transition water from wetlands into streams. The spillways would be designed to prevent erosion, and would appear as natural streams.

5) Fill removal: Soil used to fill wetlands would be removed. This soil would be used to fill ditches that were dug to drain the wetlands.

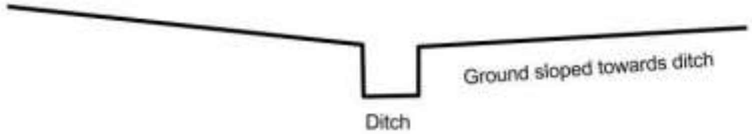
6) Landscape contouring: Areas where soil would be removed would be shaped into naturally appearing and functioning wetlands. These shallow depressions would inject water into the ground, maintaining the elevation of groundwater, and support surrounding wet-meadow wetlands. Both perennial emergent wetlands, and seasonal-ephemeral wetlands would be restored. Ephemeral wetlands, also called vernal ponds, are some of the rarest habitats in North America. The ephemeral wetlands would become wet-meadow wetlands when they dry. The ephemeral wetlands can be expected to support breeding populations of frogs, toads, salamanders, dragonflies, damselflies, fairy shrimp, tadpole shrimp, and other invertebrates. Sandhill Cranes would also make use of the wet-meadow and ephemeral wetlands.

   The ephemeral wetlands would be built so that they would dry in late summer and fall to prevent colonization by bullfrogs or nonnative fish. The wetlands can be expected to contain water for varying lengths of time, so that in wet or dry years, some would provide suitable conditions for successful breeding by amphibians and invertebrates.

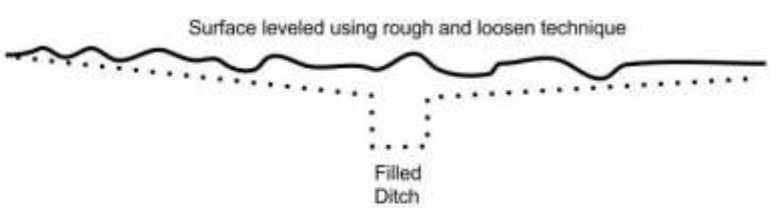


Emergent wetlands, ephemeral wetlands, and wet-meadow wetlands would be made by removing and shaping shallow depressions (Typical plan view)

7) Sheet flow: Soil surfaces surrounding the emergent and ephemeral wetlands would be contoured to restore natural, sheet-pattern-flows of runoff over the land to restore additional wet-meadow wetlands. The slopes formed to direct water into the dug ditches would be leveled, and prepared for planting using the rough and loosen technique.



Historic ditch with ground surfaces sloped towards the ditch-typical profile view



Filled ditch with surface leveled to provide a sheet flow of water-typical profile view

8) Soil loosening: Compacted soils would be loosened using the rough and loosen technique. The bucket of an excavator would be used to turn and loosen compacted soils to a depth of 70-100cm. A series of naturally appearing shallow pits and mounds would be restored over the wetland area to support a diversity of plants and animals. The loosened soils would not erode, and can be expected to provide habitat for burrowing mammals. It is important to remember that unlike what is now present in the area, natural wetlands are not smooth, compacted, or sloped towards ditches.

Here the excavator uses the *rough and loosen* technique to loosen compacted soils on a wetland restoration project. The loosened soils are seeded and planted to native species, and mulched using wheat straw to control erosion.

9) Large woody debris: Large diameter logs, branches, and root masses would be placed in the restored wetlands to improve habitat for a diversity of plant and animal species. Branches of various diameters and lengths would be placed in the wetlands to provide egg attachment sites for amphibians, and improved habitat for invertebrates, and plants. Wood would be obtained near the wetland restoration sites in advance, so it can be placed by heavy equipment during restoration.

The logs placed in this emergent wetland provide loafing sites for waterfowl.

Large diameter logs would be placed in the restored wetlands to resemble trees naturally falling over. This photo shows one of many dead trees placed in wetlands restored at Meadow Creek in January 2016.

10) Planting and seeding: Desirable native plants that may be disturbed during restoration would be saved as part of construction, and later replanted in the restored wetlands. Large clumps of native plants and their roots would be removed and saved using the excavators. Native seeds in the topsoil are expected to geminate and grow when water returns to the wetlands.

Native species of wetland plants would be seeded and planted to restore a diversity of plants in the restored wetlands. Seeds from native wetland plants growing near the worksites would be collected and sown by hand on areas of exposed soil. Other seeds and plants would be purchased. The species planted and seeded would favor flowering species used by pollinators, including the monarch butterfly. Nonnative plants would be removed and/or buried as part of the wetland restoration project.

Exposed soils would be mulched using the straw from native plants if it’s available, otherwise, wheat or oat straw would be used. Straw would be spread by hand on exposed soils in the restored wetland to control erosion, and to suppress nonnative plants. A straw blower would not be used because the rubber tires would cause unwanted compaction of the ground. Straw rarely contains weeds or nonnative plant species. Commercial hay would not be used. Hay is cut grass that often contains weeds and nonnative plants. However, hay that is cut from native species provides ideal mulch and would be used if it’s available. Portions of the wetland that are restored would be seeded, planted, and mulched the same day they are completed.

The clumps of sedges shown in this photo were saved and replanted as part of wetland restoration at Meadow Creek. The restored wetland is 4-months old in this photo.

The design prepared for the Cherry Meadows Wetland Restoration Project shows the approximate locations of where the above described techniques would be used. The actual application and placement of each technique on the ground would be finalized during implementation of the project.

This newly restored wetland at Meadow Creek was only 4-months old when the photo was taken. The clumps of sedges were saved and replanted using the excavator during construction.

Wildlife and Fish Habitat

Restoring wetlands of various depths, sizes, shapes, hydro-periods, and soil textures would enhance habitat for waterfowl and a diversity of wildlife and fish species. Features would be added to the wetlands to provide fish and wildlife species with feeding, hiding, and loafing sites. The following describes the main actions to be taken to improve habitat for both common and uncommon species:

Waterfowl

- Shallow-water wetlands of various depths, shapes, and sizes would provide foraging habitat for dabbling and diving ducks.
- Ephemeral water wetlands would contain an abundance of invertebrates that waterfowl would use for food.
- Varying water depths and hydro-periods would promote plant and invertebrate diversity.
- Wet and dry meadows surrounding ephemeral and emergent wetlands would not be grazed by livestock, and would be available for waterfowl nesting.
- Root masses, large and small woody debris would be placed in wetlands to improve habitat for invertebrates, and for use as loafing sites for waterfowl.
- A diversity of native plants would be established in and around the restored wetlands for food and cover.

Bald Eagle

- Cottonwoods would be planted on ridges made of loosened soils. These ridges would be placed within and around the wetlands for Bald Eagle perching and nesting.
- Habitat for waterfowl would be restored to serve as a food source for Bald Eagles.

Monarch Butterfly

- Native wildflowers and milkweeds would be seeded and planted on exposed soils to benefit the monarch butterfly and other pollinators
- Areas of exposed, moist, mineral soil would be created around the wetlands to provide the monarch butterfly with essential minerals.

Northern Leopard Frog

- A diversity of wetlands would be restored that are supplied primarily with surface water, not groundwater, so water temperatures would be warm enough for larvae to develop.
- Deeper-water wetlands would be built for hibernacula that are hydrologically connected with perennial flow that would not freeze.
- Ephemeral wetlands would be restored that would not support fish or bullfrogs.
- Ephemeral wetlands would be restored that are not connected to streams with fish.
- Root masses, large and small woody debris, and mounds of soil and organic material would be placed in wetlands for use as hiding and loafing sites.
- Shallow water areas would be created in wetlands that contain a diversity of plants, and have warmer water for larvae development.
- Areas of sand and gravel would be placed on high ground in full sunlight to be used as warming sites for the Northern Leopard Frog.

Shallow pools of water, like the one shown, would be made along the edges of wetlands to provide warm water for larval development.

Columbia Spotted Frogs were observed using the water in drainage ditches at Cherry Meadows.

Sandhill Crane

- Large wet-meadow wetlands would be restored that would be used for feeding and nesting.
- Ephemeral wetlands would be restored that would be used for feeding.
- Large wet-meadow wetlands would be restored in open fields that are safe for Sandhill Cranes to use.

Over 1,000 Sandhill Cranes are using this new ephemeral and wet-meadow wetland built by Tom Biebighauser at the Muscatatuck National Wildlife Refuge in Indiana.

The newly restored wetlands at the Muscatatuck NWR were built in large open fields like the ones found at Cherry Meadows.

Trumpeter and Tundra Swans

- A large number and area of wetlands would be restored in an area with limited human access to provide ideal habitat for nesting and feeding.
- A large number of ridges and islands would be built in the wetlands that would be suitable for nesting.
- Some of the wetlands would be built with deeper water in the middle with long open flight paths.

Tundra Swans are using the newly restored wetlands at Meadow Creek for feeding and nesting (Terry Halleran photo).

Western Painted Turtle

- Logs, rocks, and root masses would be placed in restored wetlands for basking sites.
- Zones where springs emerge into restored wetlands would be modified to serve as hibernacula.
- Loose piles of woody debris and organics would be placed in restored wetlands for hiding sites.
- Large ridges of sandy and gravely soils would be created in full sunlight on higher ground within and near restored wetlands for nesting sites.

The pile of sand in the foreground is one of many uncovered and placed during wetland restoration at Meadow Creek.

Piles of large and small woody debris, mixed with organics, would be placed in and near the wetlands to provide hiding sites for frogs, toads, and turtles. The pile shown in this photo was shaped to appear like an abandoned beaver house.

Western Toad

- A diversity of wetlands would be restored that are supplied primarily with surface water, not groundwater, so water temperatures would be warm enough for larvae to develop.
- Piles of rock would be placed near the wetlands to be used as hiding sites.
- Ephemeral wetlands would be restored that would not support fish or bullfrogs.
- Ephemeral wetlands would be restored that are not connected to streams with fish.
- Root masses, large and small woody debris, and mounds of soil and organic material would be placed in wetlands for use as hiding and loafing sites.
- Shallow water areas would be created in wetlands that contain a diversity of plants, and have warmer water for larvae development.

Western toads have rapidly colonized the wetlands restored at Meadow Creek.

We have found very high densities of Western toad larvae in wetlands restored at Meadow Creek.

Shorebirds can be expected to make great use of the mudflats to be created as part of wetland restoration.

The high density of tracks shown in this photo provide strong indication of the value of restored ephemeral wetlands to shorebirds.

This photo shows an emergent wetland under construction near Fernie, British Columbia. Note the ridges and logs being placed in the basin.

The ridges, islands, and peninsulas placed in this emergent wetland under construction near Fernie, British Columbia should support a diversity of plants and animals.

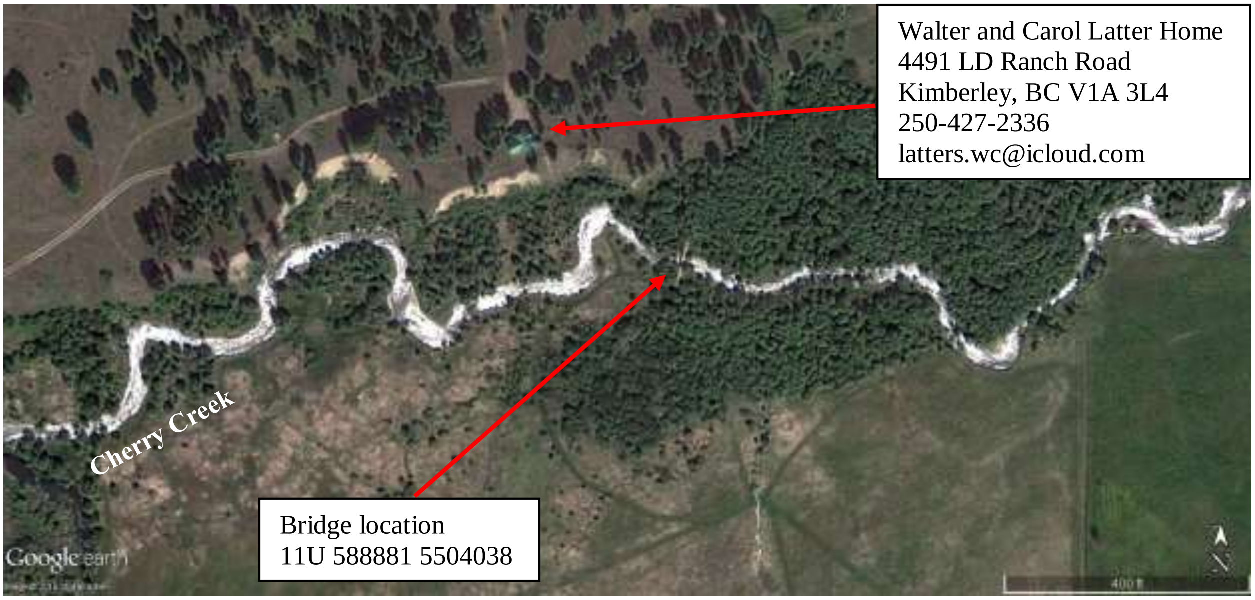
The wetlands at Cherry Meadows would be restored to have varied shapes, sizes, depths, substrates, and hydro-periods to provide habitat for common and uncommon species. This is one of many wetlands restored at Meadow Creek in January 2016. The wetland was 4-months old when this photo was taken.

The *rough and loosen* technique, shown here, would be used to loosen compacted soils to control erosion, reduce reed canary grass, promote a diversity of plants, and improve conditions for burrowing animals.

Bridge Access

It is necessary to cross Cherry Creek to access Cherry Meadows for restoring wetlands. Walter and Carol Latter built a wooden bridge across Cherry Creek to provide access to Cherry Meadows. The bridge is narrow, and was designed primarily for foot traffic. However, Walter crosses the bridge with his small tractor when mowing the trails at Cherry Meadows.

Heavy equipment would be needed to restore wetlands at Cherry Meadows. It is not safe for heavy equipment to travel the existing bridge over Cherry Creek. The heavy equipment can weigh as much as 48,000lbs.



Tom Biebighauser contacted Henry Huser to discuss crossing Cherry Creek with heavy equipment for restoring wetlands at Cherry Meadows. Henry has built bridges for years, and has worked with the author to restore wetlands. Henry offers to visit the site at no charge, and to draft recommendations on how best to access Cherry Meadows. Here is Henry Huser's contact information: phone: 250-551-7179, email: hhuser@telus.net.

Henry Huser said that it would probably be less expensive to use a temporary bridge to access Cherry Meadows, compared to building a bridge. He knows of businesses that rent temporary bridges for about $5,000.00 per month. One should also plan on the expense of setting up the temporary bridge, that can cost from $5,000 to $10,000. Henry is also willing to check with businesses to see if they would loan a temporary bridge to the Nature Conservancy, at no charge.

Here is the existing bridge over Cherry Creek

The existing bridge is supported by small diameter logs

The bridge was not designed for heavy equipment to cross

Probability of Success

The restoration of wetlands at the Cherry Meadows can be expected to be successful. The authors would be available to be onsite guiding heavy equipment operators as they restore the wetlands. Tom Biebighauser has successfully restored similar wetlands across British Columbia, Arizona, California, Colorado, and New Mexico. The techniques he has developed are being used around the world.

These photos show some of the wetlands the author has restored in the West, using the techniques recommended for use at the Cherry Meadows:

This small emergent wetland was restored near Passmore, British Columbia.

Here is another emergent wetland we restored near Passmore, British Columbia.

One of many emergent wetlands built to manage stormwater runoff near Duncan, British Columbia.

Here is one of many emergent wetlands built to manage stormwater runoff near Logan Lake, British Columbia.

This 1-day old emergent wetland was filling with groundwater when the photo was taken at Meadow Creek, British Columbia.

Emergent wetland, Southwestern Research Station, Portal, Arizona

Ephemeral wetland (4-months old) at Meadow Creek, British Columbia

Emergent wetland (4-months old) at Meadow Creek, British Columbia

Restored wetlands are great places to watch wildlife. This restored ephemeral wetland is 4-months old, near Meadow Creek, British Columbia.

Emergent wetland (4-months old), Meadow Creek, British Columbia

Emergent wetland built for treating stormwater at KP Park, Salmo, British Columbia

Emergent wetland (7-months old) built at North Jubilee Park, Rossland, British Columbia

Emergent wetland (7-months old) built at North Jubilee Park, Rossland, British Columbia

The *rough and loosen* technique was used to establish this wet-meadow wetland from a waste pile of soil at the Southwestern Research Station near Portal, Arizona.

The emergent wetland (left) and wet-meadow wetland (right) were restored by disabling a ditch and a buried drain line at the Southwestern Research Station in Arizona. The wet-meadow is supplied with water from the emergent wetland. The site was a field dominated by nonnative plants before the project took place.

This wet-meadow wetland was restored at the Southwestern Research Station in Arizona. While the site does not contain a lush growth of plants, it does provide critical habitat for juvenile Chiricahua Leopard Frogs, a Federally Threatened species

This wet-meadow and emergent wetland were restored in arid Owyhee County, Idaho. The wetlands are less than one-year old in this photo.

This small emergent wetland was built on a steep slope near Bill Dick Spring on the Mogollon Rim Ranger District, Coconino National Forest, in Arizona.

The rare northern leopard frog is using the new wetland for breeding at Bill Dick Spring in Arizona

One of 14-wetlands restored at Moreno Springs along the Mimbres River in New Mexico for the Federally Threatened Chiricahua Leopard Frog and the Chihuahua Chub. The wetlands are one-year-old in these photos, and are being used by both species.

Another one of the 14-wetlands restored at Moreno Springs along the Mimbres River in New Mexico for the Chiricahua Leopard Frog and the Chihuahua Chub. This wetland is also being used by both Federally Threatened species.

Proposed Action

The Nature Conservancy of Canada plans to restore a large number and area of wetlands from old farmed fields near Cherry Creek. A naturally appearing and functioning mosaic of emergent, ephemeral, and wet-meadow wetlands would be restored to improve habitat for waterfowl, and a diversity of wildlife on the site. Actions would be taken to disable the system of ditches, diversions, filling, and sloping used to destroy the wetlands. The flow from springs would be restored, restoring streams to connect many of the wetlands. Compacted soils would be loosened, the elevation of surface and groundwater returned, and native plants established to restore habitat for a diversity of plants and animals.

The Cherry Meadows Wetlands would be restored using the techniques described in this report, and according to the designs prepared by Thomas R. Biebighauser and Robin Annschild. The restoration of the wetlands would incorporate the techniques published in the following books by Tom Biebighauser:

- *Wetland Drainage, Restoration, and Repair*[1]
- *Wetland Restoration and Construction – A Technical Guide.*[2]

[1] Biebighauser, Thomas R., 2007. Wetland Drainage, Restoration, and Repair, Lexington, KY, University Press of Kentucky, 241pp.
[2] Biebighauser, Thomas R., 2011. Wetland Restoration and Construction – A Technical Guide. The Wetland Trust, New York, 186pp.

- *Restoration of Forests, Grasslands, and Wetlands Damaged by Off-Highway Vehicles*[3]

Heavy equipment such as an excavator and dozer would be used to fill ditches, contour soil, and remove soil as needed to restore wetlands. Heavy equipment would be cleaned prior to restoration to avoid introducing non-native plants. Nonnative plants growing on the project work area would be removed and/or buried as part of the project.

The flow from springs would be restored between the wetlands. Slopes would be changed to return natural sheet and braided flow patterns between the wetlands. Compacted soils would be loosened so they absorb water, grow a diversity of plants, and provide burrowing habitat for mammals.

Spillways and buried vertical grade control structures would be used to protect the wetlands from being destroyed by erosional head-cuts.

The wetlands would be restored *without* using these features that appear unnatural, and require maintenance:

1. No water control structures would be used.
2. No pipes would be used.
3. No pumps would be used.
4. No aerators would be used.
5. No above ground dams would be built.

Desirable plants growing in the work areas would be saved and replanted in the restored wetlands. Topsoil would be saved and spread on the restored wetlands where possible. The topsoil is expected to contain the seeds of native plants that would germinate and grow following restoration.

Thomas R. Biebighauser and/or Robin Annschild would be onsite directing heavy equipment operators in the restoration of the Cherry Meadows Wetlands. The project would be completed in partnership with Provincial and Federal Agencies.

Restoration of the Cherry Meadows Wetland would not damage trails, roads, culverts, or other improvements. The restoration of the wetlands would not increase the flooding risk of roads, trails, or neighboring properties. Restoring the wetlands and stream would not affect the water supplies of neighboring landowners

Invasive Species

Actions would be taken to prevent cattails, reed canary grass, and other nonnative plants from dominating the restored wetlands. The techniques to be used can be expected to prevent any one plant, native or nonnative, from taking over the restored wetlands:

[3] Eubanks, Ellen and Thomas Biebighauser. September 2014. *Restoration of Forests, Grasslands, and Wetlands Damaged by Off-Highway Vehicles.* 238 pages. USDA Forest Service. National Technology & Development Program, San Dimas, California. U.S. Government Printing Office: 2015-576-483/24032 Region No. 10.

1. Populations of existing nonnative plants would be removed and buried during construction.
2. Topsoil contaminated with nonnative plants would be removed and buried.
3. Elevations within each wetland would be varied to include deep and shallow areas.
4. Ridges, mounds, tufts, scrapes, and pits would be restored in each wetland.
5. Exposed soils would be seeded and planted to a diversity of native plants, and mulched.
6. The soils surrounding each wetland would be prepared using the *Rough and Loosen* technique.

The wetlands would be monitored for possible colonization of nonnative plants following construction. Nonnative plants would be controlled annually to facilitate the establishment of an attractive diversity of native plants.

Mosquitoes

The Cherry Meadows Wetland Restoration Project can be expected to lower mosquito populations in the valley. Dragonfly larvae, damselfly larvae, diving beetles, water boatman, water striders, frogs, and toads can be expected to colonize the restored wetlands and control mosquitoes in as little as one year. Swallows, bats, and adult dragonflies flying near the wetlands would consume adult mosquitos. The wetlands can be expected to become population "sinks" for mosquitoes.

Long-toed salamander larvae, like those one shown here, can be expected to control mosquito larvae in the restored wetlands

The dragonfly larvae living in the restored wetlands can also be expected to control mosquito larvae

Heavy Equipment Requirements

Suitable size and types of heavy equipment with skilled operators would be needed to restore the wetlands. A Service Contract is recommended for hiring heavy equipment and operators for the work. Under a Service Contract, the machines and operators are hired by the hour to restore the wetlands. The heavy equipment operators are directed by a wetland restoration expert who is onsite at all times while work is taking place. Under a Service Contract changes can be made to wetland design without incurring long delays and high additional costs.

The award of the Service Contract should be based on a combination of factors that include: ability to provide the required heavy equipment, performance operating heavy equipment, experience restoring wetlands, and price. The heavy equipment should be the size and type needed for restoring wetlands. Tom Biebighauser and Robin Annschild are available to help manage this project. Please let them know if you would like them to prepare a RFQ (Request for Quote) Service Contract document that can be used to advertise for bids.

Recommendations for heavy equipment are based on experience restoring similar wetlands across North America. All pieces of heavy equipment should be onsite working at the same time. Each should be operated by an experienced individual who is interested in restoring wetlands for wildlife:

Excavator (two needed)
100 or 200 Series
John Deere 200C LC or equivalent
Minimum 60-inch wide bucket (1.0yd^3) or larger
141HP Net or greater
46,000lbs or greater
Ground pressure no greater than 4.9 PSI (This is critical to staying afloat, minimizing the use of logs)
Working thumb attachment

Dozer (two needed)
CAT D6T LGP (or equivalent)
200HP Net or greater
48,000lbs
6 or 7-way blade
Blade width = 13-feet
Track shoe width = 36-inches
Ground pressure no greater than 5.2 PSI (This is critical to staying afloat)

Buried Utilities

From a safety perspective, a check for buried utilities should be conducted prior to restoration of the Cherry Meadows Wetlands. All buried utilities that are in the area must be marked so they can be avoided. The wetlands should not be built unless this critical step is completed. Heavy equipment work must not take place over buried electric, gas, phone, fiber optic, or water lines.

Project Implementation

Tom Biebighauser and Robin Annschild are available to assist with the implementation of the Cherry Meadows Wetland Restoration Project. They would help train heavy equipment operators and personnel in the design and restoration of wetlands.

Budget

An estimated budget was prepared for implementing the Cherry Meadows Wetland Restoration Project. The budget is based on the best information available at the time of preparing the design and plan for this project. This budget estimate is not based on actual quotes from contractors for supplies and heavy equipment use. The prices for these items can be expected to change after bids are received.

One main way of reducing costs is to involve Tom Biebighauser and Robin Annschild in the implementation of this project. This would save a significant amount of money by eliminating the need to prepare a detailed land survey, engineering design, set of engineering plans, and construction contract for the project.

Estimated budget for implementing the Cherry Meadows Wetland Restoration Project.

Wetland Number	Size (m²)	Excavator Hours	Excavator Cost	Dozer Hours	Dozer Cost	Logs Needed	Log Cost	Wheat bags	Wheat cost	Native Plant Seed Cost	Heavy Equipment Supervision Hours	Heavy Equipment Supervision Cost	Total Cost
1	5040	50	$9,072	27	$6,897	25	$1,386	11	$274	$504	25	$5,292	$23,424.76
2	4873	49	$8,771	26	$6,668	24	$1,340	11	$265	$487	24	$5,117	$22,648.58
3	8784	88	$15,811	46	$12,020	44	$2,416	19	$477	$878	44	$9,223	$40,826.00
4	7306	73	$13,151	38	$9,998	37	$2,009	16	$397	$731	37	$7,671	$33,956.60
5	5383	54	$9,689	28	$7,366	27	$1,480	12	$293	$538	27	$5,652	$25,018.94
6	4989	50	$8,980	26	$6,827	25	$1,372	11	$271	$499	25	$5,238	$23,187.72
7	6368	64	$11,462	34	$8,714	32	$1,751	14	$346	$637	32	$6,686	$29,596.99
8	10300	103	$18,540	54	$14,095	52	$2,833	22	$560	$1,030	52	$10,815	$47,872.02
9	8989	90	$16,180	47	$12,301	45	$2,472	20	$489	$899	45	$9,438	$41,778.79
10	3764	38	$6,775	20	$5,151	19	$1,035	8	$205	$376	19	$3,952	$17,494.20
11	5565	56	$10,017	29	$7,615	28	$1,530	12	$302	$557	28	$5,843	$25,864.83
12	1242	12	$2,236	7	$1,700	6	$342	3	$68	$124	6	$1,304	$5,772.53
13	1137	11	$2,047	6	$1,556	6	$313	2	$62	$114	6	$1,194	$5,284.51
Bridge	0												$20,000.00
Total	73740	737	$132,732	388	$100,907	369	$20,279	160	$4,008	$7,374	369	$77,427	$362,726.48

A. The Wetland Number is shown on the map for the project.
B. The size of each wetland is estimated
C. Excavator hours = Wetland size in m²/100m² progress rate/hour
D. Estimated Excavator Cost = (# excavator hours) x ($180.00 per hour)
E. Dozer hours = Wetland size in m²/190m² progress rate/hour (costs will be higher if smaller dozer is used)
F. Estimated dozer cost = (# dozer hours) x ($260.00 per hour)
G. Estimate that 1-log will be used for every 200m² of wetland built
H. Estimate $55.00/log = ($2,500 for a load of 45 logs), this cost should be moved into Excavator time if trees are obtained on site.
I. Wheat is packaged in 50lb bags, 1-50lb bag/460m² wetland built
J. Wheat cost = $25.00/50lb bag
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L. Heavy Equipment Contract Supervision Hours by Tom Biebighauser and Robin Annschild = # Excavator hours/2 (2-dozers & 2-excavators working at same time)
M. Heavy Equipment Supervision Cost = (L) x ($120.00/hour Tom Biebighauser) + ($90.00/hour Robin Annschild (includes all salary, lodging, mileage, meals, airfare)
Bridge: $5,000.00 for set up with 3-months rental @ $5,000.00/month

Training

The restoration of wetlands at Cherry Meadows may be completed in conjunction with the instruction of Hands-on Wetland Restoration Workshops. Tom Biebighauser and Robin Annschild would work in partnership with the Nature Conservancy Canada, BC Wildlife Federation, Provincial, and Federal personnel to teach people about wetland and stream restoration by involving them in the actual restoration of wetlands and streams. Tom has taught these training sessions with success for over 13-years across British Columbia. The training has been responsible for encouraging many individuals to design and build wetlands in their own communities.

Public Involvement

The authors have experienced strong opposition to the implementation of certain wetland restoration projects across North America. Individuals have been known to voice concerns about mosquitoes, public safety, loss of farmland, and the visual impact of construction when wetland projects are planned and underway in their community. Therefore, it is recommended that Nature Conservancy Canada share information about the many values of wetlands with their employees, membership, and public before the project begins.

Here are some actions the authors have taken with success to inform people of planned wetland restoration projects:

1. *Meetings* with employees to explain the project, and to listen to their concerns.
2. Preparation of a one-page *Fact Sheet* describing the planned wetland project. The Fact sheet should address mosquitoes, farmland, public safety, and the many values of wetlands. The fact sheet should be given to employees, neighbors, members, shared with the media, and posted on web-sites. Tom Biebighauser has prepared Fact Sheets for many wetland and stream restoration projects, and would be willing to work with the NCC to prepare one for this project.
3. *Presentations* about wetlands and wetland restoration. Tom Biebighauser has given numerous engaging and entertaining PowerPoint Presentation about wetlands prior to implementing wetland projects in communities. Presentations could be offered before and while wetland restoration is taking place.
4. *News Release*, accompanied by an invitation to visit the planned wetland restoration project with reporters, and the wetland project while under construction. This action can create an amazing number of positive and informed stories.
5. *Person(s) on site*: Tom Biebighauser and Robin Annschild are available to be onsite during project implementation to explain what is being done and why to the people who stop by and ask questions.

Summary

Over 40-acres of naturally appearing and functioning wetlands may be restored at Cherry Meadows near Kimberley, BC to greatly improve habitat for a diversity of waterfowl, amphibians and other wildlife species. The wetlands would be restored to improve habitat for rare species including the Northern Leopard Frog, Sandhill Crane, Trumpeter Swan, and the Western Painted Turtle. Effective techniques would be used to return the historic elevation of groundwater, flow from springs, hydric soils, and a native diversity of plants and animals.

Restoring the wetlands would control erosion, recharge groundwater, improve habitat for animals, and enhance visitor enjoyment. The wetlands would add great beauty to the landscape, and provide sites for education and research. The wetlands may be built at a reasonable price, and would require little, if any maintenance.

Recommendations

1. Please review this report and let the authors know if you have any questions.
2. We suggest a meeting with Henry Huser, Walter and Carol Latter on site to discuss access needs.
3. Consider requesting funding to implement the project in the fall of 2017.
4. Determine if the Nature Conservancy Canada would provide project management, or, if this should be contracted with Robin Annschild.

5. Schedule construction dates with Tom Biebighauser and Robin Annschild to supervise wetland restoration and provide training.
6. Obtain any permits needed to complete the project.
7. Work with Tom Biebighauser and Robin Annschild to advertise a Service Contract for the heavy equipment and operators needed to complete the project.
8. Order supplies such as native seed and mulch in advance of restoration.
9. Develop and implement a communications plan about the project for employees, members, neighbors, and the public.

About the authors

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Tom Biebighauser is a Wildlife Biologist and Wetland Ecologist who has restored over 1,800 wetlands in 22-States, in Canada and New Zealand. He retired in 2013 after working 34-years for the U.S. Forest Service. Tom has designed and restored over 300-wetlands in Arizona, British Columbia, California, Colorado, and New Mexico. He teaches practical, hands-on workshops where participants learn how to restore wetlands by becoming involved in the design and construction of naturally appearing and functioning wetlands. Tom has written 4-books about wetland restoration, and instructs college courses on the topic. He received the National Wetlands Award for Conservation and Restoration in 2015.

You are encouraged to visit http://picasaweb.google.com/tombiebighauser to see photos of the wetlands he has restored. Please visit www.wetlandrestorationandtraining.com for information about training offered in wetland restoration techniques.

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Robin Annschild has worked with Tom Biebighauser to design and build over 100-wetlands in British Columbia, Arizona, California, and South Carolina. She works with Tom Biebighauser to provide wetland restoration project design, management and construction supervision for sites across British Columbia. Robin developed project management and program planning skills in her former role as a conservation director for a land-trust. Under Robin's leadership, the conservation program raised $4.8 M dollars in program and acquisition funds to protect and restore habitat for multiple species at risk on Salt Spring Island.

Wetland Number	Size (m²)	Excavator Hours	Excavator Cost	Dozer Hours	Dozer Cost	# Logs	Log Cost	Wheat bags	Wheat cost	Native Plant Seed Cost	Heavy Equipment Supervision Hours	Heavy Equipment Supervision Cost	Total Cost
1	5040	50	$9,072	27	$6,897	25	$1,386	11	$274	$504	25	$5,292	$23,424.76
2	4873	49	$8,771	26	$6,668	24	$1,340	11	$265	$487	24	$5,117	$22,648.58
3	8784	88	$15,811	46	$12,020	44	$2,416	19	$477	$878	44	$9,223	$40,826.00
4	7306	73	$13,151	38	$9,998	37	$2,009	16	$397	$731	37	$7,671	$33,956.60
5	5383	54	$9,689	28	$7,366	27	$1,480	12	$293	$538	27	$5,652	$25,018.94
6	4989	50	$8,980	26	$6,827	25	$1,372	11	$271	$499	25	$5,238	$23,187.72
7	6368	64	$11,462	34	$8,714	32	$1,751	14	$346	$637	32	$6,686	$29,596.99
8	10300	103	$18,540	54	$14,095	52	$2,833	22	$560	$1,030	52	$10,815	$47,872.02
9	8989	90	$16,180	47	$12,301	45	$2,472	20	$489	$899	45	$9,438	$41,778.79
10	3764	38	$6,775	20	$5,151	19	$1,035	8	$205	$376	19	$3,952	$17,494.20
11	5565	56	$10,017	29	$7,615	28	$1,530	12	$302	$557	28	$5,843	$25,864.83
12	1242	12	$2,236	7	$1,700	6	$342	3	$68	$124	6	$1,304	$5,772.53
13	1137	11	$2,047	6	$1,556	6	$313	2	$62	$114	6	$1,194	$5,284.51
Bridge	0												$20,000.00
Total	73740	737	$132,732	388	$100,907	369	$20,279	160	$4,008	$7,374	369	$77,427	$362,726.48

A. The Wetland Number is shown on the map for the project.

B. The size of each wetland is estimated

C. Excavator hours = Wetland size in m²/100m² progress rate/hour

D. Estimated Excavator Cost = (# excavator hours) x ($180.00 per hour)

E. Dozer hours = Wetland size in m²/190m² progress rate/hour (costs will be higher if smaller dozer is used)

F. Estimated dozer cost = (# dozer hours) x ($260.00 per hour)

G. Estimate that 1-log will be used for every 200m² of wetland built

H. Estimate $55.00/log = ($2,500 for a load of 45 logs), this cost should be moved into Excavator time if trees are obtained on site.

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