miistakis institute
APPLIED CONSERVATION RESEARCH

Working with Beavers for Healthy Aquatic Ecosystems

Final Report

Alberta Innovates 222300155

DOCUMENT PREPARED FOR ALBERTA INNOVATES

Alberta Innovates and His Majesty the King in right of Alberta make no warranty, express or implied, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information contained in this publication, nor for any use thereof that infringes on privately owned rights. The views and opinions of the author expressed herein does not reflect those of Alberta Innovates or His Majesty the King in right of Alberta. The directors, officers, employees, agents and consultants of Alberta Innovates and The Government of Alberta are exempted, excluded and absolved from all liability for damage or injury, howsoever caused, to any person in connection with or arising out of the use by that person for any purpose of this publication or its contents.

Final Report - Working with Beavers for Healthy Aquatic Ecosystems

March 2025

Miistakis Institute
EB3013, Mount Royal University
4825 Mount Royal Gate SW
Calgary, Alberta T3E 6K6

Phone: (403) 440-8444
Email: institute@rockies.ca
Web: www.rockies.ca

Contents

1. PROJECT INFORMATION: 4
2. APPLICANT INFORMATION: 4
3. PROJECT PARTNERS 4

Executive Summary 4
INTRODUCTION 5
- Sector Introduction 5
- Knowledge Gaps 5
- Benefits Provided by Beavers 6

PROJECT DESCRIPTION 8
- Knowledge Description 8
  - Project Objectives 8
- Updates to Project Objectives 8
- Performance Metrics 8

METHODOLOGY 9
- Objective 1 Activities: 9
- Objective 2 Activities: 11

PROJECT RESULTS 13
KEY LEARNIINGS 13
- Objective 1 13
  - Growing Interest in Beaver Coexistence .. 13
  - Beavers from Space Citizen Science Program 13
  - Refining Coexistence Tool Installations ... 14
  - Development of Alberta's First Beaver BMPs 14
- Objective 2 14
  - Adapting the BRAT Model for Alberta 14
  - Best Practices for Restoration Site Selection 14
  - Implementing BDAs in Alberta 14
  - Monitoring BDA Effectiveness 14
- Broader Impacts 15
  - Influencing Permitting and Policy 15
  - Shaping Best Practices for Beaver Management 15
  - Advancing Citizen Science and Research 15
  - Enhancing Restoration and Land Management Practices 15
  - Advancing Data Availability and Decision-Making Tools 16

OUTCOMES AND IMPACTS 16
- Performance Metrics 16
- Field pilots/demonstration: installation of 4 BDA and 2 coexistence devices 16
- Knowledge mobilization: 12 extension events, launch of citizen science program with 50 citizen science participants 16
- Collaborators: 5 collaboration partners 17
- Publications: 2 technical documents 17
- Rural and Indigenous Communities: working directly with 2 Indigenous communities 17
- Sector HQP Trained: contributions to retentions of 5 HQP 17
- Sector HQP Trained:4 17
- Jobs Actual new jobs created from project: 2 new jobs in Indigenous Communities 17

BENEFITS 18
- Economic 18
- Environmental 18
- Social 19
- Building Innovation Capacity 19

RECOMMENDATION AND NEXT STEPS 19
KNOWLEDGE DISSEMINATION 20
CONCLUSIONS 20

1. PROJECT INFORMATION:

Project Title:	**Working with Beavers for Healthy Aquatic Ecosystems**
Alberta Innovates Project Number:	222300155
Submission Date:	March 7 2025
Total Project Cost:	$753,000.00
Alberta Innovates Funding:	$327,000.00
AI Project Advisor:	Alison Deas

2. APPLICANT INFORMATION:

Applicant (Organization):	**Miistakis Institute for the Rockies Inc.**
Address:	EB 3013, 4825 Mount Royal Gate SW Calgary T3E 6K6
Applicant Representative Name:	Danah Duke
Title:	Executive Director
Phone Number:	403-440-8444
Email:	danah@rockies.ca

3. PROJECT PARTNERS

Riparian Management Society – Cows and Fish – Co-Lead

Piikani Nation Lands Department – Local partner

Blood Tribe Land Management – Local partner

Executive Summary

Working with Beavers for Healthy Aquatic Ecosystems has been a highly successful initiative that has enhanced coexistence with beavers across Alberta and has demonstrated the effectiveness of using beaver dam analogues to mimic beaver function. Over the past three years we have successfully engaged with thousands of people through on-line and in-person presentations, training workshops, demonstration tours, a symposium, a highly successful citizen science initiative, and a curated website of awareness materials and resources. This focus on knowledge mobilization has expanded public

awareness and fostered widespread support for beaver coexistence strategies, bridging the gap between research and on-the-ground conservation efforts (installing beaver co-existence devices such as pond levellers, culvert protectors and tree wiring, restoring riparian ecosystems or constructing beaver dam analogues).

Our work demonstrating the effectiveness of BDA's was an innovative approach that engaged and enhanced capacity of Indigenous communities and other ENGOs to enhance watershed resiliency. By equipping landowners, municipalities, and environmental professionals with the tools and knowledge to implement nature-based solutions, we have strengthened local capacity for sustainable water and land management. The initiative has also facilitated collaboration between government agencies, Indigenous communities, and conservation groups, reinforcing the role of beavers as ecosystem engineers who contribute to climate resilience, biodiversity, and watershed health. As a result, Working with Beavers has established a strong foundation for long-term stewardship and policy integration across Alberta.

Additionally, our work has highlighted the willingness of Albertans to embrace beavers as a nature-based solution to enhance aquatic ecosystems and our work will continue to advance beaver coexistence and restoration in the province particularly through the development and implementation of the Alberta Beneficial Management Practices.

INTRODUCTION

Sector Introduction

Nature-based solutions (NbS) play a crucial role in Alberta's environmental, economic, and social resilience by addressing climate change, biodiversity loss, and land degradation. By leveraging natural ecosystems, NbS provide sustainable ways to manage environmental challenges while benefiting local communities and economies. Alberta faces increasing climate-related risks, including wildfires, droughts, and floods, making it essential to restore and maintain wetlands, grasslands, and forests, which act as carbon sinks and regulate water cycles to enhance climate resilience.

Beyond conservation, NbS provide practical benefits such as improved water management, with wetlands filtering pollutants, reducing erosion, and mitigating flood risks—especially in key watersheds like the Bow and Oldman Rivers. These solutions also strengthen Alberta's economy by supporting sustainable industries, creating green jobs, and enhancing community well-being through recreation and cultural connections, particularly for Indigenous land stewardship programs. By prioritizing nature-based solutions, Alberta can build a more resilient, biodiverse, and sustainable future while reducing reliance on costly infrastructure.

Knowledge Gaps

Beavers play a critical ecological role in Alberta, acting as a nature-based solution (NbS) for water management, biodiversity conservation, and climate resilience. Their natural ability to modify landscapes creates significant environmental benefits, making them essential allies in restoring degraded ecosystems and adapting to climate change. Restoring and enhancing wetland function (increased water storage, enhanced water quality, enhanced biodiversity, improved resiliency) can be a daunting and expensive task but for beavers it's just a way of life. Earning themselves the title of keystone species, ecosystem engineer, beavers are the ultimate climate change resiliency opportunity. Beavers are a novel nature-based solution that provide a multitude of ecosystem services through their dam building and wetland enhancing activities. After much of their population was removed during the fur trade era, populations are beginning to recover in Alberta but are still a fraction of what they used to

be and many of the ecosystem services they provided in the past are not being realized. We have an opportunity to help beavers restore our watersheds by enhancing coexistence with beavers through the installation of coexistence devices and elevating knowledge and by modifying degraded stream habitat to be more conducive to beaver recolonization through the use of Beaver Dam Analogues (BDAs).

Our collaborative work (Miistakis Institute and Cows and Fish) over the past 10 years has resulted in enhanced coexistence with beavers and enhanced knowledge of the benefits of coexisting with beavers, however, there is a need to scale this work more broadly across Alberta. One of the benefits of applying nature-based solutions is the ability to cost-effectively scale across broad landscapes. This requires continued outreach and education and demonstration of the effectiveness of tools to coexist with beavers. While many municipalities and communities are adopting co-existence approaches, many land managers still resort to traditional methods of lethal removal to deal with beavers because this is a familiar approach. We need to bolster support for coexistence by not only educating on the uses and training installations but also monitoring the coexistence sites with adaptive management in place to ensure success. There is also a need to engage with additional audiences who also manage land and come into conflict with beavers. The wide variety of ongoing requests for presentations, materials, and resources we receive shows that our project is filling a gap in knowledge and management decision-making. Based on the diversity of the audience, it is clear that the uncertainty of how to coexist with beaver is affecting many sectors of society (our request for information come from citizens, landowners, Indigenous communities, ENGO's, industry groups and media).

Benefits Provided by Beavers

The direct link beavers have to watershed function is through wetland creation through their dam building activities. This activity, undertaken by the beaver to ensure safety from predators, ample access to vegetation for food and further dam/lodge building, is what makes the beaver a keystone species, pivotal for the health and function of a watershed and the multitude of species that rely on wetland ecosystems.

Beavers modify valleys. Over time, beaver activity changes a steep gradient stream into a flatter, stair-stepped one that widens the valley. Deep, rich soils result from centuries of sediment capture behind the dams, creating fertile valley bottoms. Once beavers abandon their dams, the effect of beaver on stream valleys and vegetation lingers long past abandonment. Old dams may become enduring landscape features.

Beaver dams act as speed bumps, allowing water to gather behind each dam, create a wetland, and percolate into the soil. This percolation and reduction in stream speed allows for reduced erosion and a decrease in the amount of sediment in the flowing water as it's provided time to settle in the beaver wetlands. Sediment that is captured behind beaver ponds, and that spills into flood plains during high water events includes contaminants such as: nitrogen, phosphorous, carbon, fecal coliforms, etc. (Fitch, 2016). The capture of this sediment means that downstream of each beaver dam, the water quality is enhanced (Puttock et al., 2017).

From a carbon perspective, beavers and the wetlands they create can have a large impact on carbon storage. In rivers with beavers present, the beaver meadow (wetland and floodplain) stores 23% of the landscape's terrestrial carbon (Wohl, 2013). Beavers store carbon in a variety of ways: trapping sediment, submerging fallen trees and debris, increasing in-stream plant productivity, and slowing plant decomposition (Schultz, 2022). Although not yet quantified, BDAs can store carbon in ways

parallel to beaver engineering and will store their full potential once adopted by beaver (Schultz, 2022).

The reduction in stream speed and power caused by beaver dams also positively impacts water quantity. As the stream slows, water is stored behind the dam, eventually creating a wetland and greatly increasing the water storage potential of the stream. This slow-water environment allows the water time to percolate into the soil, moving from surface water to ground water. Groundwater recharge leads to increased annual flows (2-10 times greater), shift from intermittent flowing streams to permanent ones (especially important during the hot dry late summer period), and release of cooler water downstream of the dam (Fitch, 2016). Simply put, beavers store water and keep it on the landscape longer, 50% longer than streams without beavers (Fitch, 2016). This enhanced water storage is key to the drought mitigation benefits that beavers provide. Additionally, water storge enabled by beaver activity also enhances landscape fire resistance and acts as a refuge during wildfire (Fairfax & Whittle, 2020).

Beavers are usually blamed for localized flooding, but on a larger scale, a stream reach scale, flood waters can actually be held back by beaver dams, making the stream more resilient to floods. During the Alberta floods of 2013, Dr. Cherie Westbrook et al., had data loggers in streams in the Kananaskis region of Alberta's east slopes. She found that beaver dams retained the flood waters, delayed the flood peaks, and 2/3 of the dams were not washed away during this historic flood, providing strong support for beavers' ability to mitigate flood risk (2020).

Lastly, one of the most commonly understood benefits that beavers provide to the ecosystem is habitat enhancement. Although increasing watershed health and function is the primary goal of our project, the added benefits of adopting beaver as a nature-based solution, such as habitat enhancement, is what makes it a 'no-regrets' technique for watershed restoration. Beavers are considered a keystone species due to the disproportionately large effect they have on the landscape and other species. Browsing activity supports regeneration of many riparian species including cottonwoods and aspens, dam-building activities create ideal fish habitat, and wetland creation provides habitat for 40% of the planet's species (Madgwick, 2022). Wetlands in Alberta are of utmost importance as they "support more than 600 species of plants, some of which are
provincially listed as rare, threatened, or endangered" and provide "critical habitat for migratory and breeding waterbirds in Alberta, as well as several species at risk, including the northern leopard frog, piping plover, trumpeter swan, whooping crane and woodland caribou" (Alberta Environment and Sustainable Resource Development (ESRD), 2015).

Despite the ecosystem benefits that beaver provide, they can also cause unwanted flooding, damage infrastructure, incur maintenance costs, and remove trees. However, with better understanding of beaver ecology and effective implementation of coexistence tools, the negative impacts of beaver behaviour can be addressed. Based on results from our 2017 Alberta Beaver Survey of Alberta landowners, there is understanding of some of the benefits beavers provide and support for coexistence but also a need for more education on how to address the damages caused by beavers (Kinas et al., 2017). Through our pure and applied research, hands-on training workshops for coexistence tool installation and outreach and engagement, we can fill this knowledge gap and help landowners capitalize on the opportunity to coexist with beavers and realize their impact as a climate change mitigation tool.

PROJECT DESCRIPTION

Knowledge Description

Project Objectives

Objective 1: Enhance co-existence with beavers

Methodology approaches are grounded in knowledge mobilization and the need to enhance the knowledge and awareness of the benefits of coexisting with beavers and demonstrating tools to reduce the negative impacts of beavers. This will address the gap in knowledge and management decision-making that exists with respect to coexisting with beavers. Efforts over the past 10 years have addressed knowledge gaps in the ecology and ecological benefits afforded by beavers and we have focused our outreach with landowners and municipalities looking to enhance coexistence with beavers. We will focus on new audiences including industry groups and Indigenous communities (Kainai Nation and Piikani Nation). Additionally, enhancing coexistence with beavers requires addressing key barriers which include lack of guidance and clarity on recommended practices for beaver coexistence.

Objective 2: Test the efficacy of BDA's to mimic beaver function

Recognizing that BDA's are a relatively new and innovative technique there is a need to pilot, test, monitor and disseminate results to allow broader uptake of this nature-based climate solution. Piloting the use of BDAs on the dry southern Alberta landscape (targeting Piikani Nation and Kainai Nation) is an important step in tool development for beaver coexistence for watershed resiliency and restoration. Not only does this tool allow for enhanced water storage and wildfire risk reduction, but also for the reestablishment of beaver to the area, furthering flood and drought mitigation along with the many other benefits beaver provide.

Updates to Project Objectives

There were no significant changes to the two original objectives.

Performance Metrics

- Field pilots/demonstration: installation of 4 BDA and 2 coexistence devices
- Knowledge mobilization: 12 extension events, launch of citizen science program with 50 citizen science participants
- Collaborators: 5 collaboration partners
- Publications: 2 technical documents
- Rural and Indigenous Communities: working directly with 2 Indigenous communities
- Sector HQP Trained: contributions to retentions of 5 HQP
- Sector HQP Trained:4
- Jobs Actual new jobs created from project: 2 new jobs in Indigenous Communities

METHODOLOGY

Objective 1 Activities:

1. Install beaver coexistence devices at priority sites while delivering hands-on skills development workshops to enhance the capacity and knowledge to implement coexistence tools.

Working with end-users we identified sites appropriate for installation of coexistence devices (including beaver proof culvert installation, beaver exclusion fencing and pond-levellers). Sites were identified by end-users usually as the result of realized or potential localized flooding or infrastructure damage. Hands-on Skills Development Workshops were focused on building capacity within communities to successfully install beaver coexistence tools. The workshops were conducted in the train-the-trainer style.

2. Monitor coexistence tools

The coexistence sites were monitored to track changes in riparian health over time, with this done at 3-5 years after installation. Recognizing this monitoring extends beyond the project timeline for this project, Cows and Fish will actively monitor sites previously installed (18 sites over the past 6 years). Monitoring and revisiting of the sites was done to gather photo monitoring records, provide site maintenance, evaluate success of the tool and adjust as needed, in collaboration with the site partners. Ecological monitoring at each site includes photo monitoring, riparian health inventories including 79 ecological parameters including both vegetation and physical inventories.

3. Engage citizens in beaver coexistence through the implementation of a citizen science program to identify beaver dams and lodges

The results of the BRAT model (see activities below) identified where there is stream restoration potential based on landscape and hydrological features. However, another critical factor in beaver-mediated stream restoration is to determine if beavers are present at a location, a factor that BRAT is not able to determine. We used satellite imagery, broken into fine-scale image tiles, and asked citizen scientists to identify beaver dams and lodges on the images. Citizen science approaches are effective for democratizing science and provides access to scientific data otherwise unavailable.

This information was used to identify potential BDA sites and estimate the study area's current water storage capacity and potential capacity if streams were to be restored by beaver.

We created the on-line citizen science platform (https://www.zooniverse.org/). Zooniverse is a trusted and reliable platform that engages citizens in science projects globally. We worked with the Kainai Nation to ensure materials were culturally appropriate and launched the initiative with their community.

The combination of results from the BRAT model and the citizen science project ultimately helped us determine locations where there is high beaver-mediated restoration potential and low conflict potential (areas of low human density). Sites that have high restoration potential and high probability of conflict (areas of high human density) could allow us to better target these sites for coexistence efforts.

4. Facilitate knowledge mobilization - hosting of 3rd biannual Beaver Symposium

We identified the on-going need to bring stakeholders together to reflect on and highlight some of the great work within the field of beaver coexistence in Alberta and surrounding regions. With two successful symposiums in the past (2017 and 2019) we hosted our third Symposium in July 2023. We felt there was sufficient interest based on a high level of attendance at past events (60 attendees each year; over 87% of attendees from 2019 said they would attend another beaver symposium in 1-2 years' time).

5. Offer outreach events with a focus on building awareness of the ecology of beavers, their role in our watersheds and tools for coexistence

Outreach events included workshops, webinars, in-person presentations, conferences, one-on-one knowledge exchange and demonstration site tours. The coexistence demonstration sites (resulting from the Hands-on Skills Development Workshops and other installations) were highlighted in tours for others to see and learn from (key to knowledge mobilization) these efforts and to catalyze dialogue on the benefits and challenges of coexisting with beaver, with an aim to encourage greater social tolerance for, and acceptance of, beavers.

6. Curated materials to project website (https://www.workingwithbeavers.ca/), which sees 500 webpage views per month on average including ongoing social media (Facebook, Twitter, Instagram).

One of our key outreach methods is connecting with land managers through our project website. Many requests for detailed information on beaver coexistence come from land managers who have discovered our website, explored the available resources, and reached out for further guidance. To ensure Albertans have access to the most relevant information, we continuously update the website with new awareness materials and exemplary resources from other organizations. In addition to the website, we actively share resources across Miistakis and Cows and Fish social media channels, broadening our reach and supporting beaver coexistence and restoration efforts.

7. Develop Beaver Coexistence Best Management Practices

Recognizing that much work was occurring with beavers without proper guidance or clarity on the permissions needed or the recommended practices, led to barriers to the implementations of coexistence solutions and problem mitigation in Alberta. In 2021 we completed a document highlighting barriers to beaver coexistence in Alberta. One recommendation was the development of Beaver Coexistence Best Management Practices for Watershed Restoration to guide Albertans on solutions available to them for problem mitigation or watershed restoration using beaver.

In 2024, the Alberta Beaver Best Management Practices (https://workingwithbeavers.ca/coexist_bmp.php) document was created, that was grounded in a jurisdictional review to learn how other jurisdictions are approaching beaver coexistence management and how this applies in an Alberta context. The BMPs also incorporate our experience with coexistence tools over the past 13 years in Alberta. We met with managers of Alberta Fish and Wildlife who agreed that BMPs for beaver coexistence was needed and they offered their support and participation in the development process and incorporation of the BMPs into their own work. This work included engagement of relevant stakeholders including: GOA, municipal personnel, Indigenous groups,

trappers, landowners, environmental non-governmental organizations. This work lent to the broader application of coexistence with beavers resulting in an improved likelihood of the future use of coexistence tools across Alberta.

Objective 2 Activities:

1. Apply Beaver Restoration Assessment Tool

The Beaver Restoration Assessment Tool (BRAT) is a GIS-based modelling tool intended to assess the potential for beaver as a stream conservation and restoration agent over large regions and watersheds (Utah State University, n.d.). BRAT was developed by the Wheaton et al. lab at Utah State University and has been applied in other states as well as Riding Mountain National Park in Manitoba, Canada (Stoll & Westbrook, 2020).

Specifically, the BRAT model results were used to:

- Determine beaver dam capacity for stream segments in southwestern Alberta
- Map and prioritize areas where beaver restoration is feasible and impactful (i.e. stream reaches that have high beaver dam capacity but low beaver dam occurrence)
- Assess the water storage potential of the study area if beaver dam capacity was met

The results of this research enabled us to refine where to focus beaver coexistence and beaver-mediated stream restoration efforts; inversely, it also helped us determine sites where beaver restoration is not a viable solution.

To date we have implemented the BRAT model for the Kainai Nation study area and the results of this were used to select the site for the pilot BDA which was successfully installed in September 2022. Future runs of the model for additional study areas will now be more efficient as the first run for Kainai Nation required us to develop an equivalency methodology to use Alberta-specific data since the tool was originally created using datasets available only in the United States.

Using results from the BRAT model we identified potential sites for new BDA installations. Site selection also includes:

- Desktop review of aerial imagery
- Local knowledge of potential sites that could benefit from BDA restoration
- Field survey for BDA site assessment of potential sites
- Inquiry and application for any applicable permits/approvals

2. Beaver Dam Analogue Installations

BDA Pre-Installation Monitoring

For each BDA site, pre-installation monitoring was conducted to assess landscape and channel condition. Monitoring included stream and channel profile, surface and ground water, and vegetation (Riparian health inventory and assessment).

Details for each metric:

- Stream profile: a longitudinal profile of the entire stream, including measurements and diagrams

- Channel profile: a cross-sectional profile of the location of each BDA within the site, including measurements and diagrams
- Surface water: drone imagery as well as historic photos from Google Earth allow for assessment of changes in surface water
- Riparian vegetation: riparian health inventory and riparian health assessment for entire project site (consisting of multiple BDAs). Additionally, drone imagery as well as historic photos from Google Earth will allow for assessment of changes in riparian vegetation.

Installation of BDA

For each BDA site, the following tasks were undertaken to install the BDAs

- Material harvesting: posts and weave materials were sourced from as close to the site as possible and included: aspen, willow, spruce, sod, cobble, gravel, and mud/soil
- Purchase of materials: untreated wooden fence-posts were required for large and powerful streams
- Post-pounding: either conducted with hand tools or small machinery post-pounders. This was the main structural support for the BDAs
- Weaving of materials between the posts
- Packing mud/soil on the weave materials to make them more impermeable

Post-Installation Monitoring

For each BDA site, post-installation monitoring will occur for at least 2-3 years and will include:

- Stream profile: a longitudinal profile of the entire stream, including measurements and diagrams.
- Channel profile: a cross-sectional profile of the location of each BDA within the site, including measurements and diagrams.
- Riparian vegetation: bi-annual riparian health inventory and riparian health assessment for entire project site (consisting of multiple BDAs). Additionally, drone imagery as well as historic photos from Google Earth will allow for assessment of changes in riparian vegetation.
- BDA structural assessment: should the BDAs fail either partially or totally, it will be assessed if they need to be repaired if they should remain failed. BDAs are not meant to be permanent and if beavers do not adopt them they will fail at some point. For the research purposed of these sites, we will plan to maintain/repair the BDAs for the life of the project (3 years). If the BDAs are causing undesired effects such as flooding of unintended areas or infrastructure, they can easily be removed as mitigation.
- Remote sensing: evaluate BDA impacts on riparian vegetation health by looking at changes to Normalized Difference Vegetation Index (NDVI) pre and post BDA installation.

Recognizing that BDA's will remain in the ground beyond the life of this project, the project partners (Miistakis and Cows and Fish) intend to secure longer term funding beyond the 3 years of this project – to allow continue post-installation monitoring. Additionally, portions of the funding from this project have gone towards enhancing the capacity of land managers (Kainai Nation, Piikani Nation and Ann and

Sandy Cross Conservation Area) to ensure their commitment to this project. As the importance of nature-based solutions is increasingly recognized we are confident in securing future support.

PROJECT RESULTS

Objective	Deliverable	Status	Importance
Objective 1	Delivery of 12 extension events (workshops, webinars, presentations, demonstration site tours)	Completed - 20 extension events hosted	Enhancing coexistence with beavers through education and outreach—including presentations, conferences, and citizen science—builds awareness and promotes sustainable management of Alberta's waterways. Presentations provide science-based solutions to mitigate conflicts, while conferences bring together landowners, policymakers, and researchers to share knowledge and advance nature-based solutions like beaver dam analogues (BDAs). Citizen science initiatives, such as Beavers from Space, engage the public in monitoring beaver activity, fostering a network of environmental stewards. By focusing on knowledge mobilization, Alberta can shift perceptions of beavers from nuisance animals to valuable ecosystem engineers, ensuring long-term benefits for water retention, biodiversity, and climate resilience.
Objective 1	2023 Symposium	Completed	
Objective 1	Citizen Science Program launch	Completed	
Objective 1	Engagement with stakeholders on beaver coexistence best management practices	Completed	
Objective 1	Monitoring at coexistence sites	Completed	
Objective 1	Citizen Sicence data analyzed	Completed	
Objective 1	2 coexistence tool installations	Completed - 4 tools installed	
Objective 1	Deliver 4 hands on skills development workshops	Completed - 12 workshops	
Objective 2	BRAT modelling expanded to include Piikani Natio	Completed	The installation of some of Alberta's first beaver dam analogues (BDAs) marks a significant step toward restoring degraded waterways, improving water management, and enhancing climate resilience through nature-based solutions. Our research has demonstrated the impact BDAs have and highlighted their effectiveness as a tool to enhance watershed resiliency.
Objective 2	Apply BRAT model to BDA site selection	Completed	
Objective 2	4 BDA sites selected	Completed	
Objective 2	Pre-installation monitoring completed at 4 BDA sites	Completed	
Objective 2	BDAs installed at 4 sites	Completed	
Objective 2	Post BDA monitoring at pilot site established in Fall 2022	Completed	

KEY LEARNIINGS

Objective 1

Growing Interest in Beaver Coexistence

There is a continued and increasing demand for knowledge-sharing on beaver coexistence, from basic ecology to technical tool installation. Our symposium drew over 60 beaver practitioners from Alberta, BC, and Montana, including many first-time attendees. To meet growing interest, we exceeded our planned outreach events, maintained active engagement through the project website, and leveraged social media via Miistakis and Cows and Fish.

Beavers from Space Citizen Science Program

This component of the project progressed much faster than anticipated, highlighting broad global interest. Key lessons included:

- Freely available satellite imagery has limitations for detecting beaver dams.
- Improved zoom and time-lapse capabilities would enhance dam identification.
- Training a small, dedicated group of volunteers or students may improve efficiency in identifying dams.

Refining Coexistence Tool Installations

Despite years of experience, every installation presents new challenges, requiring adaptation during installation. Tool installation workshops continue to grow our collective expertise, and monitoring efforts—including those led by other organizations—are informing best practices. This year, we introduced "How to Wire Trees" workshops, where we refined logistics such as wire quantity estimation, volunteer coordination, and site preparation for future workshops.

Development of Alberta's First Beaver BMPs

The creation of Alberta's Beaver Beneficial Management Practices (BMPs) and interactive decision tree was a significant milestone. We learned that while site-specific modifications are often necessary, high-level BMPs provide a strong foundation for successful coexistence. User feedback confirmed the need for this resource, with requests for a field guide version to support on-site decision-making. However, we encountered challenges securing a Government of Alberta reviewer for the regulatory section, reflecting ongoing uncertainty around beaver management tool regulations—an issue that remains a key learning.

Objective 2

Adapting the BRAT Model for Alberta

The BRAT model, originally developed in the U.S., presented significant challenges due to differences in data availability. We had to source and adapt equivalent Canadian datasets, including requesting LiDAR data from the Government of Alberta. Additionally, the outdated provincial stream layer created discrepancies, showing historical watercourses that no longer flow. This issue also impacted Beavers from Space, as both relied on the same stream data. Our key takeaways: modifying BRAT for a Canadian context is challenging but feasible, and Alberta would benefit from updated stream data.

Best Practices for Restoration Site Selection

Selecting optimal restoration sites—such as those for Beaver Dam Analogues (BDAs)—requires multiple approaches. We found that using a combination of BRAT modeling, citizen science, ground-truthing, local knowledge, and site visits provided the most reliable results.

Implementing BDAs in Alberta

As a new tool for Alberta, BDA installation presented several logistical challenges, including longer-than-expected permitting and construction timelines, as well as higher material demands (e.g., wood chips, soil, water, and fence posts). These lessons are detailed in the Lessons Learned report and will help refine future project planning.

Monitoring BDA Effectiveness

Initially, we planned to monitor BDA impacts on water retention using groundwater wells. However, after the first field season, we found this method infeasible for our sites. Instead, we shifted to a remote sensing approach, analyzing vegetation greenness over time as a proxy for groundwater availability. This

method, combined with riparian health inventories, provides a robust monitoring framework. Additionally, we found that high-resolution satellite imagery was sufficient, eliminating the need for drone footage—though existing footage will be repurposed for outreach materials.

Broader Impacts

The learnings from this project will benefit beaver practitioners across Alberta, Canada, and beyond, as we are at the forefront of researching tools that are either entirely new or previously unstudied in an Alberta context. Our project has contributed to significant advancements in beaver coexistence, restoration practices, and data-driven decision-making, with implications for policy, permitting, and industry best practices.

Influencing Permitting and Policy

The growing interest in coexistence and BDA restoration tools has led to increased permit requests, and we have observed that permitters are becoming more familiar with these tools. This familiarity is expanding opportunities for implementation. However, challenges remain—particularly in defining regulatory requirements for beaver management and restoration tools. The difficulty in securing government review for the regulatory section of the Alberta Beaver Beneficial Management Practices (BMPs) highlights ongoing uncertainty. Clear provincial guidance on permitting and regulation would greatly benefit land managers and regulators and could support future policy updates to facilitate the implementation of nature-based solutions.

Shaping Best Practices for Beaver Management

The Alberta Beaver BMPs and interactive decision tree are among the few resources of their kind, with only a handful of comparable documents across North America. These BMPs serve as a foundation for proactive beaver management, including the potential development of municipal beaver management plans—a next step we hope to pursue given the strong interest from municipalities. Notably, the Alberta government has now included the BMPs as a resource on its human-beaver conflict webpage, further extending their reach and impact. By addressing knowledge gaps, improving permitting processes, and establishing best practices, this project is helping shape the future of beaver coexistence and restoration in Alberta and beyond.

Advancing Citizen Science and Research

We have drafted a manuscript on using citizen science to locate beaver dams, which we plan to publish. This research will contribute to the broader fields of conservation and citizen science, demonstrating how public participation can enhance landscape-scale monitoring.

Enhancing Restoration and Land Management Practices

Our lessons from BDA site selection and installation (e.g., challenges with permitting, material requirements, and monitoring methods) will inform future restoration projects across Alberta. This knowledge is already influencing best practices, ensuring more efficient and scalable implementation of BDAs. The shift from groundwater wells to remote sensing for BDA monitoring has broader

applications for assessing wetland and riparian restoration efforts, offering a cost-effective and scalable alternative to traditional field-based monitoring.

Advancing Data Availability and Decision-Making Tools

The adaptation of the BRAT model for Alberta has demonstrated the feasibility of using this tool outside the U.S., despite data limitations. However, our experience also underscores the need for updated, publicly accessible stream data in Alberta. The success of the Beavers from Space citizen science initiative highlights public interest in beaver-related landscape monitoring and the potential for crowdsourced data to complement other scientific assessments.

These insights are already shaping ongoing conservation efforts, influencing practitioners, and informing discussions on policy and permitting. Continued collaboration between researchers, policymakers, and land managers will be key to ensuring beaver coexistence and restoration remain viable, science-based strategies for ecosystem resilience.

OUTCOMES AND IMPACTS

Performance Metrics

Field pilots/demonstration: installation of 4 BDA and 2 coexistence devices

Completed installation of 4 Beaver Dam Analogue sites (2 located on Kainai Nation - total of 7 structures, 1 located on Piikani Nation – total of 4 structures and 1 located at Ann and Sandy Cross Conservation Area – total of 16 structures. 4 Coexistence devices installed (1 pond leveller, 3 tree wiring installations protecting over 100 trees total)

Outcome: While short term monitoring has demonstrated that the BDAs have resulted in water storage and improved greenness (pre and post photo analysis and preliminary NDVI comparison) long term monitoring will determine additional benefits including ground water recharge, erosion control, wetland creation, wildlife habitat creation and vegetation growth. The installations have resulted in an Alberta community of practice that is now knowledgeable on BDA installation and maintenance.

The installation of beaver coexistence tools, such as pond levellers and tree wiring, provides significant ecological and management benefits by allowing beavers to remain in their habitats while minimizing human-wildlife conflicts. Pond levellers regulate water levels in beaver ponds, preventing infrastructure flooding while maintaining wetland ecosystems that support biodiversity, improve water quality, and enhance climate resilience. Tree wiring protects important trees from beaver gnawing without harming the animals, preserving riparian vegetation crucial for erosion control and habitat stability. Together, these tools promote sustainable coexistence by balancing ecological integrity with land use needs, reducing the need for lethal management interventions, and supporting long-term watershed health.

Knowledge mobilization: 12 extension events, launch of citizen science program with 50 citizen science participants

Over the past three years we have hosted 20 extension events and launched citizen science program with over 1,900 citizen scientists from around the world and classified over 30,000 satellite images to locate beaver dams on the landscape. Each image was reviewed by multiple different volunteers resulting in a total of nearly 170,000 image classifications. We also had a very active chat, with volunteers asking questions about beavers, their habitats, their behaviour, and their cultural significance.

Outcome: Knowledge mobilization through presentations, symposium and citizen science has enhanced the effectiveness of beaver coexistence efforts by increasing public awareness, engagement, and support for sustainable management solutions. These efforts have helped grow a coexisting with beavers community of practice here in Alberta.

Collaborators: 5 collaboration partners

Collaboration partners included Riparian Management Society, Blood Tribe lands Department, Piikani Lands Department, Ann and Sandy Cross Conservation Area, Dr. Emily Fairfax, Oldman Watershed Council and Freshwater Conservation Canada.

Outcome: This project has resulted in enhanced capacity across all collaborators and increased the bench strength of Alberta-based organizations in their overall knowledge of beaver coexistence strategies and particularly in the installation of beaver dam analogues.

Publications: 2 technical documents

Technical documents (available via Workingwithbeavers.com) include:

- *Beaver Restoration Modelling in Southern Alberta*
- *Alberta Beaver Beneficial Management Practices*
- *Evaluating the Impacts of BDAs with Remote Sensing: three case studies*
- *Beaver Project BDA Lesson Learned*
- *Working with Beavers for Watershed Resiliency and Restoration in Alberta Demonstration Site Monitoring Report*

Outcome: Enhance knowledge mobilization as all documents will be freely available on the Workingwithbeavers.com website.

Rural and Indigenous Communities: working directly with 2 Indigenous communities

We worked directly with Blood Tribe Lands Department and Piikani Lands Department

Outcome: This has fostered collaborative stewardship, knowledge exchange, and ecological restoration rooted in traditional wisdom and cultural values. This project has supported sovereignty and self-determination by empowering our Indigenous partners to lead conservation efforts on their lands while strengthening relationships between Indigenous and non-Indigenous partners. Ultimately, this collaboration has promoted ecosystem resilience, reconciliation, and long-term environmental stewardship**.**

Sector HQP Trained: contributions to retentions of 5 HQP

Contributions to 7 HQP

Sector HQP Trained:4

8 HQP trained

Jobs Actual new jobs created from project: 2 new jobs in Indigenous Communities

2 new jobs were created in Indigenous Communities (Blood Tribe and Piikani Nation)

BENEFITS

Economic

Economic impacts include reducing infrastructure costs, improving water security, supporting sustainable industries, and enhancing ecosystem services.

1. Reduced Infrastructure & Maintenance Costs

By promoting flow devices and other non-lethal management strategies, the project helps landowners, municipalities, and industry avoid the high costs of beaver removal, repeated dam destruction, and culvert repairs. Traditional control methods, such as trapping and dam removal, are often temporary and require ongoing expenses, whereas coexistence solutions provide long-term cost savings.

2. Improved Water Storage & Drought Resilience

Beaver-created wetlands naturally store water, reducing the need for costly irrigation infrastructure and supporting Alberta's agriculture sector during droughts. This enhances crop yields and livestock health, benefiting farmers and ranchers while lowering dependence on expensive water management systems.

3. Flood Mitigation & Climate Resilience

Beaver dams slow water flow and reduce the intensity of floods, preventing costly damage to roads, bridges, and private property. This reduces disaster recovery costs for municipalities and insurance claims for landowners, making communities more resilient to extreme weather events.

4. Strengthened Agriculture & Land Productivity

The project encourages landowners to integrate beaver wetlands into regenerative agriculture, improving soil moisture, reducing erosion, and enhancing forage availability for livestock. These benefits support long-term farm productivity while reducing input costs such as irrigation, fertilizers, and erosion control.

5. Increased Eco-Tourism & Recreational Value

Beaver wetlands create rich biodiversity hotspots that attract birdwatchers, photographers, and outdoor enthusiasts, supporting local economies through tourism. Additionally, healthy wetland ecosystems contribute to fishing and hunting industries, generating revenue for rural communities.

6. Lower Public Spending on Water Treatment

Beaver wetlands naturally filter sediments and pollutants, improving water quality and reducing treatment costs for municipalities. This lowers taxpayer-funded expenses associated with water purification and ecosystem restoration.

Additionally, this project supported direct employment of 7 FTE from Alberta NGOs and 2 part-time from Alberta Indigenous communities.

Environmental

The Working with Beavers project has significant environmental benefits, particularly through the use of beaver dam analogues (BDAs)—man-made structures that mimic natural beaver dams to restore degraded waterways. BDAs slow water flow, promote sediment deposition, and enhance groundwater recharge, leading to healthier riparian ecosystems. By encouraging beaver activity in strategic areas, BDAs help create and maintain wetlands, which increase biodiversity, improve water quality, and provide habitat for fish, amphibians, and waterfowl. These restored wetlands also act as carbon sinks,

sequestering carbon and mitigating climate change impacts while improving landscape resilience to floods and droughts.

Through outreach and extension, the project educates landowners, municipalities, and industry professionals on the ecological benefits of beaver coexistence and provides practical tools for managing beaver activity effectively. Workshops, field demonstrations, and knowledge-sharing platforms help stakeholders understand how beavers naturally regulate water flow, reduce erosion, and enhance climate resilience. By fostering a shift from traditional beaver removal methods to sustainable coexistence strategies, the initiative helps protect Alberta's waterways while reducing human-wildlife conflicts. This proactive approach not only restores ecosystems but also builds community capacity for long-term environmental stewardship.

Social

The Working with Beavers project, through extensive outreach knowledge mobilization fostered community engagement and environmental stewardship through initiatives like the Beavers from Space citizen science program. This initiative empowered Albertans to participate in mapping and monitoring beaver activity using satellite imagery. By involving the public in data collection, the project increased awareness of the ecological role of beavers while strengthening connections between people and local landscapes. Citizen scientists gain hands-on experience in conservation, contributing valuable information that helps researchers and land managers make informed decisions about beaver coexistence. This collaborative approach enhanced public appreciation for nature-based solutions and encourages a sense of shared responsibility for wetland and watershed health.

The project also had a significant social impact through in-person training, outreach, and education. Workshops, field days, and knowledge-sharing sessions provided landowners, municipalities, and industry professionals with practical tools to implement beaver coexistence strategies. These efforts helped reduce conflicts between beavers and human infrastructure while fostering partnerships among diverse stakeholders, including Indigenous communities, farmers, conservation groups, and policymakers. By promoting dialogue and knowledge exchange, the project strengthened community resilience, enhanced environmental literacy, and built trust in sustainable land and water management practices across Alberta.

Building Innovation Capacity

The Working with Beavers project has supported innovation capacity in Alberta by fostering the development and application of nature-based solutions for water management, ecological restoration, and climate resilience. By promoting new and innovative tools such as beaver dam analogues (BDAs) and flow devices, the project has encouraged landowners, municipalities, and researchers to adopt cost-effective, science-backed approaches to coexisting with beavers. These solutions provide an alternative to traditional infrastructure, such as culverts and dams, demonstrating how biomimicry can enhance ecosystem services while reducing long-term maintenance costs. This has stimulated collaborative research and technological adaptation, particularly in the fields of hydrology, ecology, and environmental engineering.

RECOMMENDATION AND NEXT STEPS

Miistakis and our collaborators will continue to promote coexistence with beavers with on-going knowledge mobilization and research efforts. Our next phase of this project will include working closely with municipalities to develop beaver management plans to optimize beavers as nature-based solutions. Additionally, over the next two years we hope to further research the use of remote sensing beyond BDA sites to research beaver impacts to wildfire risk reduction and resiliency. Over the past two

year we have seen additional organizations in Alberta and BC beginning to use BDAs and they are seeking our expertise and advice so future partnerships to advance this conservation strategy are likely. We will also continue to build the BMPs by starting a beaver relocation review and pilot project.

KNOWLEDGE DISSEMINATION

Knowledge mobilization efforts by the Working with Beavers collaborative will have a significant impact on Albertans by increasing awareness of the ecological, economic, and social benefits of coexisting with beavers. By sharing research, best practices, and success stories, this initiative will help landowners, municipalities, and industry professionals better understand how beavers contribute to water management, climate resilience, and biodiversity conservation.

By promoting cost-effective coexistence strategies, such as installing flow devices to prevent flooding and using beaver dam analogs for habitat restoration, this initiative will reduce conflicts between beavers and human activities. For Albertan farmers, ranchers, and rural communities, this means improved drought resilience, flood mitigation, and water storage, leading to more sustainable land and water use. Additionally, the initiative supports policymakers in integrating nature-based solutions into land management plans, reducing reliance on costly grey infrastructure while enhancing ecosystem services. By fostering collaboration and knowledge exchange, Working with Beavers will empower Albertans to embrace beaver coexistence as a natural, practical, and long-term solution to environmental challenges.

Knowledge gained from this initiative will continue to be disseminated on our project website WorkingwithBeavers.ca and promoted on our Beaver mailing list (490 subscribers).

CONCLUSIONS

Working with Beavers for Healthy Aquatic Ecosystems has been a highly successful initiative that has enhanced coexistence with beavers across Alberta and has demonstrated the effectiveness of using beaver dam analogues to mimic beaver function. Over the past three years we have successfully engaged with thousands of people through on-line and in-person presentations, training workshops, demonstration tours, a symposium and a highly successful citizen science initiative. This focus on knowledge mobilization has expanded public awareness and fostered widespread support for beaver coexistence strategies, bridging the gap between research and on-the-ground conservation efforts.

Our work demonstrating the effectiveness of BDA's was an innovative approach that engaged and enhanced capacity of Indigenous communities to enhance watershed resiliency. By equipping landowners, municipalities, and environmental professionals with the tools and knowledge to implement nature-based solutions, we have strengthened local capacity for sustainable water and land management. The initiative has also facilitated collaboration between government agencies, Indigenous communities, and conservation groups, reinforcing the role of beavers as ecosystem engineers who contribute to climate resilience, biodiversity, and watershed health. As a result, Working with Beavers has established a strong foundation for long-term stewardship and policy integration across Alberta.

Additionally, our work has highlighted the willingness of Albertans to embrace beavers as a nature-based solution to enhance aquatic ecosystems and our work will continue to advance beaver coexistence in the province particularly through the development and implementation of the Alberta Beneficial Management Practices.

Miistakis Institute
EB3013, Mount Royal University
4825 Mount Royal Gate SW
Calgary, Alberta T3E 6K6

www.rockies.ca