The Ksik Stakii Project Beaver Mimicry Guidebook

A Guide to Natural Water Storage in Blackfeet Nation

Prepared by Jacob Levitus
with support from the Ksik Stakii Project Partners

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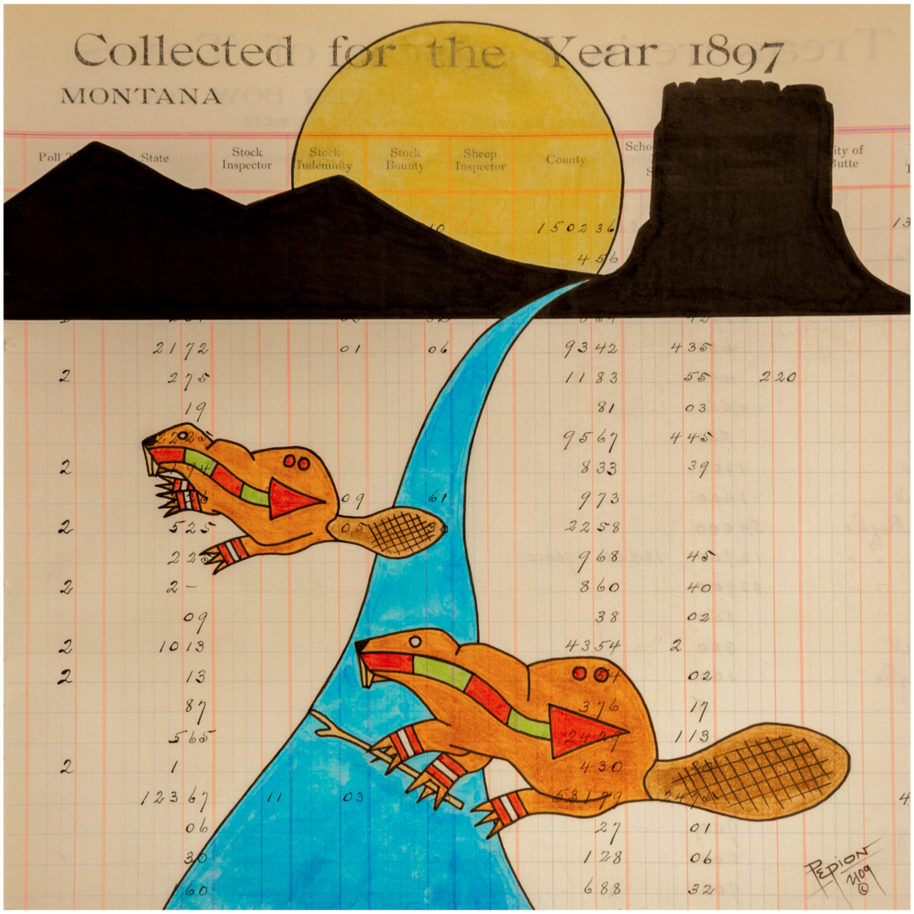

Ksik Stakii Ledger Art by John Isaiah Pepion - Piikani Artist

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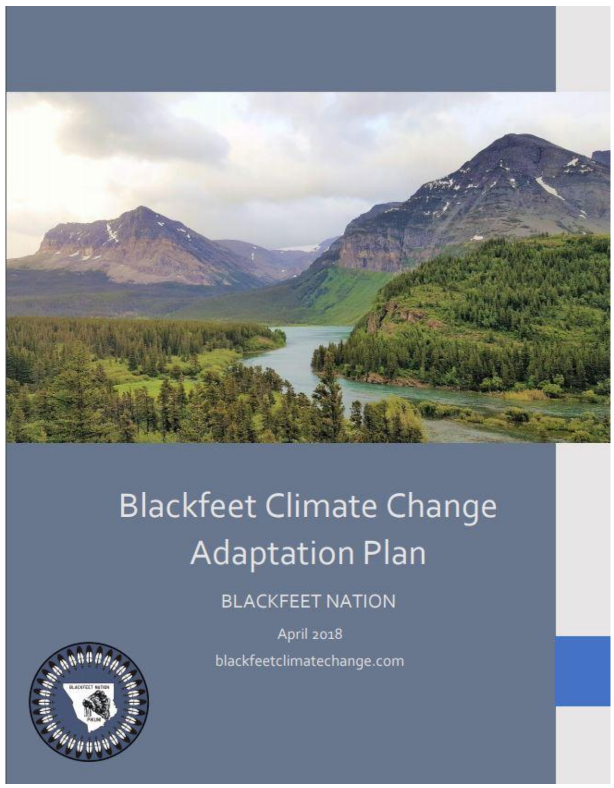
The 2019 Montana Conservation Corps Piikani Lands Crew with one of their completed beaver dam analogues

INTRODUCTION

This guidebook is a product of the Ksik Stakii (Beaver) Project, which was born out of the 2017 Blackfeet Climate Change Adaptation Plan. The project is centered around honoring and protecting beaver, an animal that is central to Blackfeet lifeways. Beaver also play a key role in climate change adaptation by building dams that naturally store surface and groundwater, create habitat for wildlife, and restore damaged streams.



The Blackfeet Climate Change Adaptation Plan can be accessed at www.blackfeetclimatechange.com

Over the course of two field seasons, students from the Blackfeet Community College Native Science Field Center and members of the Montana Conservation Corps Piikani Lands Crew built nineteen *beaver dam analogues (BDAs)*. The BDAs were constructed on two different project sites, both located on Willow Creek within the Cut Bank Creek Watershed in Blackfeet Nation. In 2018 seven BDAs were built on the Blackfeet Community College (BCC) campus and in 2019 twelve were added on a ranching family's private property. Fieldwork was completed in conjunction with an educational program that focused on climate change adaptation and mitigation.

KEY TERMS

Baseflow: The quantity or height of water that will travel in the stream even in the drier summer months.

Beaver dam analogue (BDA): Man-made structures that copy natural beaver dams to promote similar effects to beaver activity.

Beaver mimicry: The practice of building beaver dam analogues (see above).

Biodiversity: The variability among living organisms from all sources and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Floodplain: An area of low-lying land next to a river that is subject to flooding.

Groundwater: Water held underground in the soil or in pores in rock.

Incised stream: A stream that cuts a channel into the bed of a valley through erosion.

Ramp: A slight incline made of rocks and sod on the upstream end of the dam.

Riparian: Relating to or situated on the banks of a river or a wetland area.
Skirt: Willows, pine branches, and other leafy material that flows from the downstream end of the BDA. Designed to reduce scour from water going over the BDA.

Streambank: The land along a stream, river, or creek.

Surface water: Water that collects on the surface of the ground such as lakes, rivers, and oceans.

Vegetation: The collective group of plants found in a particular area or habitat.

Upland plants: Plants that occur in non-wetland areas.

Wetland: An area of land where water is present at or near the surface year-round.

Wetland plants: Plants that occur in riparian areas where the soil is typically saturated.

Wetland delineation: A thorough investigation and report of a wetland area. This includes the designation of a boundary on a map, identification of upland and wetland plants, soil types, and identification of key species. A wetland delineation is required from the U.S. Army Corps of Engineers for beaver mimicry work and other projects which impact wetland areas.

WHO IS THIS GUIDE FOR?

This guidebook is intended for anyone who is interested in learning about increasing water storage and restoring degraded streams through beaver mimicry. While this guide is specifically designed for the Blackfeet Nation, anyone is welcome to use this guide. Blackfeet Tribal members, Blackfeet Community College students, landowners, ranchers, farmers, and natural resource managers within the Blackfeet Nation may find this guide particularly useful since the guide was developed through beaver mimicry work with partners in Blackfeet Country.

Beaver dam analogues (BDAs) help increase natural water storage and restore damaged stream banks

DISCLAIMER

The purpose of this guidebook is to provide general information regarding beaver mimicry theory and practice and is intended for educational and informational purposes only. This guidebook highlights processes used, and lessons learned during two annual beaver mimicry project ("Project") seasons in Blackfeet Nation, but is not, nor intended to be, an all-inclusive manual on beaver mimicry, stream restoration, or drought resilience.

The author(s), publisher, and Project partners make no representations or warranties of any kind and assume no liabilities of any kind with respect to the accuracy or completeness of the contents. Neither the author, publisher, nor Project partners shall be held liable or responsible to any person or entity with respect to any loss or incidental or consequential damages caused, or alleged to have been caused, directly or indirectly, by the information or advice contained herein. This guidebook shall not be used to replace the advice and services of a competent beavery mimicry or wetland ecology professional for a project or other practices.

WHY IS BEAVER MIMICRY SO WONDERFUL?

Beaver mimicry is cheap, fun, and effective. Unlike other stream restoration methods that require heavy machinery and imported materials, beaver mimicry typically relies on inexpensive hand tools and natural materials that can be gathered on-site. In addition, working in the water is a great way to cool down in the hot sun during the summertime. The work is fulfilling, as visual results can often be immediate. Beaver mimicry offers a way to learn about climate change impacts while being part of a team of people preparing for a changing landscape.

All hands-on deck for the BCC Native Science Fellows

"BUILDING DAMS HAS BEEN VERY THERAPEUTIC, ESPECIALLY AROUND GOOD PEOPLE WHO KNOW HOW TO LAUGH AND HAVE A GOOD TIME."

-BLACKFEET COMMUNITY COLLEGE NATIVE SCIENCE FELLOW

WHY DO BEAVER MIMICRY?

The 2017 Montana Climate Assessment reports that Blackfeet Country has experienced a climate trend of precipitation increase in the winter and spring and decrease in the summer [1]. These changes are causing spring runoff to occur earlier in the season and with more intensity [1]. This has resulted in an increase of springtime flooding of homes, roads, and farmlands. Furthermore, there are lower stream baseflows in late summer, a trend predicted to continue into the future [2]. These lower summer stream flows are a result of hotter summer weather and drought, which can impact plants, wildlife, and human livelihoods. As periods of drought increase in frequency and intensity, the need for natural water storage will become more critical.

Low water levels on Lower Two Medicine Lake, Browning's main water source (Photo by Jake Smith, National Park Service, September 2019)

Beaver mimicry slows down the flow of water and allows for the build-up of sediment, which raises the streambed, eventually reconnecting the channel to the floodplain. In a healthy stream with an active floodplain, plant communities help reduce erosion through bank stabilization and filter runoff, which improves water quality *(see figure 1)*. The areas along a healthy stream recharge groundwater, slow down and store floodwater, and encourage biodiversity.

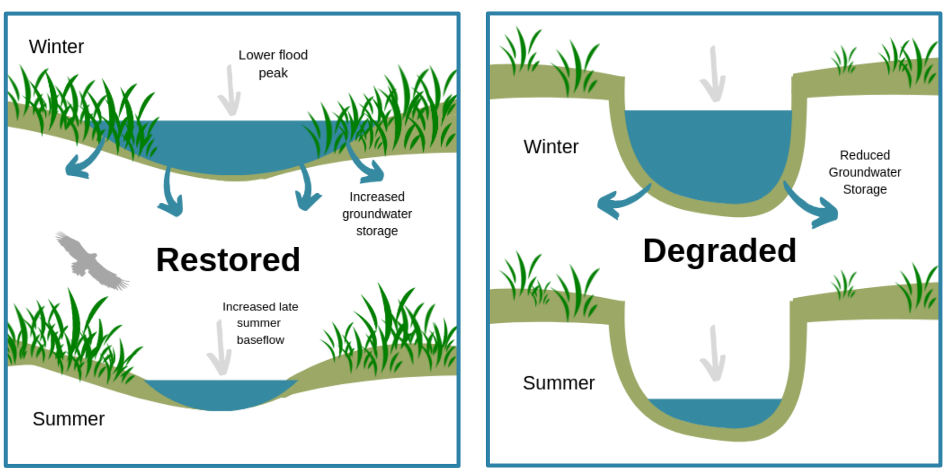


Figure 1 (left) a healthy stream, while Figure 2 (right) illustrated an incised stream bank.

Streams that have been exposed to overgrazing practices, have seen the removal or abandonment of beavers, or have had wetland vegetation removed can often benefit from beaver mimicry. In damaged streams, the banks are often cut down vertically, or incised, which can disconnect the stream from the floodplain *(see figure 2)*. When the stream is unable to access the floodplain, upland plants will often grow in the place of wetland plants. Upland plants typically do not have root systems capable of stabilizing stream banks, which leads to increased erosion and are an indicator of an unhealthy riparian area. In addition, active floodplains are important because they serve as a buffer, slowing down and storing overflowing waters, which can prevent or reduce damage from disastrous flood events.

ECOSYTEM ENGINEERS

Beaver is a critical species for natural water storage and the creation of habitat for birds, fish, and other wildlife. By building dams, a single beaver can store over 3 million gallons of water in their lifetime [3]. For this reason, beaver has and will continue to play a critical role in combatting drought and in climate change adaptation.

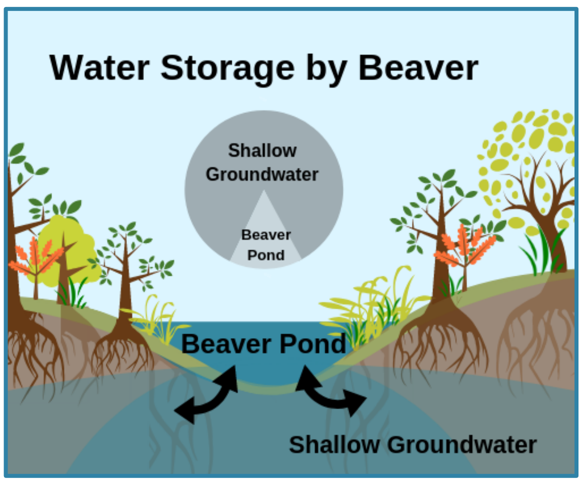


Figure 3: Most of the water stored by beavers end up in the ground

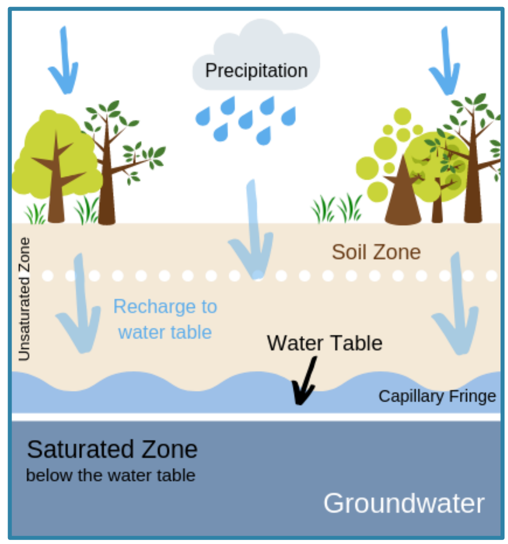


Figure 4: Aquifers, found beneath the water table, supply drinking water to over 97% of the United States' rural population

Since active floodplains slow down and naturally store water, they are able to replenish the groundwater supply by recharging underground aquifers *(see figure 3)*. Groundwater, which is typically accessed via wells, provides drinking water for over 97% of the United States' rural population and accounts for 42% of the water used for irrigation *(see figure 4)* [4]. Groundwater is also a critical component of drought resilience; its accessibility during drier periods may determine a community's ability to shoulder the challenges of intense drought.

"BEAVER MIMICRY WORK IS IMPORTANT BECAUSE WATER IS THE MAIN SOURCE THAT KEEPS THE ENVIRONMENT THRIVING AND WELL NOURISHED."

-BLACKFEET COMMUNITY COLLEGE NATIVE SCIENCE FELLOW

BEFORE YOU BUILD

Getting a beaver mimicry project off the ground can be a challenge. The following six steps are imperative for the planning phase of a beaver mimicry project.

EXPERT ASSISTANCE

Consult with a wetland ecologist or hydrologist with experience in beaver mimicry before selecting a site. Consulting with a trained professional is very important, particularly when selecting the placement and determining the size of BDAs.

1. Identify a place where natural water storage is needed and where riparian areas are degraded

- Identify streams with incised banks (as seen below, left.) These streams are often disconnected from the floodplain.

An incised streambank (left) does not allow the stream to access the floodplain, while the healthy streambank (right) allows water to access the floodplain during high-water events

- Identify streambanks that are lacking riparian vegetation such as willows, aspen trees, and cottonwood trees. These plants help strengthen the bank and slow down erosion.
- Identify streams that are impacted by warmer, drier temperatures, and earlier spring runoff. These streams often dry up in the late summer.

2. Identify areas that could benefit from increased surface and groundwater storage

This could be an area near a wellhead or a habitat restoration site. Beaver mimicry may not be the best approach if the area is habitat for an endangered or threatened species or is a sensitive ecosystem.

Amy Chadwick, wetland ecologist with Great West Engineering, explains the criteria for a beaver mimicry project to a group of students and faculty at Blackfeet Community College

3. Find people who want to help you

Beaver mimicry is a team effort. It is recommended to have three to five people working on one BDA at a time.

Reach out to volunteers who may be willing to help in the field. For example, you may want to reach out to community members, Blackfeet Community College, local school districts, Big Sky Watershed Corps (as of 2019, Tribal departments have hosted five members), and the MCC Conservation Internship Program (as of 2019, Tribal Departments have hosted four members), AmeriCorps VISTA, the Global Volunteers Program or other organizations and groups not listed here.

Montana Conservation Corps Piikani Lands Crew building a BDA

Another option is to contract a work crew to build BDAs. The Blackfeet Community College Native Science Field Center has worked on beaver mimicry projects. In addition, the MCC Piikani Lands Crew can be contracted for one week at a time and is available throughout the summer. Reach out to friends, family, and neighbors. More likely than not, they'll be excited to get in the water and contribute!

4. Survey the area

Soil core sampling is part of the wetland delineation process.

A wetland delineation is **required** before building BDAs. During the delineation, the project site and surrounding riparian area will be analyzed. Soil types, vegetation, and hydrology will be assessed. This must be done after the snow has melted so the delineator can properly identify plants on the ground. The delineation should be performed by a trained professional who is familiar with the beaver mimicry process and understands the context of the project. A specialist can be found by contacting the Blackfeet Environmental Office or Great West Engineering, a Montana-based firm.

For more information on wetland delineations visit: https://www.mdt.mt.gov/WetlandStreamDelineationProcess

5. Estimate project costs and find funding

Estimate costs for hiring a wetlands ecologist with delineation and beaver mimicry expertise and purchasing the necessary tools and equipment. Talk to Tribal departments and local nonprofits about grant opportunities. Some ideas for funding sources are:

- Montana Watershed Coordination Council (MWCC) keeps an updated watershed-related list of funding opportunities on their website (https://mtwatersheds.org/app/funding/)
- National Fish and Wildlife Foundation
- Bureau of Indian Affairs
- Environmental Protection Agency

6. Apply for and obtain necessary permits

The permit application process should begin several months to a year in advance of the project to ensure all requirements can be met in time for fieldwork. Whether the project is being undertaken on Tribal, private, or public land, there will be a permitting process. This process can be time consuming and typically requires long waiting periods. Working in Blackfeet Country, the following permits will likely be required:

DISCLAIMER

This guide is not a substitute for legal advice for which permits are needed nor how to obtain them. Legal requirements change and vary by location.

Cultural Resources Survey from the *Blackfeet Tribal Historic Preservation Office (THPO)*

- A Cultural Resources Survey at the proposed work site is required before moving forward with a beaver mimicry project. The survey will determine if there are any findings of cultural significance. Consult with the Blackfeet THPO office to schedule a culture resources survey.
- This should be done before the U.S. Army Corps of Engineers permit so that there is documentation that the project does not pose a risk to cultural sites

Aquatic Lands Protection Ordinance (APLO) 117 from the *Blackfeet Environmental Office (BEO)*

- This permit must be submitted to the BEO at least 45 calendar days prior to working in the water.
- This permit is valid for one year. (This is subject to change and should be checked regularly.)
- This permit may require additional maps, diagrams, and photos of the project site.

Section 404 Nationwide Permit 27: Aquatic Habitat, Restoration, Establishment, and Enhancement Activities from the *U.S. Army Corps of Engineers*

- This permit application must be submitted to Army Corps of Engineers at least 40 calendar days prior to working in the water. It can be helpful to establish rapport with the Army Corps project managers prior to the submission deadline so you can ask for a quick overview of your application to see if there are any major gaps in your application you might address well in advance of the deadline.
- Once the 404 Nationwide Permit 27 is conditionally approved by Army Corps, they will send a letter to the Blackfeet Environmental Office requesting a Section 401 Water Quality Certification from the Blackfeet Tribe. It will take the BEO **at least one week and up to one month** to respond to Army Corps. It is advised to discuss the proposed project with the BEO staff in advance of submitting an application.
- This permit may require additional maps, diagrams, and photos of the project site.
- After review and approval by BEO and Army Corps, you will receive your Nationwide Permit 27 with instructions on how to proceed with the project.
- Permits issued for the Ksik Stakii Project in 2018 and 2019 expire on March 18, 2022 when the existing Nationwide Permits are scheduled to be modified, reissued, or revoked.
- There are reporting requirements that must be completed after the fieldwork is finished.

DISCLAIMER

The Nationwide Permit 27 application can be very technical. In 2018 and 2019 the Ksik Stakii Project consulted with an ecologist and received assistance in preparing the application. It is recommended you consult with a wetland ecologist or hydrologist before submitting the application.

Blackfeet Nation Institutional Review Board (BNIRB)

- All research conducted within the boundaries of the Blackfeet Nation that involves human subjects must be approved by the Blackfeet IRB. Beaver mimicry may be considered by IRB to be research, so it is advisable to contact them to determine whether or not you need an IRB permit.
- Blackfeet Community College's IRB can be reached by calling (406) 338-5441. Follow the guidelines listed on the IRB Research Protocol Application.

Blackfeet Community College in Browning, Montana (Photo by Trevor Spotted Eagle, BCC)

Talk with neighbors about potential impacts

It is important to reach out to neighbors *before* installing BDAs, particularly those living upstream and downstream of the project site. While it is not required, it is important to be considerate to your neighbors. Speaking with neighbors ensures that they are aware of the beaver mimicry project and provides another friendly opportunity for people to learn about beaver mimicry. Depending on how far upstream or downstream neighbors live, they may begin to see more water on their property. According to anecdotal results, a landowner in Montana recalled seeing water flowing through a culvert in August for the first time after BDAs were installed upstream [5]. Another landowner recalled never seeing so much water in a stream that late in the season before beaver mimicry work was done [5].

A series of BDAs backing up water in the winter

Here are a few examples of things to discuss with your neighbors before installing BDAs:

- BDAs may have affects upstream and downstream.
- BDAs are *not* designed to stop water or create large ponds, they are leaky structures designed to lower stream energy, retain sediment, and rebuild stream channels.
- Invite neighbors to the project site! It's possible that they'll want BDAs installed on their property. Invite them to observe, to help volunteer, and to view the results.

GATHER SUPPLIES

Beaver mimicry can be done using natural materials and hand tools. Even though beaver mimicry does not require power tools or heavy machinery, having the proper supplies makes the job easier, safer, and more efficient.

The natural materials that are used to build Beaver dam analogues

PINE POSTS: Lodgepole pine is an ideal tree to use for the posts since they are straight and durable. Plus, lodgepole forests are often thinned for fire mitigation, providing a potentially free source of materials. Douglas fir will also work. Fresh wood works better than dry wood because it is less likely to break when getting hammered into the streambed and will last longer once installed. Posts should be approximately 1.5 feet longer than the stream depth and approximately three to four inches in diameter. You will need to sharpen the posts into a point on one end – the end that will be pounded into the streambed. There should be approximately one foot of post sticking out of the water after it has been hammered securely into the streambed.

PINE BRANCHES: Fresh green pine branches are used as a fill material in the BDA to supplement the willows in the BDA. They can be woven in between the posts and shoved in the gaps. Most importantly, pine branches are the ideal material for the skirt that prevents the BDA from scouring on the downstream end. Pine branches can be harvested in tandem with the posts, as long as they don't dry out before the project.

A trailer load of pine posts and branches

To make the project more efficient, pine posts and branches should be harvested in advance. This can be a time-consuming process, since each tree will need to be limbed. Since post lengths can vary, depending on stream depth, having a trained sawyer on site can be useful for cutting posts to the proper size.

WILLOWS: Willows will be woven between the pine posts. They should be a minimum of three feet in length, but longer is preferred. To harvest willows, cut the plant at the base at a 45-degree angle with loppers. Cutting them at an angle will give the stems a sharp end that makes it easier to jam into the bank. The willows should be as fresh as possible when woven. Willows need to be bendable. Dried willows will snap during the weaving process. It is recommended to harvest the willows the same day they will be woven into the BDA, but they will stay green for about a week. Soaking the stems in the stream or a bucket of water will keep the willows greener and fresher for longer.

A truckload of willows

Depending on the project site, there may not be a harvestable source of willows nearby. For this reason, it is highly recommended to have a truck or trailer. Hauling large loads of willows will save time and make the project more efficient.

Rocks can often be found in the streambed

ROCKS: Rocks will be used to build rock walls in the stream. The rocks should vary in size, ranging from the size of a grapefruit to a soccer ball. It is recommended to use rocks found in the streambed or nearby, when possible. It is important not to dig out the rocks near the stream banks because it can accelerate erosion.

SOD: Workers should dig up sod near the streambanks in one-foot cubes. It is important to space out the sod digging to aid in vegetation regrowth. Wetland sod is the preferred building source, but upland sod can be used as well.

MUD: Mud is used to plug gaps and should be harvested from the stream bed.

Plugging the gaps of the BDA with mud and sod

Digging up sod on the stream banks

PERMIT REMINDER

Note that you must have proper permits in place before you dig sod from a wetland area. Wetland activities are regulated by the clean water act, tribal ordinances, and other rules and laws.

ENLIST A TEAM

There are several different roles that are required to construct BDAs. The main tasks include post pounding, willow weaving, and sod digging. These jobs can all be done simultaneously, so having a group of enthusiastic workers will make the process more efficient.

When recruiting volunteers, keep in mind that beaver mimicry is a relatively new restoration practice that a lot of people are excited about. Take advantage of that eagerness and enthusiasm to do exciting work.

Blackfeet Community College Native Science Fellows and AmeriCorps members excited to work

IDENTIFY AND MANAGE RISK

There are many risks associated with beaver mimicry work. It is important to identify all of the risks before beginning fieldwork. After risks have been identified, work with your team to come up with strategies to manage and mitigate those risks.

The MCC Piikani Lands Crew's daily safety briefing and stretch circle

Below is a list of risk management and mitigation strategies

Establish an emergency protocol. This should include the following:

- Establish an evacuation plan. Have a vehicle on site for emergencies. Identify access roads.
- Determine if the work site has cellular service. If not, ensure that there is a communication device that can be used for emergencies.
- Identify the location of the nearest hospital. Prepare list of emergency contacts. Be aware of any preexisting medical conditions of crewmembers (i.e. allergies, medications, use of EpiPen, etc.).
- Bring a fully stocked First Aid kit.

Identify risks associated with the use of large, sharp, and heavy tools.

- These tools include sledgehammers, shovels and loppers.
- Use personal protective equipment (PPE) such as gloves, eye protection, and hardhats.
- Have spatial awareness and use proper communication, especially when working in confined spaces, such as a stream.
- Follow OSHA guidelines and always use PPE when operating a chainsaw. (For OSHA guidelines visit https://www.osha.gov/chainsaws.pdf)

Proper protective equipment is a great way to manage risk

Identify risk of falling into the water or getting swept in the current.

- Do a stream safety assessment by walking the full length of stream to assess risks of wildlife encounters (such as grizzly bears), hazardous trash, stream depth, and stream velocity.
- If the stream is known for having a heavy current during spring runoff, schedule the project in the summer or fall. Do not work in streams with water levels or currents that could risk trapping people underwater.

High water levels can be dangerous, especially when strong currents are present

If a worker falls in the water, they should follow these steps:

- Remain calm. Panicking could put the worker at greater risk.
- Keep your head and feet above water. Look for a spot on the shore to paddle or float to.
- Yell for help. There should be an out-of-water supervisor that could lend a hand.
- Always wear a wading belt. This can prevent the waders from filling up with water and can prevent drowning.

Identify risk of hazardous weather

- Temperatures in the Blackfeet Nation can vary from extremely hot to extremely cold, even in the summer. It is not uncommon to see snowfall during summer months.
- Dress in layers and bring extra gear to ensure comfort and preparedness.
- Take sun protective measures such using sunscreen, wearing a hat, and seeking shade when possible.
- A shade canopy is recommended for areas which do not have much shade.
- Use bug spray.
- Bring bear spray and keep it accessible. Always work in groups of two or greater. Never work alone.
- Check local forecasts and look for signs of changing weather.

A shade canopy is essential when working in open areas during the summer months

Assess Danger of Wildfire Smoke

If the work site is prone to wildfire smoke, consider planning to work during a time where the risk of wildfire is low. Wildfire smoke can cause lung and heart damage, respiratory problems, and eye irritation [6].

Check the air quality index on www.airnow.gov every day.

If air quality is inadequate for working outside, postpone work until air quality is healthy enough to safely continue working.

Smoke from wildfires limit worktime in the field

Watch Out for Lightning

Do not work in or near water during hazardous lightning events. In the event of a hazardous lightning storm seek shelter in the nearest indoor structure, vehicle, or large group of trees. Avoid single large trees, wide-open spaces, and bodies of water.

Avoid Flooding

Do not work in or near water during flood events. In the event of a flash flood, safely exit the stream and seek indoor shelter or high ground.

NOTE: These may not be all of the risks associated with beaver mimicry.

Once all of the risks have been identified, conduct a Job Hazard Analysis

For more information on Job Hazard Analyses (JHAs) visit https://www.osha.gov/Publications/osha3071.pdf and see the provided sample JHA, below.

Sample Job Hazard Analysis

JOB STEPS	POTENTIAL HAZARDS	PROTECTIVE MEASURES
1. Harvest willows using loppers	Poke eye on willows. Cut finger with loppers. Losing balance and falling into the water, with risk of not being able to stand up	Wear eye protection. Wear gloves and be mindful of fingers. Always wear waders with a belt to avoid waders filling with water. Always harvest in pairs or small groups to have someone close for assistance
2. Build rock wall using large rocks	Strain back while picking up rocks. Smash finger with large rock.	Use proper body mechanics. Wear gloves and be mindful of fingers.
3. Pound in pine posts using sledgehammer	Smash hands or fingers of person holding post in place. Strain back while swinging sledgehammer. Hit someone's head.	Wear gloves and be mindful of fingers. Use proper body mechanics. Wear hardhat and eye protection. Carefully communicate with people you are working with and ensure that everyone is very alert to the situation at all times.

NOTE: This sample JHA is incomplete. An actual JHA will be longer and more detailed.

MEASURE AND DOCUMENT CONDITIONS BEFORE BEGINNING WORK

Monitoring is the observation and documentation of change over a period of time. Effective monitoring is a key component to any project and is essential for tracking the results. Photo point monitoring is a great way to track the results of beaver mimicry work.

Photo point monitoring is a cheap and easy method used to monitor changes over time. For beaver mimicry, photo points can be used to detect changes in vegetation, water level, and streambank quality. Effective photo points can also be effectively utilized in presentations and in grants and reports.

Photo point monitoring can be implemented by following these four steps, per the U.S. Forest Service [7]:

1. Define the objective.

Consider the goals for the project. Beaver mimicry is intended to improve riparian health and increase natural water storage, though there might be additional site-specific objectives.

2. Select and establish photo and camera points.

With the objectives in mind, select photo points that can be used to effectively document the changes that will occur over time. Determine how often and when photos will be taken. Consistently taking photos at the same time each year will document the changes more accurately and with fewer variables.

Once the photo points are selected, pound in t-posts at each site using a post pounder. Use a paint pen, laminated paper, or another weatherproof labeling method to label each post. An example of post labels is R1-T1, R1-T2, R1-T3, etc. R2-T1, R2-T2, R2-T3 etc. In this example, "R" represents the reach number and "T" represents the t-post number. A GPS device can be used to document the coordinates of each point, which is useful for mapping.

T-post clearly labeled with paint pen to withstand weathering.

3. Photograph the scene or subject.

Create photo identification cards to place in the camera's field of view. These cards will help with data organization and should include the reach number, photo point number, and date. Laminated cards can be reused by writing the date and other relevant information with a dry-erase marker. A small chalkboard or dry-erase board can also be used.

Photograph each point by taking three photos: upstream, straight ahead, and downstream. These three photos increase the range of view for each point. Letting the camera rest on top of the t-post for each photo will ensure that the photos are consistently taken from the same height.

Repeat photography shows changes in water level and vegetation between October 2018 and February 2019.

4. Organize and file the data.

Having an organized set of files is a critical component of monitoring. Collapsible folders and easily identifiable file names are very important when storing photos on a computer. Explain the photo point monitoring method in detail in a word document. The directions should be descriptive and clear enough make sense to someone who has not been exposed to the project. This document could be useful when revisiting the project at a later time. Save a backup of all of the data on a hard drive or in cloud storage to prevent a loss in data in the event of a computer failure.

BUILDING BEAVER DAM ANALOGUES

Now it is time to build the beaver dam analogues! This section highlights the materials, tools, and equipment needed to build BDAs, as well as the six primary steps of BDA construction.

Materials (usually) needed to build one BDA:

Untreated Pine Posts: approximately 3-4 inches in diameter, and approximately 2 feet higher than the stream depth, with one end sharpened (tip: sharpening posts in advance will save valuable field time.)

- Approximately 10-20 posts per BDA, depending on stream width.
- Treated wood is often filled with dangerous chemicals that should not be put in the stream.

Pine posts, approximately 3-4" in diameter are ideal for beaver mimicry

<u>Willows:</u> should be at least 3 feet long and about a thumb's thickness in diameter. In addition to the willow weave, willow stems can be jammed into the streambank to encourage sprouting and regrowth. These willow stems should soak in water for at least 72 hours before being planted.

- Approximately 20-30 willows are needed per BDA, but it is highly dependent on desired BDA height and stream width.

A truckload of pine and willows (left) and a willow harvesting demonstration (right)

<u>Rocks</u>: can usually be gathered on site; in or near the stream. The rock wall should span all the way across the streambed.

Recommended tools and equipment:

Shovel for digging sod. 4 shovels recommended, but it depends on team size and desired number of BDAs.

Sledgehammers for pounding in wood posts. 8-pound sledgehammers work best. 1 or 2 sledgehammers are recommended, depending on how close people are working to each other.

5-gallon buckets for transporting mud and sod or soaking willows in water. 5 buckets are recommended.

Loppers for harvesting willows, adjusting size of willows, and clearing path to stream. Approximately 5 loppers are recommended.

Personal Protection Equipment (PPE) this includes hard-sole waders and wading belt, gloves, and eye protection for each builder. Gloves should remain pliable when wet.

STOP THE SPREAD OF Aquatic Invasive Species (AIS)

Felt-sole waders are a pathway to spreading AIS. They are illegal in the Blackfeet Nation. It is required to use hard-sole waders in Blackfeet waters.

Shade canopy, sunscreen and bug spray for builders. These are especially useful in sites without any shade.

Keeping equipment organized makes the project safer and more efficient.

Flagging for marking locations of BDAs.

Chainsaw, fuel for chainsaw, safety equipment for chainsaw operator, and a certified operator for adjusting length of posts.

T-posts and paint pen for photo monitoring points. One t-post per photo point, and a **camera** for monitoring.

Post pounder for pounding in t-posts.

Steps for building a beaver dam analogue:

BDA SITE PLACEMENT

BDA site selection requires hydrology and wetland ecology expertise. It is recommended to consult with a trained professional to identify appropriate BDA sites.

1. Once site is selected, build a rock wall using large rocks. The rock wall should span the width of the streambed and will be the beginning of the ramp, raising the water level on the upstream side of the stream a few inches.

The rock wall should begin to raise the water level, creating a ramp

2. Pound sharpened lodgepole pine posts with a sledgehammer into the streambed, directly downstream of the rock wall. Posts should be arranged in an offset "zigzag" formation, approximately 8-12 inches apart.

Pounding in pine posts

3. While workers are pounding posts, other workers can be <u>digging up sod</u> from the bank in cubes of about 1 ft. x 1 ft. x 1ft. Each cube of sod should be dug separately from the others to aid vegetation regrowth after digging. When nearing the completion of the BDA, smaller pieces of sod are great for plugging gaps that may remain.


Spacing out the sod digging reduces the long-term impact on vegetation

4. <u>Weave willows</u> in and out of posts, starting from both sides of the stream, jamming stems into the banks to encourage willow growth and sprouting. The willows should be placed as low as possible, built from the bottom to top. When possible, finish the weave with the end of the willow pointing downstream, adding to the skirt. Build up the willow weave to the desired water level. Ensuring the middle of the dam is the lowest point.


Weaving willows between pine posts

5. On the upstream end of the willow weave, fill in leaky gaps between willows with sod, mud, and smaller rocks. This should contribute to the ramp, where the water flows over the top of the BDA.

Sod and pine branches are used to plug any large gaps in the BDA

Putting the final touches on a nearly completed BDA

6. Finally, place willows and pine branches into the upstream end of the BDA to create the skirt. The skirt prevents water from scouring the BDA as it goes over the top. In the skirt, the willow and pine should flow perpendicular to the BDA.

"I LIKE HOW EVERYTHING IS HANDS-ON. I FEEL LIKE I'M LEARNING SO MUCH AND I'M ACTUALLY ABLE TO APPLY IT IN REAL LIFE."

-Blackfeet Community College Native Science Fellow

COMPLETE REPORTING REQUIREMENTS

After the beaver mimicry work is completed, it is **required by law** to notify the U.S. Army Corps of Engineers. At the time of writing, permit holders are asked to sign a “Compliance Certification” by a set date. The Certificate of Compliance is attached to the Nationwide Permit 27 that is granted by the U.S. Army Corps of Engineers.

A completed BDA in the fall time

INVITE PEOPLE TO VIEW RESULTS

Once the BDAs are installed, it is time to invite people to view the results! Giving tours of the beaver mimicry site can be beneficial for students, neighbors, landowners, and natural resource managers. A site visit could provide the inspiration for future beaver mimicry projects. Funders typically like to see the outcomes, so inviting them to view the results could be a good way to wrap up a project or encourage additional funding.

There are a few different ways to make a site visit more effective. Preparing a short presentation can help provide context to the project. A few potential ideas to discuss are what the site looked like before beaver mimicry, why beaver mimicry was done, where beaver mimicry is best suited, how the BDAs were built, and who built them. In addition, sharing challenges, mistakes, and lessons learned could be beneficial to the audience. Encourage people to ask questions. Bringing a set of laminated "before" photos and any other relevant photos will help the visitors effectively visualize any changes that have occurred over time.

After just one day, the BDA is raising the water level and stopping sediment

Blackfeet Community College Native Science Fellow Leissa Still Smoking teaches Glacier National Park employees about beaver mimicry

Photos for the guidebook are provided by Ksik Stakii Project partners Libby Khumalo, Jacob LeVitus, Angelina Gonzalez-Aller and Kendra Allen.

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The Ksik Stakii Project

http://blackfeetclimatechange.com/ksik-stakii