KAINAI / BLOOD TRIBE IINNII REMATRIATION RELATIONALITY BETWEEN PRAIRIE SOIL, PLANTS, AND PEOPLE

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Abstract

Iiniiksi (plains bison; *Bison bison*) are ecocultural keystone species that have coevolved in sacred reciprocal relationships with Siksikaitsitapi (Blackfoot People) and nonhuman Saokio (prairie) relatives since time immemorial. The historic decimation of native prairie and Iiniiksi, along with the displacement of Indigenous plains peoples, disrupted this web of prairie interrelationships, creating an imbalance in the grassland ecosystem and the Siksikaitsitapi way of life. Grounded in Blackfoot Ecological Knowledge (BEK) and Siksikaitsitapi Science (SS), my research explores interactions amongst soil, plants, and people resulting from Iinnii rematriation (the return of sacred ways that centers and restores responsibilities and relationships) to Kainaissksaahkoyi (Blood Reserve / Kainai First Nation) to offer a path forward for healing these sacred relationships. I characterized soil and plant communities in nine paired ungrazed and grazed sites on the Kainai Iinnii Rangelands two and three growing seasons after Iinnii returned. I gathered Iinnii relational BEK with five Blackfoot Elders and Knowledge Keepers to better understand the social effects of Iinnii rematriation. After one year of Iinnii grazing, there were no significant differences in soil, plant communities, or the occurrence of traditional plants. Long-term monitoring is needed to capture future Iinnii effects on the landscape. Blood Tribe Land Management (BTLM) can use essential baseline data collected in this study for an Indigenous-led community-based monitoring program. Synthesizing BEK with Western Science (WS) provided invaluable insight to reconnect people to Iinnii and Saokio and guide future Iinnii reintroduction and grassland stewardship efforts.

Acknowledgements

I am grateful to Iiniiksi for being my spiritual guide on this learning journey and reconnecting me with Aatsimoyihkaan (spirituality). I thank my Siksikaitsitapi and Dine Elders, Knowledge Keepers, Niksokowaiksi, and ancestors for reminding me of the spiritual strength and ancient knowledge that exist in me. I thank my family, especially my children, for their endless love and encouragement. I am blessed to have amazing support from the Niitsitapi community and everyone at BTLM. I also greatly respect my co-supervisors and committee for believing in this project and providing a safe path to complete my research.

Special thanks to the following BEK mentors who participated in my research through interviews and coffee visits:

Api'soomaahka (Running Coyote), William Singer, the third

Iitsspinnimakii (Going to the center to capture), Amethyst First Rider

Ikaisskini (Low Horn), Dr. Leroy Little Bear

Imakokinii (Owns Big Lodge), Elder Charlie Crow Chief

Minipoka (Berry Child), Elder Peter Weasel Moccasin

Niinaisipistoo (Owl Chief), Elder Francis First Charger

Ninna Piiksii (Chief Bird), Dr. Mike Bruised Head

Dedication

I dedicate this effort to my late mother, Mary Ann Fox (Yellowhorse), who epitomizes the love and kindness that nourishes my spirit today. I also dedicate it to the current and future Indigenous Scientists who care for the survival and well-being of Iiniiksi, Ksahkomm, and Niksokowaiksi.

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List of Abbreviations

AAFC	Agriculture and Agri-Food Canada
ASV	Amplicon Sequence Variant
BEK	Blackfoot Ecological Knowledge
BP	Before the Present
BTLM	Blood Tribe Land Management
C	Carbon
CHI	Cultural Health Index
CIPCA	Canadian Indigenous Protected and Conservation Areas
CN	Carbon-Nitrogen
DADA2	Deficiency of Adenosine Deaminase 2
DNA	Deoxyribonucleic Acid
GC-MS	Gas Chromatography-Mass Spectrometry
GIS	Geographic Information System
GVI	Grassland Vegetation Inventory
H	Healthy
HCl	Hydrochloric acid
HP	Healthy with Problems
IPA	Indigenous Protected Area
IQR	Interquartile Range
IS	Indigenous Science
ITS	Internal Transcribed Spacer
KCl	Potassium Chloride
KEPA	Kainai Ecosystem Protection Association
KIR	Kainai Iinnii Rangelands
KPBS	Konza Prairie Biological Station
MG	Mixedgrass Natural Subregion
MRDNA	Molecular Research LP
N	Nitrogen
NaHCO3	Sodium Bicarbonate
NCC	The Nature Conservancy of Canada
NH3-N	Ammonia-Nitrogen
NH4	Ammonium
NMDS	Non-Metric Multidimensional Scaling
NO3	Exchangeable Nitrate
NO3-N	Nitrate Nitrogen
OTU	Operational Taxonomic Unit
PE	Pair-End
PERMANOVA	Permutational Multivariate Analysis of Variance
PERMDISP	Permutational Multivariate Analysis of Dispersion
pH	Potential of Hydrogen
PO4	Phosphate
PO4-P	Phosphorus
QIIME	Quantitative Insights Into Microbial Ecology
RHA	Rangeland Health Assessment
rRNA	Ribosomal Ribonucleic Acid
SOC	Soil Organic Carbon
SS	Siksikaitsitapi Science
TEK	Traditional Ecological Knowledge
TN	Total Nitrogen

UH	Unhealthy
USA	United States of America
WS	Western Science

Chapter 1: Tsinikssin (story; participating in an event)

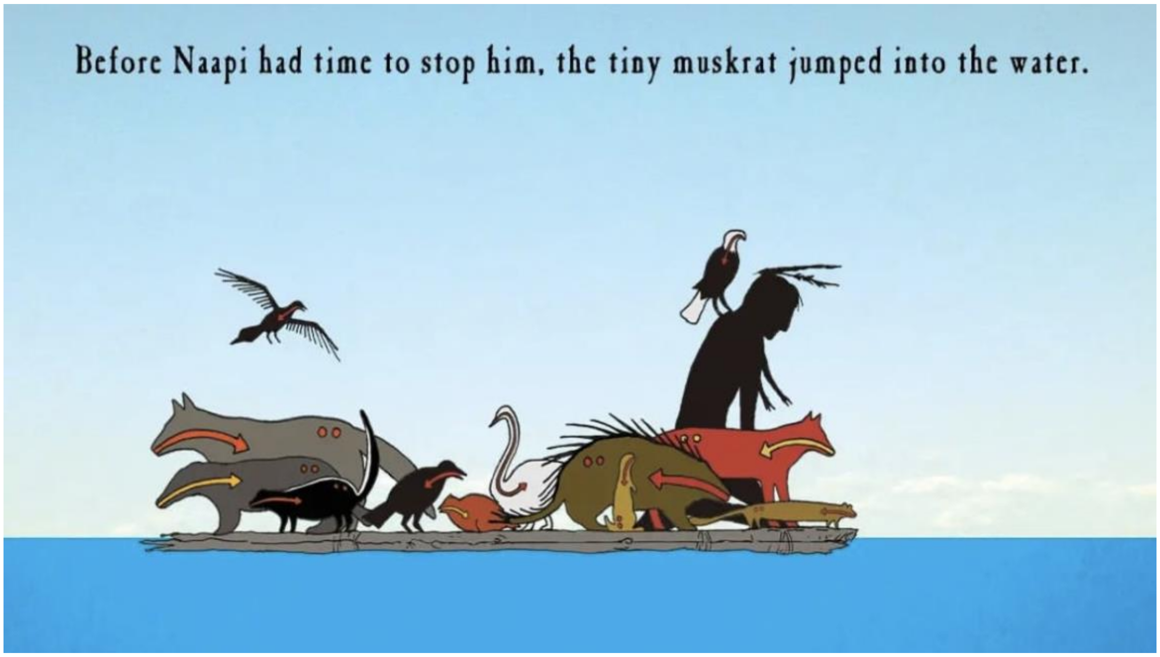

Figure 2. William Singer III, Api'soomaahka (Running Coyote). Naapi and the Flood. Kainai Nation, AB.

1.0 Ihpipototsp (my purpose)

I appreciate the ancestral knowledge shared with me for my thesis, which has been passed down since time immemorial through a web of kinship relationships and is now my responsibility to maintain and share in a good way that honours Niksokowaiksi (all my relatives). Siksikaitsitapi or Blackfoot protocol for transferring knowledge gives the listener the responsibility to take care of the knowledge and share it appropriately. If the knowledge receiver recognizes the full responsibility, they can avoid losing that relationship and understanding. My study is seen through a Siksikaitsitapi Science (SS) lens, allowing a safe space for Iinnii. Planning began for Iinnii rematriation over 13 years ago with a series of community meetings called the Buffalo Dialogues. At these meetings, Iinnii was always left an empty seat to represent the shared understanding amongst participants that the spirit of Iinnii was present. Just as Iinnii had a seat at those meetings, I want to ensure that the spirit of Iinnii is respectfully honoured in this research to collectively work towards healing the land and ourselves.

Siksikaitsitapi-based research as a holistic perspective encompasses tsinikssin or story. Creation and Naapi stories are part of our ceremonies that we still practice today and are the basis of Siksikaitsitapi Science (Bruised Head, 2022). Naapi is a Blackfoot story character portrayed as a trickster and troublemaker because of his impulsive behaviour. He teaches valuable life lessons, mostly about what not to do. Blackfoot storytellers tell stories without interpretation, so the listener must carefully conclude their learnings. My understanding of the creation of Ksahkomm (the earth) and the relationality of all its beings is told in the story of Naapi and the Flood.

> *Naapi was the only survivor of the Great Flood. For many landless days and nights, he sailed alone with only a few small birds and animals that survived the great rainstorm. Naapi's small raft was made of otsipis (willow branches) with just enough room for him and the animals. Naapi, gently paddling his raft, began hoping that someone would come soon and rescue them. As the days lingered on, Naapi became very tired and very hungry. He called to the birds and animals and commanded them to go beneath the water to search for the soil. Among the animals, Naapi had a favourite - a tiny muskrat, whose fur was the shiniest of all the animals. The birds flew away, and the animals dived in search of soil. Soon, the eagle, crow, magpie, swan and grouse returned empty-handed. The wolf, fox, badger, skunk, porcupine, gopher, and weasel all come back empty-handed. Naapi sat in his raft, wondering to himself, "Which of these birds and animals would be the most tasty to satisfy my hunger?" Naapi thought, "If I eat*

them all now, there will be no one to talk to." Tiny muskrat suspected Naapi was up to something and said to him, "Oh, Naapi, don't kill us. I will go back down beneath the waters to search for ksahkomm (soil)!" Naapi refused to let him go, but the muskrat insisted. He told Naapi, "If I do not return in four days and four nights, it will mean my expedition was unsuccessful." Before Naapi had time to stop him, the tiny muskrat jumped into the water. Days and nights passed, and Naapi waited for the tiny muskrat to return.

On the fourth day of the muskrat's voyage, Naapi jumped up and called to the waters around his raft, "Mi'sohpsski, Mi'sohpsski, Mi'sohpsski. If you are still alive, come out of the water." All of a sudden, SPLASH! The tiny muskrat stuck his head above the water. Naapi was astonished! He could not believe the muskrat had come back to him. Naapi quickly paddled his raft toward the muskrat, caught his tail and pulled him onto the raft. A moment later, the little animal opened his paws, and there was some soil he had picked up from the bottom of the water. Naapi patted the muskrat's tiny head and complimented him for his bravery and achievement.

Naapi said to the birds and animals, "Here is our hero!" Naapi then took the soil, dried it under the sunshine and spread it on the palm of his hand. In a moment of silence, he looked up into the skies and prayed for the power of the Almighty One, The Creator. Naapi blew the soil in four directions: north, south, east and west. Immediately then, the land was covered with grass and trees. Naapi freed the birds and animals, commanding them to go and inhabit the land, the sea and the skies. Naapi was pleased with the beautiful land all around him.

I share this story exactly as it was shared with me by my mentor and Siksikaitsitapi Knowledge Keeper, Api'soomaahka (William Singer III), as it was told to him by the late Elder Willie White Feathers. With respect to the spirit of stories, in this thesis, I do not change or summarize content but complement Western Science (WS) with Traditional Ecological knowledge (TEK) relational context. Blackfoot stories are a method for transferring knowledge to instill cultural values and protocols for living a balanced life. "Storytelling, for Bullchild, is the passing down of the oral history and teachings of the Creator Sun…storytelling is not just the words and listening but the actual living of the story. It is experiential" (Buffalo Treaty, 2021). The story of Naapi's Flood is foundational to my worldview and how I relate with my natural surroundings. For instance, appreciating Mi'sohpsski (muskrat), vital in creating Ksahkomm and all its inhabitants, teaches Blackfoot values of respect, reciprocity, and kinship with human and nonhuman beings.

Naapi was selfish and did not respect the animals he shared the raft with. Once tired, he commanded the animals to dive deep into the water to find soil. However, Naapi himself did not attempt to get soil. And once he got hungry, he started to decide which animal would be the tastiest. Little Muskrat realized Naapi would eat all the animals, so he chose to dive into the water, knowing he might not return. This was a great act of reciprocity for creating Ksahkomm and Naapi and the other animals' survival. SS is based on the worldview that our spiritual beliefs exist in every part of our lives. Ihtsipaitapiyop, the Creator, made all living things equal; humans were not given the right to rule or exploit nature. Plants, animals, and even abiotic components like rocks and soil have unique gifts and powers that can be shared with humans. Our stories teach us how to maintain balance in our environment.

Western science often views cultural value systems and traditional protocols, including the spiritual foundation of TEK, as unscientific despite their potential to improve scientific approaches (Zedler et al., 2018). Western Science (WS) is based on a Western or Eurocentric paradigm derived from long-term colonial dynamism and power imbalances advancing specific knowledge systems and knowledge generation (Cajete, 2000). Where Western Science is quantitative, factual, analytical, reductionist and literate, Indigenous Science (IS) is qualitative, anecdotal, intuitive, holistic, and oral (Berkes, 2012; Mistry & Berardi, 2016; Nadasdy, 1999). Both knowledge paradigms have individual strengths in specific contexts, but without hierarchy, one is not better or consistently overtakes another (Berkes, 2012) but centers on improving our world understanding (Cajete, 2000). Recently, efforts for braiding IS and WS have increased, providing numerous contributions to understanding ecology, evolution, physiology, and applied ecology (Beausoleil et al., 2022; Buell et al., 2020; Jessen et al., 2022). In this paper, I am sharing my research story from my perspective based on knowledge passed on to me from my Elders, Knowledge Keepers, Ancestors, and WS education. Both knowledge paradigms provide insight into my research, which I write for an academic audience and my community.

As an Indigenous scientist, my academic journey weaves worldviews, integrating my culture into my research. For my research study, I use a mixed-methods approach that combines quantitative and qualitative methods rooted in Blackfoot customs and values. I braid SS with WS soil and plant community data interrelating with Iinnii. I do not compare or thoroughly combine IS and WS, but I elevate SS to complement Western methodology that benefits scientific and Indigenous communities. Cajete (1999) elaborates on the issue of authenticating IS:

Whether Indigenous science exists in Western terms is largely an incestuous argument of semantic definition. Using Western science orientations to measure the credence of non-Western ways of knowing and being in the world has been applied historically to deny the reality of Indigenous people. The fact is that Indigenous people are, they exist and do not need an external measure to validate their existence in the world. Attempts to define Indigenous science, which is by its nature alive, dynamic, and ever-changing through generations, fall short, as this science is a high-context inclusive system of knowledge.

Conducting respectful WS research grounded in IS can improve scientific understanding. Western conservation policy, research and practice increasingly recognize that including Indigenous rights and knowledge is central to realizing biodiversity targets (Artelle et al., 2019; Bridgewater & Rotherham, 2019; Gavin et al., 2018; Moola & Roth, 2019). For example, in Hawaiʻi, Indigenous-based frameworks are used to improve the 'well-being of ʻāina, Hawaiʻi's biocultural landscapes and seascapes' through the Nā Kilo ʻĀina Program to build resilient socio-ecological systems (Morishige et al., 2018; Sterling et al., 2017). In Aotearoa, New Zealand, frameworks grounded in mātauraka Māori, such as the Cultural Health Index (CHI), are recognized as robust measures of waterway health (Harmsworth et al., 2011). CHI generally assesses three key components: site status (e.g. significance to tākata whenua; people of the land); values associated with food and other natural resources (e.g. presence of culturally significant species, changes in biodiversity and whether people would return to harvest at the site); and cultural stream health, including riparian vegetation, catchment land-use and water quality (Tipa & Teirney, 2006).

Indigenous scientist Dr. Jessica Hernandez (Hernandez, 2022) speaks to the importance of indigenizing land restoration to help create more effective solutions to environmental problems persisting for decades in unhealthy ecosystems:

> *Unfortunately, Indigenous peoples continue to be left out of restoration discourses owing to the linearity of those frameworks. Since restoration frameworks are developed by Western knowledge systems, they do not include the holistic lens that Indigenous peoples continue to use. These systems continue to ignore Indigenous ways of knowing because they are heavily rooted in the scientific method of hypothesis testing. This scientific philosophy requires forming knowledge that is validated through Western credentials, thus dismissing Indigenous peoples, who have a long history of first-hand observations and knowledge formation regarding their natural resources and environment.*

TEK is often used to complement WS by building and sustaining existing goals unique to the cultural values embedded in the landscape where research is conducted. Nolan and Turner (2011) point out that diverse ways of knowing and perpetuating local knowledge have intrinsic value and are culturally and socially significant. Native worldview is inseparable from place, unlike European culture, which views one's place in history in relation to time by looking backward and forward (Pierotti & Wildcat, 2000). TEK incorporates a kincentric stewardship worldview and a sense of individual responsibility for world balance and renewal. People are part of the landscape and responsible for future stewardship. Restoration aims to restore the land so the land can restore human well-being (Kimmerer, 2013). For example, before 1850, over one-third of California tribes tended sedges in the Cosumnes River floodplains, creating an open riparian area. When tending stopped, riparian succession occurred rapidly, and shrubs and saplings of Oregon ash and poison oak replaced the tended sedge bed (Stevens & Zaloza, 2015).

Similarly, native fish likely responded to lower-quality habitat after Native Californian burning and other practices ceased. "Tending of the landscape by Indigenous Californians is expected to have increased production and abundance of native fishes, sufficient to supply one-third of the Plains Miwok (Mewuk) diet for as many as 57 individuals per square mile along the streams and sloughs in the (lower Cosumnes River) for at least 1,100 years" (Stevens & Zaloza, 2015). These research examples demonstrate how cultural restorative practices advance WS restoration goals and improve community health.

Blackfoot science used in this paper is based on my understanding developed over my research journey and experiences growing up on the Blood Reserve / Kainai First Nation and working within the Blackfoot community for 19 years. Bringing the Blackfoot worldview into Western science research methods can improve ecocultural restoration and conservation science outcomes. For example, the Spomitapiiksi (above beings) taught Blackfoot women to harvest plants sustainably. Digging millions of holes each year, they carefully harvested Ma's (Prairie Turnip) by selecting different patches each year and re-seeding by refilling the hole with seeds and soil to allow Ma's time to regrow (LaPier, 2017). This knowledge is transferred to the next generations to teach methods of sustainability. Indigenous peoples globally are custodians of an estimated 38 million square kilometres of territories of immense ecological and socio-cultural significance. Blackfoot science stems from living with the land for time immemorial and continues to live and adapt as the environment changes. It is based on a holistic perspective of relationality within ecosystems that views humans as equals in a complex web of relationships. Blackfoot People refer to themselves as Niitsitapi or "the Real People" because they are equal partners in the universe with all the other beings. Our stories about our long history interwoven with the land, plants, and animals have been passed down through generations. These beings are Niksokowaiksi, "all our relations," and together in a web of relations, embody flux, energy, and spirit (Little Bear, 2000). Blackfoot worldview concepts can expand narrow definitions of science to include the spiritual realm that requires respect and responsibility for Niksokowaiksi. For example, stewardship is a term often used in conservation science and is defined as supervising or taking care of something, such as an organization or property. In Blackfoot, Ihpitsskskipaotspi (Api'soomaahka, 2020) is a similar concept but inherently implies reciprocal responsibility. In contrast, the English term requires the addition of the word responsible (responsible stewardship) to take care of something responsibly. Niitsitapiipaitapiiwahsini (Blackfoot way of life) contains natural laws to ensure responsible stewardship by giving back to the land. Ihpitsskskipaotspi requires people to care for nature, which is not an overarching WS concept for people managing nature. For instance, when disturbing plants or soil, we make an offering, aakitsitsipo'takio'pa pisstaahkaani (we leave some tobacco) (Api'soomaahka, 2020) to reset the balance and align ourselves with good intentions.

Recent research acknowledges how traditional knowledge systems can help repair the damage done to the land (Wehi & Lord, 2017). Lessons learned from this research can guide future Iinnii rematriation efforts and promote further reconciliation and healing. The Iinnii are an ecocultural keystone species that shape grassland ecosystems by revitalizing the cultural and ecological genetic memory that exists in the land that has coevolved with Iinnii for millennia. Dr. Leroy Little Bear (Ikaisskini) elaborated on this concept during my interview with him in November 2022.

> *There is the memory that exists in the land, which can be rekindled because we used the land as a place for the repository where the knowledge exists. And it's up to us to come along and rekindle and open up those repositories because the land has a much longer memory than we do. So then, the knowledge hasn't disappeared. It's just that we haven't opened up those repositories. That's why bringing the buffalo back, for instance, on the Blood reserve, starts to bring about new memories, new things, to remember songs and so on. The buffalo is helping to bring that memory back. Whereas in Western thought, because it's a linear notion, once you go from A to B to C to D and down the line and once you pass something, it's forever and a day lost. Whereas ours is about renewal because that flux brings about renewal. So, we renew things all the time. So, it's kind of like our elders and why our elders are very important. They may have been affected by changes here and there, but the elders will say this is how we used to do things, and this is how things were.*

As Indigenous scientists, we collect data grounded in Blackfoot values. These values situate humans, land, plants, and animals as equals in a web of relations and envision a more significant, holistic picture of interrelationships. The researcher is part of the interconnected system being studied and not separate from it.

To gain further insight into the holistic component of the Iinnii rematriation, I conducted five semi-standardized, recorded interviews following respectful Blackfoot protocol to exchange knowledge and ensure interviewees were comfortable sharing their knowledge and understood my research purpose. To satisfy the requirements of the University, I obtained approval for these interviews from the Research Ethics Board

(Study ID: MS2_Pro00119639). These interviews, Blackfoot stories, values and concepts are woven into my research.

1.1 Indigenous Researcher

Oki, niisto anakook (Hi, my name is) Kansie Fox or Apaitsitapiaki (white weasel woman). I am Blackfoot and Dine (Navajo), raised on the Kainai (Blood) Reserve. I am blessed to be spiritually connected with the spaces I call home in Siksikaitsitapi (Blackfoot Territory) and the Dine (Navajo) Nation. These landscapes shaped my love and appreciation of nature and continue to teach me ancestral knowledge of the land. Practicing reciprocity with the land through ceremony gives me a sense of pride, identity, and balance that I am re-learning while navigating the colonized world. My parents raised me in their Christian faith and the Western ways of living, believing it would lead to a successful life for me. They were taught those and other colonial teachings in residential schools. Growing up in my Blackfoot community, I learned about Siksikaitsitapi philosophies regarding our relationality with animate and inanimate spiritual beings. The values I was taught through Elders, Knowledge Keepers, Naapi stories, and ceremonies shaped my relationships with people and my environment. I completed my degree in my university's undergraduate program but struggled meaningfully to connect to the content. The spiritual aspect of obtaining my "conservation biology" degree was missing from the Western teachings. I knew we do not exist independently from the land and its web of interrelationships.

For example, Ninastako (Chief Mountain) is a powerful holy place given to Niitsitapi by the Creator as a source of guidance for our health and well-being. It is a part of us. To renew my relationship with Ninastako, I hike the mountain every year, leave an offering and ask for blessings and protection. The same applies to Iinnii; when we lost Iinnii, we lost a part of ourselves. These relationships come with responsibilities and respect for the natural laws upheld and renewed in ceremonies. If these laws are disrespected, they disrupt the ecological balance of our relationships, resulting in catastrophic consequences for humans and non-humans. Climate change is an example of a disruption that has caused changes to our ways of being and knowing by altering the environment so drastically that our traditional knowledge must adapt. During a Kainai community climate change session in 2017, Dr. Little Bear explained how Niitsitapi are affected by climate change.

> *Culture is a mutual relationship with the land. If changes occur to the land due to climate change, then the culture is affected. Our cultural reference points are disappearing because of climate change.*
>
> *~Ikaisskini, Dr. Leroy Little Bear*

In response to the changing climate, Iinnii rematriation is helping us adapt to warmer temperatures, erosion, drought, and flooding by building resiliency through grassland restoration. I am very grateful to be in this position as an Indigenous scientist working within my community to rematriate Iinnii and share the BEK I have learned living and working in Siksikaitsitapi.

1.2 Thesis Structure

I present this study under certain limitations of academic theses, such as formatting requirements that reduce content into Chapters and sections, while acknowledging it is a holistic study with interrelated parts. Therefore, I use Chapters to divide sections without separating the SS from the WS to demonstrate how they can complement each other. I share insights from the connections learned between SS and standard academic methods for the data I collected, the analyses I completed, and the results I interpreted. Therefore, Chapter 2 includes a literature review on the WS concerning the effects of Iinnii on their ecosystem and other contexts, the WS methods I used, and the results interspersed with BEK or SS given to me by the Elders and Knowledge Holders I interviewed or acquired through secondary research. Chapter 3 highlights the meaningful connections I learned from weaving this work together. In Chapter 4, I elaborate on the significance of Iinnii rematriation for nourishing healthy relationships between Ksahkomm, Pisatsaisskiistsi, and Maatapiiks for collective healing and well-being.

1.3 Background

1.3.1 Saokio - Native Prairie Ecological and Cultural Importance

Saokio (native prairie) is a mosaic of bioculturally diverse habitats supporting prairie species and Indigenous traditional uses. It has a wide range of ecocultural values and functions such as soil and water conservation, nutrient recycling, pollination, habitat for livestock grazing, genetic material for crops, recreation, culturally significant sites, habitat for culturally significant plants and animals and climate storage for about 34% of the terrestrial worldwide carbon supply (Federal, Provincial and Territorial Governments of Canada, 2010). Terrestrial grassland ecosystems are dominated by herbaceous and shrub vegetation shaped and maintained by Indigenous peoples' relationship to the land (Lehr, 2023), along with fire, grazing, droughts, and freezing temperatures (White et al., 2000). Grasslands are now considered the most endangered biome in the world due to human disturbance (NCC, 2005). Since the early 1800s, the North American Great Plains ecosystem (Tallgrass, Mixedgrass, and Shortgrass prairie) has declined by an average of 79% (Samson et al., 2004). Canada's central grassland ecoregions, the Prairies and Parklands, contain 34% of the remaining intact grasslands in North America that have not been converted to cropland over the past 125 years (Riley et al., 2007). My study is in the Mixedgrass Natural Subregion, which is one of four

Natural Subregions within the Grassland Natural Region that totals 14.4% of Alberta and is part of the much larger Great Plains ecosystem (Figure 2) (Natural Regions Committee, 2006). The Mixedgrass prairie is currently 19.8% of the total Grassland Natural Region area and 2.9% of Alberta, originally totalled 4.6 million acres, and now approximately 31% remains today (Adams et al., 2013). The Kainai First Nation / Blood Reserve native prairie cover is less than 30% (Figure 3).

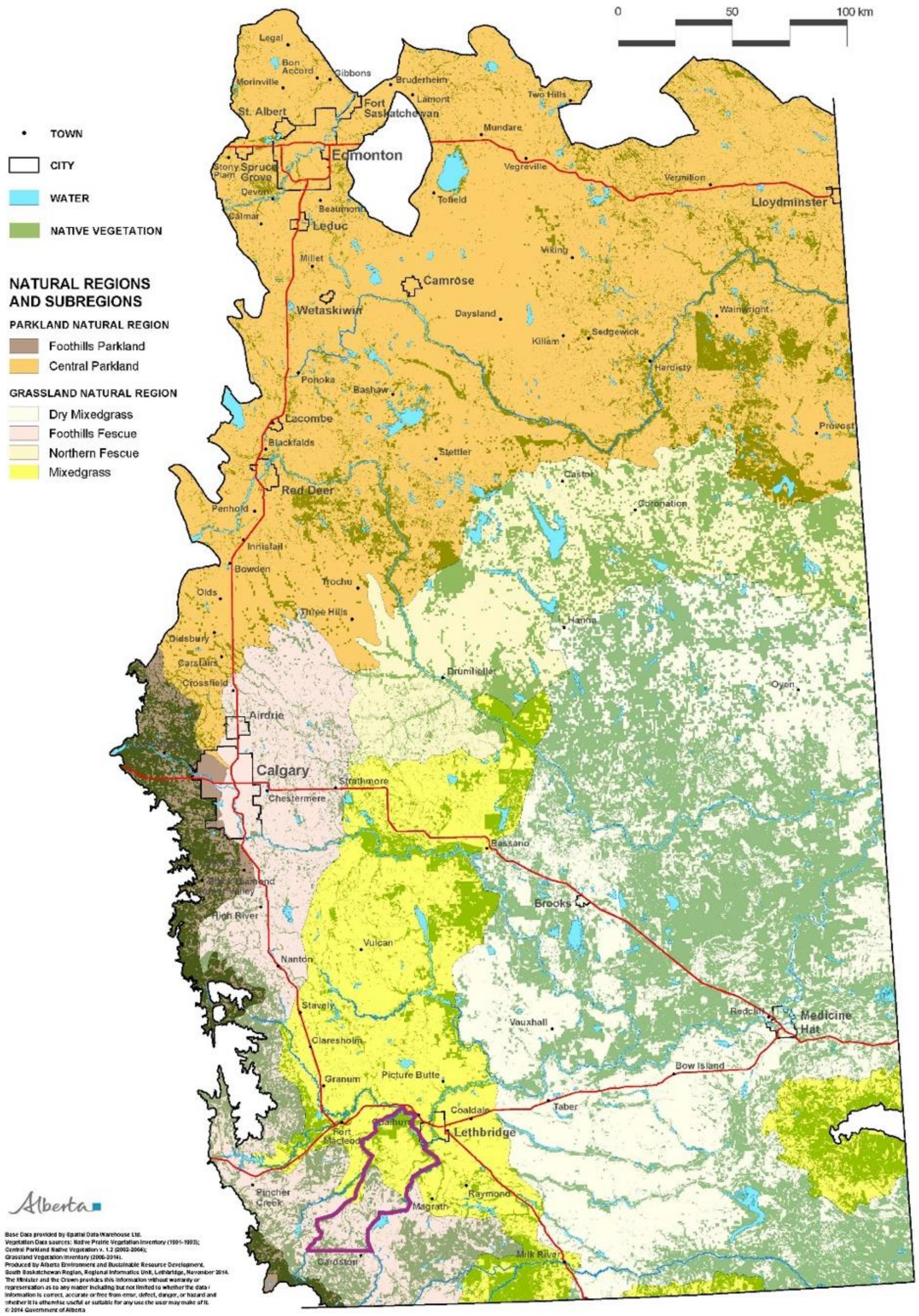

Figure 3. Southern Alberta Natural Regions and Subregions showing native vegetation in green and outlining the Kainai Nation/Blood Indian Reserve in purple. (Natural Regions Committee, 2006).

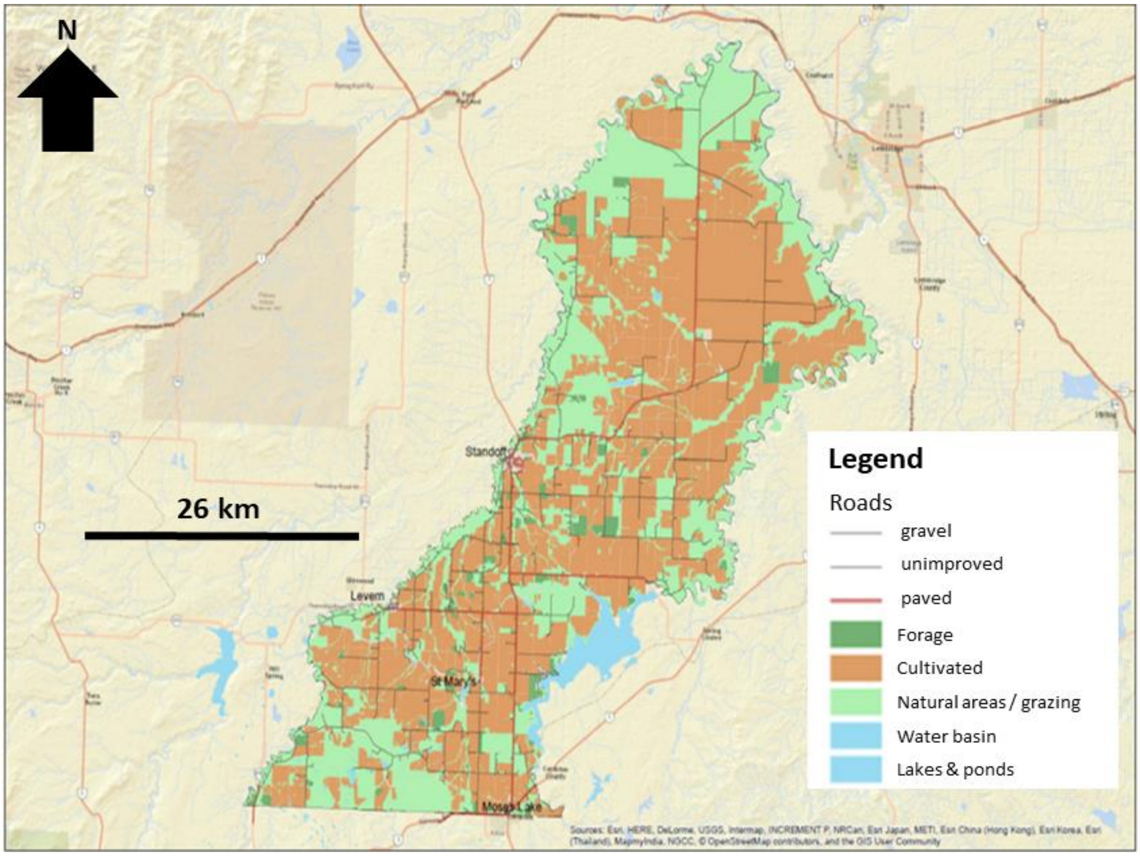

Figure 3. Map showing current land use on the Blood Reserve, with Native Grassland 30% (green) and Cultivated land (orange). (Modified from Blood Tribe Land Management GIS Division, 2016).

1.3.2 Saokio – Native Prairie Ecological and Cultural Loss

Prior to colonization, Niitsitapiiksi flourished and were exceptionally healthy as they lived in ecological balance with Niksokowaiksi. Cultural and spiritual relationships formed the basis for and maintained healthy Indigenous communities and strong governance. Only within the last 150 years, the North American prairie region has been radically altered by unsustainable practices through agricultural conversion and intensification, continued development and fragmentation, overgrazing, forest encroachment, and the spread of invasive non-native species (Federal, Provincial and Territorial Government of Canada, 2010). Globally, 21.8% of land area has been converted to human-dominated uses, driving temperate grasslands and savannas to become the most significant at-risk biomes due to extensive habitat loss and under-protection (>50% lost in North America, 4.6 % protected; Hoekstra et al., 2005). Despite increasing threats to grasslands, only 1.5-2.6% of the North American mixed-grass prairie is currently protected (Henwood, 2010). In Alberta, the Mixedgrass prairie is the most intensively cultivated subregion, with 85% converted to dryland and irrigated crops (Natural Regions Committee, 2006) and is mainly used for cattle grazing (Lupwayi et al., 2024). Kainai (the Blood Reserve) lost the most native grassland cover in Alberta at 19% between 1990 and 2010 due to conversion to irrigation farming (Blood Tribe Land Management, 2021; Prairie Conservation Forum, 2019).

Coinciding with grassland loss is the attempted Iinnii ecocide that began in the late 1700s. An estimated 30-60 million Iinnii once roamed North America from Mexico to Canada in vast herds before colonial settlement. By the late 1880s, plains bison numbers were reduced to 281 in North America (23 wild and 258 in zoos and farms; Olson & Janelle, 2022). In 1881, the last Kainai bison hunt occurred, followed by the "starvation winter" of 1883-1884, resulting in the death of approximately 25% of the Blackfoot population (Beck, 2017). The intended massacre of Iinnii was caused by colonial commercial demands for buffalo hides and meat along with United States and Canadian government extermination policies. John A. Macdonald, the Attorney General for Canada West, created the system of control that still exists today with the Gradual Civilization of Indians Act in 1858. Through this act, Canada defined Indigenous identity by enforcing “status Indians,” removing rights for First Nations communities to determine who is a member of their nations. In 1885, Macdonald enacted policies of intentional starvation to force tribal Chiefs into a treaty that confined First Nations to Reservations and subjected them to the Indian Act to control and conquer the Plains for European settlement (Daschuk, 2019). Kainai / Blood Tribe signed Treaty 7 with the

Canadian Government in 1877 with the understanding that it was a peace treaty, iinaihstsi (Bruised Head, 2022). However, the treaty was not in alignment with previous Indigenous treaties historically used as modes of governance for peaceful coexistence with other Indigenous nations and nonhumans in relation to creation (Crosschild et al., 2021).

Contrary to iinaihstsi, the government deliberately misled First Nations, forcing the surrender of lands, limiting Blackfoot territory to reservations, and disconnecting them from their livelihood. The paternalistic act controlled every facet of reserve life, from government benefits to cultural ceremonies (Carter et al., 1996). In the following years, Canada did not uphold treaty commitments, such as providing food, and in some cases, used provisions like tainted meat and medicine to maintain famine and create ecological conditions in which disease magnified (Daschuk, 2019). First Nations were negatively affected by Canadian policy through trade, legislation, and treaty-making to exploit and colonize land and resources, assimilate indigenous cultures, and extend the global economic system to Western Canada. These acts devastated Kainai's traditional economy and sovereignty rights (Crop Eared Wolf et al., 2007).

Iinnii are cultural keystone species that ecologically engineered grassland ecosystems and formed a sacred kinship with Indigenous plains cultures (Garibaldi & Turner, 2004; Samson et al., 2004). Saokio-Iinnii-Niitsitapi interrelationships that coevolved over millennia were unjustly disrupted, resulting in the decline in the resilience of both the grassland ecosystem and plains Indigenous peoples (Isenberg, 2000). For example, Kainai reciprocal practices with Traditional Blackfoot plants continue to provide Niitsitapiiksi with daily nutrition, medicine, and healing. However, Kainai community members are concerned about traditional plants that have disappeared, are less abundant, or may be contaminated because of decreased and degraded plant habitats that put traditional practices at risk of becoming extinct. Elder Blair First Rider expressed concerns about the negative changes occurring on the land that is, "being affected by climate change…when we go out to practice our aboriginal rights to harvest and gather medicinal plants, herbs, roots, or harvest the animals and birds that are a part of our societies and bundles it is getting harder and harder to find and locate certain plants, certain animals that are included within our bundles so that we can practice our ceremonies" (Kainai First Nation, 2020). Access to the harvesting of culturally important species is essential not only for the ceremony but for human social well-being, "just as human beings develop relationships through collaborative activity, and just as they suffer from disassociation or distance from such relationships, the emotional and physical exchanges that occur between places and Aboriginal people are social in nature" (Little Bear, 2009). Understanding the existing values Niitsitapiiksi has with the prairie landscape can improve human-environment connections and promote sustainable land use and management for future generations.

1.3.3 Iinnii and Saokio Resurgence

The Buffalo resurgence is gaining momentum in the Great Plains region, creating opportunities for Iinnii to fulfil its ecological and cultural keystone roles, which include conserving and protecting Saokio. Within the past decade, plains bison have been translocated across Canada and the United States from Elk Island National Park to nine Indigenous communities, Banff National Park, and the American Prairie Reserve (Parks Canada, 2020). Five of these reintroductions were to First Nations (including Kainai) from 2020-2021 to help re-establish wild buffalo and cultural herds and restore relationships in prairie ecosystems.

1.3.4 Indigenous-led Conservation

The Kainai Iinnii Holistic Management Plan is an indigenous-led collaborative effort studying the effects of bison rematriation on soil structure, mixed grassland community vegetation and Blackfoot traditional plants, insect, bird, amphibian, reptile, and mammal abundance and composition (Olson, 2019). My MSc research on soil structure, vegetation, and socio-cultural impacts is nested within this more extensive project. The baseline data collected as part of this thesis will be incorporated into a Kainai community-based long-term monitoring framework.

Indigenous-led research is recognized as a powerful mechanism for effectively achieving the conservation benefits of protecting biodiversity and preventing further ecological degradation (Artelle et al., 2019). Indigenous communities are well-positioned to effectively steward conservation areas that largely exist within Indigenous territories (Artelle et al., 2019). TEK has developed over millennia, shaping and sustaining ecosystems that are now highly valued conservation areas (Bliege Bird & Nimmo, 2018; Kimmerer, 2013; Kimmerer & Lake, 2001; Mathews & Turner, 2017). Furthermore, Indigenous peoples who have close knowledge of and connection to lands and seas may observe unique changes in these ecosystems and help develop novel ways of addressing them (Stephenson & Moller, 2009; Turner & Spalding, 2013). Historic conservation efforts that have excluded Indigenous Peoples in land management decisions have often been detrimental to people and places (Bliege Bird & Nimmo, 2018; Witter & Satterfield, 2019), especially when communities are displaced from their lands in the name of conservation (Tauli-Corpuz et al., 2018). Addressing past injustices of colonized research and conservation methods can help the ecological sciences reconcile relationships with Indigenous communities and move forward toward recognizing the importance of place-based societies in maintaining or revitalizing ecological functions on their lands. For instance, the Australian Indigenous Protected Areas (IPAs) and Canadian Indigenous Protected and Conservation Areas (IPCAs) are Government-funded programs with goals of supporting Indigenous-led conservation and reconciliation between non-Indigenous and Indigenous Peoples (Artelle et al., 2019). In Canada, this is a hopeful pathway forward that will lead to meaningful reconciliation in the context of conservation, if appropriately supported by the government and the conservation sector that is consistent with Indigenous leader's recommendations, which will result in successfully establishing and governing IPCAs (Townsend & Roth, 2023).

My work is grounded in Article 1 of the Buffalo Treaty framework: "Recognizing buffalo as a practitioner of conservation, we, collectively, agree to perpetuate conservation by respecting the interrelationship between us and 'all our relations' including animals, plants, and Mother Earth; to perpetuate and continue our spiritual ceremonies, sacred societies, sacred languages, and sacred bundles to perpetuate and practice as a means to embody the thoughts and beliefs of ecological balance" (The Buffalo Treaty Booklet, 2020). The treaty encompasses an attitude of respect regarding Iinnii as our relative who we recognize as a "wild animal" instead of "livestock." As most bison today are hybridized with cattle or hybrid woods/plains bison (Olson & Janelle, 2022) the Buffalo Treaty strives to conserve pure plains bison genetic diversity and integrity for conservation and ecocultural rewilding purposes and not solely for economical meat production. Within this broader Treaty, the objectives for my thesis are to measure the baseline and short-term post-rematriation effects of Iinnii on (1) soil communities in terms of structure and microbial diversity and composition, (2) plant communities, in particular plant community diversity and composition, and (3) the Kainai community in regard to cultural revitalization. I anticipate few short-term effects from Iinnii grazing on soil, plants, and people during my 2-year MSc study; however, I believe that over time, Iinnii Rematriation will show beneficial effects for soil and plant community diversity and composition while improving the spiritual health of the Kainai community on the Blood Reserve.

Traditional Ecological Knowledge (TEK) is a term used in WS research to define Indigenous communities' cultural knowledge and practices that have been transferred from generation to generation and acquired through cultural memories, sensitivity to change, and values that include reciprocity (Kimmerer, 2000). In my study, I use BEK and SS interchangeably to describe Blackfoot cultural relationships with Kitaowahsinnon (traditional Blackfoot Confederacy territory) that evolved over thousands of years of observation, survival, and living in harmony according to the Creator's teachings. I intend to elevate and support indigenous-led conservation in my research by appropriately braiding BEK with WS. Through Iinnii rematriation, we hope to reconnect people and prairie landscape relationships to improve community health and well-being. Revitalizing these ancient interconnections supports BEK-informed land practices that can provide beneficial habitats for Saokio species, including culturally important species and species at risk while providing opportunities for the community to relearn cultural practices that nurture identity and pride.

Figure 4. Releasing Iiniiksi into Pasture 12 with ceremony. April 2022.

1.3.5 Iinnii Rematriation and The Buffalo Treaty

Bringing Iinnii home is a community-based initiative resulting from a series of Buffalo Dialogues led by Dr. Leroy Little Bear starting in 2009. Along with community support, Tribal leadership dedicated the Kainai Iinnii Rangelands as the rematriation area to establish a cultural herd to improve community health and spiritual well-being. Multiple collaborations were essential in continuing the momentum for reintroducing wild bison for conservation and cultural purposes. In 2014, Kainai signed the historic Buffalo Treaty with seven other Canadian and United States First Nations with the vision and purpose of buffalo rematriation to their homelands to restore ecological and cultural balance. Now, 31 First Nations signatories across Canada and the United States honour, recognize and revitalize the time-immemorial relationship with buffalo (Buffalo Treaty, 2021). As a result of these efforts, the Kainai Iinnii Holistic Management Plan was co-developed by both Kainai and Western scientists (Olson, 2019). This was followed by the Kainai Chief and Council support designating an area of land for the Iinnii cultural herd through a Band Council Resolution in 2020. Forty Plains Bison yearlings (25 females/cows, 15 males/bulls) were transported from Elk Island National Park in a semitruck to Kainai grasslands on February 12, 2021, for cultural and conservation purposes. The Kainai Iinnii cultural herd is specifically to return Iinnii and associated ancient relationships back to the land and community. Holistic management of the herd is determined by the Nation to be an adaptive process that supports free-ranging and semi-wild Iinnii that are less managed as livestock.

Chapter 2: Iinnii Relationality Research

2.0 Study Site – Kainai Iinnii Rangelands

The Kainai Nation/Blood Tribe Main Reserve (separate from the other Kainai land parcel, the Blood Timber Limit) is 351,960 acres in southwestern Alberta, bordered by the Belly River on the west, the Oldman River on the north, and St. Mary River on the east (Figure 1). The study site is 666 acres located in pasture 12 (Figure 5) of the Kainai Iinnii Rangelands (KIR), formerly known as the Blood Band Ranch, and situated within the largest contiguous native grassland on the Kainai Nation that covers approximately 20,644.5 acres. The KIR is high in biocultural diversity and predominantly intact native prairie, with numerous Blackfoot traditional sites and use areas. Blood Tribe Land Management (BTLM) has surveyed and monitored wildlife and vegetation and carried out BEK surveys (species at risk, traditional plant, rangeland and riparian health) in the area since 2005 to monitor ecocultural changes. With increased development pressures on this highly valued landscape, BTLM has proposed to designate it as a "conservation or stewardship area" for protection from further degradation. Blood Tribe Land Management and the Iinnii Advisory Group selected the area to restore the land from the cumulative impacts of domestic livestock grazing, oil and gas development, the Alta Link electrical transmission line, and wastewater lagoon development. These activities, along with the absence of traditional restorative processes of bison grazing and cultural burning, have degraded ecological and cultural ecosystem function and use.

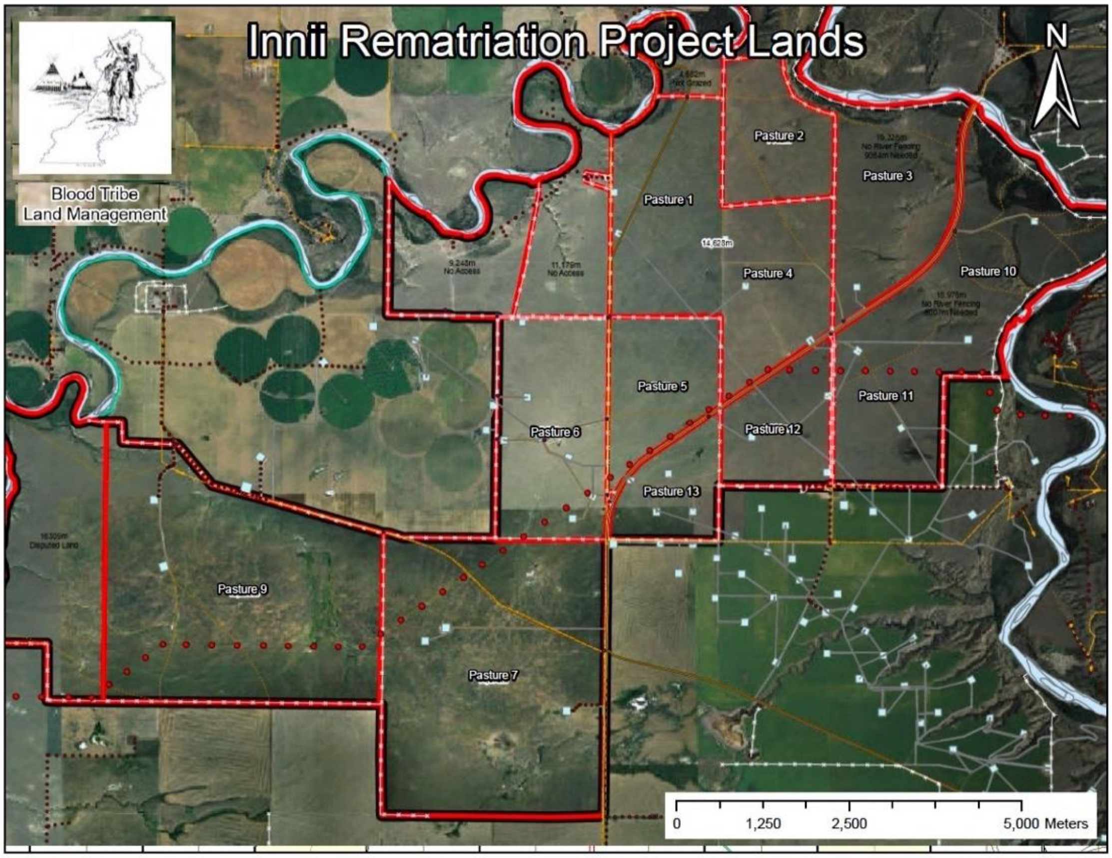

Figure 5. The Kainai Iinnii Rangelands (KIR; also known as the Iinnii Rematriation Project Lands) are outlined in red. The red dotted line shows the location of the AltaLink Transmission line. The white squares connected by grey lines are oil and gas well sites and horizontal drilling. The Oldman River delineates the eastern edge of the KIR (Map courtesy of Blood Tribe Land Management).

The KIR is within the Mixedgrass natural subregion. The average elevation for this Subregion is 975 m (Range 650-1450 m). Mean annual precipitation ranges from 336 mm to 428 mm (Adams et al., 2013). Mean daily temperature ranges from 3.8 to 6.4°C and 1541-to-1789-degree days above 5°C. Sites within this subregion are mostly flat, occurring on Dark Brown Chernozemic loamy textured soils. The vegetation for the KIR is in a transitional zone between the Mixedgrass and Foothills Fescue Natural Subregions. The dominant grass and grass-like species at the study site are western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), and sedge (*Carex spp.*). The dominant forbs in the area are aakiika'ksimii or pasture sage (*Artemesia* *frigida*), hairy golden aster (*Heterotheca vilosa*), and moss phlox (*Phlox hoodia*). The few low shrubs present are winter fat (*Eurotia lanata*) and snowberry (*Symphoricarpos occidentalis*).

Prior to being designated for the Iinnii rematriation, the KIR was grazed at varying stocking levels by sheep from the late 1940s – early 1950s and by the Blood Tribe-owned and operated cattle herd from the early 1950s – 2018 (J. Bruised Head, personal communication, March 19, 2024). Rangeland Health Assessments conducted by BTLM from 2016 to 2021 averaged 50-75%, rating the site as 'Healthy with Problems' (France et al., 2016), indicating the risk of further degradation if management practices are not adjusted. Most of the grass, forb, and shrub species were native. However, the dominance of blue grama (*Bouteloua gracilis*) and grazing resistant forb aakiika'ksimii (*Artemisia frigida*), the presence of invasive grasses, low moisture retention score, low reference plant community score, and low expected plant layer score indicated the plant community is in a mid-seral stage due to heavy grazing pressure (Big Swallow, 2020, 2022, 2023; Bruised Head, 2019; Fox, 2016, 2018). Areas within KIR with higher range health scores matched the reference plant community dominated by western wheatgrass (*Agropyron smithii*) and northern wheatgrass (*Agropyron dasystachyum*), while heavier grazed sites were dominated by blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Stipa comata*), aakiika'ksimii and had a higher presence of invasive plant species including downy brome (*Bromus tectorum*) and kentucky bluegrass (*Poa pratensis*). Results suggested that if moderate to heavy grazing pressure continues, it could result in further reduction or elimination of valuable native forage species and replacement by non-native species. Invasive agronomic grasses kentucky bluegrass (*Poa pratensis*), downy brome (*Bromus tectorum*), crested wheatgrass (*Agropyron cristatum*), and Japanese brome (*Bromus japonicas*), along with the highly invasive plants, leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea stoebe*), are spreading from the following anthropogenic disturbances: Highway 509, gravel roads, cultivated fields, oil and gas sites, the transmission line, illegal dumping, and dugouts (manmade water sources for cattle). Grassland wildfires in 2012 and 2020 were categorized as 'moderate to severe' fire severity and burned through the grassland area, causing concern for soil erosion and invasive plant spread (Craig, 2013). Kainai Chief and Council agreed to stop cattle grazing in 2018 to allow the grassland ecosystem time to recover from the effects of negative disturbances and implement a holistic restoration plan.

The overall goal of my research was to establish a baseline from which to observe changes in plant and soil community composition and diversity, including community responses to Iinnii returning to the Kainai grasslands. I randomly selected nine sample locations within pasture 12, where the bison were released to graze in April 2022. I used the ecological range site classifications in the Grassland Vegetation Inventory (GVI) polygon to stratify pasture 12 into five segments (Alberta Environment and Parks Government of Alberta, 2019). The GVI is a biophysical and land-use inventory comprised of ecological range sites based on soil information for areas of native vegetation and general land use for areas of non-native vegetation (agricultural, industrial, and residential developments). Polygons represent interpretations of relatively uniform biophysical or anthropogenic areas. Pasture 12 included five GVI polygons, representing five different categories. I used a Geographic Information System (GIS) to randomly select a location for at least one sample site within each polygon. Each sample site comprises a fenced, non-grazed site and a paired, unfenced, grazed site. Grazing exclosures were constructed by a Blood Tribe fencing consultant at an area of

0.154 acres (25 m x 25 m) using 5-foot (~ 152 cm) wire mesh and 8-foot-tall pressure-treated fence posts 56 inches above the ground (Figures 6 and 7).

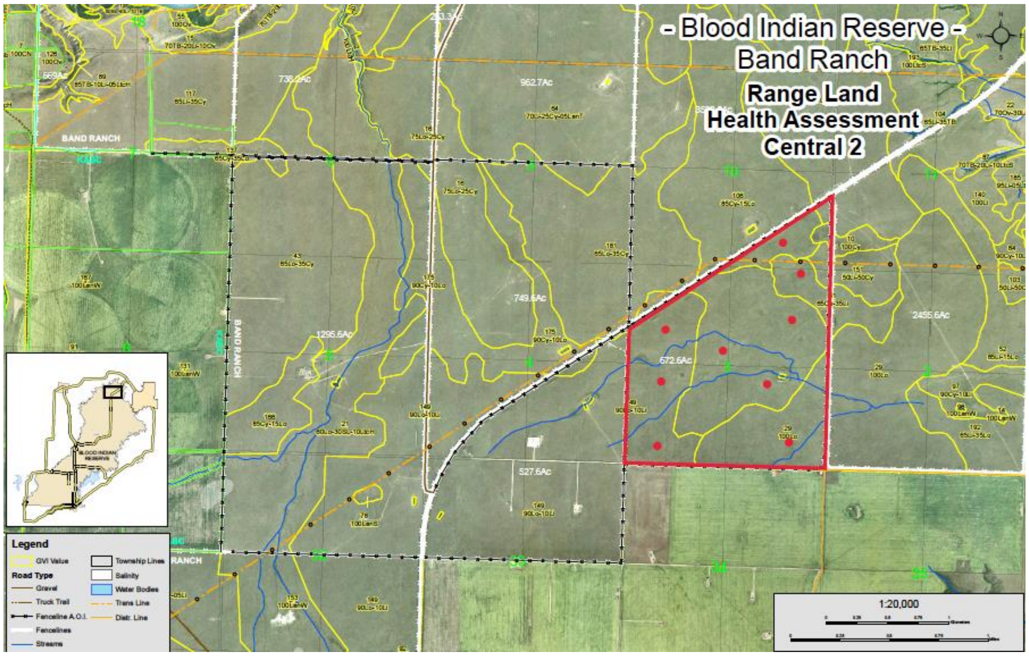

Figure 6. Kainai Iinnii Rangelands showing Pasture 12 outlined in red, GVI polygons in yellow lines and Iinnii exclosures sites with red dots.

Figure 7. Grazing exclosure.

2.1 Ksahkomm and Iiniiksi

2.1.1 BEK context, experimental design, sample collection

Creator gave all beings (animate and inanimate) roles and responsibilities to keep ecological balance and peaceful co-existence with one another. I asked my Elder, Minipoka, about this concept as we visited about my project. He kept referring to the idea of being in balance when everything works together to complete their cycles (roles and responsibilities). In Blackfoot, he called it Aahkowa, collectively working together without going too far towards the sokapii (good) or too far towards the makapii (bad). He elaborated more on the concept referring to situations when things go beyond equilibrium, the power of nature will experience ripple effects, and nature becomes imbalanced. Minipoka gave an example of human-wildlife practices that can interrupt natural cycles, which directly impact Niitsitapi, who are interdependent with cultural keystone species like Iinnii, salmon, and their environments. He noted that for the last 200 years, human health problems have been rising with the disturbance of the natural cycle of Iinnii movement on the prairie, and these healthy cycles can come back through having Iinnii back on the land. He also spoke about how Niitsitapi ways can help to balance cycles. For example, he learned about how the Heiltsuk Nation is addressing the adverse effects of salmon farming, which is causing 50% declines or more of historic abundances in salmon runs. Salmon are cultural keystone species for the Heiltsuk Nation with multilayered relationships between fish and people supporting systems of abundance through ceremony, sustainable fishing with weirs and stone fish traps, fertilizing salmonberry thickets with kelp, wood ash, crushed shells, and salmon blood/guts (Housty, 2021). To improve wild Pacific salmon health and long-term survival, Heiltsuk is using traditional monitoring practices through smolt traps, beach seining, and an ancestral-style weir in the river for fish counts (Housty et al., 2014). Similarly, Iinnii, as a cultural keystone species, can revitalize Saokio – Matapii networks based on Niitsitapi values, like Aahkowa, to inform WS about existing relationships where our collective roles and responsibilities have maintained healthy natural cycles prior to colonization.

In the story of Naapi and the Flood, the soil's role is to become ksahkomm, the Earth. As a Niitsitapi, this is how I understand the Earth was created with the help of a brave little muskrat. In the Blackfoot worldview, oral Niitsitapi stories exemplify animals' power and that all beings are created equal and have a spirit. Naapi did not want muskrat diving down into the water to find soil and even believed muskrat would not come back at all. Naapi, being selfish, bossed around the other animals on the raft to find soil and then threatened to eat them! Muskrat then decided to dive into the water and found soil. Muskrat helped the soil fulfill its role as Ksahkomm, providing food and a home for human and non-human beings. This Naapi story teaches us not to be selfish and to treat all beings respectfully, as Niksokowaiksi, as our relatives. As Siksikaitsitapi scientists, we are responsible to our Prairie relatives and community for understanding soil interrelationships and respectfully collecting data from the grassland where Iinnii was reintroduced.

Previous studies have investigated the ecological responses of Iinnii grazing on prairie soil through the lens of microbial ecology and their effects on soil nutrient properties. For example, the Konza Prairie Biological Station (KPBS) study showed how Iinnii grazing increases soil nitrogen cycling rates and enhances nitrogen availability in the Tallgrass prairie (Knapp et al., 1999). Another study at KPBS found that Iinnii grazing increased soil microbial diversity through dung-vectored dispersal (Hawkins & Zeglin, 2022). Barber et al. (2023) found that Iinnii reintroduced to the tallgrass prairie does not influence bacterial community richness or diversity but changes soil community composition. Exploring these effects is important for improving our understanding of the Iinnii and soil-interrelated processes that drive grassland ecosystem functions. Most soil health monitoring initiatives focus solely on the abiotic variables, such as soil nutrients, that do not capture the entire impacts on the soil ecosystem. Incorporating biological information, such as soil microbial community composition, provides holistic insight into soil quality because microbial communities are sensitive to environmental changes (Hermans et al., 2020).

In 1987, 30 Iinnii were reintroduced to the Tallgrass prairie, KPBS, Kansas, in a long-term study (Knapp et al., 1999) that assessed the keystone role of bison by exploring fire and grazing ecological interactions and effects on prairie biota and ecosystem processes. Iinnii rapidly altered sites that had been fire-treated for over 20 years, affecting soil nutrient cycling processes and, altogether, influencing the plant litter-soil cycling process. Plants and soils contain organic nitrogen that, through mineralization, is decomposed by microbes to ammonium (an inorganic mineral form of nitrogen), which is essential for plant productivity. Bison consume plants and return labile nitrogen-rich urine to the soil that efficiently hydrolyzes to ammonium, which can then be taken up quickly by plant roots compared to the slower mineralization of nitrogen from plant litter breakdown (Ruess & McNaughton, 1988). Bison grazing reduces nitrogen loss in burned sites by increasing the patchiness of the fire and reducing above-ground litter (Hobbs et al., 1991). KPBS results showed that bison grazed sites had 153% higher nitrogen mineralization and 126% greater nitrification than ungrazed sites. Overall, selective Iinnii grazing improved soil resource availability by increasing nitrogen cycling rates and enhancing nitrogen availability, subsequently increasing plant productivity and plant community diversity (Steinauer & Collins, 1995).

In the late 1980s, another KPBS Iinnii grazing study focused on the effects on soil microbial diversity and community composition over a three-month study (Hawkins &

Zeglin, 2022). In grassland ecosystems, microbial communities are influenced by dispersal limitation. Bison grazing may be an important dispersal vector with fecal samples containing thousands of bacteria and hundreds of archaeal taxa (Bergmann et al., 2015). On infrequently burned grazed sites, bison dung was added to test whether it was a vector of microbial dispersal. Results showed that microbial taxon richness was higher, and community richness increased. Therefore, Iinnii grazing is an important vector for dispersing microbes (through their dung), which increases grassland soil microbial richness and homogenizes microbial community composition.

In 2014, 30 Iinnii were introduced to tallgrass prairie restoration sites in the Nachusa Grasslands, Illinois, USA, to study bison effects on soil microbial communities (Barber et al., 2023). Results from soil samples collected from 2013 to 2018 showed an increase in soil carbon-to-nitrogen ratio and pH through the distribution of nutrients in Iinnii feces and urine back into the soil. Bison did not have immediate strong effects on soil bacterial richness or diversity, but grazed sites showed community compositions distinct from ungrazed soils, suggesting bison presence is driving soil microbial communities on a different trajectory of successional change that varies over time. Continued monitoring will explain if these trajectories eventually converge because of bison's ability to homogenize soil communities by dispersing soil bacteria through bison dung (Hawkins & Zeglin, 2022).

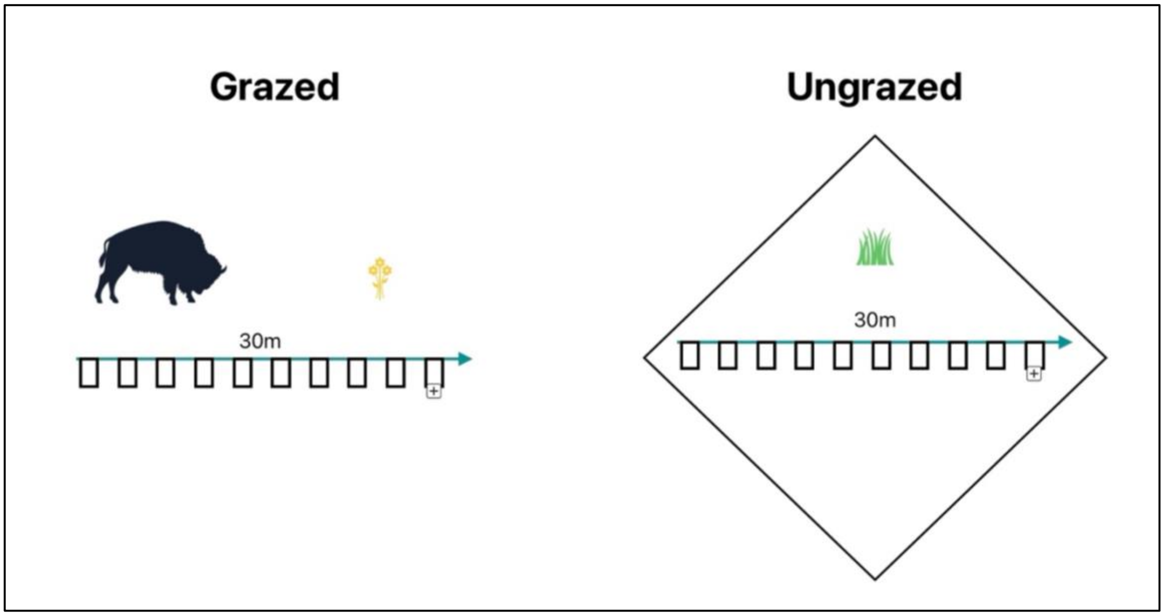

Figure 8. Paired samples with grazed and ungrazed sites.

My study focuses on how soil microbial communities change over the short term as Iinnii graze the land by comparing soil communities inside and outside nine grazing exclosures. Realizing that little is known about the long-term effects of Iinnii on microbial community composition – especially in the shortgrass and mixedgrass regions – this work will contribute soil baseline data needed to measure changes over time. We will monitor specific changes to Ksahkomm in response to Iinnii rematriation by measuring the soil nutrient status and characterizing the soil microbial community. In May 2022, three Blackfoot scientists, two Blackfoot summer students, and two Blackfoot Iinnii Herd Technicians trained and supported by two Agriculture and Agri-Food Canada (AAFC) staff members collected 90 bulk (non-rhizosphere) soil samples from pasture 12. Following respectful Blackfoot protocol for soil and the grassland beings, we offered tobacco to the site before disturbing the land, gave thanks for the gifts of soil, asked for guidance and protection during our work, and shared intentions to use this soil research in a good way. We established a W pattern for collecting 5 core samples at each of the 9 paired Iinnii-grazed and non-grazed sites. We put on clean gloves and sterilized the corer with 10% bleach or 70% ethanol before extracting samples and thereafter between each sample. We collected cores from the top 15 cm of soil using a 5 cm slide hammer coring device at the four corners and midpoint of each grazed/ungrazed site, with geographic locations recorded using the ArcGIS Field Maps application. We placed each sample into a WhirlPak bag and transported them on ice within 2-3 hours from sampling to the AAFC soil lab, where samples were sieved to 2mm and then separated into genetic (frozen) and nutrient (air-dried) sample portions. The genetic portion was stored at -20C before sending to the Genome Quebec laboratory for DNA extraction and molecular sequencing (Neuberger, 2022).

2.1.2 Ksahkomm analyses

AAFC staff members carried out the soil chemistry analyses of the samples. They crumbled, sieved <2mm, and air-dried the nutrient samples for 1 week at room temperature. Sub-samples of soil were ball-milled to pass through a 0.15 mm mesh. Finely ground samples were acidified with 75 µL of 6M HCl to remove carbonate-bound C and analyzed for SOC (Soil Organic Carbon) and TN (Total Nitrogen) using a GC-MS (Gas Chromatography-Mass Spectrometry) CN (Carbon-Nitrogen) analyzer (NC2100, Carlo Erba Instruments, Milan, Italy). They measured soil pH in a 2:1 deionized water: soil slurry mixture using air-dried soils and a pH meter. They measured exchangeable nitrate ($NO3^{-}$) and ammonium ($NH4^{+}$) by extracting at room temperature by shaking with 2.0M KCl (Maynard et al., 1993) and soil-available phosphorous ($PO4^{3-}$) by extraction with sodium bicarbonate 0.5M NaHCO3 (Carter & Gregorich, 2008).

DNA extraction and sequencing

Using the frozen soils, total genomic DNA was extracted using a Powerlyzer Powersoil Pro kit (Qiagen Sciences, 2020) following the manufacturer's instructions, combined with bead beating using an MP Biomedical Fast Prep Bead Beater (MP

Biomedicals, Ohio, USA). DNA purity was confirmed using a Biodrop spectrophotometer, and DNA concentrations were determined using a Qubit v4 fluorometer (ThermoFisher Scientific, Massachusetts, USA). Sequencing was performed on a NovaSeq 6000 at MRDNA (Shallowater, TX) with a PE 250bp library preparation kit using the 16S (515-806R) and ITS (fITS7-ITS4) primer pairs (Ihrmark et al., 2012; Parada et al., 2016).

Bioinformatics

Dr. Camilla Nesbø (University of Alberta) carried out a bioinformatics analysis of the sequences provided by Genome Quebec. The raw 16S rRNA amplicon sequences were processed and analyzed using QIIME2 version 2023.9 (Bolyen et al., 2018). After trimming the primer region with the cutadapt plug-in, amplicon sequence variants (ASVs) were generated using the DADA2 plug-in with the following settings: p-trunc-len-f = 220, p-trunc-len-r = 220 bp, p-max-ee-f = 2, p-max-ee-r = 2. Taxonomic classification was performed using the Silva-138-99-nb classifier trained on the 515f and 806r primer sets. The raw ITS amplicon sequences were processed and analyzed using the PIPITS pipeline using the default settings (Gweon et al., 2015).

The resulting ASV-table (16S rRNA) and OTU-table (ITS) were imported into R version 4.3.2 (R Core Team, 2024) using the phyloseq package (McMurdie & Holmes, 2013). Potential contaminating sequences were removed using the decontam package (Davis et al., 2018), which uses both the 'frequency' and 'prevalence' methods for contamination detection. Additionally, for the ITS dataset, only operational taxonomic units (OTUs) classified as fungi were used in the analysis. The resulting datasets were subsampled to an equal depth of 104,600 sequences for 16S and 72,840 sequences for ITS. These subsamples were used to create taxonomic profiles of the samples at phylum level.

Statistical analysis

I examined the effect of Iinnii grazing on soil nutrient status using paired t-tests for pH, total C, total N, $NO^{3-}N$, $NH^{3-}N$, and $PO^{4-}P$ inside versus outside the grazing exclosures. I used non-metric multidimensional scaling ordination (NMDS) to visualize changes to the soil fungal and bacterial OTU communities by Iinnii grazing. NMDS ordinations display Bray-Curtis distances between samples based on 16S rRNA and ITS composition.

I examined the correlations between soil variables and the ordination using the Mantel test overlayed on both NMDS ordinations. Vectors indicate the direction of the most rapid change in environmental variables with respect to the microbial community composition. I used regression analyses between soil variables and ordination axes to evaluate the strength of the vector correlation. Only soil variables with significant correlations ($p<0.05$) to the ordination axes were plotted. I used NMDS ordinations to display the correlation of soil variables with microbial communities.

I used permutational multivariate analysis of variance (PERMANOVA) with 999 permutations using the adonis function and beta diversity. Betadispersion tests are to detect differences in the spread or beta-diversity between grazed and ungrazed treatments and between sites in the pasture. Multivariate analyses were completed with the R package "vegan" (Oksanen et al., 2013; R Development Core Team, 2019).

2.2 Pisatsaisskiistsi and Iinnii

2.2.1 BEK context, experimental design, sample collection

Research grounded solely in WS that fails to capture holistic Indigenous worldviews of reciprocity and kinship relations, including human and non-humans (Kimmerer, 2011), may be extractive and cause harm to Indigenous communities and their ways of being. For example, commercialization and patents of cultural foods and medicines have occurred without compensating or recognizing Indigenous communities (Smith, 2021). The colonial context of WS has significantly contributed to the Indigenous Peoples' marginalization and disempowerment (McGregor, 2021; Nadasdy, 1999; Smith, 2021). To avoid repeating historical and systemic injustices, Siksikaitsitapi scientists choose to uplift Indigenous voices, perspectives, and sciences by acknowledging past harms and indigenizing research. For instance, Dr. Mike Bruised Head (Ninna Piiksii) introduced a unique research method based on Blackfoot pedagogy, different from the qualitative and quantitative academic institutional standards, to respectfully bring Blackfoot historical, spiritual, and ceremonial thinking into his doctoral research (Bruised Head, 2022). This created a safe space outside colonial structures for Blackfoot Elders to be recognized as experts and share their ancestral knowledge of the relationship between mountains and Itaksiistsimoo'pi (Vision Quest). I use Dr. Bruised Head's approach to decolonizing my research by meaningfully "braiding" WS and IS supporting Siksikaitsitapi priorities and the well-being of our community and lands, utilizing SS and values as the foundation of my study with the guidance of Blackfoot Elders and Knowledge Keepers. I also regard Elders and Knowledge Keepers as experts in my study who hold "BEK credentials" acquired from knowledge passed down to them from their Elders and from the knowledge of living in balance with Siksikaitsitapi for thousands of years. Therefore, my thesis is a representative approach interweaving WS and SS text instead of separating knowledge into boxes to provide the reader with a more holistic braiding experience.

As a cultural keystone species, Iinnii grazing, wallowing, trampling, and herding behaviour on the prairie landscape drives nutrient recycling processes that affect plant productivity (Olson and Janelle, 2022), which in turn nurtures Siksikaitsitapi relationship with Pisatsaisskiistsi. Iinnii has a unique relationship with plants that are being strengthened as they roam the landscape. Our Blackfoot plant stories are also being revitalized and shared more widely by the Blackfoot community through social media, plant walks, and art, showing pride in our cultural identity and connection to the land.

The following story about Ma's (Prairie turnip) and Kakatosi (Puffball mushroom) taught me the importance of Niitsitapiiksi relationship with plants.

> *This story began when two young women decided to sleep outside their lodge on a hot summer night. They woke up before dawn and looked up to see the stars in the sky. One of the girls, Soatsaki, looked up and proclaimed upon observing Iipisowaahs, the Morning Star or Early Riser as he was also known, that she would like to marry him because he was the brightest star. As it would happen, of course, she forgets that she made this statement.*
>
> *Later when Soatsaki was alone collecting wood away from the camp, Iipisowaahs appeared in human form and stopped her from returning to the camp. Soatsaki did not recognize him, and she did not like his intrusion. She asked him why he was stopping her. He replied that he was Iipisowaahs, and she had pledged to be his wife. After a moment, she remembered, acquiesced, and agreed to go with him to the Sky world.*
>
> *His parents, Naatosi, the Sun, and Kokomikisomm, the Moon, were happy with his human wife. The Sky world was similar to the Below world but with different landscapes, animals and plants, and other*

types of natural life. After she had been there awhile, Kokomikisomm provided her daughter-in-law with a root digger and instructed her on how to dig roots. Kokomikisomm told her daughter-in-law that she could go anywhere in the Sky world, but Kokomikisomm warned her daughter-in-law not to dig up the forbidden prairie turnip.

Time passed, and Soatsaki continued to live in the sky world. Eventually, she and Morning Star had a child. However, she never overcame her curiosity about the forbidden prairie turnip. One day she decided to dig it up, believing that no one would find out. She immediately learned that when she removed the prairie turnip, it opened a hole in the Sky world through which she could see the earth below. She saw her village, her friends, and her family, and she became very lonesome for her old life. When she returned to her lodge, Iipisowaahs knew by her sad demeanour what she had done.

He knew that she would never be happy in the Sky world again. And so he instructed her to return to the Below world with the Spider Man's web. She brought along her son and her new digging stick. Blackfeet women claim that they learned to dig roots from Soatsaki, who learned how from the Moon. Iipisowaahs warned his wife about not letting their son touch the earth. Soatsaki abided by this warning until one day when she allowed an old grandmother to watch the Star Child while she did her chores. The old woman did not understand the severity of the prohibition and allowed the star Child to get off the bed. When Soatsaki returned, she discovered that the Star Child had turned into a puffball fungus. Later that night, she looked up into the sky, and there was a *new star in the hole left by the turnip. The Star Child had turned into the North Star (Polaris) (LaPier, 2017).*

Blackfoot women were given these teachings from the sky world to sustainably manage plant populations by not overharvesting and preserving plants and their habitat through fire and reseeding. For example, Ma's is harvested in different locations yearly because it can take two to four years for tubers to mature. Indigenous women wait until Ma's is seeding to harvest and then re-seed their Ma's patches each year by refilling each hole with seeds and soil (LaPier, 2020). Our culturally significant plants provide food and medicine and connect us to the cosmos through ceremony. So, we walk respectfully in the prairie, knowing our connection to Ma's and Kakatosi. Api'soomaahka discussed our connection to pisatsaisskiistsi in an article he wrote, titled *Niitsitapiipaitapiiwahsini – Niitsitapi way of Life, Moto – Spring*, for the Blood Tribe News in May 2020:

Everything is connected to the Blackfoot worldview, and what connects us are the pisatsaisskiistsi/plants/flowers, as they were the first living things put here when the world was created.

~Api'soomaahka / William Singer

Restoring and protecting the Blackfoot prairie landscape is necessary to mitigate threats to traditional plant habitats and maintain healthy harvesting sites. Kainai community members have expressed increasing concern for decreasing and degrading traditional harvesting sites. The BTLM Environment Protection Division team conducts traditional plant surveys with guidance from community Knowledge Keepers to collect presence and abundance data for each native plant site. This dataset complements Range Health assessments by adding cultural value to the ecologically based Range Health score. The Range Health Assessment is a way to measure grazing impacts based on the range health protocol (France et al., 2016). It is a cumulative measure of five parameters, including community integrity (comparing current plant species composition to a reference plant community), community structural layers, hydrological function and nutrient cycling, site stability, and noxious weed presence. The five health components provide an overall rangeland health score when summed together. Rangeland health categories are used to simplify and communicate scores and are typically categorized as satisfactory (>75 %; healthy - H), at risk of degradation (>50 % but below 75 %; healthy with problems - HP) or indicate obvious degradation (<50 %; unhealthy - UH; (France et al., 2016).

Previous bison restoration research has documented the ecological effects of bison reintroduction on plant communities in the Tallgrass prairie (Knapp et al., 1999; Towne et al. 2005; Fuhlendorf et al., 2010; Gates et al., 2010), Mixedgrass prairie (McMillan et al., 2019), and Shortgrass prairie (Wilkins et al., 2019). Most studies tested the keystone effect of Iinnii to conserve and restore biological plant community diversity and function on the prairies (e.g. Frank & Evans, 1997; Knapp et al., 1999; Towne et al., 2005; McMillan et al., 2019). Others explored the impact of Iinnii on riparian plant communities (Yu,2023; Kauffman et al., 2023).

The most extensive and long-running study of the effects of bison grazing on plant communities is at the Konza Prairie Research Natural Area in Kansas, USA, where bison were reintroduced in 1987 to study the grazing effects of the keystone species on the Tallgrass prairie. Due to unique spatial and temporal selective grazing activities, Knapp et al. (1999) found that Iinnii grazing increased plant species diversity, richness and community spatial heterogeneity compared to ungrazed sites. Bison selectively graze grasses, decreasing grass canopy cover and biomass, which reduces the grass-forb aboveground plant competition. This allows forb species to increase, therefore changing plant community composition and increasing species richness (Hartnett et al., 1996). Along with grass-dominant sites, Iinnii also reselects sites that have deposition of nitrogen-rich urine, creating grazing patches or lawns that are revisited every year (Steinauer, 1994). Short-term effects (less than seven years of grazing) through leaf removal enhanced plant photosynthesis allowing plant nitrogen relocation from roots and the ability for compensatory regrowth of biomass loss to grazing. After seven years of grazing, long-term responses reduced belowground carbon allocation and storage of carbohydrate reserves (Vinton and Hartnett, 1992). Therefore, the effects of Iinnii preferential grazing directly altered plant community composition and indirectly increased microsite diversity through dung, urine, trampling and wallowing, and overall, increased plant species richness and diversity.

A similar study tested the keystone effects of bison reintroduction in Montana's mixed grassland prairie plant communities and showed comparable results, with Iinnii grazing leading to higher plant species richness and compositional heterogeneity than cattle-grazed or without grazing (McMillan et al., 2019). Sixteen bison were reintroduced to the American Prairie Reserve in 2005 and grazed year-round for 10 years, with the bison population growing to 600. Iinnii preferential grazing led to variation in plant species composition between plots for each treatment and an overall increase in plant species richness. Iinnii patch grazing behaviors decreases dominant grass cover, thereby increasing species richness and abundance. Although the short-term study did not show a significant increase in plant diversity, there was evidence of impacts, suggesting that more time may be needed to see long-term effects.

In a 10-year study, Iinnii were reintroduced to Montana’s riparian communities to evaluate its effect on vegetation communities (Yu et al., 2023). Bison do not frequent water sources as much as cattle do because of their high heat tolerance, which may have led to decreased grazing and trampling pressure in the riparian area, allowing for increased native plant species diversity and woody height heterogeneity. In comparison to cattle grazing, riparian vegetation was more diverse with year-round bison grazing than with seasonal cattle grazing.

Another study looking at Iinnii grazing in riparian areas found that buffalo are degrading the vegetation with heavy utilization in the riparian area. (Kauffman et al., 2023). Wild free-ranging bison have grazed in Yellowstone National Park since prehistoric times, with numbers increasing significantly such that the population exceeded the carrying capacity in certain areas like the riparian habitat in this study. Large numbers of bison grazing resulted in lower compositional diversity by creating warmer and drier conditions, shifting riparian species composition toward species adapted to these conditions. Findings from the study contrast with the beneficial effects of bison on riparian plant communities found by Yu et al. (2023). This shows that while Iinnii grazing can increase riparian plant diversity and reduce degradation compared to cattle grazing if the Iinnii population is too high, there can still be detrimental effects.

My research aims to holistically explore the ecological and sociocultural effects of Iinnii in southern Alberta's mixed grassland prairie ecosystem. Rangeland Health Assessments that include detailed vegetation assessments are conducted annually by Blood Tribe Land Management (BTLM) at sites across Kainaissksaahkoyi to measure the response of the grassland to Iinnii grazing and to guide sustainable pasture management. Therefore, we also conducted these assessments at the nine paired grazed and ungrazed plots. We established a 30m linear diagonal transect by randomly selecting one of the corners inside each exclosure and one in each paired grazed plot. We identified individual species of grasses, forbs, moss, lichen, and bare ground estimated % cover using a 20x50cm Daubenmire frame in each plot along the transect tape at intervals of 3 meters apart for a total of 10 sample plots in each 625 square meters sample site. We used the Mixed-Grass Prairie reference plant community guide (Community code: MGA21) as a reference plant community to assess the Rangeland Health rating (Adams et al., 2013).

Utilizing the detailed vegetation assessment data, I compared the plant community richness and composition inside and outside exclosures. First, I calculated species richness, the total number of vascular plant species across all plots in each transect. To compare species richness inside and outside the exclosures after the first year of grazing, I confirmed that the data was normally distributed and did not require transformation and used a paired t-test metric. Then, I used the Bray-Curtis dissimilarity metric and non-metric multidimensional scaling (NMDS) ordination to visualize community composition in the paired ungrazed and grazed plots inside vs. outside exclosures in 2022, and then inside vs. outside exclosures in 2023. Bray-Curtis dissimilarity measures the level of dissimilarity in plant species presence and abundance in different samples, where a value of 0 indicates identical community composition and a value of 1 indicates no species in common between each of the exclosures and paired sites (Bray & Curtis, 1957). I calculated the Bray-Curtis dissimilarity metric between each pair of plots based on the square-root transformed abundance of each species in each transect. I then used a permutational multivariate analysis of variance with 999 permutations (PERMANOVA) to test whether the plant community composition differed significantly between grazed and ungrazed sites (Anderson, 2001). I did this analysis twice, once for the 2022 data and once for the 2023 data. I used the statistical software R version 4.3.2 for all statistical analyses (R Core Team, 2024). I used 'vegan' package to calculate the Bray-Curtis dissimilarity and to do PERMANOVA tests (Oksanen et al., 2024). I also used PERMDISP (multivariate homogeneity of group dispersions) with 999 permutations to test if the grazed and ungrazed plots differ in their beta diversity (compositional change between sites).

2.3 Blackfoot Plant Surveys

Traditional land practices, like Iinnii and plant harvesting, are reciprocal relationships between Niitsitapiiksi and Saokio. They involve ceremonial offerings and gratitude to the land in exchange for nourishment and medicine. During an interview, Api'soomaahka, a Blackfoot plant knowledge keeper, spoke to the importance of Iinnii returning to improve the Blackfoot community's health and well-being.

> *For us to always evolve, we always have to maintain our world in that worldview is with the Iinnii. It gives us that opportunity to really start working together with them in a spiritual sense but also as a food source to start bringing our people back to health, and that will be in combination with the plants and the plants that they fertilized with their dung those particular plants will help with them in bringing our people to health which is why the wild turnip is a really important food and when you combine that with the Iinnii you know their meat it is medicine.*

Blood Tribe community members' increasing concern about the decrease, degradation, and absence of traditional plants used for harvesting stressed the importance of incorporating a traditional plant survey not represented in rangeland health assessments and detailed vegetation transects. The traditional plant survey was co-developed with Knowledge Keepers, BTLM staff, and consultant Dr. Cynthia Lane (Ecological Strategies, LLC) to collect distribution and abundance information. I documented traditional plants in the fenced and unfenced paired sites before bison grazed the pasture and one year afterward. The technique involves walking back and forth through the 25 x 25 m site to identify the presence of traditional plants. In accordance with Elders and Knowledge Keeper's guidance, I developed a traditional plant list that includes BEK that is appropriate to share and did not share BEK that involves sacred protocol or is inappropriate for publication.

2.4 Matapiiks (people)

The Kainai Iinnii Rematriation study takes a holistic approach based on "ecocultural rewilding" (Heuer et al., 2023), a concept used in the Banff Iinnii Reintroduction project. This project views human participation as an essential component to effective Iinnii rematriation and restoring ecologically beneficial cultural practices. Accordingly, our study objective is based on Blackfoot reciprocal relationships between Matapiiks and Niksokowaiksi as we collect data from but also give back to Iinnii and Saokio.

Because Blackfoot ways of knowing were not written, oral knowledge transfer is the basis of SS methodology. During a visit with Elder Minipoka in February 2024 to talk about some of the Blackfoot terms used in my research, he spoke to the importance of learning to speak Niitsipowahsin (Blackfoot language) because "Unwritten history supersedes written history, and the land supersedes everything." Therefore, to really understand Siksikaitsitapi Science would require an understanding of Niitsipowahsin, because it doesn't directly translate into the English language and risks losing meaning if translated. Fluent Blackfoot speakers have an entirely different understanding of relating to the world because the land shaped their cultural and psychological domain. Elders stress the importance of sustaining and preserving our cultural ways now that we, as Indigenous Scientists, have the opportunity they didn't have in the past, giving us the blessing to document BEK in a written form to be used as a foundation for future learning.

Unfortunately, the language barrier has been another limitation to my thesis because SS concepts are challenging to communicate for WS research, and likewise, WS terms and concepts are difficult to communicate to Indigenous communities. The importance of language and stories are central to BEK – song, stories, and ceremony. “Re-storyation” is the idea of telling a different story of a place that honours both intellectual knowledges (Kimmerer, 2011). I use re-storyation in my research to create an understanding of Iinnii rematriation, where WS and SS have important roles in maintaining relationships with one another and with the land. This includes speaking the truth about the colonial history of conservation and its impacts on Indigenous peoples and their lands. BEK can broaden understanding of Western concepts of stewardship and conservation while furthering goals towards reconciliation.

Indigenous knowledge is now recognized in Western systems of law and science, while historically, oral history was not valued as ‘real evidence.’ For example, the Eurocentric law system validated oral history as a source of knowledge in the Supreme Court Tslihqot’in case, which accepted Elder testimony as evidence for land claims ("Tsilhqot’in Nation v. British Columbia," 2014). Using the Tslihqot’in case as precedence, Blackfoot Elders testified orally regarding the breach of 1877’s Treaty 7 to win the 2019 Big Land Claim case (Grant, 2019). BEK/TEK is increasingly being incorporated into conservation, acknowledging the importance of Niitsitapi oral history. For example, BEK about using fire and gathering and cultivating specific plants for food and medicine that shaped Siksikaitsitapi landscapes has been passed on to subsequent generations through oral stories, cultural practices, lived experiences, and spiritual ceremonies and is contributing to whitebark pine forest restoration (Augare-Estey, 2011). Sweetgrass TEK gathered through oral interviews with Haudenosaunee both complemented and contradicted the scientific information collected in a sweetgrass ecological and ethnobotanical study but overall provided insight into sweetgrass population status and habitat requirements. "The two knowledge bases had different strengths in providing an understanding of the physical and ecological characteristics of sweetgrass" (Shebitz, 2001). By prioritizing Łeghágots'enetę (learning together), Dene TEK and WS genetic analysis described caribou biological variation that contributed to the conservation of at-risk caribou (Polfus et al., 2016). Building on oral testimony, TEK is legally incorporated into Canadian environmental and social impact assessments through the methodology represented in Tobias (2000) that guides respectful mapping of cultural and resource geography.

Previous research studied the social effects of Iinnii reintroduction for connecting people to the grasslands and benefiting human health (e.g. Crosschild et al., 2021; Haggerty et al., 2018; Heuer et al., 2023; Wilkins et al., 2019). For example, buffalo restoration at the Fort Peck reservation in Montana provided psychological and spiritual benefits of reconnection at different scales from individuals, across species, and within the community (Haggerty et al., 2018). Using a community-based participatory framework approach, 18 in-depth interviews were conducted with targeted individuals currently involved in buffalo restoration activities. For example, after the buffalo returned, interviewees reported experiences of joy and awe, release from past trauma, and an energetic feeling in the presence of buffalo that generally contributed to the Sioux and Assiniboine tribe's well-being among community members. Overall, this study provided insights into the benefits of ecological and cultural restoration for indigenous communities.

In Wilkins et al. (2019), Iinnii rematriation to the short grass prairie in Northern Colorado resulted in immediate positive benefits for connecting people to conservation, while few ecological effects were found within the short-term (2-year) study. Based on the results of structured visitor surveys conducted before and after Iinnii reintroduction, the presence of bison led to a significant increase in place attachment (emotions, meanings, and values associated with a specific area) to the grassland site. This increased connection and sense of belonging can improve human-grassland relations by enhancing the conservation and protection of Iiniiksi and grassland landscapes.

As an Indigenous-led, international effort, the Buffalo Treaty is reconnecting relations between prairie peoples and Iiniiksi. The treaty serves as an Indigenous treaty methodology that challenges settler systems to address the Buffalo genocide and its consequences on Saokio landscapes and life. In Crosschild et al. (2021), the coauthors use a visiting method with Dr. Leroy Little Bear and the Buffalo Treaty as a platform to explore the keystone role of Iinnii in sustaining prairie interconnections and activating the buffalo consciousness. Buffalo consciousness is a way of thinking that “can increase that awareness of being in and within relation to one another,” shifting focus from preservation to relationality, emphasizing cultural revitalization and Indigenous sovereignty, and promoting a holistic approach to conservation that centers Indigenous knowledge, values, and practices related to buffalo.

Based on community and cultural values, I interviewed community members to explore and document their experiences and knowledge as the Iinnii returned to the land to capture socio-cultural impacts. I used a mixed-methods approach that included guidance from Blackfoot protocol and the Mi’kmaw concept of Two-Eyed Seeing (Bartlett et al., 2012) to ensure that participation in research is respectful, responsible, and accountable to Siksikaitsitapi knowledge. Blackfoot protocol for acquiring or transferring knowledge can be complex if sacred societal knowledge is involved. I ensured a safe space for sharing by aligning my interviews with Blackfoot protocol and only asking for publicly shareable knowledge. Blackfoot protocol for my interviews included approaching the Elder / Knowledge Keeper with tobacco, introducing myself and my intentions for the knowledge shared with me and providing a gift afterwards. As a Blackfoot scientist, I assured participants that my research was going to be used in a good way for the benefit of our community and land. The concept of Etuaptmumk (Mi'kmaw for 'Two-Eyed Seeing'), created by Mi'kmaw Elder Albert Marshall, is defined as "learning to see from one eye with the strengths of Indigenous knowledge and ways of knowing, and from the other eye with the strengths of mainstream knowledge and ways of knowing, and to use both these eyes together, for the benefit of all" (Bartlett et al., 2012). I conducted interviews with a conversational method that allowed flexibility in responses as translating Western concepts into Blackfoot, and vice-versa, is not always possible (Kovach, 2010).

I chose BEK mentors for their strong relationship with the Iinnii and prairie landscape. I call the people I interviewed my BEK mentors to respect the depth of their knowledge and expertise. I chose a small group of five BEK mentors for their wisdom related to the research. This included traditional society members, community members tied to the Iinnii Rematriation project, and recommendations from the first two groups. Siksikaitsitapi societies maintain sacred relationships through ceremonies that have been given to us by Ihtsipaitapiyop for kaamotaani (survival) and misamipaitapiisini (long life). I did not use random sampling or seek out as many participants as possible but chose individuals I am already connected with as a Blackfoot Scientist and Kainai community member to prioritize in-depth knowledge gathering. As stated previously, our Elders and Knowledge Keepers are repositories of ancient wisdom, and we honour them by developing a respectful relationship with them if we wish to gather knowledge from them. I chose to interview Blackfoot scientists with Western academic and SS backgrounds because of the interdisciplinary nature of the study.

To account for cultural barriers, I gathered the Iinnii interviews in a semi-structured, conversational method that ensured flexibility in responses by allowing the participant to lead the interview in alignment with their own values and priorities. Regarding Blackfoot epistemology for honouring tsinikssin, I chose to listen and participate in their stories instead of forcing questions that may limit their responses. I did have general pre-set areas of inquiry but did not always probe all areas if the participant chose to share their experiences with Iinnii and Saokio. I generally asked for their knowledge (stories, experiences, guidance) about our connection to Iinnii and prairie interrelationships and how Iinnii rematriation might affect our community and the land. I spoke with my BEK mentors in the location of their choosing and where they were most comfortable sharing. With participant consent, I recorded the interviews with an iPad video camera, taking handwritten notes in case of technical failure.

As a community member working with the Kainai Nation for 19 years, I wanted to be accountable to my community by being transparent and obtaining consent. Kainai does not have a formal research validation process, so I brought my research to Kainai Ecosystem Protection Association (KEPA) members for guidance and support before conducting interviews. Four of the five research participants are KEPA members who are actively involved in Iinnii Rematriation.

Conventional academic written consent forms are foreign to the Blackfoot knowledge exchange protocol that has existed for millennia and may be seen as disrespectful in attempting to validate BEK. Furthermore, they may cause harm by triggering negative feelings if seen as an extractive process that doesn't respect Blackfoot ways of knowing. Using an academic form that represents colonial structures and control of knowledge outside of BEK is not in line with my study objectives. Instead of the 6-page consent form that required a signature, I obtained verbal consent from participants and provided a one-page detailed description of my study, which presented options to refuse to answer or withdraw information at any time. I visited my BEK mentors at least one more time or communicated via email, text and/or phone call to confirm their approval of transcribed interviews and that the BEK interwoven into my thesis was respectful and appropriate. I also provided written and recorded interviews upon request. I asked them if they wanted their identity kept confidential, remaining unnamed in my study. They all chose to be credited with Blackfoot / English names to uplift BEK and inspire the involvement of the Blackfoot community in Iinnii Rematriation research and Siksikaitsitapi Science.

I transcribed all five interviews, printed them, and looked for "reference points," which Dr. Little Bear refers to as the regular patterns found amongst fluxes or energies around us. Niitsitapiiksi search for reference points that enable us to coexist with the rest of Creation. For example, Dr. Little Bear referred to the land as a reference point because we can rely on the land as a source of knowledge since it has a long memory and doesn't change much compared to human memory and lifespan. In my research, I use this concept for identifying and sharing BEK teachings from my interviews that are interwoven through my thesis and named in this section.

When I started reading and listening to the interviews, I deduced the following "reference points" from the conversations with my BEK mentors: Renewal/Reciprocity through revitalizing knowledge and giving back through ceremonies such as offering tobacco to Iiniiksi and at Akokatsin (annual Sundance); Spiritual responsibility/maintaining sacred relationships is about caring for community and healing because Iinnii is part of us, and we are part of the buffalo spirit; Respect through protocol and honouring those who hold knowledge and Niksokowaiksi; and Niitsipoiyksi (speaking Blackfoot) is critical for understanding Niitsitapiisinni (our way of life).

I re-read and re-listened to the interviews throughout my master's program to conceptualize how the weaving process would work in my thesis. As I began analyzing the WS, I often referred to my “reference points” for guidance in connecting BEK and WS. These interviews will be shared with the BEK mentors for their use and stored on the Blood Tribe Land Management server for community awareness and education programs.

Chapter 3: Meaningful Connections / Flux / Renewal

Figure 9. Bryce Singer. (2024). Memory. Lethbridge, AB. Reproduced with permission from artist.

Although WS and SS methodologies run parallel to each other as completely different knowledge systems, they can elevate each other to provide meaningful results. The WS linear process of analyzing involves breaking down information for further understanding, whereas Blackfoot methodology, as a circular process, observes relationships within constant flux that are sustained by renewal. For example, Blackfoot ceremonies are the flux (energy) that reconnects and maintains relationships with each other and with Niksokowaiksi; it is spiritual knowledge that will never disappear. However, Western methodology, as a reductive process that involves fragmenting data into interview/notes sections separate from context and statistically analyzing measurements to produce a number or graph, doesn't encompass flux in a spiritual, relational context and is an end in itself.

> *So, in the same way, the buffalo and the land can be referred to as elders. They have memory. That is why a lot of elders say you should come and talk to us, come visit us, if you don't, then we have nobody to tell our stories to. It's kind of like that when we're talking about land-based education. Taking kids out on the land, it is kind of like learning from grandma, the earth, the land, and so on. It brings back those memories that are there. We are opening up repositories. That knowledge that has always been, is still there.*
>
> *~Interview with Dr. Leroy Little Bear, Ikaisskini, Winter 2022*

In this quote, Elder Leroy Little Bear teaches us that the land is like an elder. We can visit with the land and ask for knowledge and guidance, just like we visit our elders. Iinnii, as an ecocultural keystone, is an expert in ecological balance, so now we are learning from Iinnii how to rekindle those relationships that have been revived in the land. An elder's role in the community is similar to how we recognize relational networks with the land. As we respectfully ask elders for advice and guidance, following Blackfoot protocol for transferring knowledge, we develop a relationship with each visit. The same applies to our connection with the land, which strengthens through ceremonies and traditional/reciprocal/restorative practices. Strengthening and maintaining sacred relationships with our Saokio relatives provides gifts and guidance from Ihtsipaitapiyop that can be communicated in dreams, signs in the land and animals, stories, ceremonies, and songs.

Blackfoot wisdom and stories shared with me describe the meaningful relationships Iinnii is revitalizing amongst Ksahkomm, Pisatsaisskiistsi, and ourselves to reconnect to the land. In my research, I use BEK to enhance the statistical analysis of comparing the soil and plant community composition in nine ungrazed plots to nine Iinnii grazed treatment plots. In addition to measuring and analyzing soil and plant communities, BEK teaches how Iinnii unites the soil, plants, and people through reciprocal relationships that enhance grassland ecological and cultural values. During my interview with Dr. Leroy Little Bear, he tells how Iiniiksi became land beings to demonstrate these relationships.

> *There are stories about Blackfoot that we refer to as soyiistamik, which means the Buffalo ended up being in the water; they were water beings. The buffalo used to come out on the land to hunt and prey upon Humans. There came a time when the Buffalo and the humans entered into an agreement. They said that they would not kill Humans anymore. They hunted us, but now we can hunt them. In other words, they were making themselves available to us. However, the buffalo ended up laying down a condition to make this agreement real we will give you part of our family, and you give us your people. And that is the Buffalo that's now out on the land because they were originally water beings. In other words, take half of your people and give them to us. We will take half of our people and give them to you.*
>
> *Furthermore, the story goes, the Buffalo gave us half of their people, which is why there is Buffalo on the land. But the humans had second thoughts about giving up half of their people to the Buffalo to go into the water to become water beings. It so happened that the humans*

were travelling during the winter to where they were moving camp, and there was a big river. They were going across the river to camp. While crossing over the ice, the ice broke underneath them, and half of them went into the water. And the other half were saved, and so, in reality, we did give the Buffalo part of the humans as part of that exchange. So that is where the Buffalo came in. And the Buffalo now says while I am in a new place, How do I relate to this place? How do I get to know what it is? What is this all about being out of the water and living on the land? Maybe Buffalo really studied the ecological aspects, and maybe it really went out of its way to say I am going to find out what this life is all about and they did it very well. And now, we are using the Buffalo to come back and teach us how to bring about ecological balance because the buffalo had studied that ecological balance and how it fits in. And so now we as humans are turning around and using that knowledge. That is why the Buffalo is very important to us. It's part of our family. But we never corralled or domesticated it. We said you go out and live out there. You know, the way you have always lived. We let it be free, and when we needed something, we could go and hunt the Buffalo in the old days, and we just took as much as we needed. We did not overdo it. So that is one story, one lesson that comes about.

Iinnii provides the grassland with ecological balancing practices, such as creating optimal soil conditions for new plant growth, which restores and sustains the Saokio relational networks. Niitsitapiiksi contribute to and benefit from these balancing practices by harvesting Iinnii and plants for food and medicine to heal the community and land. During our conversations, my BEK mentors described the holistic relationship between the land and community health:

> *Iinnii was always a part of us because of their connection to the land, and we're a part of that connection. Having Iinnii back on the land in our territory, especially here on the North End of the reserve, gives many of our people the opportunity to see them. They are in our own backyard, and they're not animals you can only see in the zoo, but the whole intent of having the Buffalo is it's for our well-being, our destiny.*
>
> ~Interview with Api'soomaahka

> *We know the buffalo spirit was always here they never left us. The young ones need to know our ways and understand that the spirit of the buffalo has always been there and they're back home on the reserve.*
>
> ~Interview with Niinaisipistoo, Elder Francis First Charger

3.0 Ksahkomm connections

There were no significant differences in the soil chemical (Table 1) and microbial properties between grazed and ungrazed sites. However, there were significant differences between sampling sites. Taxonomic profiles of the samples at the phylum level are shown in Figure 10 for the 16S rRNA data and Figure 11 for the ITS data.

Table 1. Table showing soil chemical variables for each site. The mean was calculated for site subsamples. The final row shows the paired t-test comparing paired samples inside vs. outside exclosures.

Site	Treatment	pH	Nitrogen%	Carbon%	Nitrogen(mg)	Sample wt.(mg)	Carbon(mg)	NO3-N (µg_g-1)	NH3-N (µg_g-1)	PO4-P (mg_kg-1)
1	Grazed	7.81	0.26	2.90	0.10	40.06	1.16	1.41	3.28	3.34
2	Grazed	7.90	0.24	3.07	0.10	40.12	1.23	2.19	4.21	3.39
3	Grazed	7.09	0.24	2.49	0.10	40.04	0.99	0.74	6.17	2.22
4	Grazed	7.98	0.24	2.96	0.10	39.54	1.17	1.27	6.26	1.54
5	Grazed	6.82	0.22	2.35	0.09	40.14	0.94	0.61	6.31	1.18
6	Grazed	7.48	0.28	3.10	0.11	39.84	1.23	0.87	4.69	2.46
7	Grazed	7.35	0.25	2.85	0.10	39.60	1.13	1.02	5.13	1.75
8	Grazed	7.44	0.28	3.24	0.11	40.06	1.30	0.66	4.95	2.71
9	Grazed	6.65	0.26	2.83	0.10	39.52	1.12	1.04	8.99	3.95
Mean (Grazed)	Grazed	7.39	0.25	2.87	0.10	39.88	1.14	1.09	5.55	2.50
1	Ungrazed	7.59	0.25	2.66	0.10	40.32	1.07	1.09	2.95	2.49
2	Ungrazed	8.11	0.23	2.87	0.09	40.20	1.15	2.22	3.04	2.57
3	Ungrazed	6.95	0.25	2.82	0.10	40.14	1.13	0.92	7.03	2.85
4	Ungrazed	7.92	0.25	2.99	0.10	40.44	1.21	1.25	6.16	2.24
5	Ungrazed	7.60	0.27	3.29	0.11	40.24	1.33	1.19	5.67	1.20
6	Ungrazed	7.74	0.26	3.13	0.10	40.04	1.25	1.20	5.68	2.85
7	Ungrazed	7.73	0.27	3.11	0.11	40.06	1.24	1.11	4.31	1.12
8	Ungrazed	6.92	0.27	2.87	0.11	39.60	1.14	0.88	3.43	2.32
9	Ungrazed	6.65	0.25	2.62	0.10	40.10	1.05	0.49	5.54	2.48
Mean (Ungrazed)	Ungrazed	7.47	0.25	2.93	0.10	40.13	1.18	1.15	4.87	2.24
T value		2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
P value		0.56	0.82	0.65	0.66	0.09	0.57	0.61	0.16	0.31

NMDS ordinations of Bray-Curtis distances between samples based on the 16S rRNA and ITS amplicon data are shown in Figures 12 and 13. There are no significant differences between samples of grazed and ungrazed sites. This was confirmed by adonis (PERMANOVA) and betadispersion tests that were not statistically significant for these treatments. There are, however, significant differences in the beta diversity of grazed versus ungrazed sites (16S rRNA betadisp $p = 0.0007$, ITS betadisp $p = 0.003$). Figure 13 is identical to Figure 14, except samples are coloured by site, showing how sites 1-5 and 6-9 are clustered together, indicating a shift in composition in bacterial communities.

As shown in Figure 15 and Figure 16, the soil characteristics most strongly correlated with changes in bacterial and fungal species composition were pH, N03-N (Nitrate Nitrogen), NH3-N (Ammonium Nitrogen), Total Carbon, and Total Nitrogen.

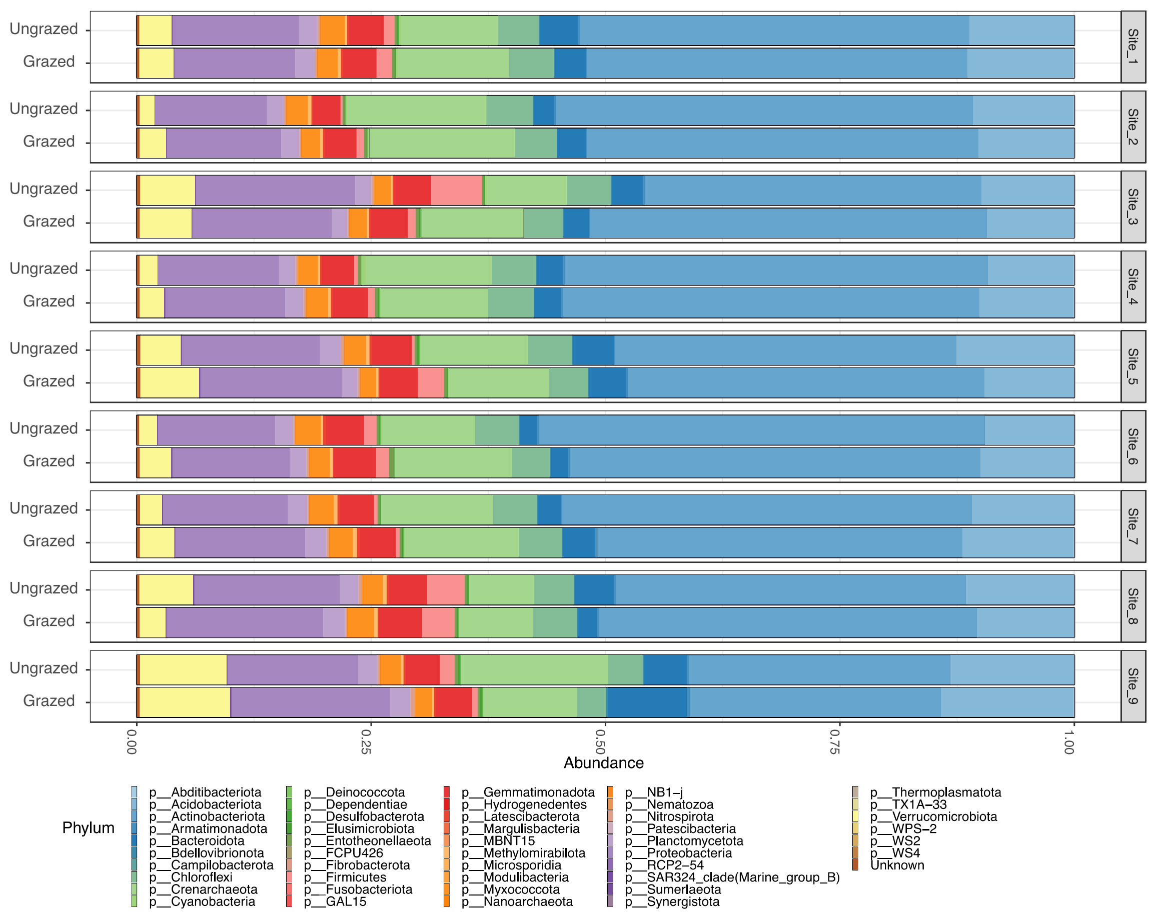

Figure 10. Bar chart showing the taxonomic distribution of soil bacteria at phylum level at each site based on 16S rRNA ASVs. Replicates were merged at each site. The most abundant phyla are Actinobacteriota, Acidobacteriota, Verrumicrobiota and Crenarchaeota.

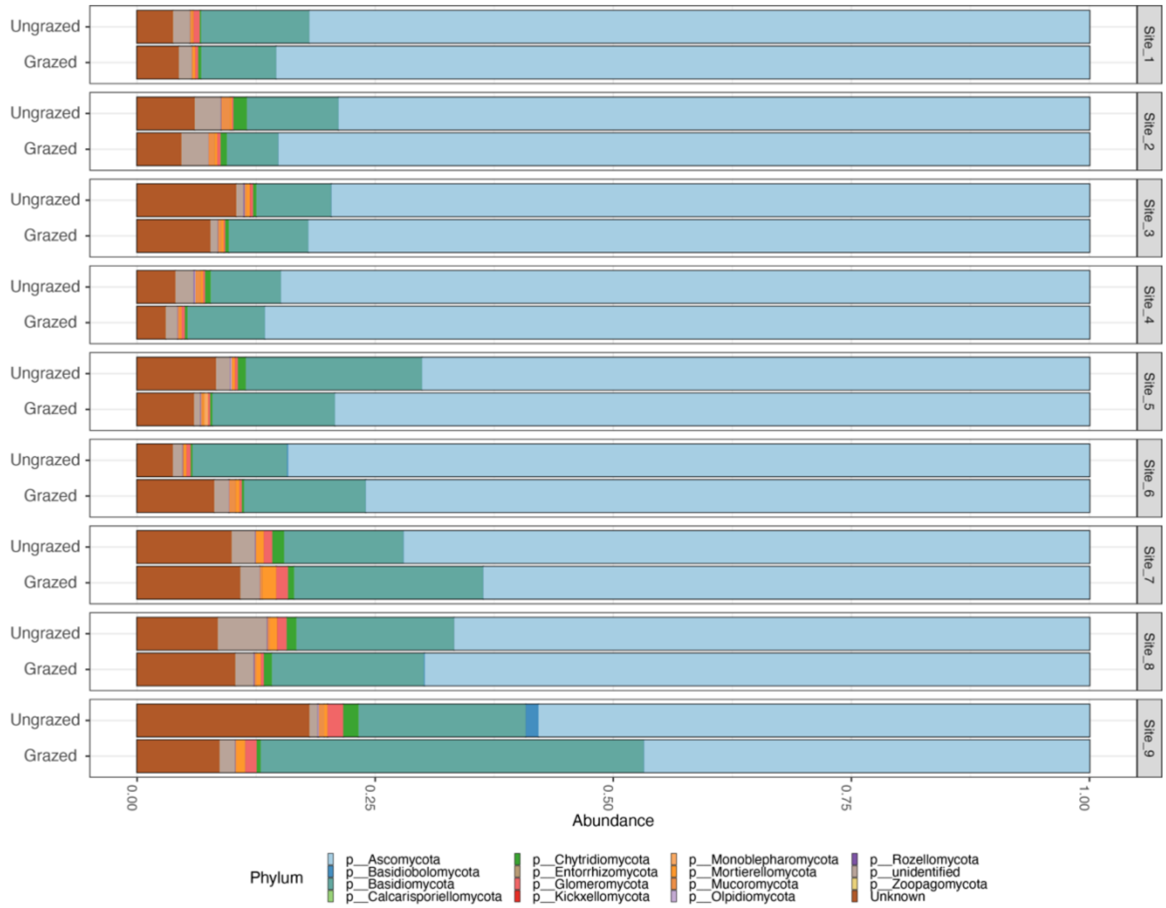

Figure 11. Bar chart showing the taxonomic distribution of fungi at phylum level at each site based on ITS OTUs. The most abundant phyla are Ascomycota and Basidiomycota.

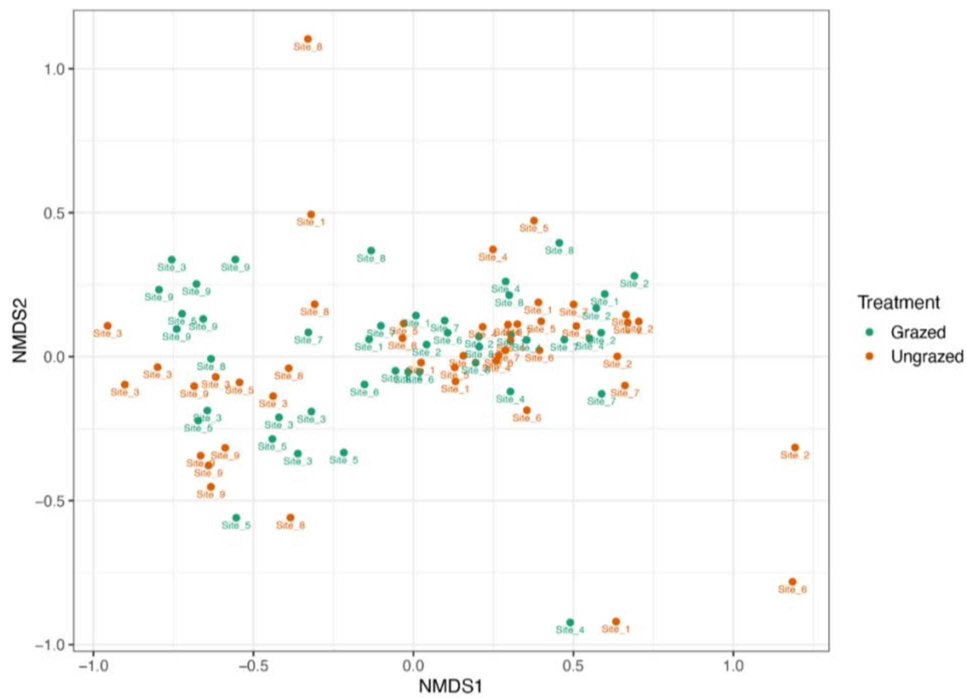

Figure 12. NMDS ordination of soil samples based on the abundance of soil bacteria at the phylum level at each site based on 16S rRNA ASVs. Stress in 2 dimensions is 0.12. Samples are coloured by treatment (Grazed and Ungrazed) and labelled by the sample site.

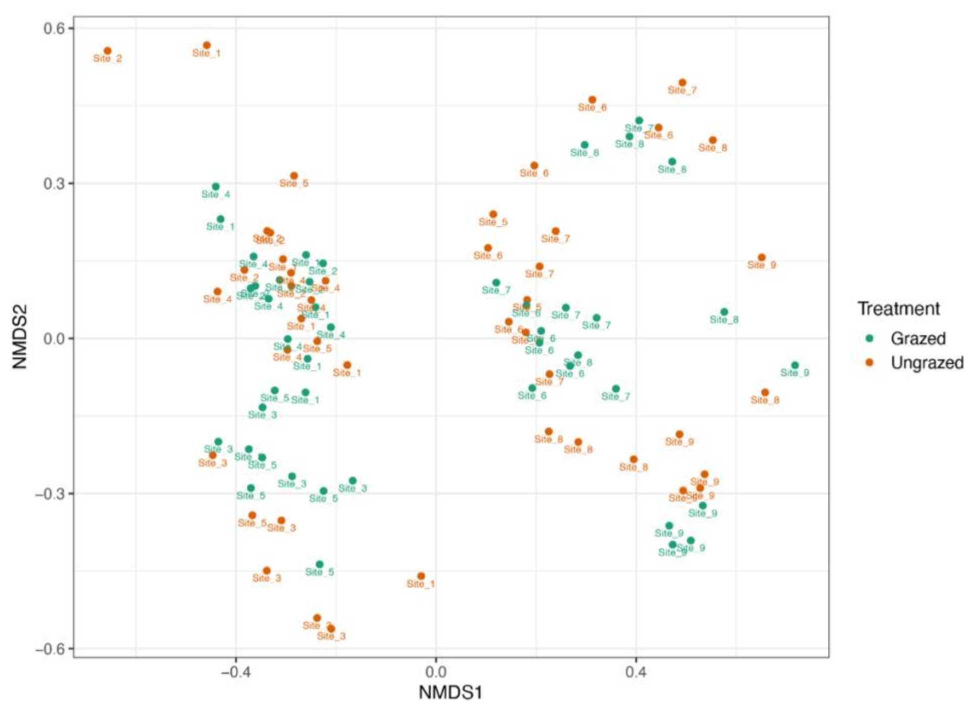

Figure 13. NMDS ordination of soil samples based on the abundance of soil fungi at the phylum level at each site based on ITS OTUs. Stress in 2 dimensions is 0.15. Samples are coloured by treatment (Grazed and Ungrazed) and labelled by the sample site.

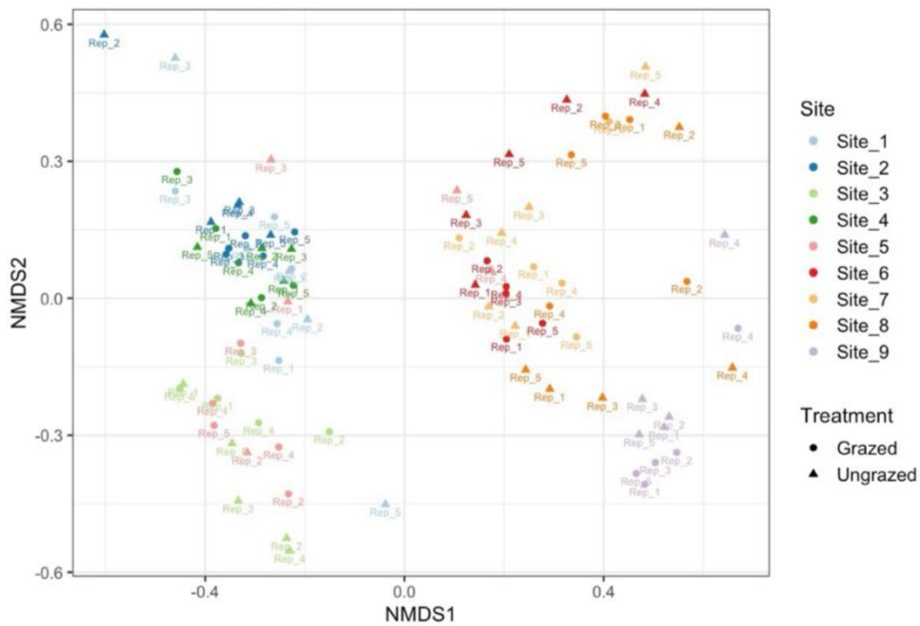

Figure 14. NMDS ordination of soil samples based on the abundance of soil fungi at the phylum level at each site based on ITS OTUs. Stress in 2 dimensions is 0.15. Samples are coloured by sample site with different symbols for each treatment (Grazed and Ungrazed).

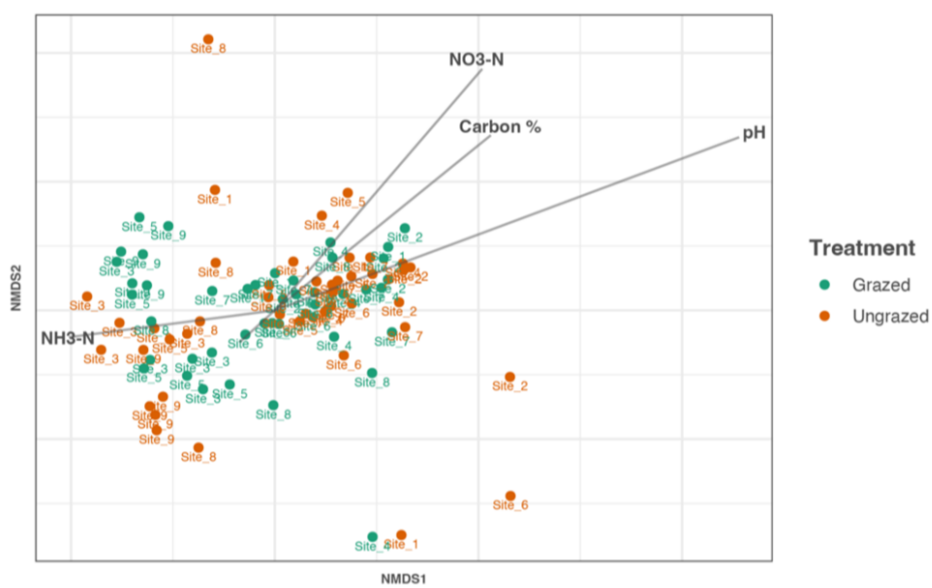

Figure 15. NMDS of soil samples based on the abundance of soil bacteria at the phylum level at each site based on 16S rRNA ASVs. Stress in 2 dimensions is 0.12. Samples are coloured by treatment (Grazed and Ungrazed) and labelled by the sample site. Vectors represent soil metrics most strongly correlated with the gradient in soil bacterial composition. Vector length is proportional to the correlation between the soil variable and the ordination.

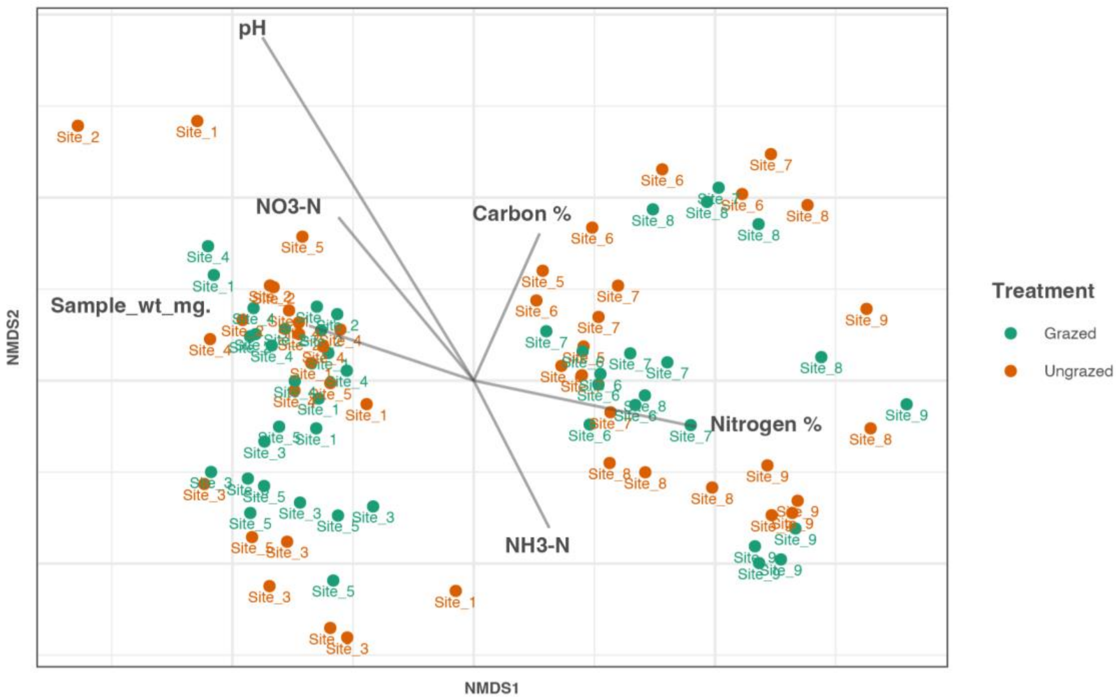

Figure 16. NMDS ordination of soil samples based on the abundance of soil fungi at the phylum level at each site based on ITS OTUs. Stress in 2 dimensions is 0.15. Samples are coloured by treatment (Grazed and Ungrazed) and labelled by the sample site. Vectors represent soil metrics most strongly correlated with the gradient in fungal composition. Vector length is proportional to the correlation between the soil variable and the ordination.

There were no significant differences in the mean species diversity measured by the Shannon diversity index between grazed and ungrazed sites for the marker genes tested (Figures 17 and 18). However, for the 16S rRNA ASVs, there was a difference in variance in the Shannon diversity between the two groups ($F = 0.47351$, p-value = 0.01478, var.test in R). The ungrazed sites had a greater variance in bacterial diversity distribution than the grazed sites. There was no difference in variance for the ITS data.

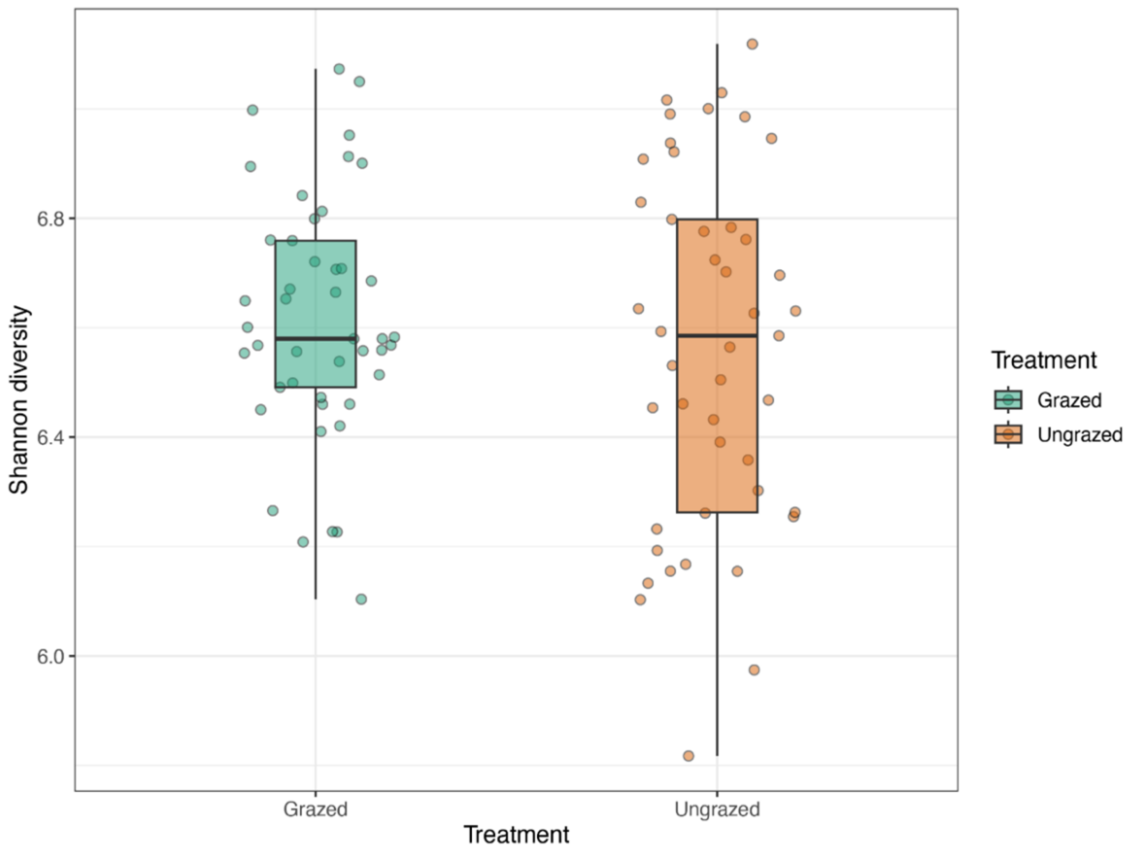

Figure 17. Shannon diversity index of soil samples calculated from the 16S rRNA ASV data comparing soil bacterial diversity of grazed and ungrazed samples. The points show the raw data. The thick horizontal line indicates the median, the box represents the first and third quartiles (lower and upper 25th and 75th percentiles), and the whiskers extend from the smallest to the largest value no further than 1.5 * the inter-quartile range (IQR) from the hinge.

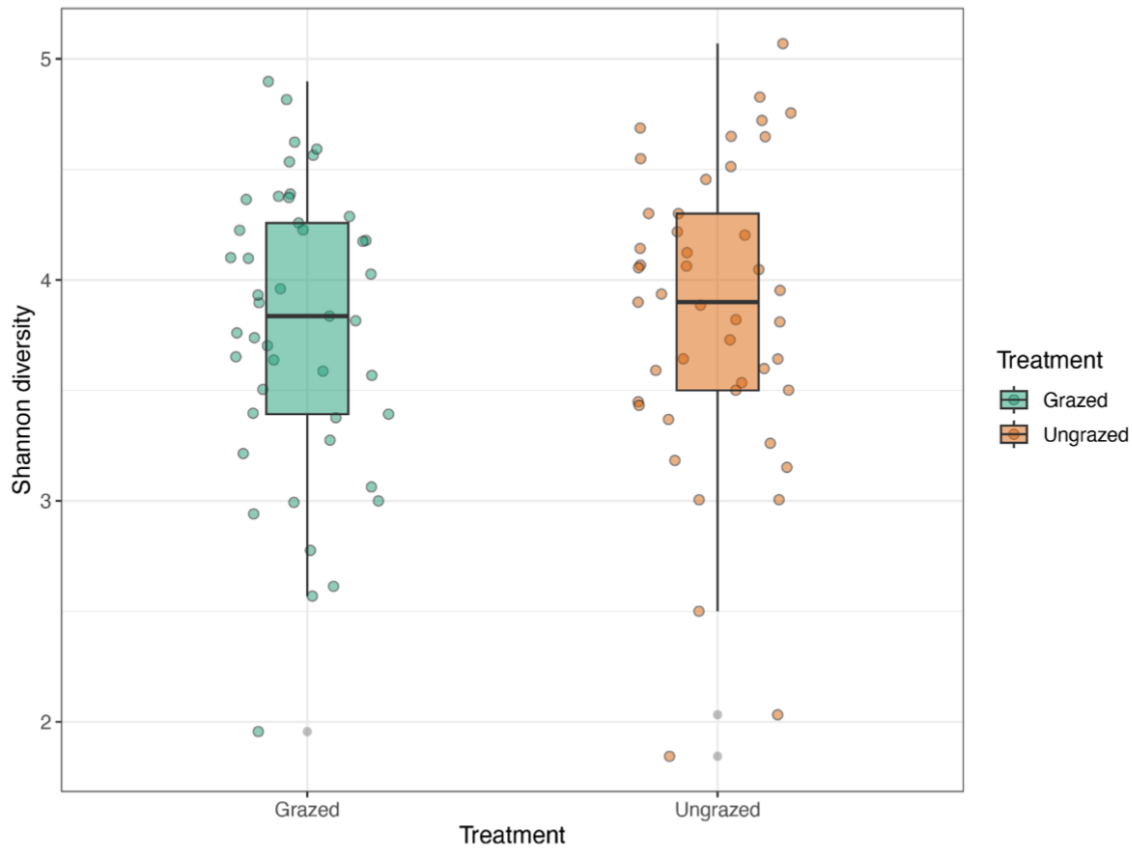

Figure 18. Shannon diversity index calculated from the ITS OTU data comparing soil fungal diversity of grazed and ungrazed samples. The points show the raw data. The thick horizontal line indicates the median, the box represents the first and third quartiles (lower and upper 25th and 75th percentiles), and the whiskers extend from the smallest to the largest value no further than 1.5 * the inter-quartile range (IQR) from the hinge. Data past the whiskers are plotted individually.

The most abundant genera based on 16S rRNA ASVs at most sites were Nitrophosphaeraceae and Rubrobacter, while sites 3 and 9 also had high abundances of Udaeobacter and sites 1, 2, and 5 had higher abundances of Bacillus in the grazed compared to the ungrazed (Figure 19). The most abundant genera based on ITS were unidentified Ascomycota and Leohumicola, while the grazed site 9 had a high abundance of Agaricus (Figure 20).

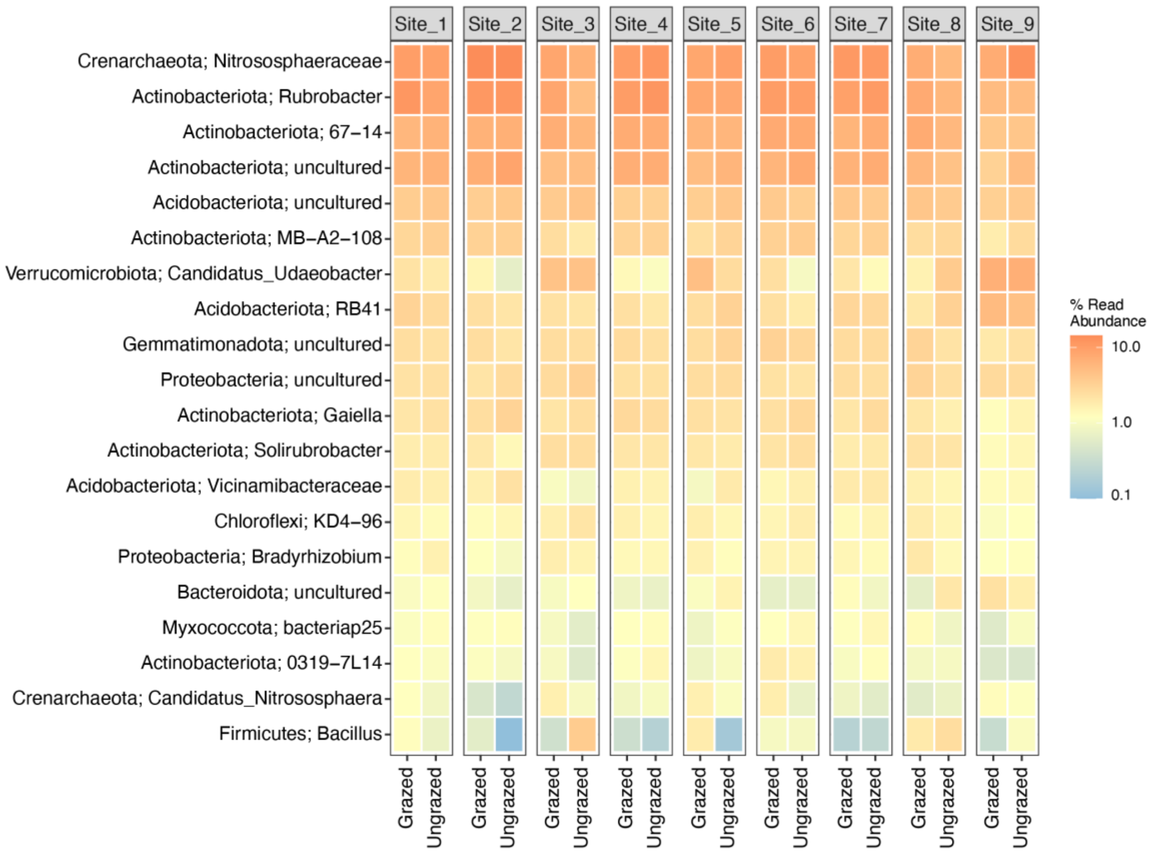

Figure 19. Heatmap of the 20 most frequent bacterial genera identified in the 16S rRNA data. If genus classification was not available, the best taxonomic classification is shown. The phylum for each taxon is also included. Note that genera reported as uncultured may contain many different uncultured genera-level lineages.

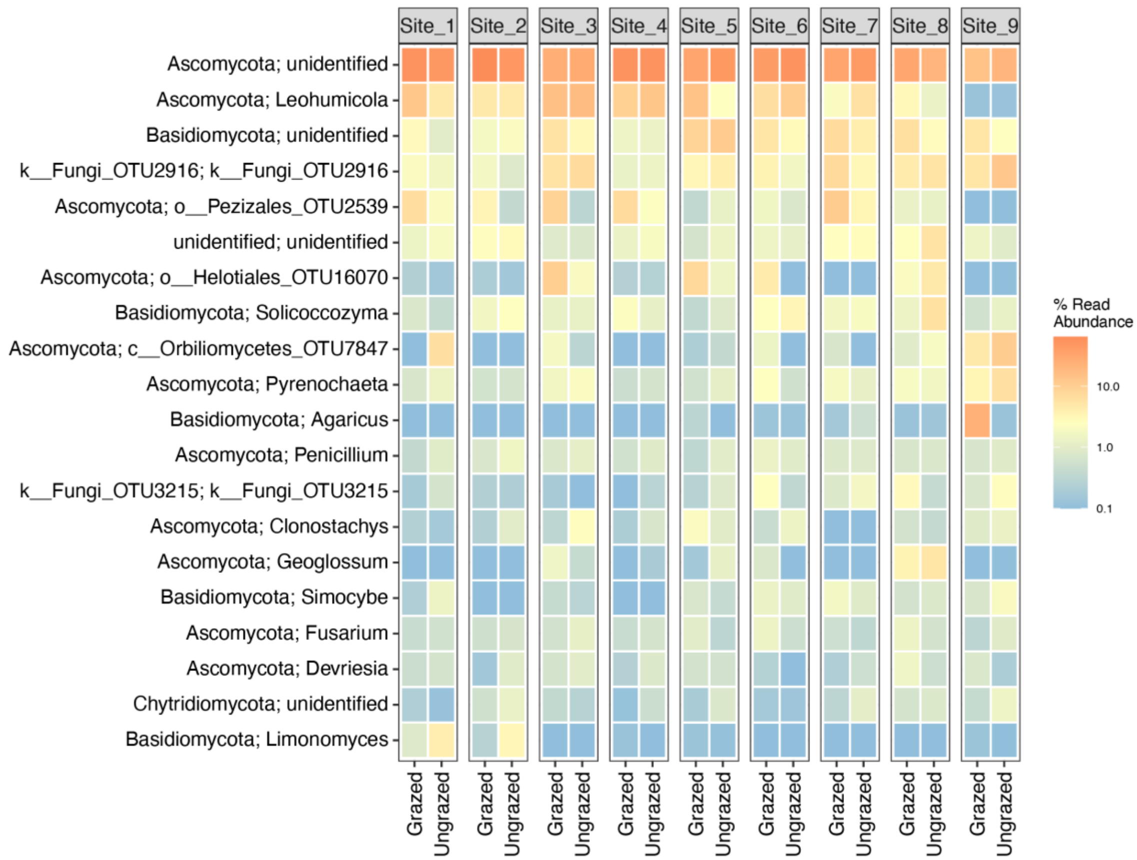

Figure 20. Heatmap of the 20 most frequent fungal genera identified in the ITS data. If genus classification was not available, the best taxonomic classification is shown. The phylum for each taxon is also included. Note that genera reported as unidentified may contain many different unidentified genera-level lineages.

Flux & Renewal

Ksahkomm is full of life, including a complex web of microbiomes interacting within physical and chemical environments. These interactions are being explored to understand the importance of soil biological communities and their role in controlling ecological functions. Recent Iinnii studies have provided insight into the relationship between Iinnii and soil microorganisms essential for nutrition cycles, carbon cycles, and healthy soil formation. This, in turn, influences the soil-microbe-plant relationship. To nourish these relationships, the Kainai cultural herd is not treated with antiparasitic drugs, providing an opportunity to re-establish natural soil and plant interactions. When

Iinnii dung is naturally parasiticide-free, dung beetles effectively distribute nutrients throughout the soil (Spector, 2006).

During my interview with Dr. Leroy Little Bear, he shared another story about how Iinnii is one of the ceremonial gifts from Scarface's journey that is still used for renewal and healing today.

> *Scarface made a trip to the Sun. I won't go into all the details about his trip to the Sun. When he was over there, the Sun and the Moon (we refer to them as being married as a couple) had a child, a son, who was the Morning Star, Iipisowaahs. The Sun and the Moon liked Scarface so much as he fitted into their way of life out there, so there was a time when they mistakenly called Scarface Iipisowaahs when he was not the real Morning Star. So that's why we now have the Mistaken Morning Star, Pahsiipisowahs. But Scarface said I think it's time for me to go home. I've been visiting you and thanked them for doing away with the scars on his face. Before he went home, the sun asked him, "What animal is the smartest?" Before Scarface could answer, Sun told him it was the Raven; it is the smartest animal and is never without food and always adapts to different things; talking about the flux, he's very adaptable. He asked Scarface the same thing. What of these animals is the most sacred? And before Scarface could answer, he says the buffalo. He also asked him, "What part of the Buffalo is the most important part?" Then again, before he could answer, the Sun says, the tongue. Along with that, they had entered into a Sweat Lodge, and consequently, Sweat Lodges are part of the Scarface story. It was a*

ceremonial gift from the Sun. He came back with other knowledge about the Buffalo, ravens, and the tongues of the Buffalo.

And so, by bringing those back. It begins to say, hey, what's the ecological relationship? In other words, this happened long, long time ago, so if we can put it in those terms. And so, how long has the Buffalo been around? We got that respect for it. Because it's one of the most important animals and we use its tongue for our Sundances and so see all those came with that. And consequently, the buffalo is out there. It's part of the relational network.

The soil chemical properties results are similar to values for typical pastures in southern Alberta. P and N values are low/normal, the total C is high/normal, and the pH is quite high (Zhang et al., 2019). The soil microbiome results of my study are typical across Great Plains prairie, with no clear differences between Iinnii grazed and ungrazed samples. Large herbivore grazing produces varying responses of soil microbial communities across grasslands (Leff et al., 2018), over time (Shade et al., 2013) and with different grazing pressures. For example, at multiple grassland sites, Zhao et al. (2017) found grazing may not always produce a belowground response except under high grazing pressure, which reduces microbial biomass. The greatest differences in soil microbial community composition in my study were between sites, with no significant differences between grazed and ungrazed plots. We will continue to monitor the soil community to track changes over time. These data provide a baseline that will allow us to quantify future changes caused by Iiniiksi.

3.1 Pisatsaisskiistsi Connections

The overall health of Pasture 12, as classified under the Rangeland Health Assessment (RHA), is “Healthy,” meaning that all the important rangeland functions are being performed. The grazed plots in the pasture shown in Table 2 have an average score of 75, a rating of "Healthy." The ungrazed plots in pasture 12 scored an average of 90, "Healthy" (Table 3). Most sites showed higher RHA scores in the ungrazed compared to the grazed plots, except in sites 7 and 9 (Figure 21). This is mainly due to the difference in the "Moisture Retention Score," which is a measure of the amount of present litter (mulch or previous years' old plant residue) in comparison to the expected litter for the reference plant community collected by sample raking a ¼ m^2 area. Litter acts as a buffer for soil protection against erosion and dry conditions by limiting moisture loss. It is expected for litter to initially decrease with Iinnii grazing corroborating with the Allenbrand (2020) results that show how Iinnii grazing changes plant communities.

Table 2: Average scores of each grazed plot from the 2023 Range Health Assessment. Each category is scored from 0 to 100, with higher scores indicating that the plot is closer to the reference plant community.

Plots	Plant Community Score	Expectant Plant Layer Score	Moisture Retention Score	Soil Erosion Score	Bare Soil Score	Noxious Weed Score	Total Score	Health Rating
Plot 1	40	10	0	10	5	10	75	Healthy
Plot 2	27	3	13	7	5	10	65	Healthy with Problems
Plot 3	40	10	0	7	5	10	72	Healthy with Problems
Plot 4	40	7	0	10	5	10	72	Healthy with Problems
Plot 5	40	7	13	10	5	10	85	Healthy
Plot 6	40	10	0	10	5	10	75	Healthy
Plot 7	40	10	13	10	5	10	88	Healthy
Plot 8	40	3	0	10	5	10	68	Healhty with Problems
Plot 9	15	10	25	10	5	10	75	Healthy
Average	**36**	**8**	**7**	**9**	**5**	**10**	**75**	Healthy

Table 3: Average scores of each ungrazed plot from the 2023 Range Health Assessment. Each category is scored from 0 to 100, with higher scores indicating that the plot is closer to the reference plant community.

Plots	Plant Community Score	Expectant Plant Layer Score	Moisture Retention Score	Soil Erosion Score	Bare Soil Score	Noxious Weed Score	Total Score	Health Rating
Plot 1	40	10	25	10	5	10	100	Healthy
Plot 2	40	10	0	10	5	10	75	Healthy
Plot 3	40	10	13	10	5	10	88	Healthy
Plot 4	40	10	25	10	5	10	100	Healthy
Plot 5	40	10	25	10	5	10	100	Healthy
Plot 6	40	10	25	10	5	10	100	Healthy
Plot 7	27	10	25	10	5	10	87	Healthy
Plot 8	27	10	25	10	5	10	87	Healthy
Plot 9	27	10	13	10	5	10	75	Healthy
Average	**36**	**10**	**20**	**10**	**5**	**10**	**90**	**Healthy**

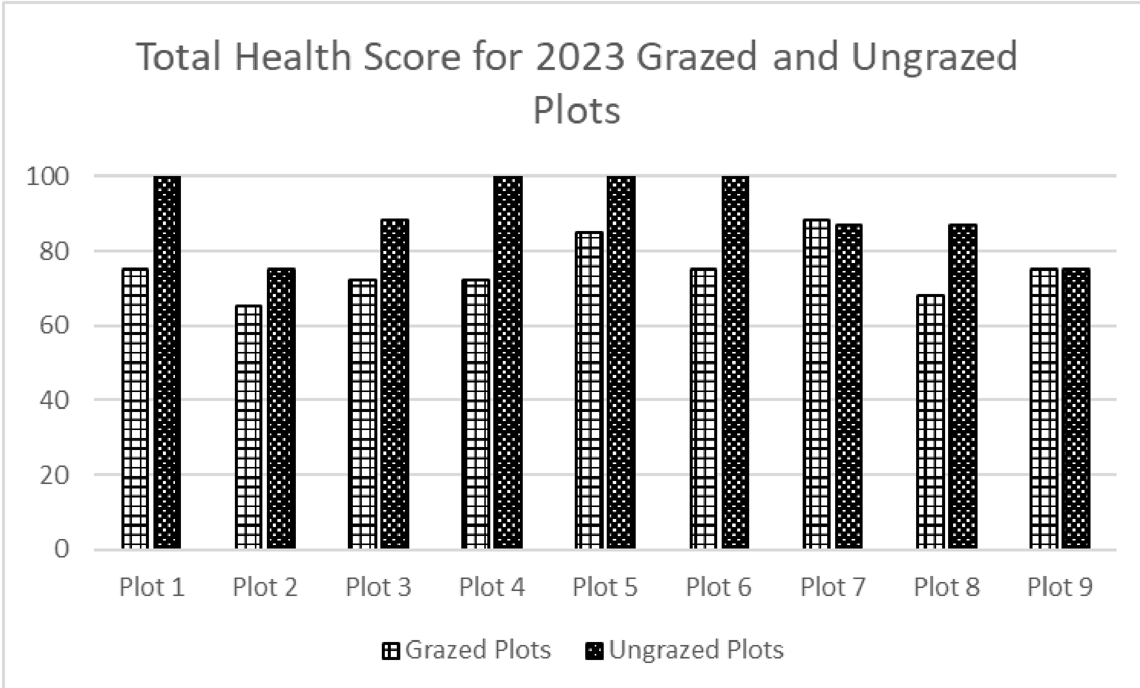

Figure 21. Total Health Score for 2023 Grazed and Ungrazed plots.

Our detailed plant surveys recorded a total of 26 vascular plant species within the quadrats surveyed in the 18 plots. Twenty-three of these species are native to Alberta, while 3 are exotic. The most frequent species was blue gramma (*Bouteloua gracilis)*, found in 17 out of 18 plots. The most frequent exotic species was Kentucky bluegrass (*Poa pratensis)*, found in 17 of 18 plots. Pisatsiinikimm or Prairie onion (*Allium textile)* was rare, found on only one transect.

There were no significant differences in the plant species richness of the ungrazed plots compared to the grazed plots in 2022 or 2023 (Paired t-test, $p>0.05$; Figure 18). The mean species richness was 16 in ungrazed transects and 17 in grazed transects in 2022. Mean species richness was 14 in ungrazed transects and 14 in grazed transects in 2023.

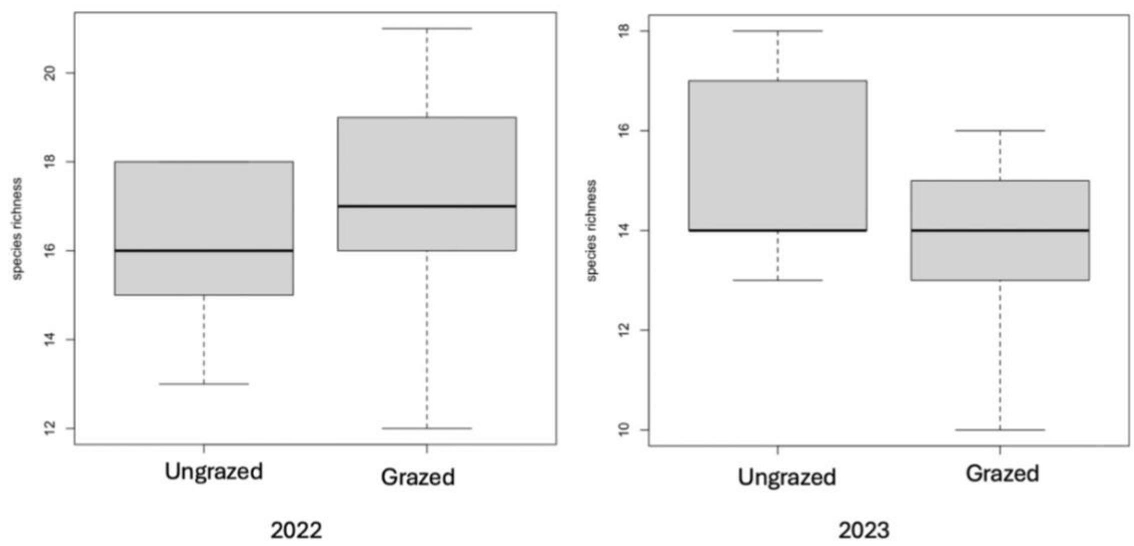

Figure 22. Number of vascular plant species detected in surveyed transects within nine ungrazed and nine grazed plots in 2022 and 2023. The black lines indicate the median species richness for each treatment. Whiskers are 1.5 times the interquartile range. Note that the y-axis range differs each year.

There was a large overlap in plant community composition among grazed and ungrazed sites in 2022 and 2023 (Figure 23). The PERMANOVA test confirmed that there was no significant difference in community composition between ungrazed and grazed plots in both 2022 and 2023 ($F = 0.5$, $p=0.9$; $F = 0.8$, $p=0.7$), nor did the variability in plant community composition differ significantly as confirmed by the PERMDISP test ($F = 0.2$, $p=0.7$; $F = 0.9$, $p=0.3$). In 2023, grazed plots are more clumped together in the NMDS and have a reduced PERMDISP p-value, showing grazed sites are more homogenous in community composition than ungrazed sites. This suggests changes in the plant community may be shifting towards species more tolerant to Iinnii grazing.

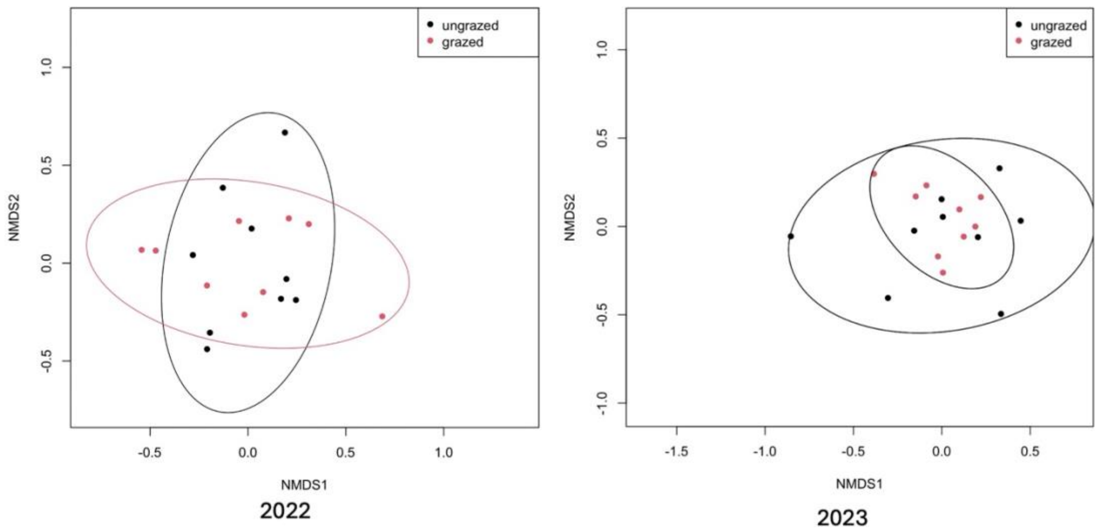

Figure 23. NMDS ordination of sites based on plant species abundance data for 2022 and 2023. Stress in 3 dimensions is 0.11 and 0.13. Sample sites are coloured by treatment (Grazed and Ungrazed). Ellipses show the 90% confidence intervals range of the plant community composition for each treatment.

BTLM has an ongoing list of culturally important Blackfoot plants that is continually expanded when new BEK is gathered from Elders and Knowledge Keepers. The list in Table 4 contains Blackfoot plants identified from surveys in 2022 and 2023. Some plants do not have a Blackfoot name but have culturally important uses, medicine, and/or sustenance.

Table 4. List of culturally important Blackfoot plants that were identified in both 2022 and 2023.

Blackfoot	Literal	English	Latin
Aakiika'ksimii	woman sage	Pasture sage	*Artemisia frigida*
Aakspii		Curlycup gumweed	*Grindelia squarrosa*
Aohtoksooki		Common yarrow	*Achilliea millefolium*
Amaohkaapistsisskitsi		Scarlet globemallow	*Sphaeralcea coccinea*
Aokspiiyipisatssaisski		Prairie coneflower	*Ratibida columnifera*
Isttstsissii'pisatssaissk		Goatsbeard	*Tragopon dubius*
Ma's	root	Indian breadroot	*Pediomelum esculentum*
Naatosipisa tssaisski		Dandelion	*Taraxacum officinale*
Ninaika'ksimii	man sage	Prairie sagewort	*Artemisia ludoviciana*
Otahkoottsis		Prickly pear cactus	*Opuntia polyacantha*
Otahkoyitsi	blue root	Bastard toadflax	*Comandra umbellata*
Ótskaapistsisskitsi		Prairie aster	*Aster sp.*
Otsstatsimaan		Cushion cactus	*Coryphantha vivipara*
Pisatsiinikimm		Wild onion	*Allium textile*
Kakatan		Canadian milk vetch	*Astragalus canadensis*
Kakato'si	star	Puffball mushroom	*Lycoperdaceae*
Saokiipisatsiinikimm	funny vine	Nodding onion	*Allium cernuum*
Soyaiaiihtsi	lies on its belly	Three-flowered Avens; Prairie smoke	*Geum triflorum*
		Blanket flower	*Gaillardia aristata*
		Blue grama	*Bouteloua gracilis*
		Moss phlox	*Phlox hoodii*
		Small-leaved pussytoes/everlasting	*Antenneria parvifolia*
		Stiff goldenrod	*Solidago rigida*
		Wild blue flax	*Linum lewisii*
		Winterfat	*Krascheninnikovia lanata*

Chapter 4: Nourishing Reciprocal Relationships

Figure 24. The Newborn Iinnii calf was born in the Spring of 2024.

During an interview in the fall of 2022, Elder Charlie Crow Chief (Imakokinii) shared some Iinnii BEK with me that speaks to Siksikaitsitapi niipaitapiiyssin (maintaining balance with kin).

> *At a very young age, as the old people say, in the future people, there'll be some people, younger future generations, who will see the buffalo come home and show you what life is all about and our relationship and the environment how they preserve. They preserve it by not overgrazing. They'll show you the trails they left behind, and you will acknowledge that they are back. They made their trails on this land before the time. And we see them now on the side of the hills where the trails are. You go a lot of places, and you see, this must be the buffalo, returning home; I was there, and I was one of the future generations to see them come back. And they say we're from the buffalo. We're related to the buffalo. As you see, in the Horn Society, that's the basic start of*

our repeating their way of life, so we adapt to it, and that's why they call it the Horn Society. That's the buffalo with the horns, and the females, Motokik, had their role in life. The time came; I don't know how many years, almost over 1000 years, the day the tribe sees them, how they do things, watch out for everybody, unity, watch out for everyone. Why they go, sit down, then the horn will get up and look around where they're staying, watching out. They won't leave any one of them to go away, to stray. And why they are called buffalo; it was known in the wintertime, on a cold day, they head down and blow. Puff blow becomes an English word; when they're breathing low...bufflow, they puff towards the ground, thanking the Creator, the Mother Earth, for being around. As it came along, the people studied being with them. They started communicating in a spiritual way, so over 1000 years, and the native people imitated them, the Horn Society, and the Buffalo Women, Motokik. So then, it became a tradition they found out a certain time when the moon and the sun connect in the summer. That's when they put out the camp, circle camp. They are always in a circle and turn around to follow the sun. That's how they see it: imitating the buffalo, the horn society, and the Motokik do the ceremony on one side. Do you see them at Sundance? You watch them running around, running around how they jump. You see the Horn Society and Motokik because that's what they see (how buffalo are). And they respect us as we respect them, and (buffalo) don't overgraze at one place. When they want to move, four buffalos go out and scout a fresh place so they don't overgraze on that part; they move like we do in the old days. If they overgraze where they are camping, they move; it's enough; when we *overcut the wood, the grass is down to nothing, they move camp, just like the buffalo because they got everything from the buffalo*.

My research aims to promote the revitalization of sacred traditional land practices and knowledge systems taken from us by colonialism. Historically, Blackfoot communities thrived by learning and maintaining sacred relationships to the land, including traditional practices such as cultural burning to attract bison and renewing these relationships through ceremony and the Sundance (Little Bear, 2000). If bison were not exterminated and Indigenous peoples were not restricted to Indian Reservations amongst other colonial policies, Indigenous peoples would still be prosperous, healthy communities with sovereign systems in place. Through bison rematriation, we can further efforts towards revitalizing and healing relationships for ourselves, each other, and the land. This is the significance of our research as the first bison rematriation designed, managed, and monitored by Indigenous peoples in Canada.

Indigenous-led conservation is important for promoting TEK and involving Indigenous peoples in research on Indigenous traditional lands as opposed to science rooted in colonialism that is not meaningful and poses the risk of assimilating or misrepresenting Indigenous communities. Indigenous peoples have always been "scientists" as they observed and managed the prairie, and this knowledge is crucial for the successful protection of grasslands. Blackfoot presence is shown in archeological findings greater than 10,000 years BP with subsistence activities and ecological practices evidenced in successional shifts in plant communities (Eisenberg et al., 2019).

We predict that species' biocultural diversity, abundance, and distribution before and after buffalo grazing the landscape over time will reestablish ancient interrelationships that previously revolved around the Iinnii. This short-term research is vital for assessing Iniiksi effects on soils, plants, and people and can help guide future rematriation efforts.

Future challenges for prairie land management involve changes to plant and soil communities that may lead to “novel ecosystems” caused by ongoing climate change (Hobbs et al., 2006). Conserving and safeguarding the Niitsitapi way, using TEK/BEK provides an enhanced approach to caring for our traditional plant habitats and fostering more resilient native plant and soil microbial species. This is of utmost importance as the climate changes and prairie landscape continue to degrade and diminish. For example, Ma's (Blackfoot for Wild Turnip) is a part of Blackfoot origin stories and is a resilient prairie plant adapted to fire, drought, wind, and harvesting but needs an intact prairie habitat for survival.

Indigenous ways of knowing encompass responsibility, accountability and practicing reciprocity, which broadens perception to see the world as interrelated, such as the complex interrelation of human health, storytelling, gendered and intergenerational relationships, cultural and ceremonial life, the intimacy of human relations with plants, animals, and entities; and the moral responsibilities that come with family, clan, and band memberships (Kimmerer, 2013). It is an opportunity to connect mainstream society to the land and reconcile relationships with land and history. Our research approach will help us understand the effect of bringing bison back into the Blackfoot community to provide further insight into best practices for braiding WS and TEK.

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