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Mapping With the Land: Co-developing a Cumulative Impact Monitoring and Land Stewardship Framework with Sambaa K'e First Nation, Northwest Territories, Canada

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Mapping *With* the Land: Co-developing a Cumulative Impact Monitoring and Land Stewardship Framework with Sambaa K'e First Nation, Northwest Territories, Canada

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Abstract

Across the Northwest Territories (NWT), Canada, Indigenous populations are striving to achieve effective environmental protection, whilst navigating complex methods, policies, and research relationships within co-management contexts. This thesis seeks to identify how differing cultural systems, environmental change, and fractured partnerships may be unified to align with the needs of the Sambaa K'e First Nation (SKFN), a remote Dehcho Dene community. Indigenous methodologies guided co-development of research questions with SKFN leadership which yielded objectives a) develop a GIS-based method to manage, organize and mobilize cultural and environmental data; b) develop a new stewardship monitoring procedure so that users can apply the former while 'With The Land" (WTL), and c) test new methods developed in (a) and (b). A mapping rubric developed by the NWT Geologic Survey's Thermokarst Collective (TKC) working group was expanded to include themes related to biological, cultural, and socio-political change. Interviews, focus groups, and participant observation directed the collection of 195 GPS-link observations which centered Dene perspectives of space and place. This thesis provides SKFN with an improved operational procedure for data collection as well as a functional social framework adapted for the organization of grassroots, community based, intergenerational knowledge exchange. This produced the praxis, 'Mapping *with* the Land,' where youth and Elders are united through cumulative impact monitoring and cultural revitalization, with the assistance of GIS. This aims to increase communication and understanding between local, institutional, and government actors by bridging gaps in research capabilities, local capacity, and recognition of Dene Law.

Acknowledgements

This work was conducted within the traditional territory of the Sambaa K'e Dene in close collaboration with Sambaa K'e First Nation leadership, harvesters, and youth. This work was made possible through the countless contributions from community members who accepted the author into the community, shared personal experiences and knowledge, and guided the author on his research journey. I acknowledge all of my relatives and ancestors who came before me to lay the foundations upon which we walk together as one. I acknowledge my friends and family as one of the largest influences and inspirations in every aspect of my life from academics to personal character. Teaching me to be a true student of the world while encouraging me to learn, ask questions and cherish the journey of education; my personal relationships were instrumental to the existence and completion of this work. This work was highly supported and bolstered by the work previously laid out through established relationships in the territory. The Dehcho First Nations Grand Chief Gladys Norwegian and Communications Director Ramona Pearson (in these roles at the time) were instrumental in guiding the author's research paradigm throughout his Undergraduate thesis while co-developing the All Ages All Voices Podcast. Additionally, this work was possible due to collaboration with the Thermokarst Collective working group including Steve Kokeji, Tristan Gingrass-Hill, and Seamus Daly as well as countless Scotty Creek Research Station affiliates. I acknowledge the work completed by Alex Latta and Ryan Planche in developing ethical protocols and agreements between our research group and Sambaa K'e First Nation.

Table of Contents

List of Tables

List of Figures

List of Appendix Sections

Positionality

The sensitivity of the information discussed throughout this thesis instills a personal duty within the author to divulge how their personal experiences and cultural background may influence this thesis; commonly referred to as one's positionality. Positionality is defined as the idea about how socio-political, economic, and cultural identity determine epistemological and ontological ways of living which ultimately influence our research position (Queens University,

2023). Merriam Webster defines epistemology as the study of, or a theory of, the nature and grounds of knowledge with regards to its limits and validity while ontology is defined as a branch of metaphysics concerned with the nature and relations of being (Merriam Webster, 2023). The author's positionality is found in Section i of the appendix.

Additionally, it should be stated, an author can never be sure which approach is best when navigating problematic language. Many words used in this thesis are problematic. The term 'Western', although problematic, was chosen over the term 'Eurocentric' in this paper. The term 'Western' in the context of this paper refers to states, actors, or dominating perspectives which either subscribe to, reinforce, or evolve from, ideologies of domination, extraction, and nationalism. Western is used in this thesis to encompass the main approach used throughout the globe to exert power through geo-politics, economics, and dispossession, sometimes referred to as settler-colonial or neo-colonial, which results from widespread assimilation into 'Western' cultural systems. Eurocentric implies that these ideas are restricted to Europe despite these lines of thinking dominating globally through various means. The author is not negatively commenting or passing judgement on 'Western culture' but merely providing insight on how Indigenous cultures could be more meaningfully be supported and welcomed within research and society. Given these inherent cultural differences, and the authors positionality, this thesis ought only to provide a set of epistemological, ontological, and ethical processes used when planning, executing, and developing an Indigenous-led research project. However, the production of a GIS stewardship tool and it's subsequent field-testing, expounds how this nature of being, or process, might exist within the complex socio-political reality of SKFN's environmental endeavours and what implications this may have.

Introduction

Across the globe intense heat waves, devastating floods, and uncontrollable wildfires have set the stage for a crucial time in human history, one of united action (Estrada et al., 2023; Tang et al., 2023; IPPC, 2023, pg 52-66). Countless broken climate records (Blake, 2023; Hausfather, 2023) and discovery of anthropogenic geologic markers (McCarthy et al., 2023; Witze, 2023) have had negligible impact on global climate action so far (Gunderson, 2023; Stern et al. 2022; Viens, 2022). The Northwest Territories (NWT), Canada, is one of the most rapidly warming areas on Earth (Box et al., 2019). Indigenous Nations in the territory are working with academics and government partners on holistic solutions to manage the land and people through multi-disciplinary research initiatives (Gordon et al., 2023; Quinton Pearson & Sioui, 2022; Andrade-Sanchez et al., 2021; Reed et al., 2020; Popp et al., 2020; Tran et al., 2020; Mantyka-pringle et al., 2017; Woo et al., 2007; Natcher et al., 2005). Indigenous Peoples recognize how human interaction with the land ultimately affects other species and thus are reverent of their place within the ecosystem (Dominguez & Luoma, 2020; Colbourne et al., 2020). The combination of respect for the land, attuned empirical observation, and refined protocols within Indigenous cultures contribute greatly to scientific investigation and collaboration, making them an essential constituent in developing workable solutions (Sioui, 2022, pg. 1-11; Wickham et al., 2022; Hansen & Antsanen, 2018; Sioui & Mcleman, 2014; Von der Porten & De Loë, 2013; Pulsifer et al., 2011; Louis; 2007; McGregor, 2004).

Sambaa K'e First Nation (SKFN) is a member of the Dehcho First Nation (DFN) administrative government which unites 8 predominately Dene communities. SKFN utilizes a Two Walking as One (TWAO) ideology when managing their land and people according to Dene

Law. TWAO is a Dene ethos related to balancing two contrasting ways of living through a mixed method approach which preserves the integrity of each while centering perspectives of Dene Law. When Indigenous peoples control, direct, and foster the management of land and people according to cultural ways of living and knowing it is referred to as Indigenous governance (Irlbacher-Fox & MacNeill, 2020; Thompson, Reece & Robinson, et al., 2019; Folke et al., 2005). Indigenous governance captures complex social and environmental factors in policy and approaches through attuning interactions with the land around natural cycles (Reed et al., 2021; Popp et al., 2020; Beckford et al., 2010; Eisner et al., 2009). Land stewardship is an emerging governance practice utilized by Indigenous Nations (Wali et al., 2017; Hansen & Antsanen, 2018). Indigenous land stewardship is the act of caring for the environment utilizing one's local resources (regardless of ownership) according to Indigenous Knowledge and ways of living (Beckford et al., 2010; Reed et al., 2020).

Indigenous research methods embrace teachings, values, and perspectives contained within Indigenous knowledge to learn about the world, its relationships, and how humans interact with it. These methods produce ethically viable solutions emphasized by distinct strengths, goals, and worldviews (Kovach, 2009; Louis, 2007; De Leeuw et al., 2012). Indigenous approaches are diverse in application although they adhere to sacred Laws which uphold strict principles of autonomy, self-determination, and equitable division of power (Lertzman, 2010; Fulmer, Godoy & Neff, 2008; Goetze, 2005). Indigenous Law ensures Indigenous knowledge (IK) production is conducted with the land, and not on it, by rooting methods in reciprocal relationships, mutual respect, and accountability (Herman-Mercer et al., 2016; Tobias et al., 2013; Bartlett et al., 2012; Battiste & Henderson, 2000). This requires that Indigenous peoples

and their relations are equal partners in research and management, able to exercise authority over the planning, execution, and decision-making processes (Saturno et al., 2023; Hovel et al., 2020; Tran et al., 2020; Thompson, Reece, & Robinson et al., 2019). Broadly speaking, an approach to research that includes both Indigenous and Western scientific methods is called a 'braided', 'two-eyed seeing' or 'woven' methodology (Henri et al., 2021; Coulbourne et al., 2020; Popp et al., 2020; Sarmiento et al., 2020; Kimmerer, 2013; Bartlett et al., 2012). These approaches have gained traction for their ability to address practical and ethical gaps in Western scientific knowledge (WSK) and management strategies (Latta, 2022; Sioui, 2022; Artelle et al., 2018; Kouril et al., 2016; Johnson et al. 2015; Natcher et al., 2005; Pierotti & Wildcat, 2000). Mapping with Indigenous partners is one approach which can ensure ownership over sensitive data, authority over dissemination, and solidify roles in decision making and process planning (Pulsifer et al., 2012; Pulsifer et al., 2011; Ridhwan et al., 2020; Andrade-Sánchez et al., 2021).

One partnership SKFN engages in is the Dehcho Collaborative on Permafrost (DCoP) who are leaders in 'braided' permafrost research (DCOP, 2023). Focused on two-way knowledge exchange and innovative cross-cultural techniques, DCOP develops and tests Dene-informed adaptation and mitigation strategies to improve the understanding of permafrost thaw processes and associated impacts. The Thermokarst Collective is another noteworthy collaboration involving SKFN (Kokelj et al., 2023). The collective aims to "establish a collaborative approach to develop and implement a mapping methodology to generate NWT-wide thermokarst and permafrost feature inventory maps" utilizing ArcGIS and Survey123 Connect (ECC, 2023). Programs which assist regional governance efforts include The Dehcho

Guardians, Aboriginal Aquatic Resources and Oceans Management (AAROM), Mackenzie Valley Land and Water Board (MVLWB), and Cumulative Impact Monitoring Program (CIMP). Despite countless successes in the region, multi-lateral partnerships struggle to connect results, resources, and solutions on the ground and in policy due to a lack of capacity and research infrastructure within SKFN.

To address this, a top priority for Sambaa K'e's leadership since 1997 has been to establish indefinite environmental protection through an Indigenous Protected and Conserved Area (IPCA), which by definition is a governmentally recognized protected area managed according to local cultural knowledge. SKFN's candidate protected area (hereafter referred to as an IPCA) is currently on stage six of nine and is proposed to protect 10,600 km^2 or approximately 50 km in any direction around Sambaa K'e (SNWT 2019,c.11 SI-007-AMENDED BY SNWT 2020,c.14 [F]). Progress has been stalled due to the Federal devolution of lands to the Territorial government in 2014. Literature has identified increasing complexity of cumulative change, rising costs of resource management, and growing needs for improved physical and social infrastructure as major obstacles to this progression (Reidlinger, 2001; Schindler, 2001; Prowse et al., 2009; Pearce et al., 2010; Wesche & Armitage, 2014; Kipp et al., 2019; Hovel et al., 2020; Proverbs & Lantz, 2020). SKFN aims to increase interdisciplinarity in research approaches and solutions through integrating community-led conservation stewardship and capacity building. Interdisciplinarity means the ability to synthesize, harmonize, and link results from various studies, disciplines, or fields of work into meaningful, accessible, and effective resources, tools, theories, or knowledges. Changes in SKFN's well-being, and the mechanisms

which cause or antagonize external obstacles, must be understood for effective IPCA management, cross-cultural collaboration, and environmental protection.

Objectives

In response, this thesis will co-develop a new GIS-based data management and collection framework for the grass roots organization of land stewardship action within SKFN based on a previous GNWT Thermokarst collective initiative. Co-developed research questions with SKFN leadership yielded the following objectives: a) develop a new GIS-based method and logic model to manage, organize and mobilize environmental and cultural data; b) develop a new stewardship monitoring procedure so that users can apply the former while 'with the land" (WTL), and c) test the new methods developed in (a) and (b).

Literature Review

Indigenous Research Paradigms

Centering Indigenous environmental perspectives, this section contrasts the pitfalls and successes of Western research and governance approaches while establishing a foundational approach to predicate the subsequent union between scientific research and Indigenous self-determination. Scholars refer to the methods, models, or patterns used in Indigenous theoretical contexts as Indigenous research paradigms or frameworks. Indigenous paradigms operate within a unique set of ideas, beliefs, or understandings which ensure cultural theories and practices can function (Wolfe et al., 2007; Smith, 2015; Lertzman, 2010; Cochran et al., 2013). Orienting research actions around life sustaining relationships secures the perpetuation of natural cycles for future generations (Borrows, 2002). This holistic approach is known

amongst researchers as sustainable systems thinking, or circular thinking when Indigenous (Csaki, 2016; Sarmiento et al., 2020; Louis, 2007).

Although geographically diverse, scholars agree Indigenous paradigms prioritize an intrinsic sense of duty to 'take care of' or 'steward' Mother Earth through knowledge production. Miguel Sioui refers to this as a responsibility-based ethos (Sioui, 2022 ch. 1 pg. 1-11). SKFN embraces land stewardship and circular thinking through research paradigms which uphold sacred Dene Law in environmental, social, and political pursuits (Dehcho First Nations, 2023). Dene Law forms the ethical basis of SKFN culture.

"That Dene Law circle written there' (Figure 1 adaptation*) took about 6 months to learn all that. One word, you can… find there's about one paragraph in each (word). So, it would take quite a while to learn all that." – Victor Jumbo*

Figure 1: *Simple translation of the nine Dehcho Dene Laws adapted from Dehcho First Nations website (Dehcho.org) and private poster developed for communities in the region (2023) produced by author using ArcMap Pro World Imagery Base Map and Microsoft Powerpoint*

It is important to understand that the nine Dene Laws displayed in (Figure 1) are simplified translations of a complex descriptive language that cannot be truly and accurately understood, communicated, or captured using other vocabularies and ways of thinking; nor through means of academic writing. Dene Law informs research paradigms to unify human survival with the well-being of all living and non-living relations. This ethical guidance upholds love, respect, and accountability when interacting with the land and people in a research context. The fundamental ideas outlined above are generally absent from Western research approaches, recommended solutions, and proposed environmental management strategies, requiring truth and reconciliation in environmental conversations (Wickham et al., 2022; Tanskanen, 2009). The misalignment between cultural values and approaches to environmental management has often led to conflicts and ineffective support for Nations.

A Deep-Rooted History

Western ways of thinking dominate schools of thought in academia resulting in deeply entrenched ideological dogmas. Over recent decades, a large effort has been made to analyze and re-evaluate dominating knowledge systems, methods, and ideologies with strong foundations in colonialism and Western thinking (Spivak, 1988; Marie & Grande, 1999; Barnett, 2006; Shaw, Herman & Dobbs 2006; Jazeel & McFarland, 2007; Cajete, 2018; Artelle et al., 2018). Researchers have created a space for these long suppressed and opposed Indigenous knowledge systems to be heard, validated, and implemented through challenging these taken-for-granted ideas in academia and in their everyday lives (Mullings, 1999; Battiste & Henderson, 2000; Tackas, 2003; Shaw, Herman & Dobbs, 2006; De Leeuw et al., 2012; Larsen & Johnson, 2012; Bartlett et al., 2012). Two important facets of this practice are recognizing differing

conceptions of nature and reconciling the ideological incongruencies in environmental land ethics (Leopold, 1966; Spivak, 1988; Cronon, 1995; Marie & Grande, 1999; Borrows, 2002; Raju, 2002; Holland et al., 2009; Kovach, 2009; Tanskanen, 2009; Whyte, 2015; Hansen & Antsanen, 2018)

In pre-colonial North and South America, a unique way of living, being, and knowing resulted from living closely with nature, vast knowledge sharing and trade relationships, and millennia of global isolation from differing ideologies (Mann, 2002). Amid colonization, a vigorous clashing between divergent knowledge systems and ways of living occurred, illustrated by systematic violence, dispossession, and oppression (Barnett, 2006; Harris, 2004; Mcewan, 2009). Western domination of land, politics, and conversational platforms effectively reinforces the agendas of Western nations which undermines opportunities for true Indigenous soveringty (Goetez, 2005; Spak, 2005; Fulmer, Godoy & Neff, 2008, Cowan et al., 2012; Labbé et al., 2017; Viens, 2022). The self-removed, linear-objective, and extractive developmental systems of Western culture starkly juxtapose experiential, place-based, and relationship-oriented Indigenous systems (Marie & Grande, 1999; McGregor, 2004; Periotti & Wildcat, 2000; Romero-Toledo & Jenkins, 2022; Gunderson, 2023). Utilizing sources mentioned above, the author created *Figure 2* which provides a high- level comparison of differing cultural perspectives employed in environmental land management across Canada. *Figure 2* demonstrates how braided perspectives embrace culturally distinct ways of thinking in a complimentary way to preserve the integrity of each and arrive at an ethically aligned, balanced, and comprehensive view of the natural world. This amalgamation of perspectives provides a new 'braided' lens which guides how one ought to inquire about the natural world in a cross-cultural setting.

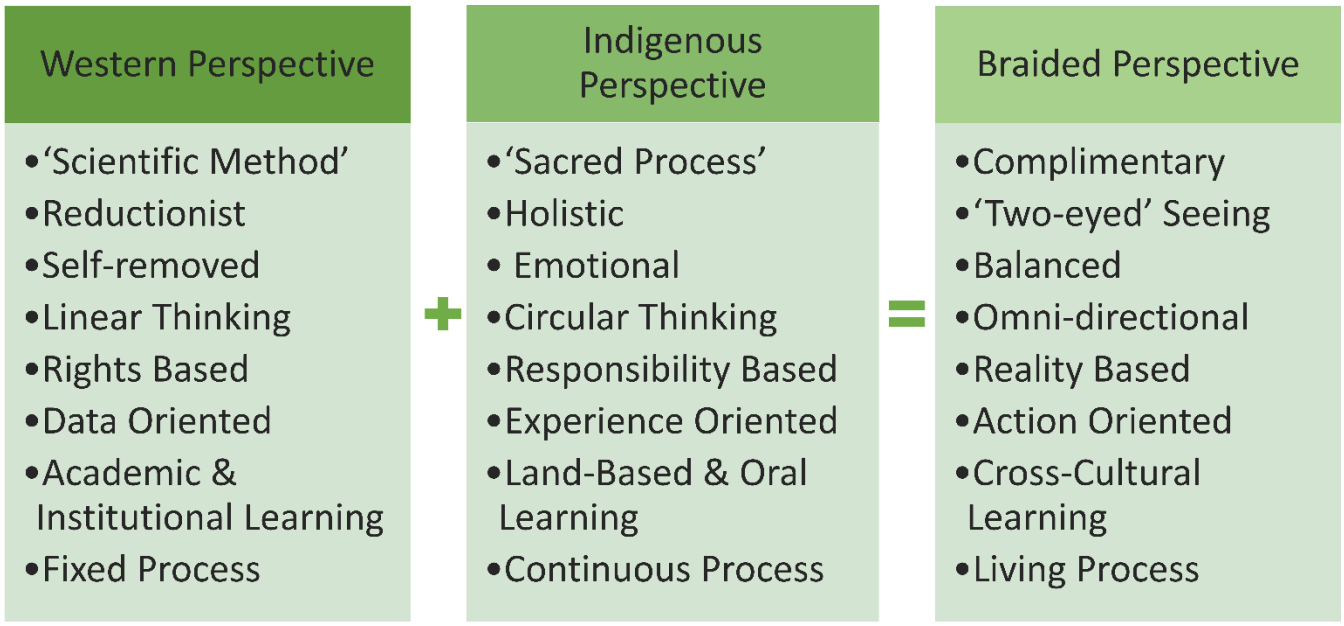


Figure 2*: High-level comparison of Western, Indigenous and 'Braided' environmental management perspectives, produced by author using Microsoft PowerPoint ®.*

The Trouble With Wilderness by William Cronon (1995), details the dynamic history of Western conceptualizations of wilderness (hereinafter, nature) and how perceptions have evolved from a place of repudiation to a place of exploitation. Cronon challenges Western conceptualizations of nature by demonstrating how these constructs have arisen out of human agenda to be weaponized to serve social, political, and economic agendas across history. Cronon (1995) concludes his paper by synthesizing the Western perception of nature throughout history into a praxis called 'learning to honour the wild.' He explains that it is the relationship to the natural world which requires focus and humans must be self-conscious and reflective in our actions and uses. With this, Cronon is suggesting that humans must shift nature from an 'other', to a significant place within our circle of moral concern (1995). These conclusions are significant in the process of bridging systems of thinking about the land, although cannot be removed from the content of their analysis. The history of this ontology is

where the potential for reconciling these cross-cultural challenges lies, thus it must be addressed first in this thesis and subsequently connected to results. Cronon proposes a corrupted view of nature began as a result of dominating social notions and human conceptions of the unknown turning nature into a being of our psyches worst impositions, rather than and being integral to our survival (1995). Conservationism was born out of the loss of the great romantic and sublime landscape associated with the frontier while the subjugation of land and people was born through the loss of raw opportunity and the rise of competition over and land ownership (Cronon, 1995). The 20th century produced a dichotomy of views on nature, focused on its protection in its 'natural form' and using our ability to dominate nature through knowledge and power to gain economic and geopolitical security. Perceptions of the Canadian State as well as Western institutions remain a dynamic mixture of these antiquated views (Viens, 2022; Kidd et al., 2019; McCreary & Milligan, 2014).

Researchers since Cronon (1995) have investigated a plethora of ways in which respectful relationships to nature can exist in modern environments and the various benefits they provide to citizens although how the healing of relationships is achieved in practice remains a large research gap (Campbell-Arvai, 2019; Larsen et al., 2016; Whyte, 2015; Fuller et al., 2007). Victoria Campbell-Arvai (2019) demonstrated how urban biodiversity loss may be influenced by non-physical variables such as level of environmental education, perception of nature, aesthetic, and motivations of fear having indirect or direct effects on environmental interaction. Experiential and cultural services of an ecosystem or environment can be defined as benefits that are unquantifiable and subjective and have a large role in solution success (Larsen et al., 2016). Recreation; mental health; knowledge production; relationship building;

and non-extractive economic benefits are examples of important environmental services of landscapes to consider in land and community management (Larsen et al., 2016; Fuller et al., 2007). Although, these studies demonstrate only a small fraction of advancements in Western perceptions of nature, they provide useful snapshots into what tools scientists may use to reconnect humans with nature. However, why Westerners engage with nature is increasingly motivated by recreation, escapism, and necessary conservation out of economic interest. These issues are where Indigenous values of space, place, and responsibility contribute immensely.

A Space of Place, Duty, and Responsibility

Nature, hereafter referred to as the Land, is a central tenant of Indigenous cultures that is starkly different in practice, meaning, and application compared to Western culture and management practices (Lertzman, 2010; Whyte, 2015; Irlbacher-Fox & MacNeill, 2020). In general, Indigenous cultures live and act according to teachings from creation stories, ceremony, and livelihood practices (Scott, 2015; Kimmerer, 2018) which recognize our role as stewards of the land and people who are responsible for maintaining integrity of the ecosystem and accountable for its maintenance (Turner & Spalding, 2013; Beckford et al., 2010). In contrast, Western societies generally feel they have a right to the land, a right to clean food and water, and a right to have ownership over the land and the knowledge that comes from it (Whyte, 2015; Domíngues & Luoma, 2022; Sioui, 2022). Scholars such as Worm & Paine (2016) reflect trends in Western environmentalism which counter these dominating notions by characterizing humans as “a higher-order or ‘hyperkeystone’ species that drives complex interaction chains by affecting other keystone actors across different habitats” (2016).

Despite this progress towards acknowledgement of anthropogenic impacts on the environment, differing perspectives, practices, and relationships with the land cumulate in practical challenges. These challenges relate to shifting perceptions away from collective entitlement towards instilling personal accountability (Whyte, 2015; Colbourne et al., 2022). This difference manifests in Western cultures as disrupted power dynamics, over-consumption, and collective inaction from citizens who wield divine right to apathetic extraction of the natural world without consequences or reverence (Stern et al., 2022; Veins, 2022; Cronon, 1995). Conversely, Kimmerer (2018) states:

> *"Native environmental philosophy acknowledges that our human lives are utterly dependent on the lives of other beings and thus our first responsibility is for gratitude…. Western storytelling tradition is strangely silent on this matter. So, we find ourselves in an era when centuries of overconsumption have depleted natural resources and left human societies materially and culturally impoverished by a deep disconnection from the living world"*
>
> *(*Kimmerer, 2018; p. 31*).*

Indigenous peoples see the surrounding environment, wild or settled, as their home and thus feel compelled to cherish, respect, and honour all that it has given (Cajete, 2018). Consistent empirical observation of these highly regarded natural cycles and living beings produced complex archives of knowledge, ethical protocols, and governance approaches (Borrows, 2002; Scott, 2015; Turner & Spalding, 2013; Cajete, 2021). Ability to adapt a population's collective action through teachings of an individual's space, place, and responsibility in the ecosystem resulted in flexible societies able to evolve with the land's harsh conditions amidst countless changes (Larsen & Johnson, 2012). Knowledge production to

Indigenous peoples is thus a sacred process intimately tied to the relationships between beings; relationships with the self; with the land; and existence (Louis, 2007). Learning is a forever ongoing process facilitated by close connections between these components and honouring this space of place, duty, and responsibility (Datta, 2018; Cajete, 2018; Cajete, 2021). The philosophical discourse surrounding cultural land ethics warrants appropriate explanation of the dangers of ignorant comparison.

Aldo Leopold's (1966) work on Western environmental land ethics brought Western culture closer to understanding of our place in nature. Though revolutionary, all too many misconceptions were made about Leopold's writing which had lasting effects in environmentalism as pointed out by Cronnon (1995). Kyle Whyte (2015) in *How Similar Are Indigenous North American and Leopoldian Environmental Ethics* brought these problematic discrepancies to light. Kyle Whyte (2015) acknowledged the merit in recognizing both the similarities and shortcomings of this pedagogy and helped correct the misplaced steppingstone set by Leopold towards 'two-eyed' seeing. Comparing and analyzing differences between cultures has catalyzed academia's journey to reconciling the differences among old epistemologies, bringing us closer to reaching effective cross-cultural collaboration and Indigenous self-determination. Residual ignorant comparisons and hap-hazard understandings of the differences and similarities remain an issue which contributes to strains on relationships (Gordon et al., 2023; Colbourne et al., 2020; Marie & Grande, 1999).

Leopold's land ethic rests on the premise that humans should act as "plain citizens" within the ecosystem and can only act righteously "when it tends to preserve the integrity, stability and beauty of the biotic community" (Leopold, 1966). Similarly, to Cronon (1995),

Leopold promotes harmony with the living environment and re-considering our place in nature and our relationship to it. Although Whyte agrees, similarities to Indigenous North American land ethics exist, the author discusses three key issues with this comparison. Firstly, he points out Leopold's writing lacks an actionable stewardship framework which is central to many Indigenous cultures in North America. Secondly, he states Leopold argues that land ethics have followed the recent moral evolution of social ethics away from individualism to a collective community based moral system (Whyte, 2015). This is a prominent difference between the historical progression of each culture and must be acknowledged as a contributing factor to current environmental collapse. Lastly, Whyte discusses the issue of Leopold's assumed role as translator of Indigenous ethics arguing this has to potential to silence and discourage collaboration between cultures (2015). These writings collectively demonstrate how cultural lines of thought diverge extensively in their application, meaning, and significance due to problematic settler relationships with nature and power dynamics (Whyte, 2015; Kimmerer, 2018; Cajete, 2018). Western thinking is still very much removed from our place in nature, often attuned to economic exchanges between beings, and void of recognition for human lifestyle accountability (Leopold, 1966, Larsen & Johnson, 2012). Whyte then states Indigenous systems cannot be superficially compared as they stem from different epistemologies, practices, and relationships (Whyte, 2015; Kimmerer, 2018). It is highly problematic to compare systems through a Western dominated lens and the effort to do so emphasizes how settler colonialism acts to eliminate the space for Indigenous voices and knowledges to be heard (Whyte, 2015; Cajete, 2018). This practice of forcing Indigenous peoples to conform their ideologies to Western norms reinforces the colonial and settler narrative actively de-validating

Indigenous views and halting progress. This is further complicated by the cumulative impacts introduced by the orchestrated reliance on fixed external markets, technology, and nation state support.

A Walk Together Through Time

The utilization of two-eyed seeing conceptual frameworks by Indigenous and non-Indigenous authors has brought academia closer to de-colonizing the discipline of geography (Shaw, Herman & Dobbs, 2006; Bartlett et al., 2012). Spivak (1988) in her work *Can The Subaltern Speak* demonstrates the importance of speaking *with* our research partners, instead of speaking *for* our research partners. As researchers we have a responsibility to conduct work ethically and represent our interactions with research partners in a truthful way from the perspective of the subaltern (Spivak, 1998). We must also situate our research in their political and social norms to conduct fair and meaningful research (Spivak, 1988; Sarmiento et al., 2020). This idea extends to areas of knowledge representation. Researchers working with Indigenous peoples must portray the complex and cultural nature of knowledge systems in a respectful way while disseminating it in accessible forms to both Indigenous communities and academic fields, so the knowledge is not taken out of the community, silenced in academia, or reported out of context (Jazeel & McFarland, 2007). Spivak (1988) further states, in order to not marginalize knowledge oppressed in Western dominant disciplines one must protect and defend the appropriative uses and sharing of those knowledges in collaboration with their research partners. This is done through directing outputs towards the community, ensuring their goals and desires are implemented in research plans, and they remain in control over their contributions (Jazeel & McFarland, 2007; De Leeuw et al., 2012). Decolonization of geography

thus means “de-constructing the discursive edifice that has resulted from the confluence of ‘Western’ knowledge building and empire-building, and an undermining of the hegemonic forces that keep it in place” (Shaw, Herman, & Dobbs, 2006; p. 273). It is now essential for these Indigenous research paradigms to be applied to climate change research. Understanding change in the Denendehé, or Land of the People in Dene Yatié, requires a scientific perspective which centers the ideas discussed above.

Climatic Changes in the Denendehé

The Taiga Plains and Boreal Forest

Climate change has shifted subarctic ecosystems to a new state characterized by intense wildfires, changing hydrological regimes, landcover transition, and ecological vulnerability (Cohen, 1997; Quinton, Berg & Braverman et al., 2019). The study area falls within Taiga Plains Trout Upland High and Mid-boreal Zones; as per the GNWT Department of Energy and Natural Resources report on the Taiga Plains Ecosystem Classification Group, (ECC, 2009, pg. 104 & 105). The department is now called Environment and Climate Change, hereafter ECC. This section will briefly review micro and macro scale changes with specific examples from the Taiga Plains High-Boreal (HB) and Mid-Boreal (MB) ecozones.

Mean annual temperature and precipitation inputs within the study area ecozones are -3.0°C to -5.0°C with 300-500 mm of precipitation (HB) and -1°C to -4.5°C with 400-500 mm of precipitation (MB) (ENR, 2009 pg. 8). These climatic conditions allow the formation of permafrost which exists in mainly sporadic, discontinuous, or isolated forms in the MB and HB Taiga plains ecozone (Quinton et al., 2019; IPCC, 2023). Permafrost is rock, sediment or soil which temperature stays below 0 degrees Celsius for two or more years. Permafrost acts to

regulate substrate for habitat, hydrologic movement, and soil development processes (Payette, 1988; Jorgenson & Osterkamp, 2005; Janowicz, 2008). Monitoring changes in thaw is important for developing locationally specific environmental indicators for communities (Camill et al., 2016; Walvoord & Kurylyk, 2016; Jones et al., 2014). Vincent et al. (2015) found mean annual air temperatures have increased by 2.5°C between 1950 and 2015 in the Taiga Plains eco-region, with different rates in the winter of 4.5°C between the same time. The 2023 International Panel on Climate Change suggests this will have long term effects on water resources (IPCC, 2023 p. 46).

Permafrost is overlain by the active layer, which thaws and freezes annually (Clayton, et al., 2021; IPCC, 2007). As the climate warms, the depth of frost penetration during refreezing decreases, and as a result, the thickness of the active layer decreases (Becker, Davies & Pollard, 2016). The formation and degradation of permafrost occurs on a 600-year cycle and is highly dependent on-air temperature, the presence of *sphagnum fuscum*, and ice bulb coalescence (Zoltai, 1993). Given this relationship, the future presence of permafrost in this region is uncertain (Devoie et al., 2019). Active layer thinning introduces a new layer of ground that occupies the space between the top of the permafrost (i.e. permafrost table) and the bottom of the active layer. This space is known as a talik, which by definition is perennially thawed (Connon et al., 2018). Talik formation leads to further thinning of the active layer and can initiate and accelerate permafrost thaw (Devoie et al., 2019). When hydrologically connected, taliks can transport water year-round, altering water flow and storage processes (Connon et al., 2014; Jacques & Sauchyn, 2009).

Permafrost thaw is the main driving mechanism of ecosystem change in the region. Changes in local energy balances enable greater energy conduction into the ground leading to thaw. Peat is a good thermal conductor when wet, but a poor thermal conductor when dry (Payette, 1988; Camill, 1999). Typically, wet peat allows energy to leave the ground during the winter and dry peat insulates the ground during the summer (Higgins & Garon-Labrecque, 2018). The combination of increased mean annual air temperature (2.8°C 1995 to 2015) as well as wetter snowpacks with lower albedos exacerbate thinning of the active layer (Connon et al., 2018; Patankar et al., 2015; Swindles et al., 2015). Hummock growth, vegetation establishment, and geophysical processes collectively produce mosaics of morphological land features across the NWT (Kokeji et al., 2005; Hallinger et al., 2010). The vertical growth of *sphagnum fuscum* leads to an accumulation of living moss overlying peat (Zoltai, 1993). As the hummocks grow, their surfaces rise above the water table creating an unsaturated layer (Haynes et al., 2021) which is needed for the survival of tree roots (Islam & Macdonald, 2004).

Landscape Features

The landscape features covered in this thesis include wetlands and peatlands and will be classified using the National Wetlands Working Group Classification (1988) and the GNWT geologic survey Thermokarst Collective working group report (Kokeji et al., 2023). Aerial photos of land features mentioned can be seen in the Appendix, section ii.

Peat Plateaus

Peat plateaus are approximately elevated 1 to 2 meters above the surrounding surface due to the presence of permafrost. When permafrost forms, the ice pushes the material above it higher than the surrounding land features due to the relationship between freezing processes

and water volume (Jorgenson & Osterkamp, 2005; Chasmer & Hopkinson, 2017). Peat Plateaus are runoff generators due to their relatively high topographic position and the relatively impermeable upper surface of seasonally frozen ground (i.e. the frost table) and of the permafrost table. Their high topographic position and the presence of permafrost excludes all hydrological inputs other than precipitation (Connon et al., 2014; Jorgenson & Osterkamp, 2005; Zoltai, 1993). Plateaus can function as 'permafrost dams' since their permafrost tables occupy a higher topographic position than the water table of the wetlands on their adjacent and upslope sides (Quinton et al., 2019; Connon et al., 2014; Carpino et al, 2021). Peat Plateaus are dominated by black spruce (*p. mariana*), Labrador Tea *(R. groenlandicum*), and sphagnum mosses (Zoltai & Tarnocai, 1975; Islam & Macdonald, 2004). Tree canopy and understory vegetation has multiple effects on local energy balances through ground shading, wind protection, increased snow deposition, hydrologic interception, and increased aerodynamic roughness length (Wallace & Baltzer, 2020; Warren et al., 2018; Jones et al., 2014; Buttle et al., 2009). Higher densities of shrub or tree vegetation leads to deeper snowpacks, warmer winter and summer soil temperatures, higher evapotranspiration, and increased albedo when compared to unforested areas (Disher et al., 2021; Warren et al., 2018; Göckede et al., 2017; Hallinger et al., 2010).

Collapse Scar Wetlands

Permafrost free and void of trees, collapse scar wetlands, often called "collapse scar bogs" or just "collapse scars" (Zoltai, 1971) are water storage features formed by thermokarst erosion, leading to localized subsidence (Disher et al., 2021). It should be noted that the word "bog" used here is misleading since, bogs receive hydrological input from the atmosphere only,

but by virtue of their relatively low topographic position, collapse scars receive water draining from the active layer of adjacent plateaus. Collapse scars support a variety biodiversity (Camill, 1999). Owing to the absence of a tree canopy, high incident solar radiation inputs cause this feature to be snow-free before other landcovers (Connon et al., 2021; Jones et al., 2014). Collapse scars are internally drained as they lose water only through evaporation or through interaction with groundwater (Jorgenson & Osterkamp, 2005; Connon et al., 2014). Collapse scars typically have little or no unsaturated zone (Disher et al., 2021; Haynes et al., 2021) due to their inability to export water through surface or near surface drainage pathways. However, Connon et al. (2014) demonstrated that permafrost thaw along the margins of collapse scars has lowered the permafrost table sufficiently to allow collapse scars to partially drain.

It has been proposed that widespread permafrost thaw induced drainage of collapse scars has increased flow from streams and rivers throughout much of the Dehcho region (Janowicz, 2008; Jacques & Sauchyn, 2009) although it is now generally suspected this may lead to a long-term decline in water storage in certain areas (Jones et al., 2014; Quinton, Berg & Braverman et al., 2019). Haynes et al. (2021) demonstrated that the de-watering of collapse scars has generated the growth of hummocks whose relatively dry surfaces support the establishment of black spruce seedlings. Over a period of decades, continued dewatering and colonization by tree species transforms collapse scars into treed collapse scars (Disher et al., 2021) and eventually mature black spruce forest (Carpino et al. 2021).

Treed Collapse Scar Wetlands

Treed collapse scar wetlands are a relatively new land classification which presents significant implications for hydrology, ecology, and permafrost stability (Haynes et al., 2021;

Carpino et al., 2021). Treed wetlands are actively draining collapse scars with small ice bulbs beneath sphagnum hummocks that rise above the surrounding ground surface by up to 0.5 m falling intermediately between plateaus and collapse scar bogs (Devoie et el., 2019; Disher et al., 2021; Haynes et al., 2022). They also have a higher near-surface volumetric water content than peat plateaus but lower volumetric water content than collapse scars (Disher et al., 2021). The gradient of decreasing tree density in the transition from peat plateaus to collapse scars is mirrored by an increase in snow depth over this transition owing to the dampening effect of the tree canopy on aeolian erosion of snow (Connon et al. 2021). Treed wetlands will have distinct impacts on hydrological budget, subsurface nutrient cycles, and land use suitability which should be monitored and linked with Indigenous knowledge and land use.

Channel Fens

Channel fens are pedogenic features, meaning they contribute to soil genesis, making them a key feature in landscape succession. Fens rely on groundwater inputs to slowly transport water from their surrounding terrain toward the basin outlet (Haynes et al., 2021; Connon et al., 2014; Jorgenson & Osterkamp, 2005). Containing large floating vegetative mats and nutrient rich water these features host a wide array of ecological diversity (Quinton et al., 2019). Fens provide major ecological services including water remediation, nutrient recycling, and erosion prevention (Weixelman & Cooper, pg. 2 2009; Camill, 1999).

Environmental Disturbance

Environmental disturbances exacerbate social impacts brought on by climatic change, but also play a characteristic role in controlling environmental conditions (Grau et al., 2012; Helbig et al., 2016; Baltzer et al., 2014). Disturbances including mass wasting, windthrow, insect

outbreak, flooding and wildfire are expected to increase in severity and frequency as the climate warms (Proverbs & Lantz, 2020; Seidl et al., 2020; Rich et al., 2007). Disturbances are important in maintaining ecological diversity as they initially decrease the relative abundance of dominant species creating opportunities for the establishment of early successional and opportunistic organisms (Dearborn et al., 2021). Increasing disturbance has inspired research on the environmental impacts of extreme events (Estrada et al., 2023). In the year following an El Niño event, it was found that many hydrological characteristics were altered including increased runoff ratios, rates of thaw, and shifts in water budgets highlighting how unexpected weather events are driving local catastrophes and reducing nation resilience (Tang et al., 2023). Loecke et al. (2017), examined how variations in local climate or 'weather whiplash' drove increases in Nitrogen concentrations affecting water quality ultimately limiting applicability of policy. Kokeji et al., (2005) studied the effects of thermokarst slumping on small upland lakes, finding basin area affected by slumping is positively associated with proportional increases in ionic concentrations of Calcium, Magnesium, and Sulfates ($SO4^-$) and negatively proportional to dissolved organic content.

Helbig et al. (2016) and others have demonstrated forest fires are of equal magnitude to permafrost thaw for changing land cover while a thesis by Holloway (2020) emphasized the need to account for landscape heterogeneity when developing indicators of post-fire permafrost impacts and temperature trajectory. Specifically, implications of differential drainage conditions, substrate, and organic layer thicknesses should be considered as variables in data collection. In the discontinuous zone, permafrost after wildfire can persist in fine-textured soils although permafrost thaw was enhanced without recovery by wildfire in areas

with low volumetric water content, coarse-grained soil, and a thin organic layer; these conditions ultimately lead to decreased tree cover due to subsidence and changes in hydrological and ecological function (Holloway, 2020; Helbig et al., 2016). Kuntzemann et al., (2023) studied how these characteristics of different land features influence the probability of fire refugia, finding peatlands may provide a higher probability of refugia during wildfires. Carpino et al., (2021) suspects reforestation in permafrost-free areas can occur in less than 40 years, however, estimates of future forest trajectory and ecological integrity of these forests remains a gap. For example, Clason et al., (2022) studied the importance of tracking forest carbon fluxes through dead wood loss during post-fire remediation projects to ensure accurate tracking of carbon emissions. Senior et al., (2018) demonstrate the importance of considering microbial-feedbacks in forest reforestation after wildfires while Micheletti et al., (2021) demonstrates the complexity of variables needed to be considered independently, and within the context of greater ecological change.

The changing proportion and function of each land feature, controlling ecosystem service, and underlying hydrologic pathway will determine habitable substrate for each species, including humans (Higgins & Garon-Lebrecque, 2018). Grau et al. (2012) demonstrated the importance of herbivory, land use, and canopy interactions on ecological succession; highlighting micro and macro variation in vegetative establishment due to competition, nutrient supply, and moisture content are essential components to consider in projections of change. Grau et al. (2012) also demonstrated that parasitic outbreaks have various impacts on species diversity, acting to diminish variance in early years but promote diversity over longer time frames depending on the severity and frequency of events. Windthrow and mass wasting are

prominent mechanisms of disturbance in communities leading to concerns over land access, wood harvesting, and sediment mobilization (Wesche & Armitage, 2014; Pennesi et al., 2012; Woo et al., 2007). Hummocky topography could have a positive feedback loop on tree establishment if future conditions support the aggregation of permafrost to induce hummock growth (Haynes et al., 2021; Higgins & Garon-Labreque, 2018). Flood tolerant successional species may capitalize on the loss of black spruce stands and colonize openings in the tree canopy or on edges of stable peat plateaus. Increased mobilization of nitrogen rich permafrost meltwater, and groundwater movement, in taliks and fens may provide greater nutrient availability in areas nutrient poor before thaw, creating opportunities for the colonization of nutrient demanding species (Dearborn et al., 2021; Carpino et al., 2018).

Shrubs and tamaracks are projected to colonize mineral soils and may be able to establish on organic soils under the condition they are fed by groundwater or permafrost melt water rich in nutrients, as found in channel and northern ribbed fens (Carpino et al., 2021; Cameron & Lantz, 2020; Islam & Macdonald, 2004). Studies such as Meunier and Begin (2007) and Despland and Houle (1997) found years with dryer conditions beneficial for black spruce seed germination and cone initiation suggesting climate warming without inundation may increase black spruce productivity (Truchon-Savard et al., 2019; Iverson & Prasad, 2002). Dearborn et al. (2021) noted the reproductive success of shrubs with vegetative propagation in the region and how higher sapling proliferation rates were observed after fires. Cameron & Lantz (2016) studied drivers of shrub colonization along the Dempster Highway in the NWT, shedding light on effects of linear disturbances while Hansson et al., (2019) studied effects of clearcutting on root zone hydrology and soil compaction in boreal forests.

The totality of micro and macro-sale changes in the Taiga plains ecozone have large implications on Dene livelihood and must be addressed from a circular perspective (Boyd, Jardine & Frugal, 2010). How environmental changes will affect forest composition, succession, and long-term trajectory are not well understood in the context of small-scale management (Haynes et al., 2021, Disher et al., 2021; Dylewski et al., 2020; Carpino et al., 2018; Swindles et al., 2015; Jones et al., 2014; Cohen et al., 2012). Land feature type and human interaction will play a large role in controlling hydrological, ecological, and disturbance mechanisms through targeted solutions (Holloway, 2020; Becker & Pollard, 2016; Baltzer et al., 2014; Göckede et al., 2017; Kokeji et al., 2007). Although locationally diverse, this section demonstrates the complexity of accounting for, analyzing and responding to, key mechanisms of change operating within SKFN. Collective ability to understand cumulative impacts to the land and people will ultimately determine the Federal, Territorial, and local policy responsible for determining whether Canada's role in global climate action is positive or negative.

Participatory Research Within Indigenous Governance

Domínguez & Luoma (2020) and Worm & Paine (2016) explain extirpation of Indigenous peoples from traditional landscapes undermines inherent ecological relationships which act to conserve the environment through human interaction and land tenure. The combination of systematic dispossession of Indigenous peoples, disjunct perspectives between cultures, and level of multi-scale collaboration required to develop and implement solutions ought to bring change in environmental approaches. Anthropogenic climate change is evidence that settlers are struggling to maintain the inherent ecological relationships Indigenous to the areas in which their imposed socio-political systems operate. Literature suggests reintegration of Indigenous

land use practices in conservation through Indigenous led-projects is the first step towards restoring these relationships (Wickham et al., 2022; Andrade-Sánchez et al., 2021; Tran et al., 2020; Parks Canada, 2018; Wali et al., 2017; Gilmore & Younge, 2012; Simmons et al., 2012).

Indigenous participatory research is one of many nomenclatures used to describe research which makes Indigenous engagement integral to project execution by creating active and authoritative roles for partners throughout the project (Quinton, Pearson & Sioui, 2022; Thompson, Reece & Robbinson et al., 2019). Participatory research equips research partners with cross-cultural tools and knowledge which offer increasingly powerful ways to asserting sovereignty within governance (Wilson et al., 2018; Tobias et al., 2013; De Leeuw et al., 2012). This section of the literature review introduces the constructive interaction between Dene land stewardship, community-led mapping tools, and priority research agendas across the NWT.

An Awaited Journey

Cumulative Impact Monitoring, Indigenous Protected and Conserved Areas and Indigenous Guardianship Programs serve as flag-ship examples of participatory research occurring in the NWT. The GNWT Cumulative Impact Monitoring Program focuses on collaboratively documenting cumulative environmental effects which arise from human interaction with the land (GNWT CIMP, 2021). IPCA's are nominated as candidate areas by individuals, groups, or organizations and later approved by territorial governments in a total of 8 steps involving various actors according to the *Protected Areas Act* (SNWT 2019,c.11 SI-007-AMENDED BY SNWT 2020,c.14 [F]). Guardian programs are guided by Indigenous ways of interacting with the land and the application of IK and WSK to protect the environment through monitoring. Additional information can be found at the GNWT website under NWT's

Conservation Network (ECC, n.d). These programs amplify worldviews of land stewardship as they provide structured economic, political, and legal capacity to assert Indigenous beliefs on the land, in research, and in policy. Despite the success of these programs, they continue to operate under colonial socio-political ideologies which hinder authority over enforcement and decision-making (Bowie, 2013; Reed et al., 2020; Reed et al., 2021). Indigenous geography provides many useful tools which may help close socio-political gaps in these programs such as participatory and counter mapping.

Smith et al. (2012, 2017) defines participatory mapping as mapping with the involvement of the people used to improve geographic understandings, hold deeper conversations about social challenges and goals, and elucidate IK into a standardized ethical format. In contrast, counter mapping is used to fight back against extractive colonial powers and private interests by equipping communities with cartographic tools to reflect their historical presence and deep on-going relationships with the land when asserting their socio-political soveringty (Syme, 2020; Kidd, 2019; Smith et al., 2017; Willow, 2013). Participatory cartographic methods have strong foundations in engagement, collaboration, and goals of de-coloniality contributing immensely to environmental management, cultural expression, and policy planning efforts (Thompson, Reece & Robbinson et al., 2019; Saturno et al., 2023; McGurk & Caquard, 2020; Olson et al., 2016; Smith et al., 2012). These mapping approaches aid in reflecting truthful cartographic of representations Indigenous identity, history, and realities to improve adaptation and mitigation planning, facilitate collaboration, and uphold Indigenous autonomy within environmental and political discourse (Ridhwan et al., 2021; Jayaratne, 2021;

Sumner et al., 2019; Ramirez-Gomez et al., 2016; Kouril et al., 2016; Olson et al., 2016; Gilmore & Younge, 2012; Roth, 2009; De Leewu et al., 2012; Tanskanen, 2009; Ribot, 1995)

These two mapping frameworks have been applied throughout the Dehcho region and are highly valuable when applied to CIMPs, IPCA's, and Guardianship programs, (DFN, 2023). Mapping can encourage co-creation of research questions through improved ability to capture nuances of land and culture in decision making and project design leading to greater outcomes of community empowerment (Ridhwan et al., 2021; Wali et al., 2017; Turner & Spalding, 2013; Johnson, 2007). These methods aim to put the researcher in the context of the local community's cultural traditions, needs, and knowledge systems (Henri et al., 2021; Stenekes et al. 2020; Thompson, Thapa, & Whiteway, 2019; Sumner et al., 2019; Gilmore & Young, 2012). These applied research paradigms provide an opportunity to privilege Indigenous concepts of land, space, and place through the incorporation of toponyms, teachings, stories, and reflection of relationships in the scientific process (Becker, 2014; Roth, 2009; Hanks & Pokotylo, 1989). Decolonial mapping focuses on animating the being and relationships which define the people and landscape, not discerning arbitrarily drawn lines and categories of interest (Fairhead & Leach, 2015; Robbins, 2001; Ribot, 1995; Black, 1990). Additionally, mapping projects can reveal novel information in Indigenous languages about the processes and organizations of landforms, ecosystems, and geophysical cycles previously not described in academia or Western vocabulary (Johnson, 2007; Smith et al., 2012; Becker, 2014; Olson et al., 2016). Mapping project rationales are often identified through a recollection-based approach which allows participants to revisit memories, activities, and relationships connected to potential study locations and variables (Belyea, 1996; Smith, 2003). GPS technology in combination with

monitoring is strategically employed to protect land use areas, animal migration routes, and identify landcover change (Dedats'eetsaa: Tłı̨chǫ Research and Training Institute, 2017; Chen et al., 2018; Sumner et al., 2019; Lantz et al., 2020; Chasmer et al., 2020; Andrade-Sánchez et a., 2021; Chakraborty et al., 2021; Cohn et al., 2022).

Mapping: The Past, Present, and Future

Mapping has always been a powerful tool used for navigation, data categorization, and boundary demarcation by colonial settlers to dispossess and dominate Indigenous populations (Shaw, Herman & Dobbs, 2006; Mcewan, 2009; Roth, 2009; Barnett, 2006). In the past, settlers sought Indigenous involvement in mapping efforts to gain knowledge of a foreign landscape, oppress cultural relationships, and seize geopolitical power (Harris; 2004). Fears of the misuse, misrepresentation, and decontextualization of data by settler ideologues exist widely across the globe to this day. Therefore, colonial tools, such as maps, require an appropriate understanding of their colonial origins and underlying difference in how cultures relate with space and place before use (Harris, 2004; Smith et al., 2012; Kidd, 2019; Domínguez & Luoma, 2020).

A paper by Belyea (1996) aims to convey the challenges and shortcomings of forcing Indigenous peoples to conform to colonial spatial representations within Western cartographic techniques, stating "The problem with using Amerindian geographical knowledge lay in translating its descriptions and graphic signs into terms that were understood and accepted in the context of European scientific mapping" (Belyea, 1996; pg 4). Maps are subjective, contingent on convention, and based on the locale of the culture, highlighting the importance of understanding the diverse ways in which people understand space and location (Barnett 2006). Land and experience are intertwined for many Indigenous cultures in the Americas and

this relationship must be understood in research and incorporated on maps (Larsen & Johnson, 2012; Barnett, 2006). Thus, translation and interpretation of culturally different maps can only be done on a surficial level, often at the loss of pertinent information and experiential insight.

Scholars are attentive to the possibility that Western cartographic practices may change perceptions of the land, facilitating a shift from a reliance on experiences to digital data (Cowan et al., 2012; Willow, 2013; Carothers et al., 2014; Herman-Mercer et al., 2016). Willow (2013) and Smith et al (2012) address potential conflicts between neighbouring nations as a result of fixed map boundaries, residual effects of colonial imposition. Olson et al., (2016) and Syme (2020) in response stress the need for IK quality control (QC) and quality assurance (QA) measures within mapping projects to ensure true protection. Digital storage and dissemination require the use of technical protocols and various media sharing agreements between researchers and Indigenous Nations (Battiste & Henderson, 2000; Olson et al., 2016). Additionally, GIS frameworks and online mapping websites create issues of third-party data sharing with companies (Cowan et al., 2012).

Black (1990), Ribot (1995), and Robbins (2001) progressively expanded on the dangers of landscape classification and misrepresentation between differing cultures and how this intersection must be considered in regional political ecology and collaboration. Smith et al (2012) points out that settler narratives and Western conceptions may still categorize and label people and land as objects, while Willow (2013) fears ideology of the ecologically noble savage (Marie & Grande, 1999) may be used to illegitimatize and in-authenticate Indigenous partners knowledge and decision making. Fairhead & Leach (1995) provide more evidence in the necessity of exploring counter narratives when mapping with Indigenous Peoples. Specifically,

validating historical data through local consultation, augmenting TK with cartographic outputs, and emphasizing the impacts of occupation and conflict on differing perceptions (Fairhead & Leach, 1995). Due to many external factors, challenges arise in remote and underfunded Nations that do not have access to electricity, reliable internet, or streamlined support (Smith et al., 2017; McGurk & Caquard, 2020; Syme, 2020). Mapping projects involve a high reliance on technical training while Indigenous participants invest substantial amounts of time, knowledge, and trust (Smith et al., 2012; Smith et al., 2017; McGurk & Caquard, 2020). For these reasons, Hovel et al., (2020) and Sarmiento et al., (2020) stress the importance of continuous dialogue through mapping projects to gauge feedback, catch misrepresentations of data, and effectively transition projects to community led.

Indigenous Nations and scholars are now working to establish projects led by Indigenous Nations which orient mapping studies around the local culture's assets, values, and perspectives of the land (Harcourt & Awatere, 2022; Romero-Toledo & Jenkins, 2022; Carothers et al., 2014; Fulmer et al., 2008; Zhouri & Pascoal, 2022). Amy Becker (2014), McGurk & Caquard (2020), and Jayaratne (2021) argue for the integration of data which transcends boundaries of 2-D colonial maps such as stories, videos, pictures, and songs. This use of circular thinking within mapping allows Indigenous Nations to map the 'unmappable' and create graphical displays of life on the land, affects of colonization, and ongoing conflicts to better reflect current realities. Climate change research formulated within Indigenous paradigms provide a unique opportunity to situate an applied scientific praxis within proper cultural contexts and safeguards. Derek Smith has frequently commented on the domination of males within mapping studies (Smith, 2003; Smith et al., 2012; Smith et al., 2017) with McGurk &

Caquard suggesting this discrepancy may be due to the difference in gender roles, specifically pertaining to travel and land use knowledge (2020). Sioui (2018) addresses the significance of Women's Water law in Haudenosaunee environmental management perspectives and emphasizes the benefits of adopting a gendered lens to ensure fair representation with methodology and research partners. The totality of literature in this review demonstrates the demand for projects which center omni-directional engagement from community members, researchers, and government partners with a focus on land ethics, practical tools, and cumulative impacts of climatic and cultural change.

Study Location

Sambaa K'e First Nation

This study was conducted within the traditional territory of the Sambaa K'e First Nation Northwest Territories, Canada, denoted in the Appendix, Section iii. Sambaa K'e First Nation (SKFN) formerly known as the Trout Lake Dene Band (officially SKFN in 2016), was federally recognized in 1985. Frank Tetcho informally established the community on the southeastern shoreline of Sambaa K'e in the 1960's when he built his log cabin. Over time the population has grown to approximately 100 people today. In response to growth, colonization, and modernization the community has experienced a wide range of changes both positive and negative. The installation of an airport, water treatment plant, electrical grid, and local store brought the withstanding remote community out of total isolation, opening it up to tourism and research opportunities. These developments also introduced threats of resource extraction, declines in traditional knowledge, and influences of Western lifestyles.

Environmental Characteristics

The environmental characteristics of Sambaa K'e greatly influence the applicability and efficacy of potential land management strategies. The landscape in Sambaa K'e is situated upon a gently sloping glacial till plain predominately overlain by large peatland complexes housing diverse mixed-wood forests dwarfed by prominent sedimentary cap ridges of sandstone and shale (Huntley, Mills & Paulen, 2008). The low-lying landscape is intermittently fragmented by glacial veneer ridges and interconnected hydrological, periglacial, and glacio-fluvial geomorphological features. Organic and gleysolic soils dominate wetlands while finer textured luvisols are associated with moderately well-drained sites. Upland areas consist of brunisols while regosols are found along valley walls and on alluvial flats where mass wasting events impede soil development (ECC, 2009 pg. 104). The soil type distribution and associated geomorphology of the study play a key role in influencing local hydrology, habitat suitability, and movement across the landscape (Huntley, Mills & Paulen, 2008). All-terrain vehicles, snowmobiles, charter airlines, winter roads, and personal travel equipment is often required to access majority of the region.

Methodology

A mixture of methods were embraced to capture human and environmental dimensions of change in SKFN from June 4th 2022 to August 26th, 2022. Methods are categorized into Western Scientific and Indigenous methods. Western Scientific methods are classified here as methods which provide a structured framework for potential avenues of investigation equipped with tools and logic models to test hypotheses, analyze trends, and validate findings according to standardized knowledge. In contrast, Indigenous methods provide cultural perspectives and

actionable ethical frameworks grounded in circular thinking, wider circles of moral concern, and spiritual connection to the land which produce transparent and reciprocal research relationships. When done appropriately, the braiding of these two methodologies strengthens their individual contributions while providing a basis for scientific investigation established upon mutually preferred outcomes and culturally viable solutions. Sambaa K'e First Nation protocols, customs, and values reigned with supreme authority, facilitating a customized, equitable, and focused approach to research.

Scientific Methods

ESRI® products Survey123 Connect and ArcMap Pro were used to document, map, and manage environmental and cultural variables. Survey123 Connect was used to create a logical progression of questions and related answers to understand cultural and environmental change, hereafter referred to as a survey logical model. ArcGIS was used to manage, analyze, and disseminate data collected using the logic model while the researcher interacted with the land and community. Survey creation and ArcGIS database development was highly informed by 'The Thermokarst Collective' logical model for the Territorial Geological Survey mapping initiative. Training of the author on the software was self led and supported by ESRI produced help webpages and the TKC working team, Steve Kokelj, Seamus Daly, and Tristan Gingrass-Hill (Kokeji et al., 2023). Subsequent survey co-development, customization, and modification was completed solely by the lead author. Logic model development began in June 2022 once the author arrived in Sambaa K'e and was functionally completed in early July and modified until August.

'Mapping With the Land' Design Methodology

Once a template methodology was identified, the author began investigating the successes and shortcomings of the Thermokarst Collective's (TKC) logic model and implementation approach. The existing GNWT TKC logic model, covering mass wasting (MW), hydrological (HY) and periglacial observations (PG), worked well for collecting and organizing information but was insufficient in capturing local needs and perspectives. Given limited scope and low participation rates of the TKC logic model, the researcher incorporated additional impacts, systems, or relationships important to Dene culture. In response, an additional 8 themes were added to better customize the logic model to SKFN including: Animals (AN), Vegetation (VG), Biological processes (BP), Cultural (CU), Research (RE), Weather & Seasons (SW), Community Infrastructure (INF), and Contamination & Waste (CW).

Microsoft Excel forms equipped with Survey123 software were used to add and modify questions and responses. Each theme covered distinctive issues relevant to SKFN and included a rational progression of factor-based or setting-based questions covering potential observation types or response combinations. The author identified potential variables and indicators of change based on IK and WSK, circular relationships, and Dene livelihoods. Themes where the researcher could not rely on scientific training, resources, or critical thinking, such as the cultural theme, community members chose what was included or excluded in the logical model. In summary, this approach comprised of listening to what community members were conveying about observations, changes, or goals for the future and making a direct effort to incorporate it into the survey in some way, if applicable.

Data Collection

Survey123 Connect mobile application was downloaded onto mobile device(s) that were used in the field. A DCOP provided ArcGIS online account was used to sign in and download the 'Mapping WTL' survey for offline use. Base imagery, specifically ERSI World Imagery Base Map 2018, was then downloaded to improve the accuracy of manual location identification. Once downloaded and accessible offline, the survey logic model was operational. Data was collected in-situ with an accompanying local participant according to protocol, however temporally irrelevant data or locations identified through conversation were retrospectively appended to data logs in certain cases. Data was collected alone by the researcher only when partners were unavailable and requesting an observation be made on their behalf. On the first page of the logic model, users document necessary preliminary data like GPS data, photos, and user information, in addition to optional data such as Dene words, audio recordings, or raw data files. The second page of the survey directs the user to choose one of 11 themes. Populating surveys was facilitated by the author's familiarity with the software and guided by community member interests, concerns, and desires following foundations of participatory mapping. Each observation was documented as a single survey, regardless of proximity to other nearby observations to ensure proper operation of data filtration and categorization. If close by observations were related, operational procedure required additional notes to be added in the general comment section of the survey.

Mapping <u>With</u> The Land Trips

A total of 6 full day "With The Land" (WTL) trips were conducted with a total of 5 Elders, 1 adult and 1 Youth. These trips served to orient data collection around how Elders interact

with the land through traditional lifestyle activities. During WTL trips, the author accompanied participants on boat rides and long hikes to document areas or variables of concern in SKFN's traditional territory. Observations made by local participants were documented with the intent of developing a community-built database, although data was subject to review and quality control by the author according to principles of cross-cultural data validation. Data collection during WTL trips served to contextualize knowledge transfer; facilitate experiential learning of the researcher; populate the database; explore familial differences in TK and land use areas; and capture climatic and social challenges through firsthand experience. Unplanned excursions contributed data points in smaller disjunct quantities and were separated into a category titled stochastic observations. Data was collected using a combination of purposeful and convenience sampling due to the influence of travel limitations, participant life experience, and ability to make accurate identification in the field.

Aerial Flight Observations

Aerial observation became available through multilateral partnerships with the GNWT, Wilfrid Laurier University, and Sambaa K'e First Nation. Two helicopter flights occurred on July 11th (N=36) and August 17th, 2022 (N=52) respectively. The flight on July 11th, 2022, was organized by the GNWT's Geologic Survey Team who deployed the original TKC 3 theme logic model during the flight. This helicopter flight included 2 GNWT employees in addition to the author Michael McPhee, and Environmental Coordinator at the time, Jessica Jumbo. Jessica Jumbo and the author filled out the tailored 'Mapping *With* the Land' Survey. The GNWT flight path was pre-planned without consultation with SKFN members and lasted approximately 45 minutes following the yellow flight path on the map found in section ii of the appendix.

The flight on August 17th was organized in consultation with Sambaa K'e First Nation using a portion of community flight hours allotted to the community every year. In contrast to the July 11th flight, this flight was pre-planned in conjunction with a local construction project which required helicopter services. Three proposed flight paths were drafted by the author in ArcGIS Pro covering different areas of importance around the traditional territory that were inaccessible by ground. The flight line seen in red, found on the map in section ii of the appendix, was chosen as it intersected with the highest number of important areas to the community. The flight lasted about 1 hour and 30 minutes. The lead researcher Michael McPhee was accompanied by three Elders, David, Arthur, and Victor Jumbo.

Data Storage, Organization & Manipulation

Once GPS and logic model data was collected, the author accessed data in map or tabulated response form through ArcGIS Online. Existing survey data and a host service feature layer were exported from ArcGIS Online to ArcMap Pro desktop version. ArcMap Pro allows for greater data manipulation, organization, and analysis capabilities. ArcGIS also provides greater data privacy upon isolation to non-network linked projects. Upon exportation to ArcMap Pro, survey responses were displayed in a single layer with one symbology against a default base map. World Imagery was applied as the base layer and its extent was restricted to a manageable area surrounding the Sambaa K'e Traditional Territory. Survey data symbology was then changed to display unique values aligning with the 11 Themes found in the survey. Each theme was given a descriptive symbol using the unique value symbology function to divide the single layer into visually identifiable categories. The Query Definition function was then used to create filters for data toggling based on theme type, time of observation, data collector, and

other specific survey fields. New survey responses are automatically manipulated according to the formatting procedure for each theme when displayed on the map. The use of cloud-based ArcGIS Online servers and external hard drives ensured data collected was protected from loss or corruption. ArcGIS Online was used to retrospectively edit collected survey responses, GPS locations, and append old versions of the survey to updated versions. The cloud-based service provided significant hurdles when updating logic model design, appending data logs, and editing data between two servers.

Additional shapefiles were created from the survey data displaying locations as a heat, cluster, and gradient map. This displays differing intensity of observations across areas effectively highlighting areas void or concentrated with observations while simultaneously providing data anonymity. Shapefiles of governmental boundaries and the established and candidate Indigenous protected and conserved areas were added to the database. Digital Elevation Models were input for the area to add additional context to the survey data. A grid format was applied to easily identify and group landmarks, observations, or areas, into a standardized and labeled grid cell. The digitization tool was utilized to trace the location of the Enbridge Line 21 oil pipeline infrastructure and create a map of proposed and travelled flight lines. The National Fire Information Safety Database was accessed and shapefiles for the surrounding area of Sambaa K'e were added to show the areas of historical wildfires relative to infrastructure, observations, and locally important livelihood areas. The author documented and digitized the names and locations of 50 SKFN specific traditional place names or toponyms using the community's private Third Edition Book, *Wisdom of Our Elders*, as a resource. Development locations, anthropogenic footprints, effective policy ranges and other files were

accessed off various governmental discovery portal websites and added to the SKFN map and database.

Indigenous Methods

Situating Knowledge and Praxis

The researcher sought to conduct all scientific methodology under the guidelines set forth by Indigenous research paradigms. Prior to meeting with Sambaa K'e representatives, self-education on a researcher's space, place, and role within northern Indigenous research was undertaken. Actively seeking works by Indigenous scholars and taking courses dealing with Indigenous voices in school served as a primary introduction to Indigenous research. The author gained practical experience with Indigenous paradigms during his undergraduate thesis working with the Dehcho First Nations. These steps helped situate the researcher's relationships to past ideas, academic conceptualizations, preconceived identities, and research approaches around Dehcho Dene Culture. Regional relationships in the Dehcho predicated this thesis and greatly expedited relationship building on a local scale. Prior experience reinforced a 'consultation first' approach and initially situated thesis scope around production of actionable tools, wider regional objectives, and consideration of all ages and all voices.

Consultations

Conversations with SKFN leadership occurred over E-mail after briefly meeting Senior Administrative Officer (SAO) Ruby Jumbo at the Scotty Creek Research Station. This initial correspondence debriefed the Nation on the author's personal approach to research and potential interests in the community. Leadership responded positively, "I debriefed with Chief Dolphus Jumbo of SKFN, and he is very supportive of your research…and… mentioned that

'there is a lot of talk of climate change in Western Society but very little participation from Indigenous people who are with the land and living climate change'" (Ruby Jumbo 27/10/2021). A series of consultations on Zoom® with SKFN's Environmental Coordinator, Jessica Jumbo, took place over several months to discuss common issues, local initiatives, and research gaps. Meetings served to increase familiarity in the working team and discuss diverse skill sets one might bring to the project. Roles, responsibilities, and major project themes were defined within this stage. *Figure 3* displays the results from these initial consultations summarized into six distinct categories which comprised the main logic model components.

Figure 3*: Mind map of categorized results from consultations between Michael McPhee and Jessica Jumbo over the period of October 2021 – June 2022*

Relationship Building

Relationship building was achieved in the community through immersion, collaboration, and reciprocation. Friendly introductions around town, working at the band office, and always providing a helping hand made the researchers reason for being there well-known. Informational documents provided locals with plain language explanations of the research purposes, involvement, and methods. These initial techniques of familiarization around the community led to the researcher quickly being invited to play games with the youth; attend workshops; go on hikes; boat rides; help install new roofing at the wellness camp; and set up new irrigation lines at the community garden. The researcher dedicated time to learning several words and phrases in Dene Yatié (Dialect used in Sambaa K'e, Zhatie is used in Łíídlıı̨ Kų́ę́) utilizing physical and digital dictionaries, auditory learning skills, and consistent memory recollection. The researcher was unaware of dialectal differences between Dehcho communities and began learning the local Sambaa K'e dialect Dene Yatié upon arriving. Community members provided words to learn, tips on pronunciation, as well as pop quizzes to aid in the researcher's learning journey. The researcher also went on hikes with community members to identify plant and landform names in Dene Yatié. These small but important activities facilitate getting to know one another on a professional and personal level and are integral to building trust and diminishing barriers to communication. Team building activities, although often argued not to be related to research, lead to intense conversations full of rich and valuable insight, knowledge, and context. It is such stochastic conversations which highlight the significance of implementing knowledge sharing agreements, consent documents, and

ethical protocols to protect partners while engaging in living research. Information pertaining to specific protocols, agreements and ethics can be found in the Appendix, part VI.

Interviews

A total of 3 interviews were conducted on August 25th, 2022, at the Wellness Camp located northwest from the community on the eastern shore of the main arm of Sambaa K'e (the lake). Elders Margaret, Victor, and Arthur Jumbo, as well as SAO Ruby Jumbo were asked a series of comparable questions as seen in section VII of the Appendix. Interviews were conducted outside using a voice memo application on a mobile phone as a recording device. Notes were seldomly taken to ensure participants were intently listened to. Each interviewee was paid $50 per 30 minutes and was provided a digital copy of their transcript for review and editing. Interview length varied between 30min and 1hr and 45 minutes depending on participant. Transcripts were produced manually by listening and typing in a Microsoft word document. When the researcher was unsure of what was said a note was made in the initial transcript copy and sent back to SKFN for clarification.

Focus Group

A single focus group lasting 2 hours was held on August 3rd, 2022, in the band office. Chief Dolphus Jumbo, Environment Coordinator, Jessica Jumbo, and SAO Ruby Jumbo were invited. Chief Dolphus was unable to attend due to limited capacity and a time sensitive issue occurring across the lake. The purpose of the focus group was to obtain feedback on the researcher's time so far in Sambaa K'e to create a work plan for the final month. Work completed was shown and discussed to provide an update to leadership and maintain transparency. Goals for the future consultations with community members were identified,

which comprised later WTL trips and interviews. Important discussions were raised around gaps in capacity, community monitoring, conservation, funding, protocols, and customary behaviour.

Methodological Limitations and Considerations

Despite successes in these methods individually, in-situ co-development, modification, and testing of methods over the field season were limiting factors controlling the volume and analysis of data. Data collection experienced delays due to challenges in scheduling time with the land and Elders in conjunction with suitable weather and daily operations. Limited data and time produced elementary analysis which requires larger datasets, quantifiable variables, and investments of time to perform rigorous analysis with high levels of confidence. Purposeful, snowball, and stratified sampling techniques created the potential for sampling bias in the results. Majority of the study population is directly involved in leadership roles or are indirectly considered leadership through customary hierarchies. This issue is exacerbated by SKFNs small population and high number of dependent citizens who are inherently excluded from prominent roles within the project. The author aimed to minimize this bias and low capacity through frequently gauging cohesion on a wide range of opinions, stances, and perspectives in SKFN. Monitoring designs should be weary of data skew towards environmental variables, data collection method, and individual observations. Data sets should be curated according to quality control and assurance standards by multiple members and methods for accurate representation of community desires and environmental changes. Theme logic models must be reviewed when a modification is made to the survey to ensure there are no disruptions in the database connections and workflows. Specific variables, characteristic fields, and measurements are not yet matched with regulatory guidelines and specifications leading to

inefficiencies in cross-linking data. Integration of rigorous data collection procedures customized by theme and variable should be considered (ex. caribou lichen patch observation: approximate size, frequency of use by herd, proximity to community infrastructure or development, vulnerability to change). Future self-guided engagement in the community will ultimately dictate whether the map is indicative of the totality of desires, experienced impacts, and individual realities based on the number of individuals engaging on the project.

Results

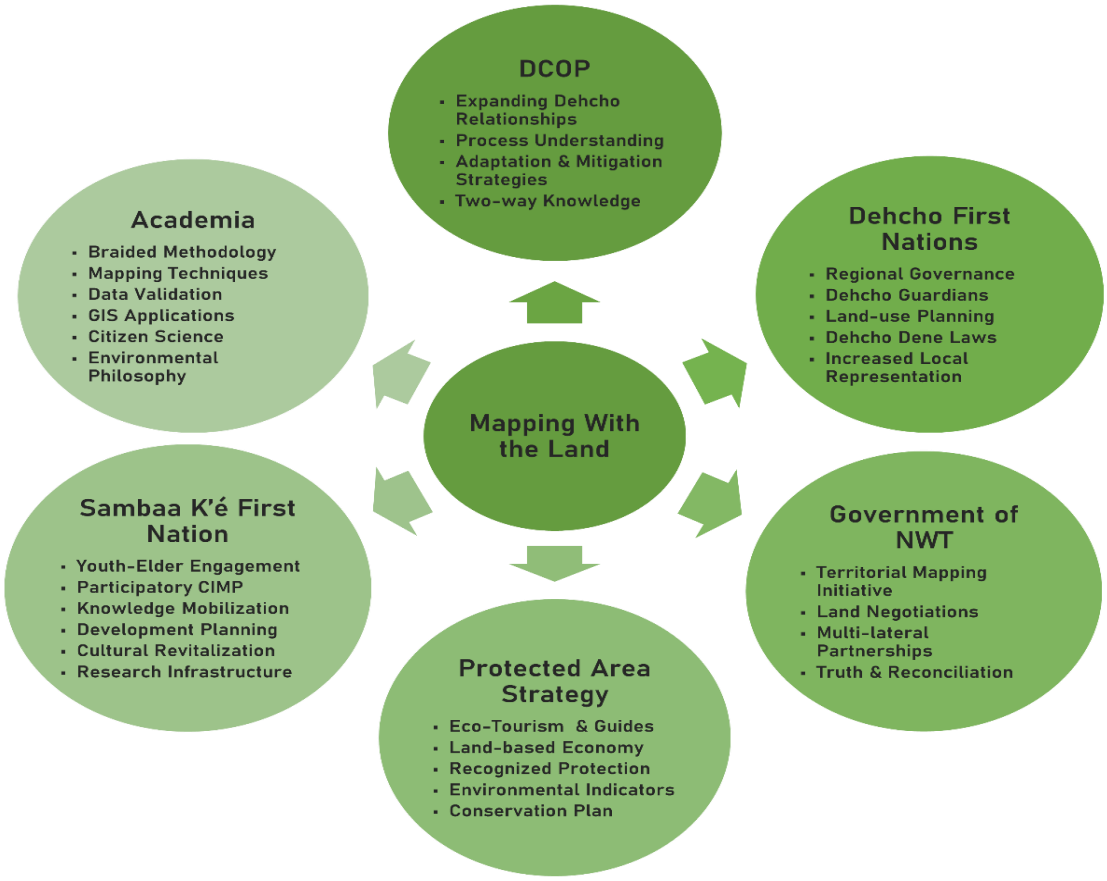


Figure 4: *Mapping with the Land significant contribution matrix. Mapping with the land aims to be integrated with prominent multi-lateral objectives across the NWT set by government, academia, and supportive partnerships.*

Mapping With the Land Data

Table 1: Thematic distribution of observations displayed by data collection method

Theme of Observation	Total Population	Filtered Population	Combined Flight Data	GNWT Flight	SKFN Flight
Periglacial	32	2	30	17	13
Hydrological	37	4	33	11	22
Mass Wasting	11	9	2	0	2
Animal Data	23	17	6	3	3
Biological Processes	11	6	5	2	3
Contamination & Waste	13	13	0	0	0
Cultural	27	25	2	0	2
Infrastructure & Community	14	12	2	0	2
Research	8	8	0	0	0
Vegetation Data	8	5	3	3	0
Weather & Seasons	11	6	5	0	5
Population Size	195	107	88	36	52

Table 2: *Thematic distribution by WTL trip and participant*

Theme	David Jumbo	Tony Jumbo	Arthur Jumbo	Margaret & Victor 1	Margaret & Victor 2	Ruby Jumbo	Stochastic Observations	Youth K'ai Shih Trip	Total Distirbution
Periglacial	0	0	0	1	1	0	0	0	2
Hydrological	0	0	0	0	0	0	1	2	3
Mass Wasting	1	1	1	5	0	0	0	1	9
Animal Data	4	5	2	2	2	0	1	1	17
Biological Processes	2	4	0	0	0	0	0	0	6
Contamination & Waste	0	0	6	0	0	9	0	0	15
Cultural	10	2	6	0	2	2	2	0	24
Infrastructure & Communit	2	4	2	1	1	2	0	1	13
Research	1	2	1	0	1	2	0	0	7
Vegetation Data	1	2	0	0	2	0	0	0	5
Weather & Seasons	2	0	0	1	1	0	1	1	6
Population Size	23	20	18	10	10	15	5	6	107

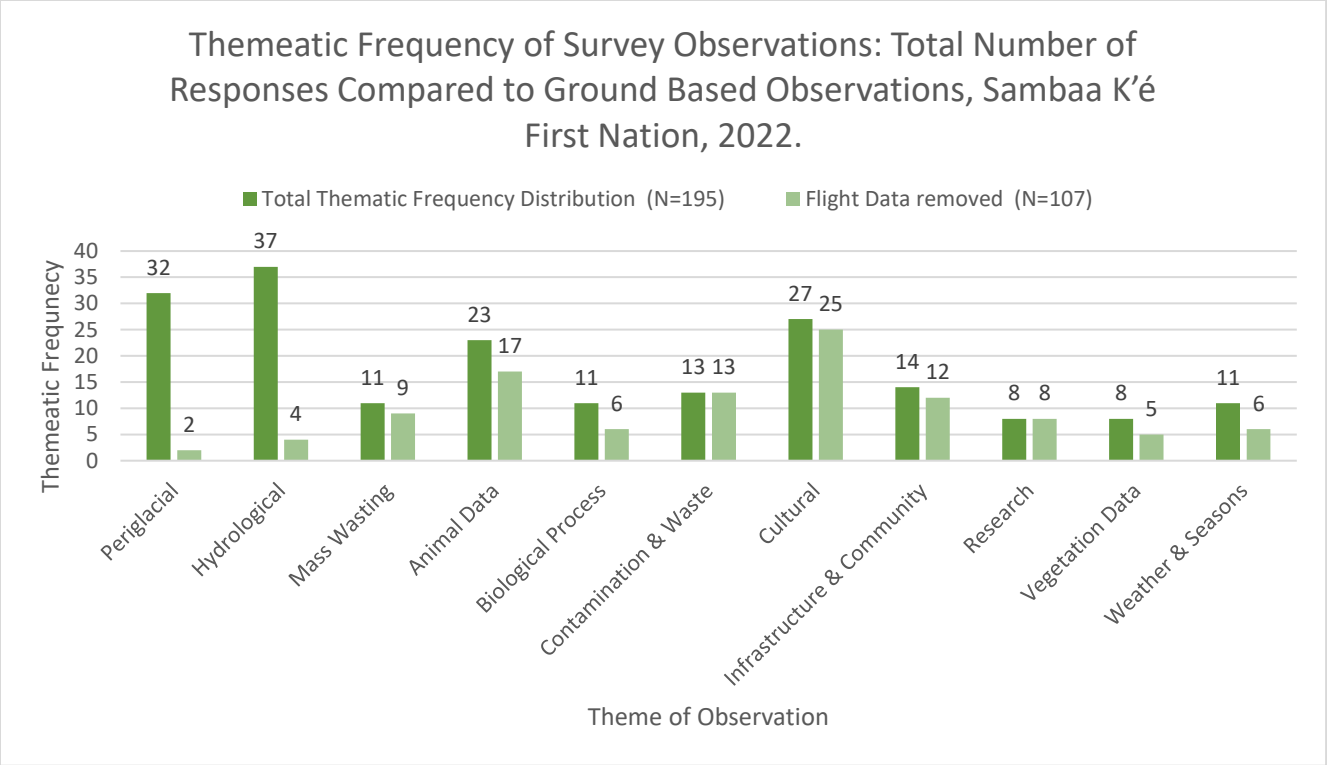


Figure 5*: Bar graph displaying the total thematic frequency of Mapping With the Land observations by data collection method*

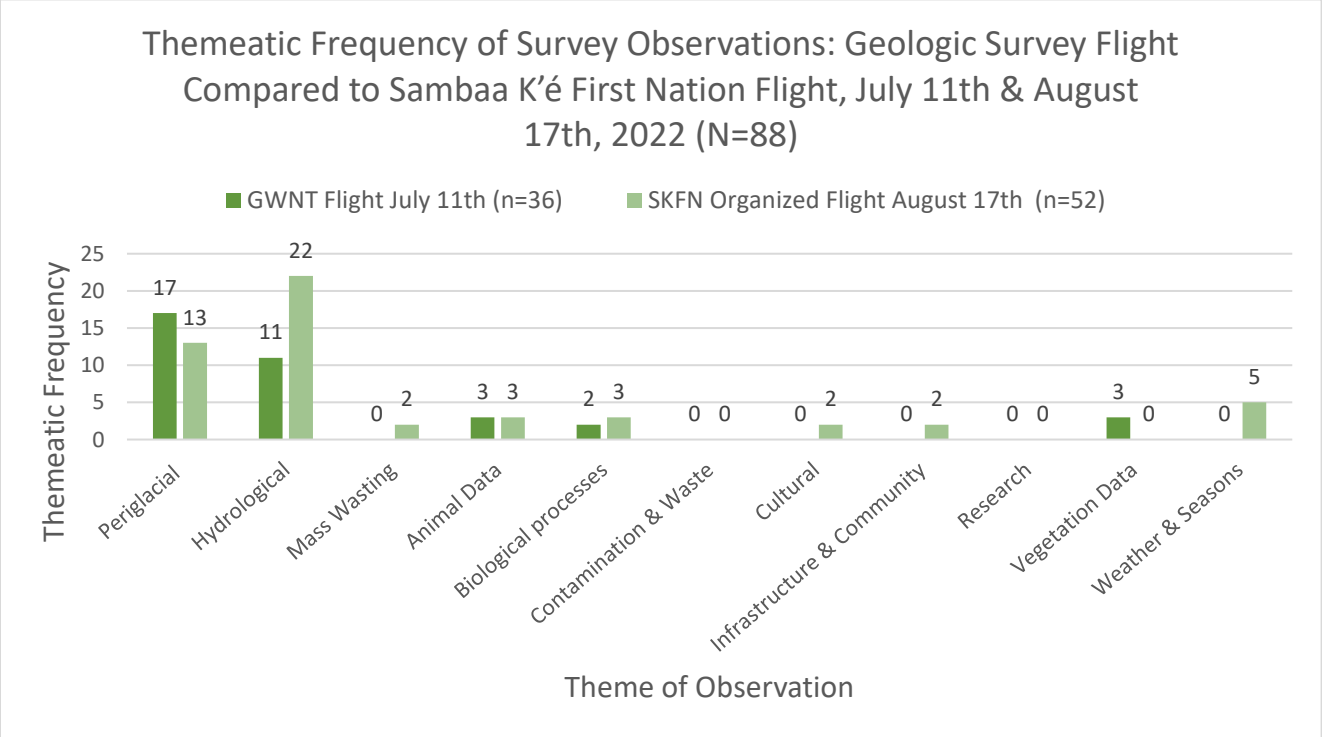


Figure 6: *Bar graph displaying the thematic frequency of survey observations collected using aerial observation methods.*

Results from Mapping *With* the Land contribute to a network of multi-lateral objectives, as seen in Figure 4. A total of 195 GPS-linked surveys were documented over the field season. Inferential and descriptive statistical analysis revealed what type of data was collected, the theme it belonged to, and its frequency across space and time. It was found the TKC's original 3 themes were extremely valuable to the community, accounting for (n= 88/ N= 195) of observations. However, these themes did not effectively fill knowledge gaps within SKFN, nor capture the most significant changes to the environment according to community participants. The thematic frequency across the total population produced a distribution skewed towards hydrological and periglacial observations, as seen in Figure 5. HY and PG themes were disproportionately identified from the air. The author corrected this data to improve insight on SKFNs true intentions and data collection preferences by removing surveys collected on helicopter flights, this can be seen in the second series of data in Figure 5. Results from thematic analysis of total population and flight data can be seen in Table 1. Figure 6 displays 2 series of data, data collected on July 11th during the GNWT flight and on August 17th during the SKFN flight. The thematic distribution compared to WTL trip location and participant demographic can be seen in Table 2.

July 11th GNWT Helicopter Flight

The area of interest southwest of the community hosts a dendritic multi-basinal drainage pattern dominated by changing land features. PG observations reported 5 collapse scar basins; 6 patterned forest observations (shrub/forest = 4, String bog = 2); 1 sorted stripe; 3 patterned ponding (Undifferentiated = 2, string bog = 1); and 1 flow track observation. These

observations were accompanied with reports of low degradation (<30% by area) although 2 collapse scar basins indicated high degradation (>60% by area). 2 patterned forest and 1 patterned ponding observation were observed nearby to these highly degrading collapse scars.

HY observations (n=11) included reports concerning 7 ponds, 3 lakes and 1 river. Characteristic fields reported 3 ramparted lake features, 2 lowered lakes, 3 lake expansions, and 3 water discolorations. Remaining observations (n=8) included 3 VG, 3 AN, and 2 BP observations. The VG themed responses reported the habitat location of a large patch of caribou lichen, a highly productive riparian zone along a lowered river, and a localized increase in vegetation reported by Jessica Jumbo. AN theme reported 2 separate food locations for caribou and the location of a beaver dam near Tetcho lake. The BP observations reported past forest fire locations and possible ecosystem fragmentation leading to habitat change. The documentation of suspected red iron oxide dyed fire retardant in the comment section allowed for contamination data to be collected despite the theme not existing at the time of the flight. This observation of fire retardant was later investigated. The MW theme, although developed by GNWT, was not filled out on the flight, most likely due to the difference in terrain between the July and August flight path.

August 17th SKFN Helicopter Flight

The SKFN organized flight produced a total of (N=52) observations. The SKFN flight followed the same thematic distribution as the July 11th GNWT flight with HY and PG themes accounting for 67% (n=35/52) of total flight 2 responses. PG observations were all made on wetland or peatland ecological settings with organic physiography dominated by multi and

dendritic drainage patterns. Of the 13 PG observations, 9 were of collapse scar basins, 3 were patterned forest / shrub, and 2 were of discrete collapse scars. Two of the collapse scar basin observations reported areas of high permafrost degradation (>60% by area) causing mass tree mortality without obvious signs of reforestation or successional processes. Another collapse scar basin observation reported high plateau degradation with the formation of permafrost moats indicating changes in local hydrological storage regimes and functional operation of 'permafrost dams' in the local area as referenced by Quinton and Connon (2018, 2014). HY responses included 11 lake, 6 river, 3 wetland, and 2 forest observations. The lake and river observations reported low water levels with discolouration due to algae, sediment, and dissolved organic carbon, depending on location. Majority of these observations were given discrete spatial extents, although 4 larger spatial extents were given to a series of similarly affected lakes. The HY theme general comments provided additional insight on cabin locations, animal populations, lake quality, and productive areas which may be important for community land-use.

Remaining 33% of responses from the SKFN flight were dominated by the WS theme which indicated severe windstorms causing damage to growth structure, or tree mortality (n=17 WS=5, AN = 3, BP= 3, MW = 2, INF = 2, CUL = 2). AN observation reported 2 caribou food locations and 1 beaver dam. The BP observations (n=3) denoted fragmentation of habitat. Two translational landslides were reported in the MW theme of the SKFN flight although the features differed in their setting and size, one being >20m in length from scarp to tip located river side while the other was between 5-20m and landlocked. The INF theme recorded locations of cutline convergence while CUL observations denoted a location frequently used by

Elders. In addition, the cultural theme documented a cabin on Trainor Lake or K'éotsee meaning a “place he dug out” in Dene Yatié.

Mapping With The Land Day Trip Results

Margaret and Victor Jumbo July 20th

On July 20th, 2022, a total of 10 observations were recorded while Michael McPhee accompanied Margaret and Victor Jumbo on a AAROM monitoring trip on the lake utilizing a boat provided by AAROM. This trip provided understanding on what type of data is collected, associated procedures, and current strengths and weaknesses of the Aboriginal Aquatic Resources and Oceans Management program. AN themed observations revealed productive fishing locations as well as changes in spawning location for lake trout. WS observations documented where a windstorm touched down consecutively for 2 years during mid-summer causing high tree mortality. The mortality of otherwise healthy trees prompted the INF theme to indicate a potential location for a wood harvesting in the area. A PG observation indicated the location of a collapsed permafrost plateau resulting in a thaw lake. The remaining 5 observations belonged to the MW theme. These observations documented 2 thaw slumps (1 translation, 1 rotational), 2 shallow translational landslides, and one riverbank erosional feature of severe undercutting leading to tree mortality. The 4 landslide observations were all concentrated on the eastern shoreline of the ridge known as K’ai Shih or Willow Ridge in English. Possible reasons for a concentration of mass wasting features on this shoreline, although speculative, are explored further in the Tony Jumbo trip analysis and commented on in the discussion.

Margaret and Victor Jumbo July 26th

A total of 10 responses covering 7 themes were documented on a second AAROM monitoring trip led by Margaret and Victor Jumbo accompanied by Michael McPhee and two researchers from another project. The location of the community wellness camp was documented in the INF theme. Two AN observations documented moose tracks and the location of changing bug and fish populations prompting conversations on animal behaviour. The Elders shared that insect and fish populations have declined in comparison to years prior stating in the past insect populations had densities resembling rising smoke from the spruce (T'su) trees. Elders shared that fish would be constantly seen jumping from the water as insects would descend to the water in the evening however this is not seen in recent years. The Elder's suggest that a consistent and observable decline in insect populations around Sambaa K'e, in combination with other effects, are altering behaviour of various populations. This decline may be attributed to changes in feeding locations, reductions in harvester land use, or declines in relative abundance. This question may be answered through consistent WTL monitoring to develop a baseline using the application of IK and frameworks such as this.

Victor wanted to document a CUL observation for the cabin his parents built for him and his brothers in the 1940s before moving across the lake in the 1960s. In the past, the Punches, another family group in the community, also had a cabin nearby to Victor's which accounted for the second CUL observation. Victors old cabin has reportedly subsided 10ft. In post data analysis it was seen an additional PG observation was made in this area during the July 11th flight. These observations with the added aerial perspective resembled a cascading bog complex occurring near the cabin before transforming into a fen which terminates into a small

thermokarst lake, although ground validation is required to be sure. This indicated a possible discrete, highly degraded, collapsing peatland complex affected by thermokarst induced land subsidence which prompted the documentation of 1 PG observation in the location.

After completing half the monitoring locations, the group stopped at one of Margaret and Victor's current cabins on a small island. Victor and Margaret discussed how the windstorm documented on July 20th almost destroyed their cabin. Damage from this event is seen in Weather and Seasons theme in appendix section IV. While exploring the island the author noticed a *Hibiscus moscheutos* with damage to the leaves and a growth structure unrecognizable to the researcher. It was later found to be gull wasp eggs through dissemination of this data point to other land users and regional researchers. Several cotton wood trees had an appearance on their leaves like aspen leaf miner affected polars with a rusty brown colour indicating a possible parasite, fungus, or bacteria, seen in the appendix, section IV: Animal, Vegetation and Biological Processes Photos. Margaret stated she has seen it before but does not know what it is. This highlights the framework's ability to create opportunities to close gaps in Elder knowledge on a variety of topics using the survey as a means of gap identification and WSK education. A variety of species are harvested by Dene and changes should be monitored closely and disseminated amongst the community and wider supporting network of experts to direct forest conservation.

Later in the trip, Margaret and Victor shared stories about hunting and trapping in the area, meeting each other in their teens, and Victor's accomplishments as Chief while the group ate lunch and enjoyed tea. The group discussed mining and angle drilling near the British Colombia (BC) and Alberta (AB) border, which later inspired the August 17th helicopter flight.

Conversations shifted to challenges and successes of community action, monitoring, intergenerational knowledge transfer in SKFN. Researchers listened intently as a sense of sorrow and pungent resilience filled the air as the Elders recounted events from residential schools and how much of an impact it had. Victor spoke proudly of the day the federal agents met the true strength of Frank Tetcho as he initially refused to send his children away to residential school. The couple described the emotions, conditions, traumas, and current struggles associated with their time at genocidal schools in Canada.

> "We're fluent but I don't know why we do it (in reference to speaking English to grandchildren). Because we were taught that. It was engrained in us. I remember I got punished for speaking my language, how many times my ears were pulled, I'm surprised my ears never got stretched." – Margaret Jumbo

The couple described losing their knowledge, language, and culture, feeling a sense of guilt for being one of the few lucky ones to retain and relearn some of their identity when others were not as fortunate. This quote illuminates how residual effects create barriers to healing which are felt indirectly by younger generations. These conversations provided valuable insight into the Elders lived experiences, knowledge sets, worldviews, and plans for future generations while making current obstacles to achieving those plans apparent. These conversations informed much of the framework's multivariate consolidation around enacting Dene Law through stewardship and will always be regarded as a highly emotional and personal experience to the author. This prompted the author to investigate the nuances of cultural revitalisation amidst social and environmental change as explored in later sections.

David Jumbo August 13th

Michael McPhee and Ruby Jumbo accompanied David Jumbo to document his cultural knowledge and environmental observations in addition to nearby ancestral burial grounds. A total of (N= 21) observations were made across 7 themes with the most frequent theme being cultural (n=9). Historical sites were documented 3 separate times and were tied to land-use areas or cultural legends. Remaining cultural observations (n=6) marked the location of burial grounds, cabins, or toponyms.

Animal Data (n=4) denoted two lake environments with a beaver lodge and caribou tracks, as well as two river environments with bear tracks and the presence of ducks (chi). Two past forest fire locations were reported in the BP theme, 2 windstorm induced cases of tree mortality were documented in WS, and finally a dry wood harvesting location and educational area were documented in the INF theme. Lastly, MW tracked the locations of a large series of translational landslides. A VG observation documented an unknown plant species. Within the Dene Yatié Place Name survey field, 2 Dene names were documented with respective GPS locations.

Tony Jumbo August 14th

A total of N= 20 responses were collected with harvester Tony Jumbo and his niece Deanna Jumbo. Deanna accompanied Tony on the trip to assist in translation and interpretation. Deanna was specifically chosen to gain insight on how the framework may facilitate familial inter-generational knowledge transfer. The AN theme (N=5) reported the presence of ducks and prairie chickens as well as the location of a beaver lodge. Additionally,

two unknown parasites/diseases were identified, one parasite affecting willow shrubs and a fungus affecting saskatoon berries, seen in the Animal, Vegetation, and Biological Process theme of appendix, IV. VG reported black spruce and tamarack mortality along the banks of the most southwestern river and documented the location an unknown plant to the researcher and harvester for later identification. BP (n = 4) reported two locations in the most southwestern river where fish were observed to be floating to the surface with no damage to bodies. Close in proximity to these fish die outs, algal blooms were reported in the river, seen in Appendix section IV Hydrological Observation theme (bottom right photo). Due to the co-occurrence of observations, it was theorized these 'fish die outs' were caused by localized decreases in dissolved oxygen concentrations due to rising temperatures, reduced stratigraphic mixing, and increased nutrient mobilization contributing to increased algae productivity. The final BP observation documented a location of a past forest fire.

A series of translational landslides were documented occurring on the southeastern flank of the of K'ai Shih or Willow Ridge. These landslides were documented in the MW theme from a far in July however this trip provided accurate measurements and up-close qualitative observations. The land slide was approximately 20m from scar to toe and about 10m in depth occurring on highly sorted fine clay sediments supporting a mix of deciduous shrubs and trees, photos can be seen in the Mass Wasting theme in section IV of the appendix. The appearance of the sediment's surface texture suggested the area has high levels of rain-on-clay interactions which may have lead to high fluxes in moisture content and structural failures. Permafrost was not tested for due to lack of proper equipment in the community. HY theme reported a hydrological input stream to Sambaa K'e (lake). Lastly The CUL theme reported a cabin and

location tied to a Sambaa K'e Legend. The RE theme reported one potential monitoring site and one future research site resembling conditions found in Scotty Creek Research Centre. INF (n = 4) reported the locations of cutlines, a past educational site, and a potential educational site.

Ruby Jumbo – August 15th

Ruby Jumbo guided the researcher to several specific locations related to waste management, community wellbeing and cultural preservation around the community. Locations were selected due to a lack of documentation and the data's potential to support specific initiatives. A total of N = 15 observations were made with Contamination and Waste accounting for 60% of observations (n=9/15). Most locations were situated off small access roads ending a short distance from the community; however, some were more isolated. The community's two main current waste areas were documented and can be seen in the second group of photos within the Contamination and Waste theme, section IV of appendix. The solid waste dump is a rectangular open top fenced in area containing a wide array of sorted household and commercial waste. Gathering of avian wildlife are frequently found feeding on garbage at the dump. In 2022, 5 bears entered the community around the dump in search of food resulting in the community using deadly force against 3. The sewage lagoon is a rectangular body of remediating liquid waste confined by raised berms and lined by an impermeable liner, top right photo. Although the liquid waste in the lagoon is deemed safe to enter the environment once the remediation process is complete, if the lagoon fills beyond its volumetric capacity, the community must decant the lagoon into the surrounding muskeg. This area drains towards the lake via Black dog creek, shown in culvert picture of section IV Contamination and Waste in the appendix. Ruby stated a series of tests were conducted on

water quality around the current dump location and results suggested the area and lagoon posed no threat to the community, although Elders are skeptical. The remaining 5 CW observations documented hap-hazard dumps around SKFN. Majority of the dumps contained household waste, old appliances, and rusted out cars. However, three specific locations were reported to contain high numbers of old batteries, metals, and toxic hydrocarbons such as oils and fuels. INF observations indicated the location of SKFN's gravel pit, biofuel pile, and the location of the old SKFN borrow pit quarry, seen in section IV of the appendix Contamination and Waste.

This trip also documented one of Arthur Jumbos permafrost wells that had been experiencing changes in water quality near SKFN's old quarry (seen in appendix, IV Contamination and waste theme photo group 1). Although the issue has reduced over time, difference in well appearance is still seen today based on proximity to the quarry, comparison photos in appendix. In interviews, Arthur shared his suspicions that there may have been some chemical or sediment contaminating the water. Allegedly, in the past the well was suspected to be causing mortality in rabbits, foxes, and birds. Arthur remembers employing a litmus test but can not remember the results, indicating once again a systematic monitoring framework is needed. Arthur states the well has been remediated due to growing vegetation and reduction in mining activity. Upon inspection, the well was a 2-3 foot wide and deep hole in the dehydrated peatland with a plywood cover, left photo in group 1. The C horizon of the well soil profile was highly developed, containing ped structures of sandy clay overlain by a thin O horizon of decayed peat and moss. The well contained insignificant amounts of organic debris to affect taste. The water appeared rusty brown in colour although was highly transparent in

small quantities. This well was documented as not safe to drink, so no further analysis could be completed. In comparison, the well documented farther away from the quarry had the same structural appearance although the peatland around it was not dehydrated and the water had a higher translucency with a less rusty brown colour (comparison photo in Section IV of appendix). This well was reported as safe to drink, and an in-situ sample of the water revealed a gustation, or taste, resembling salty-sweet ice-cold water mixed with a light hint of sulphur; potentially indicating background concentrations of sulphate-based contaminant. Allegedly, sulphur gustation has reduced in comparison to years prior. Elders prefer permafrost well water for a verity of uses (e.g. tea) over Lake or filtered water.

The proximity of the well to the quarry may be the main reasons for the change in taste and colour of the water, although chemical testing and hydrologic analysis is required to be certain. Most prominent factors would be changes in local hydrologic characteristics associated with impacts from mining, clear cutting, and vehicle traffic leading to increased mobilization of foreign compounds (Hansson et al., 2019; Zhouri & Pascoal, 2022). The author did not reflect on possible connections in the field due to limited time. It was not until data was reviewed in ArcGIS that this potential cause-effect was evident. An additional RE theme observation retrospectively denoted a monitoring location for well water quality. Similarly, a potential monitoring site was identified at Tłı̨k'ee Deehą́a or Black Dog Creek due to its confluence into a main tributary steam of Sambaa K'e.

In this instance, pairing of INF and HY observations created a new perspective for data acquisition, multiplying the results obtained from one locational stop into multiple distinct data points. This not only created new locational data points but added temporal, human, and

investigative dimensions to this observation. This is significant as the community experiences gravel or 'pit-run' shortages and is in the process of identifying a new location for gravel quarry development which may have similar impacts on the environment and require similar monitoring responses from stewards. At the end of the trip Ruby directed the researcher to two burial grounds situated within the heart of the community. These observations will ensure their protection by allowing future generations of SKFN to accurately identify these sacred sites when development planning and conduct archeological work according to Dene principles.

Arthur Jumbo August 18th

This trip was planned to document Arthur's traditional knowledge, the location of his (functional) permafrost well, and locate the exact coordinates of garbage leftover from World War 2. Additionally, Ruby Jumbo suggested the group utilize the trip to document burial sites. A group comprised of several youth and the author documented changes around SKFN's Lodge area. 2 INF theme observations were made near the Lodge pertaining to community management and education. Arthur and Ruby documented a location used as an emergency float plane landing site. Ruby suggested documenting the location of a property boundary stakes for the lodge, stating it may be good to have the boundary on the map for planning and tourism purposes. These observations can be utilized in public safety posters and ensure the property line of the Lodge is not encroached upon if the stake is moved. The AN theme, n = 2, concerned the locational behaviour of animals. Arthur then stated he suspects caribou have been extirpated from the area due to construction of the lodge increasing noise pollution and the presence of humans. This is supported by the NWT Cumulative Impact Monitoring Program action plan and other studies (Government of Northwest Territories, 2022; Species at Risk

Committee, 2022; Chen et al., 2018; Beauchesne et al., 2014). According to Arthur, Prairie Chickens are still seen in the area although have declined over the years, possibly in relation to dryer summers and lower cranberry yields.

Arthur, Ruby and the author documented several observations alone at an old Canadian Armed Forces (CAF) Outpost to not put youth at risk of exposure to unknown contaminants (photos seen in Section IV of Appendix in Contamination and Waste theme photo group 3). CW and CUL observations accounted for 75% of total responses, (N= 18, n = 12/18). CW observations (n=6) documented old battery dump sites; oil drums; fuel canisters; contaminated soil; and relic infrastructure from a Canadian Armed Forces outpost. Majority of materials used, disposal procedures, and activities of the Canadian Armed Forces is unknown, leaving many uncertainties in proper response strategies. The group recorded a story of Elders participating in outpost clean up which left an oil drum buried on the shoreline through open text survey fields. Observations of high energy mechanical forces eroding the eastern shoreline of Sambaa K'e were documented, making contaminant mobilization in this area increasingly more likely due to the proximity of the base to the shoreline and substandard decommissioning procedures of the CAF. These features are caused by a combination of incident wind direction, wave action, and lake ice which scour away non-cohesive sandy sediment. Vegetation on the shoreline consisted mainly of low growing vegetation, shrubs, and black spruce trees which provide little resistance to erosion. Shorelines around Sambaa K'e consist of non-cohesive, cohesive, and armoured sediments. A collection of impacts can be seen in the Shoreline Erosion theme in section IV of the appendix.

Mapping With the Land Research Process Results

This project successfully reflected TWAO principles within the GIS framework through the application of WSK as a supportive tool in the development of an Indigenous-led research project. This stewardship framework grounded in cultural revitalization acts as a metaphorical sinew attaching the meat of SKFN stewardship (the People) to the bone of Dene cultural identity (The Land); answering the thesis research question of how Western cultural influence, ecological change, and land management approaches may synergize into a cohesive strategy for embodying TWAO ideals within future land management in Sambaa K'e. This thesis provides scientific infrastructure and a standard operating procedure for the collection of cumulative impact data and subsequent organization of grass-roots action to preserve, maintain, and facilitate reciprocal relationships amongst the Land and People. Documentation and analysis of 195 survey results across 11 themes will contribute to development of IK informed environmental and cultural indicators of change. GIS-based stewardship was found to provide the capability to understand, communicate, and respond to impacts and barriers hindering the development of implementable solutions. With The Land trips provided the most opportunities for experiential learning and two-way knowledge exchange as they contained the most impactful insights when compared with other methods. Engaging in stewardship activities surrounded by sacred relationships, histories, and places yielded opportunities for enhanced descriptions of observations, follow up discussions, and contextualization of data point significance. Opportunities like this are missed when passive, non-collaborative methods are used such as image-based feature identification, literature analysis, aerial observation, or unaccompanied data collection by researchers. Cumulative impact data collected by local

monitors may improve management plans for water quality, wildlife, and landscape change based on IK and WSK indicators. Socio-political or community-oriented themes aim to situate coarse environmental data within the context of Dene Law, cultural revitalization, and local asset development plans. Local GIS capabilities within the community may increase external data utilization and integration through layering of variables within a centralized housing platform for easy data access and analysis.

Overall, results reveal many important successes, on-going challenges, and novel obstacles related to the employment of braided research methodologies and the actualization of Indigenous-led projects. It was found splitting field time between developing the logic model, building relationships, and collecting data was challenging, yet beneficial. The mixed methods worked synergistically to provide topics of conversation and gain feedback from partners. Open trustworthy discussion was instrumental in connecting abstract issues of capacity, cultural decay, and environmental monitoring through a solid framework grounded in Dene Law. Additionally, this format continuously provided new variables, applications, and problems to explore which allowed for consistent logic model evolution.

Utilization of GNWT and SKFN resources to achieve a common goal aided in continuing two-way knowledge exchange between partners, despite differences in agenda. The SKFN planned flight heavily focused on areas important to land use, development monitoring, boundary enforcement, and leadership concerns. In comparison, the GNWT flight focused only on documenting HY, PG, and MW, events to inform the NWT's Geologic Survey. This revealed differences in the type of, and reason for, data collection as well as differences in the selection of monitoring location. Both flights improved understanding of landscape change, although the

SKFN flight also contributed to socio-political goals of protection, soveringty, and security. This is one example where government programs limit endeavours to a singular agenda and effectively exclude considering, supporting, and assisting First Nation objectives. No consultation was held with community members to plan the GNWT flight line. This effectively limited SKFN's involvement to a bystander role and prevented them from being active partners. However, the later use of a community-owned helicopter provided real world experience employing the framework to monitor locations outside the daily reach of SKFN, such as the southern NWT border with BC and Alberta. Stories of unannounced visitors arriving in short range helicopters to gather supplies for an unknown camp potentially violating First Nation from across the border indicates the opportunity to employ counter-mapping techniques (Kidd, 2019). This highlights the importance of scientifically informed and socio-politically oriented stewardship frameworks which consider variables outside arbitrary borders, circles of moral concern, and government agendas.

A commitment to meaningful collaboration and learning about the land and people showed a consistent dedication, passion, and effort to actualizing such a framework within SKFN. Learning significant Dene Yatié words, phrases, and worldviews provided deeper insights into the way Elders and locals describe the landscape and the beings scattered across it. It also provided an advantage when trying to understand language disconnects between generations, ways of living, and relating with the land. Community engagement, participant observation, and relationship building techniques were thus integral when bridging gaps in environmental and socio-political endeavours to contextualize multidimensional results into workable solutions. This was accomplished by providing a centralized platform to manage past, present, and future

research data to consolidate developmental and stewardship policies through a Dene stewardship praxis. Accountability, agreements, and protocols ensured a TWAO foundation was maintained through constant communication and flexible incorporation of feedback in the author's approach. Day trips provided instrumental data and context on what challenges are experienced with the land. Relationship building and interviews provide insight into how Mapping with the Land may contribute to actualization of local land management by dismantling overlooked socio-political barriers.

Interviews

Interviews highlight how Dene solutions highly depend on the functionality of the environment, employment of traditional protocols, and interdisciplinarity of cross-cultural collaboration. Interview questions can be found in appendix section VII and are summarized into five distinct themes: Research in Sambaa K'e; Changing Land and People; Traditional Protocols in Sambaa K'e; Youth-Elder Engagement in Sambaa K'e; Mapping with the Land Stewardship in Sambaa k'e

Research In Sambaa K'e

> *"The Creator put the Earth here for us to live here and share good things with it. But the government is telling us different things. You know. Its separating it. We need to get back together." – Margaret Jumbo*

This section highlights how past research projects have been beneficial, yet collaborative barriers continue to reduce effectiveness. When asked about past research success, participants distinguished between university affiliated researchers, and private or

governmental researchers. Ruby Jumbo stressed that institutional researchers are perceived differently due to a sense of trust, a difference in tools used, and greater applicability of recommendations. This was partly expected due to shortcomings in agenda driven approaches creating often-palpable rifts between parties. The focus of private and government approaches on extracting knowledge, money, or power often eliminates the possibility for Indigenous people to receive true consultation, self-determination, and autonomy. Dehcho Dene soveringty, land management and livelihoods are perpetually threatened by outdated extractive policies and corporate agendas, leading to a sour reputation towards these entities. This is complicated by a history of IK being used against the Dene in policy and regulation with little accountability on behalf of private and government sectors. This hinders relationship building and leads to omni-directional resistance. This often means successful projects are not meaningfully integrated or accepted within larger institutional mandates due to a failure to recognize fundamental incongruencies between management objectives and investigate past linear agendas. Victor illustrates a picture of knowledge holders and scientists working together on a mutually acceptable watershed boundary only to be impeded by external power imbalances.

"What we didn't really like is that the first time we were making the boundary for the protected area. All those lines we did was all watershed going out eh…. Because what we did was, we're all harvesters and we know where the water goes right to the lake. But then the government came along and said you got it too big, make it smaller. To me, like, they don't say that (explicitly), but the message I get from them was that you're a small community, you don't need that much." – Victor Jumbo

SKFN's agenda is aimed at protecting a homeland and culture using science and IK while the GNWT's is to retain the Canadian State's power and entitlement to resources within the traditional territory through co-management. This is further complicated by disjunct federal legislative duties, academic directions, and slow bureaucratic processes that stall protection and drain local capacity. Moreover, lack of in community support for grass roots action amplifies challenges associated with community-led protection. SKFN experiences significant hurdles when actualizing community driven monitoring on a large scale such as universal logistical issues when planning trips, delays due to increasing no-travel days due to inclement weather, and rising costs of business. These facets of the research process are overlooked when projects are confined to deadlines, budgets, Western developmental agendas, and linear methods. This results in unactualized solutions within the community, reinforcing issues of knowledge transfer, low capacity, and external reliance.

One example raised in interviews was the AAROM program. Participants speak highly of AAROM but state impact is limited by discontinuous funding, level of local engagement, and ability to understand data outside of workshop environments. Margaret and Victor in their response to Q13 describe how AAROM data is not integrated into a local database or policy but feel it mostly sits in binders in the office for annual review. Land users must transmit observations, concerns, or proposed solutions orally to leadership who have no tools or capacity to organize, contextualize, and report observations to proper partners. Ruby explains an additional cumulative impact is having to schedule trips just to get experts in and out of the community. In addition to $900-$1,400 CAD charter flights in the summer, SKFN must then plan smaller trips, often involving boats, ATVs, and long Hikes, just to get to the specific study area,

which removes essential human capacity away from other tasks. On top of this, lack of local research infrastructure often requires SKFN leadership to evaluate observation credibility, severity of the issue, and whether it deserves a portion of their budget without the proper information. This is a large investment in time, money, and resources, all to be provided with insufficient advice or solutions from the experts they eventually get into the community. For these reasons training and leaving tools inside the community is highly regarded by Chief Dolphus Jumbo and was prioritized by the author. Interviewee's hope government programs and research projects directly involve youth in ground truthing, interviewing, and data analysis.

This theme demonstrates, problems often arise in the socio-political actualization of braided or TWAO methods, not their development. Challenges arise when increasing interdisciplinarity for remote communities as multi-lateral partnerships do not capture Dene perspectives of social and environmental change, nor equip locals with the necessary infrastructure and capacity to be self sufficient.

Changing Land and People

Given the multidimensional changes revealed by *Mapping with the Land*, the author asked is there anything that you would want to see documented right away or are there any specifically sensitive areas? Arthur's response "no, it is all sensitive" reflected foundational principles of Dene stewardship; everything is sacred and performs a key role which needs to be respected within a circular perspective. A single discipline, variable, or place never takes priority as circular thinking is applied to consider all relations, our dependence on them, and their inherent value. This response unexpectedly illuminated the hubris of Western environmental

perspectives, the separation of relationships and emotional significance from scientific inquiries. Yet Western sciences 'recognize' the value of emotion-based lines of inquiry, they starkly ignore deeper ethical questions in management due to prioritization of capital, external markets, or mandates. In contrast, Dene connections to the land actively and passively manage the community's wellbeing through maintaining land stewardship and familial relationships.

SKFN desires an ecological approach which extends arbitrary borders to monitor the land, air, and water, all year round. Ruby shared how holidays and the arrival of grants often provide time and money needed to get out with the Land as a community or kickstart priority initiatives. In addition, Elders are ageing, youth are distracted or at school, and the daily duties of modern life prevent most from receiving the opportunity live according to their desires. Arthur identified winter data collection as a problem due to youth being out of community at school in Fort Simpson and Elders needing a travel escort due to safety protocols. This results in less time for environmental education through traditional activities or organized workshops fundamental to Indigenous land management.

Ruby states fear lingers within the community surrounding the hazards of a changing climate. A sense of freedom and preparedness is fleeting within Elders as the community approaches a climate confined way of living reliant on external markets, other cultures, and unreliable services. Arthur and Ruby are concerned about the rate of change, wondering how shifts in the efficacy of SKFNs Indigenous knowledge systems may require the community to learn traditional protocols and practices from other First Nations and cultures. The unpredictability of weather conditions is reducing harvester confidence as well as opportunities to practice, build on, and share their knowledge. Ruby believes land feature and seasonal

differences will exacerbate these issues, requiring SKFN to resort to float planes or helicopters to plan excursions to previously accessible locations. Ruby specifically noted that the overcomplication of modern processes and technology reduces SKFN's self-sufficiency leading to greater stresses on local capacity and funding.

These responses indicated SKFN was unsatisfied with the existing monitoring framework and validated the importance of improving documentation and reporting protocols which specifically target variables across a wider range of environments and disciplines. Additionally, this warranted investigation into how cultural protocols, ontologies, and epistemologies may be influenced by co-occurring environmental and socio-political changes.

Traditional Protocols in Sambaa K'e

Participant responses stress that Dene Law guides social and environmental interactions with the land. Protocols are essential for harvesting food, transferring knowledge, and strengthening familial relations which instills ethical and responsibility-based ethos within individuals and society. Protocols and Dene Law are threatened by environmental changes and imposition of Western lifestyles and ideological approaches which impede or undermine connections to the land and people. The rate of landscape change and frequency of local observations exceeds the rate at which SKFN can fill knowledge gaps under hindered protocols and sluggish external support systems. This directly impedes decision-making related to cohesive revitalization and management solutions. Ruby Jumbo explains how Dene environmental stewardship and traditional protocols are intertwined beings which build capacity from the ground up.

"There are also protocols going with picking berries……. You can't just go grab them. It takes patience picking one by one. Its all one by one. And that's patience. And today my one of the youths, thanks me for teaching her. She said thank you because that taught her patience…..its also healing too, attached to it. You're sitting there, on the Mother Earth, you're healing from it."

– Ruby Jumbo

Ruby's quote demonstrates the intricacies of land use activities and how they offer foundational learning opportunities needed to understand what societal protocols are in place, why they exist, and what skills they offer in one's journey. Attuning skills, virtues, and philosophies is essential to conducting land use according to Dene law. Margaret and Victor responded with teachings about the importance of developing new protocols with respect to technology and the land, as "the land is changing and so are the Dene" – Margaret Jumbo.

Margaret explains how back in the day they had radios, and their parents told them they were not allowed to use them on the land or when doing certain activities. They always had to be there watching, paying attention, and learning. Margaret expresses frustration that their generation were forced to adapt to the new and novel challenges of modernization and are confused why there is so much trouble laying down similar rules today. Victor added to Margaret's idea commenting on old traditions and knowledges being replaced by unreliable technology. Victor explains youth prefer taking short cuts to get information rather than putting in effort to learn their cultural knowledge by asking Elders or figuring it out themselves.

"People in leadership or who require their phones to do their jobs in that moment should be allowed phones but everyone else, mothers, kids, youth, the instructors, should strictly be prohibited from bringing them to these camps, workshops, or on the land"

– Margaret Jumbo.

"Now those kids they're sitting across (on their phones) and go tomorrow its gonna rain, but tomorrow its gonna be sunny. Because they are looking at their phones. By Dene Laws, you look at the sky and you'll know. You'll find out if its gonna rain if it will be foggy and all that. Its just looking at some of these kids and some are making short cuts, and they don't really tell us at least. You know sometimes they make mistakes because of those little boxes (phones). Sometimes they say its gonna rain or snow and its nice and sunny. "

– Victor Jumbo

These responses highlight how the primary institutions of education and equitable governance (the Land) are being ignored and replaced for Western based ideas, technologies, and systems. Ruby explains how this issue is further influenced by the introduction of external markets and economies. Elders and Ruby fear traditional foods will become delicacies as less and less people hunt and fish and access to store bought food increases. Dry meat and fish are already coveted by youth in the community as only a few land users hunt regularly, and protocols require Elders be served foods from the land first. Ruby's Response to Q5 explores how SKFN is combatting Western economic influence and reliance through a novel protocol related to job sharing in efforts to restore balance in lifestyle.

"In the bigger communities it's more of like, wage scale economies, and there's less people going out With The Land. Its just a hobby only on the weekend. But here I find that First Nations have more flexibility, we can have culture leave, 2 weeks for fall hunt, for families to harvest for the winter." – Ruby Jumbo

Job-sharing protocols provide community members bi-weekly jobs and enough currency to purchase Western goods followed by two weeks off for traditional activities like harvesting wild foods for their families or upholding sacred duties and responsibilities. Sambaa K'e has been practicing job sharing in the community for decades. Job sharing is SKFN's way of resisting complete assimilation into Western culture; if they lose their land, their time, and their family ties they lose everything of what it means to be Dene. Not only is balanced living a form of economic resistance but it allows for cultural resistance through traditional activities and environmental stewardship acts. Ruby expresses that this is an example of an essential future protocol that must be developed, one teaching to balance time spent working and being With the Land.

Dene culture revolves around IK and specialized skills being passed on orally and experientially through with the land learning and following protocols. The proliferation of Western extractive policies, ecological change undermines youth-Elder engagement which is the key to embodying protocols and maintaining accountability.

Youth - Elder Engagement in Sambaa K'e

Participants agree that engagement With the Land is an essential Dene responsibility. If ignored, declines in intergenerational knowledge transfer will lead to the irreversible loss of

Dene cultural knowledge and practices. Participants divulge into the complexities of youth-Elder engagement amidst environmental and socio-political changes outlined above. Participants fear not enough exposure may lead to youth becoming disconnected from the land and culture to the point of avoiding participation in Dene activities all together. Elders fear youth may seek refuge in the comforts awarded by Western society and rights-based thinking. Intergenerational relationships to the land preserve traditional knowledge through equipping the next generation with the foundational tools, ethical frameworks, and practical skills needed to orient the future of the land and people within Dene Law. Elders believe embodying Dene Law in action means investing time and love into family relationships, traditional roles, and being with the land.

Ruby in QR6 cites traditional healing, moose hide tanning, fish harvesting, and environmental workshops as foundational WTL activities which strengthen cultural connection within the community and heal residual effects of colonialism. Arthur states that it is equally important for the Elders and adults in addition to the youth to participate in workshops and continuous learning, stating "*Its how Dene learn, its how Dene get stronger".* Margaret and Arthur explain, experiential learning allows youth to understand what the bush is all about and build their self-confidence as Dene. Margaret indicates Elders and adults must assume responsibilities as teachers who maintain cultural and linguistic strength within Sambaa K'e.

"As leaders and Elders and grandparents in the communities in the Dehcho, we need to maybe once a month or so, get them all together and explain why its so important. This is very important. The lake is important. The river is important. The trees. The plants. The Earth. The water, the rain. Everything is important. We need to protect those. That's why we're doing this. I

don't think anybody has time to sit with them and explain and that's why were held back. Because they don't know why they are out there. That's why they said it's so boring." - Margaret Jumbo

Margaret and Victor re-state new roles, responsibilities, and protocols must be included in future explanations of what the bush and living the Dene way is all about. Ruby highlighted a novel role for youth in bridging the technological gaps between older generations. Arthur stated despite the many obstacles everyone encourages youth to go out WTL and fulfill the role that the Elders have done before as much as possible. This highlights the importance of restoring the traditional systems of stewardship which yield generations attuned to the land and equipped with the wisdom of their Elders. SKFN centres this approach around language, education, and healing. Effective management of the land and people via traditional ways of living are thus functions of intergenerational interactions with the land and dependent on external factors such as environmental and socio-political change.

Residential schools and forced assimilation bring feelings of shame, guilt, and embarrassment leading to challenges when normalizing Dene Yatié in everyday language. Ruby states that last time she checked she has 30 youth, and out of those 30 only 2 came into adulthood fluent in Dene or only 6 %. As stated on the July 20th WTL day trip, Elders feel shameful and guilty about their knowledge and do not pass it on, while youth feel shameful and guilty for not knowing their culture. In both cases it is neither of their faults and it leads to both parties receding from trying. Ruby mentioned the meaning behind the words Elders use and the tone in their voice is challenging for youth to interpret leading to misunderstandings, high-tempers, and emotionally charged activities. She says everyone feels they must be incredibly

detailed and considerate when talking depending on the demographic. Community members often lack the specific linguistic, cultural, and practical knowledge needed to fully understand and effectively communicate in either Dene or English. Ruby expressed her father expects her to know everything just because she is Dene. Ruby replied with reverent frustration, "*Being Dene doesn't mean you inherently know these things*." Margaret and Victor in response to a different question stress how relatives can easily learn to be Dene and speak Dene with a little dedication and effort, as Dene is inherently within them. This stood out as a similar example of disconnect in understanding between age groups resulting in unintentional obstacles to intergenerational association, as alluded to by Ruby. It could be argued youth may feel discourage when they hear statements like Margaret's and Ruby's father's as they may see their inability to quickly pick up the language or cultural activities, laws, or protocols as something wrong with them. On the other hand, statements like these are meant to instill confidence, resilience, and strength within youth.

These responses represent the unimaginable struggles Indigenous peoples experience related to changes in socio-cultural perceptions, traditional knowledge, and familial systems. These life affecting changes are not focused on enough in governance, local research, and NWT policy. Psychological and sociological traumas greatly contribute to the overall issue of Indigenous peoples losing connections to their culture through disintegrating cultural cohesion and unreliable environmental systems brought on by troublesome Western connections to nature. These challenges intertwine with the thesis research question and proposed GIS-based praxis which aims to answer it. Revitalization-oriented stewardship provides an opportunity to

reinvigorate responsibility-based land ethics in governance strategies through traditional healing and cumulative impact monitoring.

Mapping With the Land; Stewardship in Sambaa K'e

"To me it's important because it's always been important to our people and our Elders. They kept the land. They were land users, and we do a lot of land use. And everything out there needs to be monitored. The trees, the land, the water, the animals, and the birds. That's our future. So, you know they really drill a lot of things into us even as tiny kids. If you're not gonna make a good use of it don't bother hurting it. There's a lot of things that strictly are Dene law" – Margaret Jumbo

Margaret's quote perfectly illustrates that stewardship is, and has always been, present in Sambaa K'e culture, way of life, and world views. Ruby explains good opportunities come from support of stewardship-based initiatives including protection, training, and involvement. Benefits and protection are awarded by structured, governmentally recognized, and Dene value-oriented frameworks such as IPCA's, Dehcho Guardianship, and Indigenous asset ownership. Arthur explains in response to Q6 that a recognized protected area and central place for documenting and sharing changes has been something long discussed by Elders. He expressed a sense of urgency in creating these resources now so that when things continue to get worse year after year, the community is that much more prepared. Arthur believes actions and roles are essential when managing the IPCA and GIS framework. Arthur says Elders and adults should be taking a more active role in leading outsiders around or in tourism by bringing guests on the traplines, stopping by the lodge, and grabbing people for a ride if they are open

to it. Ruby relays a similar response stating the GIS framework could be used for documenting things like popular travel routes, ancestral trails, land use areas, dangers, hunting grounds and IK before it is lost to time. The use of aerial imagery and ArcGIS pro capabilities may allow for less experienced demographics and tourists to navigate and feel more confident with the Land on their own.

"We need more help and scientific ways to deal with climate change and youth need to get involved. More training like Deanna and Shannon (referring to the in-community training conducted by researcher during time in field). Teach them more about it so they get used to it and can help them out to go forward." – Arthur Jumbo

Ruby explains how the GIS framework can assist the Sambaa K'e people to walk in the path of their Elders again. Specifically noting inter-communal trail systems and camping grounds used for trade, ceremony, visiting family, and more. Ruby dreams of a day where the communities can band together to reopen these ancestral trails for community use and Indigenous led tourism. Ruby and Arthur share how the map may improve their safety plans, something notably important with increasing reports of troubles on winter roads, rough waters, thinning lake ice, and wildfires. In conversation, the author communicated direct benefits of aerial imagery and digital tools in development and monitoring for infrastructure such as housing, energy systems, roads, and waste disposal areas (Lantz et al., 2020; Flynn et al., 2019; Hansson et al., 2019; Fawcett et al., 2018; Doré et al., 2016; Daanen et al., 2011).

Question 15 revealed hesitancies and results which undermined certain GIS purposes. Traditionally in Dene culture maps served little purpose, however, current changes to the

environment and culture have led to a knowledge gap. This loss of knowledge and feeling of intangible cultural identity make maps useful for several purposes across generations. First, knowledge was preserved through stories, legends, and experiential learning (Scott, 2015). The lack of barriers to truly living free with the land removed many of the Western rationales for maps such as boundary demarcation, ownership, land categorization, and navigation as stated by Harris (2004) and McEwan (2009). Arthur stated, Dene know the land so well through years of experience, stories, and teachings they hold all the information they need, there is no reason for a map. People not attuned to their environment to the same degree see the land as a series of routes, properties, and resources. Margaret Jumbo proclaims, “Back in the day the people weren’t divided, maps and borders hadn’t been created, and everything was free and everywhere was accessible.” Secondly, when prompted with mapping possibilities in SKFN responses revealed differences in the need for maps based on level of traditional knowledge. Youth and outsiders would seem to use it to fill gaps in knowledge, whereas Elders see the use in documenting observations, traditional knowledge, and decision making. Arthur states teachings and stories warn of areas to avoid and respect which these areas typically align with dangerous or culturally significant locations. Arthur explains however that in light of cultural breakdown, one benefit of the GIS framework would be documenting these places to inform those who may not have this cultural knowledge. Age and level of exposure to traditional living is a major factor affecting levels of this knowledge in the community demographics. A difference between framework use rationale relates to gaps in low capacity for leadership and Elders.

The mapping framework once populated will provide supporting tools to the youth language program, IPCA, CIMP, and more. Specifically, the ability to document words and names will provide an opportunity to practice Dene Yatié writing, spelling, and pronunciation. The community can use the map to strengthen knowledge on the names, words, and places documented by their peers. Other available resources, such as interviews, recordings, SKFN published books, and educational references may be integrated to create an interactive learning experience. Ruby says kids may read things and want to locate or investigate places mentioned in legends, books, or stories using the mapping software. They can mark where they have travelled, what route they took, what they saw, and explore the traditional Sambaa K'e territory helping to educate themselves and future generations who may read their entries.

"Making a path and foundation for them. To make it easier for them. I could be anywhere else, but I chose to come back here because I want to be able to live a prime example for going away for education and then coming back. And then practicing my values of what my grandparents had taught me and my parents taught me before I went away for school." – Ruby Jumbo

Discussion

Mapping *With* The Land: A Living Research Approach

A living research framework is one where the research is conceived, fostered, and sustained through individuals, institutions, and ways of living. Co-developed research questions and continuous consultations suggest that SKFN must aim to solve *specific* problems, *collectively,* through a consolidated framework rooted in Dene culture. Existing project results and supportive tools were effectively linked through a consolidated framework acting to

analyze trends and relationships between in-situ data and external datasets. Prior to the development of this thesis, SKFN lacked the in-situ ability to effectively store data, build solutions, and actualize them, *with* the land. The accumulation of capacity issues due to continuous lifestyle adaptation, ethical compromise, and inadequate actualization of solutions dilutes SKFN's ability to create self-sustaining progress. Researchers and contractors often complete their contract, research objective, or mandates and stop there. Methodologies such as these reduce the socio-political actualization of solutions on the ground for communities.

Exemplar evidence of this is seen in lack of community access to the GIS shapefiles of Dene Place names used to create SKFN's private 3rd edition book, *Wisdom of our Elders*. This required the author to dedicate several hours trying to diligently reproduce previously completed and paid for work, using less accurate visual identification techniques as coordinates were not available. This time and energy could have been utilized more effectively if simple actions were prioritized by external bodies, such as building the local capacity required to use any information created for the community, in this case GIS files. Time could, and should, have been spent furthering training of community members on GIS techniques, refinement of survey QA and QC protocols, or the digitization of previously undocumented cultural locations. This is time the Elders, community, and Land cannot afford to waste. This relates to other aspects of environmental and socio-political management where guidelines and data are left in purgatory until enough funding comes through to get bodies in the community to conduct piece meal studies which provide needed infrastructure, synthesize disjunct results, or integrate Indigenous perspectives to make the work meaningful. This is an insanely backwards approach given regional, territorial, federal, and international commitments to truth and reconciliation,

climate protection, and self-determination. Pre-emptively correcting this oversight was a main thesis focus and was achieved by ensuring supportive tools, knowledge, and resources were provided and accessible in the community. More importantly, it was achieved by orienting research approaches towards Dene ways of knowing and being so that the framework could be naturally integrated into Dene ways of life.

In response, *mapping with the land* created pathways to interdisciplinary research and meaningful reconciliation within collaborative approaches through indiscriminate local engagement and project customization. This specifically addresses gaps expressed by Smith et al., (2017) and others pertaining to limited roles, voices, and responsibilities of Indigenous Peoples, specifically youth and females, in participatory mapping, government programs, and academic projects. This also helped account for 'consultation fatigue', as suggested by Young et al. (2020) and others, through engaging multiple participants, effectively planning time, and reducing burdens of research participation. It was found a consolidated database and circular approach may expedite consultations, improve cross-cultural understanding, and reduce clashes between outsiders and locals. As users navigate through Dene placenames, community collected data sets, and the swath of environmental changes they will see the evolving identity and landscape of Sambaa K'e. The capability to document audio and video gives SKFN the opportunity to preserve voices and stories from Elders, youth, adults, and researchers reaching beyond 2D representations; providing insight into the places and spaces as they once knew it by capturing the nuances of sacred connection to the Land and Dene oral story telling traditions.

The default format of data files within the GIS database allows SKFN to contribute to, or access, data belonging to various knowledge archives spanning decades of research such as the

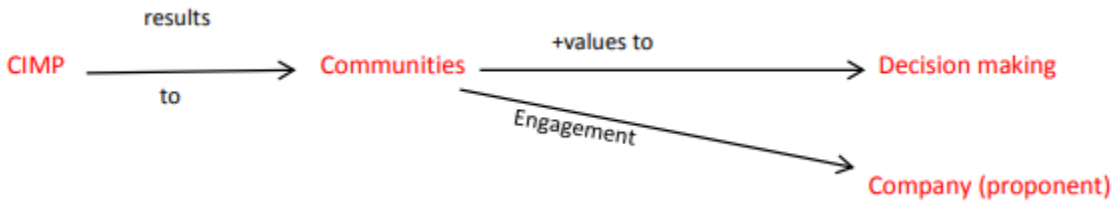
Dehcho First Nation website, GNWT Discovery Portal, and Canada Climate Change Data Portal. The extensive list of potential data sets, scientific instruments, and cartographic techniques that can be integrated with the praxis going forward allows SKFN to transform With the Land observations into statistically validated outputs and informed strategies. Layering landscape change data with these deeper 'unmappable' (Becker, 2014) aspects of land and people creates the necessary circular perspective to move forward *With the Land* according to Dene Law. Respecting the role of intergenerational knowledge transfer systems within data collection and dissemination procedures directly facilitated the philosophical evaluation and development of novel protocols related to embedding *mapping with the land* principles in different aspects of community life. A developed two-eyed seeing praxis and database provides context of the cultural connection Sambaa K'e has had with the territory since time immemorial in a way which facilitates spiritual discussion. This ensures academics receive information through correctly oriented lenses as generally requested through literature (Mantyka-Pringle et al., 2017; Scott, 2015; Smith, 2015; Larsen & Johnson et al., 2012; Beckford et al., 2010; Louis, 2007). How to do this is less understood in practice although utilization of GIS in this approach has risen in popularity (Stenekes et al., 2020; Johnson et al., 2015).

This thesis in response provides an easily customizable template to incorporate empirical observation, Indigenous Law, and cumulative impact stewardship into a praxis which sparks deeper conversation, relationships, and understanding between knowledge holders, land users, and future generations. Mapping *With* the Land is therefore a perfect embodiment of a living research approach as it centers working together to leave behind a dynamic record of this sacred connection through documenting lived experience according to a Dene informed

operating procedure and social framework for organization of grass roots action which reorients SKFN members towards routes of self-determination and living *with* the Land, not on it.

Mapping <u>With</u> the Land Integration

Figure 7 displays dissemination techniques used in the Dehcho region by AAROM, CIMP, and local communities, according to a 2016 Dehcho K'éhodi meeting report (DFN AAROM, 2016). Small improvements have been made over time although the process for mandating how high-level decision-making incorporates knowledge generated by communities on the ground through stewardship action and self government is still a large gap. This general format can be related to wider government agendas, developmental plans, and mandates for engagement which ultimately influence in-community capacity through controlling funding, time, and cultural revitalization. For example, under this framework SKFN and other communities lack meaningful collaboration from company or proponent levels; a major player in stewardship effectiveness. This is highly reflected in interview responses, as clashes between oil and gas entities and Indigenous communities have occurred across the region for decades.



<u>Figure 7</u><u>: Dehcho CIMP dissemination technique. Source: DFN AAROM, 2016</u>

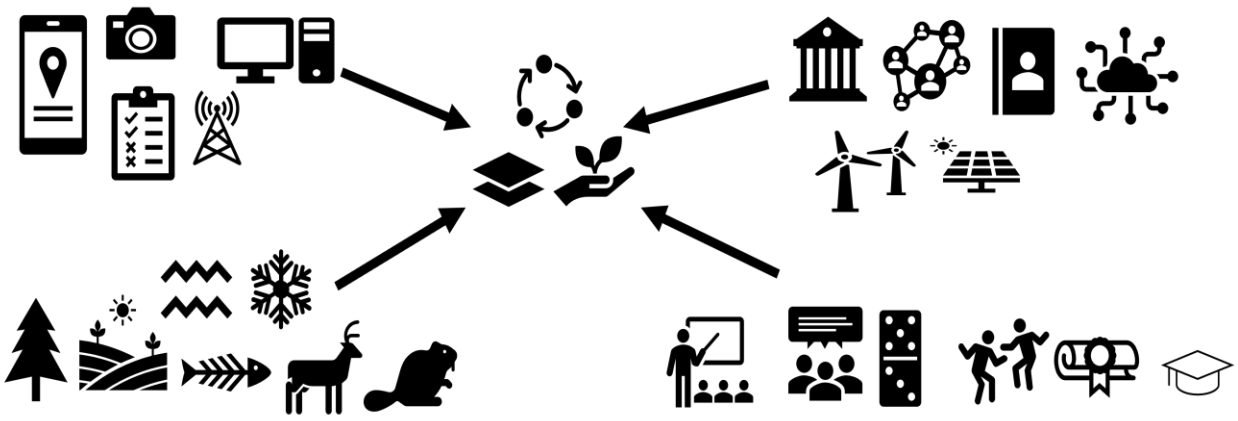


Figure 8*: Recommended dissemination technique utilizing SKFN cumulative impact monitoring and land stewardship framework. © Michael McPhee created in Microsoft PowerPoint*

Figure 8 displays a proposed improved dissemination framework for the region utilizing SKFNs GIS stewardship framework, visualized by an interconnected layering of stewardship components: the land, people, policy and environmental innovation. This improved framework equips all parties with omni-directional data collection, sharing, and contextualization abilities grounded in layering cumulative impact data collected in a land-based context to reduce socio-political barriers to actualization. Circular thinking within a stewardship context could facilitate balanced relationships between physical and metaphysical beings and the systems which sustain them. Creating a living stewardship framework means the research is embodied within a variety of individuals, systems, and journeys of knowledge production through holding collective accountability to all relations in our actions. True success of this methodological approach lay not in cumulative impact design but the subsequent coalescence of an ethically informed stewardship framework which transcends Western societal limitations of Nature to Nation coexistence. This directly advances the misplaced stepping stones laid by Leopold

(1966), as pointed out by Cronon, (1995), Marie & Grande (1999), and Whyte (2015), as it shifts all actors and stakeholders within this framework from “plain citizens” (Leopold, 1966) to directly engaged stewards of the land of the people, upholding historical connections to The Denendehé (Land of the People). Engaging all ages and all voices in the living research framework through enacting traditional protocols of land stewardship and cultural responsibility in SKFNs scientific and social endeavours platforms the expression, protection, and honouring of Dene identity in governance, collaboration, and northern research. Integration and application of this tool is therefore a key component in understanding how Western influence, ecological change, and barriers to socio-political actualization will converge within SKFN’s land management approach.

Mapping <u>With</u> the Land Application

" We have to have somebody to like, what I said, send our youth to go to university to learn these things because we don’t have those kinds of tools to put up fancy stations and all these things. Pairs of youth and Elders, with dedicated local scientists, local or not local to begin with, to help monitor and research these questions." – Margaret Jumbo

Changes in macroscale energy balances, population dynamics, and landscape stability were substantiated with harvester testimony and compared with literature. Data collection identified numerous areas, processes, and impacts associated with 11 survey themes providing a holistic view of change around Sambaa K’e. An observed shift towards a redistribution of water on the landscape through changing storage, flow, and energy pathways are like those reported in literature (Janowicz, 2008; Jacques & Sauchyn, 2009; Connon et al., 2015; Carpino

et al., 2018; Devoie et al., 2019; Quinton, Pearson & Sioui, 2022). Interview responses emphasized the need for a comprehensive ecological watershed approach to aquatic and terrestrial monitoring as these shifts are having a cascading effect on ecological, geophysical, and cultural systems. The eco-cultural management style characteristic of the NWT indicates Indigenous Nations or communities may find advantages in sharing certain strategies, data, and limited resources to develop a community-specific but territorially synergistic standardized protocol for environmental management.

Several guidelines around environmental and cultural impacts have been developed in support of local communities (Marchildon (Complier), 2016; Saturno et al., 2023; Henri et al., 2021; Popp et al., 2020; Proverbs & Lantz, 2020; Hovel et al., 2020). Similar approaches can be applied to all 11 themes of SKFN's in-situ database to create a comprehensive management plan which incorporates local scientific and Indigenous perspectives around circular thinking (Parlee et al., 2014; Ramirez-Gomez et al., 2016; Johnson et al., 2015). Saturno et al., (2023) and others provided a systematic map protocol for integrating Indigenous perspectives in Boreal Forest Caribou conservation planning (Smith, 2015; Chen et al., 2018). The monitoring of caribou lichen presence, behavioural changes, and developmental locations over the field season may aid in linking GNWT guidelines with SKFN WTL action (Simmons et al., 2012). GNWT guidelines state "patches of undisturbed habitat need to be at least 100 km2 in size to be considered a large habitat patch" (Government of Northwest Territories, 2022). During oblique aerial identification with Jessica Jumbo these guidelines were not integrated in the survey as they were unknown to the author. Integrating guidelines going forwards for ground, aerial, and imagery-based identification methods can improve quality control and recommendation

compliance. Additionally, studies on caribou sensory impacts recommend 6 km and 40 km buffer zones, dependent on development size, to be established for sight and sound pollution sources (Rabesca et al., 2017; Beauchesne et al., 2014).

Results from similar studies can be aligned with specific reports of animal disappearance and incorporated by refining a variety of specifications in the questionnaire to all applicable species, processes, or phenomena (Olson et al., 2016; Jayaratne, 2021). This can be done by utilizing the multidisciplinary nature of academic literature and the interdisciplinary capabilities of the 11-theme structure. Potential impacts from future development can be mitigated based on integration of community specific data, the latest policy recommendations, and tailored projections of climate change. For example, a variety of environmental aspects can be improved through tailoring the framework to match specific literature on improving community well-being or local education (Wali et al., 2017; Gilmore & Young, 2012; Campbell-Arvai, 2019; Allen et al., 2014; Datta, 2018; Beckford et al., 2010). Studies applying similar methods as Cohn et al., (2022) or Stenekes, et al., (2020) may provide a beneficial framework for integrating SKFNs traditional aquatic knowledge program with the GIS framework to enhance water quality and fish monitoring efforts. AAROM may be able to utilize the layering capabilities to create recommendations, improve data analysis, or identify new monitoring locations given the availability of policy-integrated and community-driven data (Von der Porten & De Loë, 2013). Understanding links between changes on the land and affects on aquatic systems is a large gap which becomes exponentially larger under changing hydrological pathways and disturbance regimes (Baldwin et al., 2017; Jacques & Sauchyn, 2009; Kokelj et al., 2005). This framework may facilitate the production of new knowledge which relates to cascading impacts affecting

essential Dene systems and be used to identify hazards on the landscape (Mantyak-Pringle et al., 2017; Flynn et al., 2019). One such example is the intersection between change in aquatic species health, erosion, and harvester accessibility.

The increasing severity of mass wasting events (Rich et al., 2007) in fluvial and shoreline environments seen in Sambaa K'e should be integrated with biological, hydrological, and chemical data to inform harvesters of aquatic ecosystem stressors, processes of riverbank erosion, and riparian succession. Several other studies in the area and within the Scotty Creek Research Group at Wilfrid Laurier University have explored fluvial erosion, fire severity, and river monitoring rubrics oriented to community participation which may be easily adapted. The GIS-framework could be utilized to identify areas affected by MW events, document cumulative impacts of MW pertaining to aquatic systems, and dangers to harvesters. Members may utilize the survey to develop potential adaptation and mitigation strategies via land stewardship which reduce co—occurring impacts such as strains on subsistence and wellbeing (Fawcett et al., 2018). This may include developing harvesting programs around trees affected by windthrow or mass wasting as a resource to support local biofuel production, reduce importation via winter road, or provide local revenue. Mass wasting occurred frequently on sand and clay textured soil. Wind induced mortality of poplar, birch, black spruce, and jack pine occurred in a greater proportion and with damage to plant physiology in areas with loose sandy, fine clay, or non-cohesive mineral soil in comparison to organic soils. Antecedent soil conditions could be monitored closely in conjunction with these events to identify thresholds, process models, and harvesting guidelines. Layering of cultural and environmental variables may be used when navigating how to co-manage or develop sensitive areas. This is starkly apparent in situations

where disturbances occur near sacred sites, like the one documented on the Tony Jumbo Day Trip. The presence of the sacred site in this area prevents certain solutions from being ethically viable from a SKFN perspective and may even increased the priority of mitigation. This highlights the importance of situating perspectives when using the survey to ensure social or cultural dimensions of environmental change are captured and integrated with mitigation measures.

Forested areas were identified as major ecological entities affected by change which pose significant implications for Dene land use. Carpino and Haynes et al., (2021) suggest treed wetlands may be an important stage for forest regeneration and have significant impact on hydrological, ecological, and thermal regimes. Investigation specific to SKFN is warranted due to confinement on result applicability due to study site divergence. Additionally, populations of invasive species in Sambaa K'e require investigation into potential impacts of new organisms which may occupy vacant, non-vacant, or novel niches through competition in an ecosystem with reduced resiliency due to cumulative changes. Influences of these species on ecosystem dynamics amidst increases in opportunistic colonization via ecosystem disturbance and fragmentation should be considered. How the community ought to respond given potential implications to land use, conservation, and culture requires additional mapping WTL directed at understanding competition within food webs and impacts on traditional Dene relationships. This must be considered as soon as possible due to the often-exponential population growth of invasive species and already fragile populations of Species at Risk in the NWT.

Conservation plans essential to ensuring at risk species are protected recommend including customized IK indicators; models or simulations to inform policy; accurate monitoring

based on stewardship teams; and various routes of legislative protection and financial support (Harcourt & Awatere, 2023; Pither et al., 2023; Latta, 2022; Micheletti et al., 2021; Clason et al., 2022). Land stewardship activities may be employed to direct impact mitigation measures such as disturbance prevention, population control, and ecosystem remediation. This study provides a useful template to advance land stewardship which centers the application of traditional protocols in scientific approaches in interdisciplinary conservation research. Effective utilization of simple on the ground observation and GIS analysis techniques assisted SKFN in meeting a variety of goals beyond climate change research. This included resource identification, boundary monitoring, and development planning. In the future, this may include developing protocols and regulations to enhance educational stewardship and the mobilization of youth-Elder monitoring teams.

These examples showcase how existing data, methodologies, and solutions can easily be applied to a participatory framework to inform the socio-political actualization of environmental objectives through increased understanding of change, community leadership, and utilization of existing climate change research within proper cultural contexts. This produces reciprocal benefits as the ecosystem is protected from uncharacteristic impacts through land tenure intervention, which reinforces community wellness through improved ability to conduct traditional lifestyles and cultural revitalization. Furthermore, this provides opportunities to educate community members and harvesters on impacts and their role in protection to proactively understand any secondary impacts on ecology, hydrology, and energy fluxes via future development and land use (Flynn et al., 2019; der Sluijs et al., 2016; Buttle et al., 2009).

Identifying satisfied and unsatisfied needs within the community led to the documentation of educational spaces, potential developmental areas, and culturally significant locations. This is significant as environmental projects often heavily focus on environmental variables but ignore deeper services gained from connections with the land (Syme, 2020; Campbell-Arvi, 2019; Mohammadimanesh et al., 2019; Thompson, Thapa & Whiteway, 2019; Kovach, 2009; Jazeel & McFarlane, 2007). Areas identified with the survey may aid in structuring locations for tourism, cultural educational camps, traditional workshops, and gathering areas (Cajete, 2021; Proverb & Lantz, 2020; Datta et al., 2018; Fawcett et al., 2018; Jarvenpa, 2008; Fuller et al., 2007). Infrastructure and Community observations may aid in directing community land use planning around transitioning energy infrastructure away from fossil fuels, sourcing of local building materials, and enhancing local asset utilization within community adaptation planning. SKFN may improve resource sustainability through transitioning their fossil fuel dependent infrastructure to renewable energy sources like biofuel, solar, and more as outlined in the SKFN Energy Development Strategy through using GIS planning tools to identify suitable locations for each installment of infrastructure. The integration of layered GIS data with real time updates of how the community sees the land changing, currently uses the land, and how they plan to use the land in the future, provides improved capacity to move forward according to Dene Law.

"The Sambaa K'e Dene Band wants to manage and use energy in ways that respect the land and honour future generations. The community is rooted in its traditions and cultural practices and wants to maintain them while introducing new and basic energy strategies" – SKFN Community Energy Plan 2010

Mapping With the Land: Limitations

Despite success, it should be noted limitations exist in current survey design, level of local engagement, and Western influence mainly due to limitations on time, author expertise, and complexity of issues at hand. Gordon et al., (2023) emphasizes the importance of supporting networks of academic and institutional partnerships to actualize Indigenous leadership in braided management approaches and may provide SKFN with useful insights on how to approach specific limitations going forward. For example, if monitoring is limited to ground-based techniques, such as the proposed youth-Elder WTL model, gaps in spatial and temporal coverage will emerge over time as data collection is intermittent, dependent on social factors, and limited by physical travel or observation. Brief training conducted within the community over the field season is not enough to develop and sustain a knowledge base of GIS techniques needed to apply the consistent rational developed within this study. It is imperative this limitation be addressed as it emphasizes the very limitation in overall northern environmental management in Indigenous nations; an access to tools and strategies on the ground is limited by a lack of support, capacity, and knowledge (cultural & Western) needed to actualize them with the land and people independently according to their own values.

In response, Sambaa K'e and other communities undertaking GIS-based stewardship are recommended to take immediate action to develop a local GIS analyst, stewardship monitoring team, and network of support from experts to fill gaps within the framework design, management, and utilization; until someone locally can be trained in the role. This requires a secondary observation method, most logically an imagery analysis component employing

various methods studied across GIS literature. Raw data should be analyzed using geoprocessing and geo-statistics for the research community. Participants express the importance of capturing seasonal perspectives of change oriented around natural cycles of the land. Yearly or seasonal summary points describing notable events, changes, and developments should be added as a layer to the final map to act as a centralized tracking and reference point for leadership. Mapping With the Land monitoring trips of adults and Elders year-round may help to close this reduction in WTL monitoring and contribute to intergenerational knowledge exchange. Limitations remain in relation to data collection during winter months as a direct result of youth being away from community attending education, increased dangers on the land, and internal limiting factors such as capacity and motivation. Weather unpredictability and socioeconomic factors are likely to compound in the future causing further gaps in data acquisition (Fischer & Young, 2007). Encouragement of members to follow traditional teachings of year-round land tenure in combination with passive monitoring techniques such as automated recording units, trail cameras, and space-based monitoring could appease these gaps (Birchall & Bonett, 2020).

Collection of data must work according to traditional teachings and ideas of circular thinking to actualize the practical and philosophical endeavours of environmental management into a common land-based praxis. This is why collaboration between various parties is essential to moving forward as each party lacks some bit of perspective, knowledge base, or power which the other possesses. However, shortcomings in collaboration between multi-lateral partnerships manifest as imposing systems which hinder SKFN engagement, involvement, and discourse limiting progress in this domain. This is emphasized in the difference between

motivations and acceptable techniques employed by various government parties around the world (Zhouri & Pascoal, 2022; Yates, 2022; Tsetta et al., 2005; Stonich, 1989). Although *mapping with the land* remedied the context in which climatic change is addressed by researchers and community members, external challenges remain in terms of how bridging two juxtaposed ways of living and relating with the environmental is actualized within the land and people's hearts.

Two Walking as One, A Current Dilemma

Stewardship is a perfect opportunity to bridge generations, yet significant limitations exist for TWAO approaches due to disruption of IK transmission. Science intensive and data focused approaches limit meaningful community engagement and fail to address key issues of Western cultural imposition on intergenerational knowledge transfer (Gordon et al., 2023; Cajete, 2021; Datta, 2018). This known phenomenon was highlighted when selecting a viable thesis topic during consultations with supervisors and SKFN leadership as typical linear approaches best suited to a master's thesis template were unacceptable to the author due to limited Indigenous involvement. In contrast, projects oriented around high engagement were challenging to parse down into an acceptable sized project that was manageable for both parties. Furthermore, challenges were experienced in communicating the depth of interconnectivity between climate change, cultural revitalization, and research paradigms in a standardized thesis format. In general, this may be a leading reason why projects such as these are not as common in master's programs despite the research need being prominent.

This illuminates a fundamental shortcoming of support systems which inadvertently limit how Nations *ought* to address multi-level objectives through imbalanced power

structures, linear timelines, and different epistemological and ontological systems. Allies are often forced from project inception to conform to Western project designs which prioritize colonially imposed ways of living and being which later impede true socio-political implementation (Hanks & Pokotylo, 1989; Cajete, 2021; Hovel et al., 2020; Tran et al., 2020; Wesche & Armitage, 2014). This often affects institutional support, limits Indigenous-led research, and positions partners in a philosophical dilemma. These are major contradictions to the fundamentals of Indigenous research paradigms which are often set aside in the race to complete agenda driven objectives. Legacy impacts of environmental solutions on cultural integrity due to forced conformity is under studied in relation to specific environmental approaches and loss of IK.

Contemplation on philosophical dilemmas and legacy impacts should be approached through open discussion and treated as a clean slate moving toward progress, not hinderance. This important reflection yielded by this research is comparable to how archaeologists' approach irreplaceable works according to standardized ethical principles. Intergenerational relationships, freedom of expression, and ways of relating are equitable to pottery shards or arrow heads; they must be understood and preserved within their unaltered context. Researchers have a duty to maintain the integrity of the learning environment and record of truth left behind. This extends to the influence our tools have on knowledge systems, management systems, and potential routes of self-determination such as expression and livelihood. This is evident in outlawing of ceremonial practices, reduction in traditional economies, and reliance on markets which has erased much of this living record. The Society of American Archaeology (SAA) is a leading body promoting education around ethical standards

and codes of conduct for archaeologists. The Fundamental Principles of Ethical Archaeology outlined on the SAA website states the first principle is stewardship.

> *"The archaeological record, that is, in situ archaeological material and sites, archaeological collections, records and reports, is irreplaceable. It is the responsibility of all archaeologists to work for the long-term conservation and protection of the archaeological record by practicing and promoting stewardship of the archaeological record. Stewards are both caretakers of and advocates for the archaeological record for the benefit of all people; as they investigate and interpret the record, they should use the specialized knowledge they gain to promote public understanding and support for its long-term preservation." - SAA Ethics in Archaeology Committee (1996)*

As researchers dealing with IK and living records of time and irreplaceable culture, we have a duty to follow similar ethical principles to take care of this living archaeological record. This means one cannot remove material from the context it is found; alter the form, integrity, or existence of the specimen, and must engage in stewardship when in the presence of the record (Hanks & Pokotylo, 1989). These ideas are applied with rigor for remnants of past cultures due to the understanding of how significantly human actions and wrongful ideas can damage the archaeological record, yet this is completely ignored when applied to how we treat living, existing, and vanishing cultures. The same rationale should be applied when interacting with species of the living biological record. Precautionary principles yield protections for vast knowledge sets which stand to be undiscoverable due to the hap-hazard destruction of environment. This comparison helps contextually convey why epistemology and ontology

cannot be overlooked or taken out of the cultural context in which they inherently operate. Specific examples from time in the community starkly highlight this importance.

Changing Epistemologies, Ontologies, and Identities

"I feel ashamed sometime because most of us who went to school were raised in residential school. Like I said, some of us are lucky. We kept our knowledge and everything else passed onto us. But when we had kids, guess what happened. We start speaking to them in English because that's where our knowledge and language is cut off." – Margaret Jumbo

The perpetual adaptation to imposed impacts, restrictive administrative policies, and narrow research projects exacerbate inner conflicts within partners around recommendations proposed by researchers, contractors, and government employees. Moreover, this phenomenon is exacerbated by the tempting benefits of Western tools and technology which often undermine traditional protocols, sacred processes, and self-sufficiency which dilute inherent relationships to the environment as a life sustaining entity. Researchers must actively work at protecting ways of living through developing appropriate frameworks which acknowledge these incongruencies and act to dismantle them, not limit possibilities of expression. This includes developing protectionary protocols for the handling; documentation; storage; and dissemination of data just as much as it includes one related to methodology and dismantling oppressive systems. Interviews emphasized how confidence in Indigenous Knowledge is diminished in the community from climate change and assimilation. Elders feel they need to educate youth and adults on what being with the land really means and how to properly respect it; while adults feel they must watch Elders and youth while with the land to ensure safety. This is concerning as opportunities to engage with the land are affected by

environmental change, scheduling conflicts, and intergenerational differences. This creates multidimensional resistance in WTL engagement which is exacerbated by ineffective responses by researchers or institutions (Folke et al., 2005). This is highly significant as it poses a potential danger as Indigenous youth and adults are increasingly recommended to apply Western rationales in the absence of land-based settings which is known to contribute to divides in intergenerational perspectives (Allen et al., 2014; Wesche & Armitage, 2014; Herman-Mercer et al., 2016). This becomes dire when partners are confined to ways of living which only accommodate narrow research agendas and lack the ability to integrate Dene Law within appropriate intergenerational protocols for educational and developmental safeguards (Sarmiento et al., 2020; Wali et al., 2017).

Colonial cartographic techniques emphasize removal of relationships, stories, and connections to the land in favour of raw data, 2D categorizations, and summarized snapshots (Roth, 2009; Shaw, Herman, & Dobbs, 2006; Harris, 2004). Users should be aware of changing perceptions and ensure proper intergenerational interaction grounded within Dene Law. Literature may provide Sambaa K'e First Nation with further guidance in navigating this matter in relation to youth engagement and use of research tools given challenges of epistemological and ontological change (Wesche & Armitage, 2014; Allen et al., 2014; Cajete 2018; Cajete 2021; Datta, 2018). It is essential Elder and youth perspective, interaction, and embodiment of Dene Law do not diverge due to disintegrating environmental and intergenerational systems. Additional GIS harm reduction measures should be developed with SKFN in light of already apparent differences in framework application between generations. Generational differences can work synergistically if approached correctly, however, if this difference grows due to

environmental and cultural change, this tool may be more hazardous in the long term. Community healing programs are thus essential for the open recognition of these existent barriers, dangers, and valid anxieties between disconnected populations. The author stresses change in social and cultural perception warrants the direct involvement of youth in interview, consultation, experiential learning, and background knowledge development processes. Despite level of youth interest or skills, this provides a terrific opportunity for children to gain baseline knowledge they may be missing that new researchers must learn before collecting data.

This is the epitome of where TWAO is challenged. Although the framework was conceived and developed within SKFN culture, it appears as though the current severity of social and environmental change permeated the very fabric of the living research design. A fractured system cannot progress until the forces which harmed it are addressed. Communities must conduct extensive due diligence to ensure data management, collection, and dissemination practices do not eliminate cultural identity (Hanks & Pokotylo, 1989; Cowan et al., 2012). Engaging in Western practices which may alter the traditional operation and cognition of protocols or systems of thinking and being with the land must be counter acted. This was done by directly incorporating intergenerational knowledge transfer and experiential learning in the design of the survey and social framework to remedy this generational divergence phenomena. It is essential that the framework is used as a support system and not a replacement for experiential learning *With* the Land.

This theoretical framework is useful in emphasizing why youth-Elder interactions with the land must persist in the presence of advanced technology, communication gaps, and

climatological barriers. Further, it highlights the role of ancestral protocols, customs, and procedures of oral and experiential knowledge transmission in maintaining environmental and social cohesion. Land use and knowledge transfer are intertwined beings which need to be respected, accommodated, and enhanced in environmental strategies. More importantly their cultural roles must be acknowledged and inherently protected by overall systems of society, such as in collective philosophies, economics, and geopolitics. This prompted further contemplation of how currently imposed systems in SKFN affect the living record and future of Dene culture.

Juxtaposed Ways of Living

"We have to stop. We have to put our feet down to pick up the language. Were fluent but I don't know why we do it. Because we were taught that. It was engrained in us." – Margaret Jumbo

One example of juxtaposed systems in Sambaa K'e culminating in the direct and indirect harm of the living cultural record is revealed in the Contamination and Waste theme. With the advent of technology, inorganic products, and consumer markets came the simultaneous disintegration of connection to the land, creator, and reciprocity which previously maintained appropriate practices for Indigenous Nations across the globe (Assuah & Sinclair, 2021). It should first be stated the word 'waste' in this context is misleading. Indigenous circular perspectives adhere to natural cycles of death and rebirth which value everything around regardless of their 'service' to human means, so nothing is waste (Csaki, 2016). As a result, many traditional protocols require specific ceremonial practices to properly dispose of materials. However, results show many of these ceremonies are being erased from the living record and are not practiced, or they do not apply to industrialized food systems. The high

expense of infrastructure associated with waste processing and transportation in small remote communities often prompts the use of multiple hap-hazard waste sites leading to environmental pollution. Indigenous inclusion in socio-economic and political discourse is therefore essential to development of solutions to environmental problems which arise from these imposed systems (Spivak, 1988).

SKFN's current waste management approach recommended by WSK is not globally sustainable, nor ethically viable. This is a useful lens which perfectly encapsulates the diversity and severity of TWAO dilemmas within environmental research. The Ruby Jumbo WTL trip revealed the need for a culturally congruent plan for the materials they use, how they are used, and how they are disposed of. Two locations documented over the field season were specifically designated for ceremonial disposal according to traditional protocols. A "Bone Dump" as it is referred to in the community, is a specified location in which any material or product coming from a local animal is to be disposed of, including bones, hair, teeth etc. The second location is referred to as the "Diaper Dump" and is the modern adaptation of traditional protocols surrounding returning diapers from babies to the land. Ruby stated anything which comes from the land is sacred and therefore everything must be given back as a sign of respect and gratitude. Despite the strong spiritual and moral origin of these practices, both dumps contained inappropriate waste such as common household garbage and other trash not acceptable according to protocols, pictures seen within Appendix section IV, Contamination and Waste. This is the result of proliferation of capitalist environmental negligence in global consumer markets being imposed on SKFN through dispossession of land and culture which once sustain dietary needs. Solving issues of unsustainable food systems transcend the reaches

of this research, yet the general mechanism of imposition occurring in Sambaa K'e is indicative of globally systemic issue. One which is central to this thesis' discourse on fighting climate change through community-based solutions.

This example enforces the idea that SKFN's traditional protocols have been ignored and oppressed to the point in which juxtaposed societal development systems have led to levels of acceptable environmental degradation and negligence. Albeit this has occurred through slow introduction of ethically removed economistic approaches to community development, but this is an essential result given this is the main mode of environmental impact across the globe. Reliance on modern goods, services, and fixed external markets are rarely in reach of local efforts though evidently subject Indigenous populations to troublesome circumstances (Romero-Toledo & Jenkins, 2022; Jayaratne, 2021; Thompson, Thapa, & Whiteway, 2019; McCreary & Milligan, 2014; Wesche & Armitage, 2014; Jarvenpa, 2008; Schindler, 2001). This is essential given that with an increase in access to Western goods and services it is expected SKFN will become more reliant on culturally juxtaposed ways of living and complacent with their impacts (Ford et al., 2018; Wesche & Armitage, 2014; McLaughlin & Webster, 2014; Carothers et al., 2014; Andrachuk & Smit, 2012; Pearce et al., 2010).

Complete divergence from external systems such as food and technology are not completely feasible, nor productive. Some Individuals may require access to specialized services such as particular diets, medical services, and social care, highlighting the importance of TWAO ideals moving forward. In response, the community may set pollution caps, establish TK indicators, or employ contamination mitigation techniques. Understanding cumulative impacts stimulate greater philosophical contemplation as a circular perspective of the issue begins to

form. Mapping with the land may assist leadership in designing waste management and food systems more appropriately given connections with larger issues such as traditional harvesting, Dene Law, and renewable or sustainable strategies (Hansen & Antsanen, 2018). Furthermore, Nations should be given proper autonomy in management and production if forced to participate in industrialized food systems; this can be applied to resource extraction or research stations occurring on their lands as well. Destigmatizing harmful perspectives described in the ecologically noble savage by Marie & Grande (1999) will be essential in increasing collaboration between parties. The Narwhal reports on how First Nation communities in BC are strengthening connections to the sacred process of food harvesting through stewardship by reviving traditional foods which have not been harvested regularly for generations (Kwetásel'wet Wood, 2023).

SKFN's dilemma echoes findings from authors like Redclif (2006) which help illuminate the shortcomings of 'sustainable development.' The very progress of humanity is consistently undermined by Western ideological ignorance and the inadequate normalities of globally imposed systems of extraction, exploitation, material extravagance, and reductionist circles of moral concern. These perspectives culminate in social and political systems which treat the land and our relationships to it as lesser value than constant production and consumption. Systems are not oriented around Dene existence which perpetuates due to taking what is needed to survive and respecting reciprocity in necessary extraction. The inherent hubris of sustainable development hinders the very tools, resources, and funding Indigenous Nations receive to combat environmental change. This warrants further platforming of Indigenous-led initiatives

which develop innovative systems of living and tools which support self-determination in ways of living.

Dehcho Dene Land Stewardship as a Governance Approach

"What I think, is that the Federal Government needs to recognize our Dene Laws, strongly. They have their own laws; we have our own laws. They can not tell us you can't use your Dene Laws. We can't. Because it's within us." - Margaret Jumbo

It is clear Western products and systems have met some of SKFN's needs at the expense of certain aspects of Dene culture. Authors conducting work related to cumulative impact indicators such as Tsetta et al., (2005) and Andrachuk & Smit (2012) highlight how wage scale economies and impacts from large out of community projects may lead to individuals experiencing conflict or loss with their culture in pursuit of higher salaries. A declining number of community members making traditional tools and works in Sambaa K'e is directly related to colonization and modernization eliminating the ability, desire and need to produce traditional versions. In effect, criminalization of Indigenous knowledge and identity has pushed community towards external reliance through guilt, shame, and lost knowledge. Despite this reality, interviews convey that SKFN remains optimistic in their ability to adapt to change.

Ruby believes combining traditional berry picking with cross cultural jarring techniques may enhance and revitalize the fading activity regardless of store-bought jam availability. Similar rationale can be applied to other practices such as snowshoes, tools, art works, and more which may be able to adopt modern techniques or materials into traditional processes. A key benefit of revitalizing traditional product making would be mitigating risks associated with

reliance on technology, money, and repair services by providing secondary traditional tools, food sources, and modes of transportation. Additionally, having knowledge holders actively teaching these activities within the community would provide an exemplar opportunity for youth engagement and knowledge transfer. Youth would gain specialized knowledge and experience utilizing the survey framework while engaging With the Land helping knowledge holders gather materials needed to build the product and gain skills engrained within related protocols. In effect, development of novel protocols which adhere to Dene Law but assume a TWAO ideology which allow threatened traditions to continue is a highly valuable result. This retrofitting approach to updating traditional protocols or activities should be explored more locally as it is essential in retaining cultural identity through spirit, WTL action, and a sense of community. Ruby's experience navigating protocol development mirrors SKFNs challenge of revitalizing land stewardship amidst environmental and social change. In both instances, traditional protocols have become obsolete or ineffective either due to change in the very systems in which they function and maintain balance, or they are undermined by Western intervention in Dene affairs.

Researchers, community leadership, youth, Elders, parents, and allies must be aware of these dangers and actively seek out pathways for socio-political actualization of Indigenous sovereign affairs in families, communities, and institutions. SKFN is trapped in a 'ticking time bomb' perpetuated by their esoteric captures relentlessly in pursuit of domination and extraction, sustained by ineffective action and collaboration between citizens. This inaction is manifested through the dissolution of the union between land and people. It can be argued this occurred a century ago in Western cultures, if not more, with the rise of industrialization and

subjugation of environment and personal relationships in trade of development. Thus, grass roots stewardship in all aspects of the community is essential to binding compartmentalized systems and resources into effective actions which align with SKFN environmental, developmental, and cultural objectives. SKFN is currently stuck seeking advice on how to remedy environmental issues while their proverbial physicians are trying to reconcile their own broken relationships to the land. This starkly highlights the importance of integrating traditional protocols, Laws, and systems of relating to the land within all aspects of research. Sambaa K'e members have an ideal opportunity to merge scientific, social, and spiritual pursuits through stewardship outlets such as CIMP, IPCA, and Dehcho Guardians.

Multidimensional change in the use of Dene Law has affected numerous fundamental relationships, activities, and systems which characterize SKFN identity and governance. This is simultaneously exacerbated by the addictive influences of technology and culture oppression of modern society. These ultimately impede the ability for Dene values to be consistently upheld and reflected when engaging in the ground action as they are consistently confined by Western tools and imposed systems. Elders express that Dene Law must be recognized and respected by the Canadian Government for their people to live as Dene. One can imagine an approach which centers the actualization of Dene Law in research process, results, and solutions through adhering to Dene perspectives on knowledge production, sharing, and analysis. This means research should be tied to strengthening individual connections to the land, their relatives, and language (Cajete, 2021). Research with Indigenous peoples should not be used to advance the very dogmas, agendas, and disciplines which oppress them such as land 'management', resource extraction, and 'sustainable' development (Natcher et al., 2005). Advancements in

areas important to society and collective knowledge will emerge naturally through ethically aligned pathways created through the consistent re-evaluation of incoherent relationships we have to our space and place within the ecosystem.

Engaging All My Relations

"*Ancestors from Sambaa K'e territory always strived for the idea of two people walking as one. Because they're teaching their kids their traditional cultural values and language. And then in terms of Western society, they encourage them and sponsor them to succeed in scholarship. Everything towards Western society and putting those two cultures together and making their younger generation stronger."* – Ruby Jumbo

All ages and all voices have directly carved out roles going forward in research and WTL stewardship action in accordance with Dene Law, local protocols, and customary practices. The framework requires collaboration, embracing the responsibility-based land ethics of SKFN culture. Synthesizing cultural praxis with social endeavours through programs focused on Dene Law may motivate members to assume responsibility-based roles and participate within the framework. Engagement with the land and intergenerational communication may lead to experiential learning and embodiment of Dene Law. This may create a positive feedback loop which over time may aid to fill small knowledge gaps and remedy omni-directional resistances between age groups, demographics, and research partners. The author suspects the job-sharing economic framework utilized by SKFN to meet logistical, community, and administrative needs may be able to be modified to support increased monitoring efforts from youth, adults, and Elders via the Mapping *with* the land stewardship design. If Mapping *With* the Land can be incorporated with the IPCA management plan, residents could be given a source of income

through secured Federal grants like Project Finance for Permanence (Changed to NWT: Our Lands for the Future) to conduct land stewardship and conservation. Actualized community-oriented solutions free Indigenous Nations from being trapped looking for solutions from a culture who haphazardly acknowledges the existence of their environmental apathy while simultaneously expanding practices which cause these problems.

The GIS framework enhances SKFNs ability to execute these practices according to mutually developed tools in the face of climatic change. SKFNs stewardship land ethic encourages benefactors, doers, and practitioners to investigate different objectives of stewardship such as ecosystem restoration; environmental conservation; impact monitoring; improving resource sustainability; cultural protection; creating awareness around our space and place within the ecosystem. SKFN can amplify the actions of individual stewards and the relationships between them using the data and capacity multiplying capabilities of GIS. With united investment of resources, compassion, and time into *mapping with the land* SKFN will have the human and cultural capacity to affect greater change. SKFN is now equipped with a limitless foundation to shape their Dene Law informed conservation approach within their IPCA boundary while making recommendations outside of it. SKFN community practitioners may spread awareness through disseminating knowledge into relevant information across jurisdictional boundaries enhancing cohesion between local, regional, and national parties. The SKFN community may protect endangered and at-risk species through traditional land use activities, enforcement of regulations and acts, and supporting protection of their territory beyond governmentally imposed boundaries.

The priority of engaging all our relations through research and cultural revitalization is hard to ignore and equally challenging to communicate with the correct magnitude. Statistics Canada reports "Approximately 237,420 Indigenous people in Canada reported they could speak an Indigenous language well enough to conduct a conversation in 2021, down by 10,750, or 4.3%, from 2016. While most Indigenous languages experienced declines, some experienced a revitalization with large proportional growth. For example, … speakers of Haisla, Halkomelem, Heiltsuk and Michif all grew by a third (33.3%) or more since 2016" (Statistics Canada, 2023). If the true mechanisms of climatic and cultural change are addressed fast enough, Sambaa K'e may be another Indigenous community across Canada turning these statistics positive and preserving one of Canada's unique Indigenous identities.

A Local Study; A Global Approach

"I always told you young people one of these days if there was war happening down south …, and if something ever happened over there and those things (satellites/ electronics) don't work anymore what are we gonna do? …. I was looking at news north and we have a Ukrainian here in Yellowknife. and there's this guy they have his picture there. I was reading it yesterday. And he moved his whole family there. He said its so peaceful" – Victor Jumbo

The increasing devastation left by climatic and cultural change highlights the necessity for communities to integrate social, political, and economic systems around producing a future in which the risks, probability, and impacts of these increasingly frequent disturbances are minimized and mitigated. Although this study is specific to its context, its living research framework could be embodied across traditional lands to increase the interdisciplinarity of self-

determination on the ground for Indigenous nations. Indigenous resiliency and land-based cultures help protect 85% of global biodiversity despite making up only roughly 5% of the global population (Hoffman et al., 2021). SKFN, among other Indigenous Nations and non-Indigenous partners at the forefront of protecting one the largest carbon sinks across in Canada, the subarctic Boreal Forest. Accepting Indigenous ways of living and knowing and their freedom in routes of expression are essential to our global effort to protect the environment.

Victor's quote prompted several important thoughts which synthesize *Mapping With the Land* into a global approach. Victor conveys the importance of reviving self sufficiency to secure a future congruent with Dene values through practicing of Dene knowledge and Law. Victor takes a global approach to expound the fragility of globally interconnected systems of oppression and forced reliance on Nation States through his commentary on Russo-Ukrainian conflict migration. This emphasizes the importance of divesting and diverging from these systems to accommodate future change and issues of humanitarian nature and not contribute to them. Scholars similarly suggest climate and conflict induced migration is a major rising challenge globally (Mcleman, 2018; Nishimura, 2015; Sakdapolrak et al., 2016).

This reality of forced migration was highlighted on a local scale during the researcher's time in SKFN, wildfires forced the evacuation of entire communities and destroyed the internationally renowned centre piece of the Dehcho Collaborative on Permafrost, The Scotty Creek Research Station. A brief time later, in May of 2023 Sambaa K'e First Nation fell victim to this deadly combination as a wildfire reached within 5km of the southeastern edge of the community claiming a house indirectly and burning an area of 842,000 hectares as of late September 2023 prompting months of evacuation (burn size according to a statement to SKFN

leadership by GNWT ECC) (Limberlink, 2023; Limberlink, 2023). A news segment on Al Jazeera, retrieved on YouTube, highlights the importance of grassroots action during the wildfire in Lahaina, Hawaii, USA in August 2023. Noelani Ahia, an Indigenous resident discusses how cultural values instill compassionate resiliency during times of disaster amidst government inaction and discussions of land dispossession, stating:

> *"They (the government) are starting to realize that they don't have the capacity or the relationships in the community to really effectively meet those needs and it's the people coming together taking care of each other as we have always done here in Hawaii … We've been removed constantly over and over and over by the Plantations, now by the over development (and) by the tourist industry, now we have this disaster and there's all this open land it's like people are seeing dollar signs"* - Noelani Ahia, Al Jazeera, 2023

This phenomenon often occurs after other destructive events such as territorial occupations, political regime changes, scarcity conflicts, and land desertification which leave populations forcibly displaced due to inappropriate application of ethics. The added threat of wildfires, exploitation, and forced relocation should be on the minds of SKFN leadership amongst concerns of development and frequent emergency displacement in the territory. This unrelenting destruction of the land through development climatological destruction is the modern form of forced Indigenous displacement and cultural genocide. International systemic issues of global mistreatment and disconnection with the land have led to Sambaa K'e and even the farthest reaches of the world being indoctrinated by externally imposed systems which dispossess self-sufficiency of Nations. Climate change was not caused by SKFN, culturally juxtaposed food systems were not chosen by SKFN, fractured multijurisdictional governance

systems were not preferred by SKFN, cross Atlantic journeys looking for new trade routes were not conducted on behalf of SKFN, but SKFN chooses to steward the land and assert their values on their territory. It is time researchers recognize the paradox we place our research partners in, whether that be the people, plants, animals, water, or rocks. We have a duty to do some introspection of why we are doing research if its true impact is diminished by willful acceptance of their causes. These systems of oppression cannot be continuously accepted and imposed despite full awareness of their role in global suffering and the very issues participatory action research is trying to solve.

Development in proportion to population, economic stability, and geopolitical security is integral to all nations. However, it is not integral to dispossess, extract, and divest from the land and people to achieve this. We are currently in a paradigm where we remedy surface level issues which affect the land and people and not the systems or ways of living which cause them. How this connects to Indigenous land stewardship is through the very idea of Living ***with*** the land, and all our relations. And that means a stark re-evaluation of global systems of oppression. However, I believe equally as important is shifting away from focusing on the oppressors and the systems they impose towards looking at how communities, nations, and ultimately individuals can produce their own, ethically viable systems which empower, protect, and actively care for all relations instead of exploiting them. This is done through forming systems of governance around embodying ethical codes when conducting activities and strengthening familial relationships or in this context Dene Law, traditional land tenure, and Youth-Elder Engagement ***with*** the Land.

This is important as the global issue experienced by collective society isn't necessarily a oppressive body forcing everything to do things out of authoritarianism, but more out of dimming the collective ethical integrity and passion within humanity. This is referred to as the collective unconscious by Carl Jung. This idea of a reduction in the ethical integrity we hold ourselves to when conducting research, daily activities (work, eating, living), or developing nations is key to understanding how to move away from this paradoxical dilemma. Its almost a matter of availability of options which don't exploit the land or people or somehow rely on systems which indirectly contribute to it. I believe passionately in the use of humanities greatest strengths, adaptability, and compassion, to develop solutions which share ethical values and ways of living with the world.

This Mapping with the Land framework provides a multi-dimensional tool to move forward which has these ideas of land stewardship, braided approaches to environmental research, and recognition of culture and ethics-based contradictions fundamentally engrained in its operation and use in guiding future research, discussion, and application. Youth Elder relationships are considered and studied within the correct space, place, and positionality, while actively equipping SKFN with tools that are not reliant on juxtaposed systems to support them. Mapping with the land truly is a living research framework which centers on Indigenous person and value-led self-determination.

A Call to Action: Why so Hard?

The time for organized interconnected stewardship action is now. Proactive planning of Indigenous involvement through locally integrated research economies should be undertaken.

Especially as researchers and communities decide how best to undertake the rebuilding of damaged stations, infrastructures, and ecosystems. The common need to investigate newly revealed scientific and cultural questions because of these events provides an equal opportunity for prior consultation, involvement in decision making, and a clean slate to improve aspects of research relationships in the area. The GIS land stewardship framework may be applied to advance rebuilding, direct evacuation, enhance impact monitoring, and improve prevention efforts related to natural disasters, disturbances, or unexpected emergencies. As stated, the ability to produce informed educational resources for local and external use within the community quickly enhances capacity to disseminate knowledge effectively, and to a wider range of audiences (Cajete, 2021; Cajete, 2018; Datta, 2018). In the future the community can use the framework to direct on the ground action to prevent, respond, and manage potential threats posed by disturbances such as fire and flooding.

The heart of the Dehcho must also be the heart of where novel research protocols are developed to reinforce traditional lifestyles, encapsulate Dene Law, and promote experiential learning with Elders, youth, and researchers. Ultimately the common goal between all actors is getting a holistic view of change across time and space in the Dehcho region while having the ability to link data and resources with each Nation's local objectives and infrastructure. This thesis and framework provide the tools and pathways to achieve this goal. This living research framework will continue to support SKFN as they express their cultural identity through 'Mapping with the Land' stewardship.

Conclusion

Through embracing TWAO ideals, the author successfully addressed objectives a), b), and c) by developing an Indigenous-led GIS-based cumulative impact monitoring and stewardship framework containing 11 themes. This framework targets gaps, actions, or systems, which impede the socio-political actualization of SKFNs self-determination from a place of cultural connection, Dene survival, and interdisciplinarity. It was found TKC agendas were too specific and did not account for variables which facilitate actualized engagement within the community. Expanding survey scope to include circular thinking perspectives and cumulative impact data relevant to past, present, and future generations provided engagement opportunities to a wider range of demographics. Increased engagement and involvement in the project significantly enhanced community representation within cultural, land use, and management contexts allowing additional consideration of initiatives such as food soveringty, tourism, Guardians, and SKFN's IPCA strategy.

Researchers must create ethical routes to solutions which operate within the land based cultural praxis of honouring the creator (Gordon et al., 2023). It is the balance between scientific praxis and social endeavour which yields solutions grounded in Dene culture and Western science interdisciplinarity, the Two Walking as One Dene principle. The advantage of sustained community-led stewardship activities such as inventory mapping, WTL monitoring, and conservation increases the effectiveness of delegating limited resources within SKFN and aids in bolstering individual capacity to make change. This provides an opportunity for SKFN to embody the wisdom of their Elders and achieve their goals through living the Dene way and shaping the future from the land up. This thesis answers calls for meaningful assistance through interdisciplinary multi-level partnerships, local research infrastructure, and the establishment

of pathways for true self-determination and soveringty through stewardship governance amidst rapid environmental change (Cochran et al., 2013). Respectful reciprocal relationships prior to the design and execution of thesis research provided adequate support systems and respective understandings required to accommodate Dene Law.

This research recommended a set of mapping framework applications relative to observations captured within diversified themes. This allowed thesis objectives to contribute beyond institutional and governmental program agendas. Utilizing a survey template developed within the government-academic dynamic of the TKC revealed the common issue of low community engagement due to insufficient consideration of barriers to contribution. Participatory GIS-based cumulative impact assessment via Survey123 and ArcGIS provided an excellent methodology for expanding the consideration of variables important to cultural change in the community. Results from the field season, suggest multi-dimensional changes in geophysical systems across both terrestrial and aquatic environments are occurring leading to a cascading effect on land use, culture, and governance. Most notably, changes in land feature stability, ecosystem population dynamics, and local weather patterns. These are subsequently exacerbating declines in Traditional Knowledge transfer and cultural engagement. These factors account for the largest challenges to conducting traditional lifestyles and achieving desired support through multi-lateral partnerships and stewardship governance. Framework results suggest that a community created geodatabase of observations, actions, and leadership plans created while engaging in ‘mapping with the land’ stewardship activities may provide SKFN with improved capacity to govern their land and people according to Dene Law. This framework emphasizes scientific understandings of climatic, economic, and political change

through a reinvigorated TWAO approach to research centered on traditional protocols, intergenerational knowledge transfer, and informed decision making. The ability for SKFN to leverage GIS capabilities and control the foundation upon which Western science enters the conversation gives a continuous advantage in asserting autonomy over how their opinions are viewed. Results emphasize arguments for interdisciplinarity in frameworks for documenting, planning, and revitalizing land stewardship efforts. The researcher's dedication to building an actionable participatory co-developed living research project ensured the creation of a project design rooted in action, knowledge dissemination, and self-determination.

Future mapping initiatives involving crowd sourced input or impact assessment are recommended to adopt a comprehensive approach to variable consideration, documentation, and data type acquisition. Caution and consideration of epistemological and ontological phenomena is highly stressed to researchers, governments, and Indigenous Nations. This study's wider policy implications related to Indigenous self-governance and the intersectionality of social, economic, and environmental projects should be considered by industry, government, policy analysts, and Impact assessment practitioners. The applications of GIS in community-based stewardship and knowledge transfer and dissemination projects should also be explored by citizen scientists, underfunded groups of action-oriented peoples, and nations or governments with current cumulative impact monitoring programs or initiatives based on participatory conservation. The results of this study further support current research directions to facilitate Indigenous-led GIS cumulative impact mapping and stewardship initiatives to enhance the many ways in which Indigenous populations around the world are represented, engaged with, and given proper autonomy and authority over their lands, knowledge, and the

research conducted on them. This methodology and its resultant framework can act as a pilot project or case study for the synergy between community-based mapping and action-based stewardship programs within complex multi-jurisdictional Indigenous contexts by providing a tested data management system and cultural revitalization procedure.

Fulfilling our role as stewards in the ecosystem must encompass the socio-political actualization of interpersonal relationships, land tenure, and knowledge systems into ethical governance systems. Corrupted social views of nature resulting from dominating geo-political systems and human conceptions of the morally distant 'other' have turned nature into a being of our psyches worst impositions, rather than a network of equal beings integral to our well-being. The most uncertain results of research are often the lives affected, and systems changed by academic work. However, the ability to impact lives and systems as a result of research should be regarded as the most statistically significant measure of validity. Without relationship building taking place first, the opportunity to identify a mutually meaningful research scope is reduced to imposition of preconceived superficial understandings of a stranger's needs and wants. This new way of asserting autonomous Dene sovereignty over SKFN territory while promoting the healing of meaningful relationships from the land up, facilitates healing of this corrupted social view and addresses fundamental issues in collective action.

Appendix

I. Positionality

Recognition of Place

The author is a non-Indigenous, straight, white male who grew up in an upper-middle class, two parent, double income household in Southern Ontario, Canada, a

nation created and sustained through the extraction and systematic eradication of Indigenous nations. The author wants to recognize his space, place, and positionality to convey the ethical motivations upon which his career, thesis, and research relationships are predicated. I recognize my responsibility to conduct research in an ethically correct manner and uphold this responsibility throughout my research. I remain dedicated to fostering relationships with Indigenous Nations in the Dehcho and elsewhere while achieving common goals. I continue to work at developing ethical and respectful foundations for meaningful cross-cultural research design and collaboration with Indigenous Nations focused on self-determination, soveringty, and cultural empowerment. When working within unfamiliar cultures, epistemologies, and ontologies guidance from peers, Elders, partners, and supervisors is essential. The author had only a very brief experience between 2019-2021 working with Indigenous partners in the Dehcho Region during his Bachelor of Environmental Science Undergraduate thesis. Thus, direction from local Indigenous partners and my co-supervisors served as my main guidance throughout the research process. I have always been a student of the land; the land has been my greatest teacher. I learned geography walking across Mother Earths peaks and valleys, hydrology swimming in her lakes and playing in her rivers, biology walking through her forests and listening, medicine studying her plants, and creation and death studying the relationships she sustains. Everything has a purpose in this world, and that purpose is a sacred thing that must be respected in all aspects of our lives, especially our work. I take this idea and project it into my everyday life through my

academics, personal ethos, and circles of moral concern by advocating for fair treatment, self-determination, and autonomy.

Recognition of Space

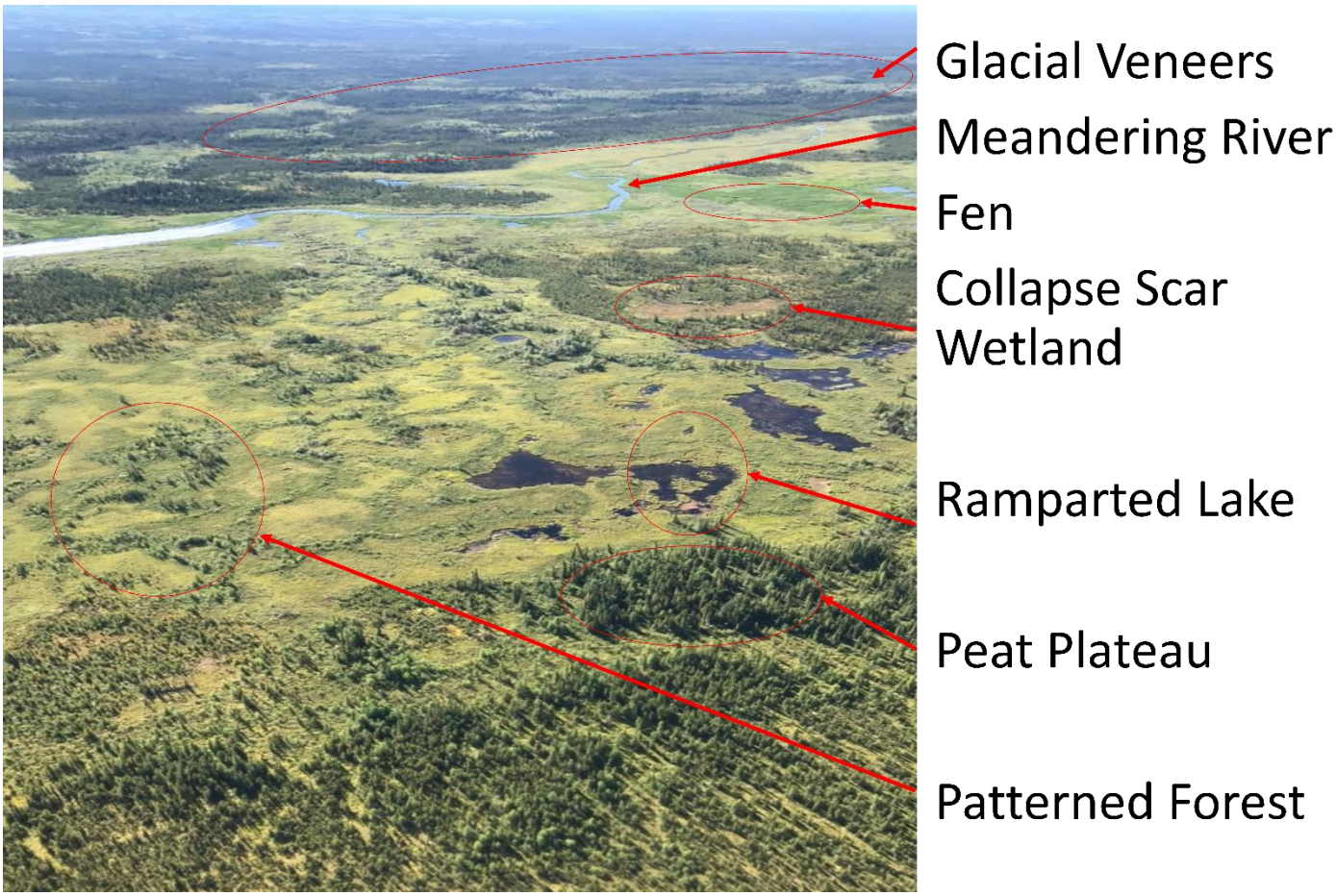
My passion for understanding the natural laws and systems of the universe and how to co-exist within them as humans has always been driven by a child like fascination with the questions why and how. Science seemed like the perfect discipline for me and so I started familiarising myself with how to think like a scientist. Seeing the world as a macrocosm of systems sustained through interconnected relationships that fluctuate between stable and unstable states fascinated me as it brought together my love for scientific thinking and my admiration of the joy and sadness of the human experience. This led to me find a new passion in environmental science because it allowed me to academically explore multiple physical science subjects like chemistry, biology, geography, and consider important human experiences like cultural connections to the environment, geo-political implications, and climate change related policy. This passion came to fruition when I was introduced to Indigenous environmental perspectives. This discipline engages all my academic passions through a praxis centered on compassion, understanding and problem solving.

Recognition of Duty

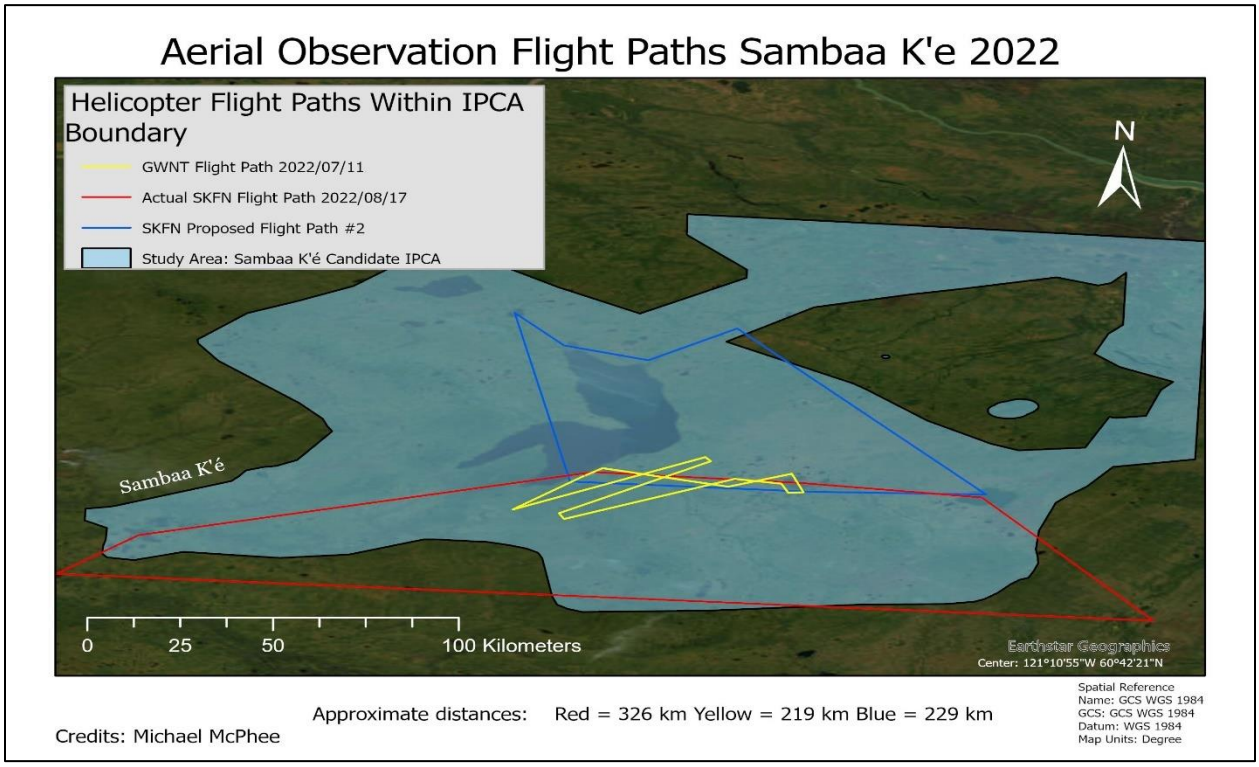
I strongly recognize and want to emphasize my belief that physical scientists cannot address the complexities of climate change without first understanding and incorporating the greater influences of life into a more holistic, interdisciplinary, and

collaborative approach. This approach must operate with addressing ecological breakdown and social inequalities at the heart of its pursuit. In my opinion, climate and environmental scientists have done an outstanding job outlining the issues, projections, reasons for climate change and potential solutions. It is now the job of present and future generations and academics to synthesize this information and apply it to how we are living and interacting with the land and each other to re-write these injustices and inequalities through actionable steps. We need true stewards of the Land, Earth, and people to make the necessary changes to our social and political systems to achieve ecological and economic balance and restore social justice. Too many people are sick with Affluenza (Merriam Webster, n.d), we can no longer rely on the extortion and domination of Mother Earth to sustain glutinous needs at the expense of the vulnerable, dispossessed, and enlightened. Our global society needs to look to living in harmony with all our relations as we are all interdependent on the wellbeing of each other. I am a firm believer that we are a species with the ability to live in happiness and harmony if our knowledge systems and moral motivations are attuned to natural laws of nature. Living with a severed connection to Mother Earth for centuries has effectively disrupted the fundamental driving forces of nature which maintain order, peace and balance within the universe, societies, and individual's lives.

ii. Important Land Features within the Sambaa K'e Territory



iii. Flight Line Map



IV. Mapping With The Land Photos

This section displays a subset of photos taken as observations while Mapping With the Land Hydrological Observations

Periglacial Observations

Mass Wasting Observations

Shoreline Erosion

Weather and Seasons Observations









Contamination and Waste



Infrastructure & Community, Research, and Cultural

Animal, Vegetation, and Biological Process Data

V. Mapping With The Land observation protocol (Private to SKFN)

VI. Protocols, Agreements and Ethics

Several co-developed and pre-existing binding documents were utilized in this study to ensure the protection and safety of participants. Well established and credited territorial and regional ethics and research licences, such as ARI and TSP2 REB (Research Ethics Board), were also obtained prior to commencing any data collection in the field. Due to the sensitivity of data throughout this study, it was imperative that knowledge sharing, collection, ownership, and honorarium agreements were mutually drafted and agreed upon. These agreements were

signed off by the respective official institutional and governmental representatives of both parties as well as individual researchers and participants. The agreements outlined the ethical and professional responsibilities of all parties involved and served as the backbone of trust and transparency throughout the project.

Participant Observation

A participant observation agreement allows researchers to document daily experiences and conversations throughout the field season upon written or verbal consent. Consideration of these deep insights obtained during the nuances of Indigenous methods must be ethically implemented into the design, execution, and planning of the project. To address this Alex Latta on behalf of the SKFN research group developed a participant observation agreement between Wilfrid Laurier University and SKFN which provided informed consent of the documentation and daily note taking of conversations within the community. Informative participant observation pamphlets were distributed around the community to make the community aware of this methodology. When the author would take notes, the author would ask participants once again if they feel comfortable having the conversations documented and used within the thesis.

Informed Consent

Prior to collection of data from community participants and leadership, informed consent documents would be requested to be completed. Three distinct documents aided in simply outlining; rationale for data collection; what data is collected; how data is used; what data will be used for; how data is manipulated; and how data is disseminated. These

documents implemented ownership and control over raw and polished data, the ability to retract, edit or restrict data, and delineated participant anonymity prior to publishing. Each document was uniquely made to suit the nuances of each data collection method. One document pertained to collection of GPS and TK data related directly to the production of the geospatial stewardship framework, one pertained to conducting interviews, and the last for workshops or focus groups.

Honorarium

An honorarium agreement was signed between Wilfrid Laurier University and Sambaa K'e First Nation establishing rates of pay for knowledge, gas, and time. Interview and focus group rates were $50 every half hour capping at $200. Full day With The Land community mapping excursions with Elders or land users paid $200 for the full day for knowledge, $100 for gasoline as travel is a large component, and $100 for an interpreter if necessary. This honorarium agreement ensured Elders and community members were compensated for time they spent interacting with the researcher while With The Land and sharing knowledge, life experiences, and interests. Honorarium payments were tracked through signed consent agreements denoting amount of pay, number of hours, and participant signatures which were then saved by both SKFN leadership and primary researcher. An expenses ledger for housing, food, and honorarium was kept over the field season and an invoice was later turned over to SKFN for approval and submission to Laurier University for payout. All raw data and transcripts were stored on password protected devices and later transferred to an external password-protected and encrypted hard drive kept behind lock and key in line with ethical research protocols and agreements.

VII. Interview Questions_SKFN_M.Sc.Thesis.docx

Sambaa K'e and Michael McPhee Interview Questions

Arthur Jumbo, Victor Jumbo, Margaret Jumbo, and Ruby Jumbo

Sambaa K'e, Wellness Camp August 2022

Q1 Why do you think its important to document the changes you guys are seeing on the land for future generations? (R) Can you talk about the importance of community-based stewardship and monitoring and where you would like to see the monitoring head in the future. what does monitoring mean to you?

Q 2 What role do you think the youth should take going forward in managing the environmental observations and taking care of the land? (M/V): Do you see them taking over the jobs you have been doing in terms of going out on the land everyday? Should it be responsibility based?

Q3. What are some of the changes you've been seeing around Sambaa K'e? Any things that are concerning you within the community in terms of climate change? Can you tell me some things you are excited for?

Q4. Do you think the changes are gonna affect the way people are gonna live on the land?

Q5: (A) How would you encourage youth to get out on the land / Why do you think going out on the land with the Elders is important? (R) why is it important to get youth out on the land? Do you think that would help fix that communication error over time, through just being exposed to the way they talk and how they communicate? Do you think this mapping project will help in restoring that two people walking as one idea? Is this a good opportunity going forward for that knowledge transfer?

Q6. (A) Do you think having something that can document all these changes in one place that youth can look at is important. (R) How do you think the map I am making could benefit the community and IPCA?

Q7: Is there anything that you would want to see documented right away?

Q8. Why is the IPCA important?

Q9. How do you see the community using the map?

Q10. In the past, when researchers have come do you feel you guys have been involved in the research? Can you speak on the role research has played in the past in the community?

Q11. Can you talk about how the community interacted with research in the past, have they contributed to data creation have they used the data the research has produced, or have they participated in the initiatives and programs the research has started? And do you find that when the researchers leave you get access to that data, or does it just sit somewhere?

Q12. Do you think there should be monitoring on the land as well not just on the water?

Q13. So, normally when you go out on the land and you see something that's changed do you usually make a mental note of it, where it is, and what is changing?

Q14. Any changes you haven't seen before?

Q15. Do you guys ever use a map? If there was a map that would show you where there are dangerous areas to travel would you look at that before you go out on the land?

Q16. Are most youth wanting to out on the land with elders? Are they engaging with the traditional activities as much?

Q17: For the protected area, how would you like to see it managed in the future?

Q18. Why do you think its important to speak Dene on the land and teach the kids? Can think of any ways in which this project may get youth out on the land and speaking the language and interacting with Elders?

Q19. What do you think the biggest challenges are that you face when going out on the land?

Q20. When you are harvesting are you finding there's lot of changes from year to year in the numbers?

Q 21. Are any areas specifically sensitive? (Arthur Only)

Q22. What tools do you have right now to respond to the threats and impacts of climate change? And what tools do you think you guys are lacking? Do you think that is something SKFN will want more of in the future? Research that gives you guys more hands-on tools where you can take over that research role in your community?

Q23. Do you think its hard to interact with researchers coming into the community because they are always so brand new, and you can't trust them?

Q24. Is there anything that you would like to talk about during the interview? Any concerns you think are important to address going forward?

Q25. What changes have you seen with the wells?

Q26: Why did SKFN think the IPCA's establishment was important? How did it get established?

Q27. Can you speak to the side of using the map for future decision-making processes in Sambaa K'e First Nation?

Q28 Do you feel my (The authours) research approach, how I interacted with the community and how I set up the mapping initiative, was an effective way to braid western and indigenous perspectives to create a new project that benefits the community and contributes to academia? Do you have any suggestions about how I could have done it better? What things you liked and any thing you didn't?

29 Do you think protocols for harvesting, respecting animals, and the land is important for ensuring climate change doesn't get worse, or, at least so that you as Dene, are doing your role in maintaining balance? Do you see a new generation of protocols being very important going forward, whether that be adopting them from other nations or coming up with new protocols based off what changes you are seeing? I assume that will play a large role in managing the IPCA? M/V: Do you see the potential for creating new protocols for being out on the land in this era of technology and distractions?

Q30. Do you find that there's a big issue with trying to do these traditional activities and live a traditional lifestyle with the influences of wage economies, the need for new technology and things, kind of that capitalistic system vs the traditional lifestyle? Do you find there are challenges in that, how do you see people navigating that in the future, when they have less time to go out on the land and spend with kids because they are at work? (M/V) Is this causing division in the community, the introduction of money and needing to go to work and not having time to spend doing traditional activities and spending time with the kids on the land?

Q31: So do you feel that programs, whether they are for children, adults or Elders, are important thing to keep the culture alive and keep people active and always learning?

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