The Limits and Opportunities of Using GIS as a Boundary Object to Represent Beardy's and Okemasis First Nation (BOFN) Indigenous Knowledge in the Nisbet Provincial Forest Implementation Processes

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ABSTRACT

In Canada, forest and natural resource management is guided by a paradigm that is predominately based on the understandings and values of Westernized society. As a result, the application and meaningful inclusion of other knowledges, such as Indigenous Knowledge (IK), to influence the decision-making process within these management systems is fraught with challenges. Although extensive research has been done on addressing these challenges and including Indigenous communities in a decision-making role, practical and innovative tools are still needed to focus on how IK may more effectively shape forest and natural resource management. My study assessed the limits and opportunities of using Geographic Information Systems (GIS) maps as a boundary object to represent IK in resource planning and implementation processes. Four boundary object criteria were derived from the boundary object literature and used to evaluate the limits and opportunities of GIS maps to act as boundary objects: flexibility, concreteness, joint process, and information need.

The IK used in the thesis was categorized according to the Six Faces of Traditional Ecological Knowledge, a framework developed by Houde (2007). Knowledge for this study was provided from a case study community: Beardy's and Okemasis First Nation (BOFN) of Saskatchewan, Canada. Through document analysis and semi-structured interviews, knowledge was categorized, and GIS maps were then developed to display this knowledge. I then evaluated whether and how the GIS maps were effective boundary objects using the boundary object criteria.

There are four main findings from my study. First, GIS maps have the potential as boundary objects to effectively represent IK in resource planning and implementation. Second, not all of the Six Faces used to inform the GIS maps met the criteria at the time the knowledge for these Faces was collected. Third, some Faces were not suitable to include in the GIS maps, partly as a result of not meeting all the criteria and limitations due to the data that were collected. Fourth, the criteria suggested specific ways to improve on the current barriers inhibiting greater use of IK in GIS maps such that they can function as effective boundary objects. In summary, this research has helped to partially address the gap in knowledge for developing boundary objects to facilitate the use of IK in forest and natural resource management planning processes.

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LIST OF ABBREVIATIONS

Beardy's and Okemasis First Nation (BOFN)

Duty to Consult (DTC)

First Nation Island Forest Management (FNIFM)

Forest Management Plan (FMP)

Geographic Information System (GIS)

Indigenous Knowledge (IK)

Integrated Forest Land Use Plan (IFLUP)

Nisbet Implementation Team (NIT)

School of Environment and Sustainability (SENS)

Traditional Ecological Knowledge (TEK)

Western Scientific Knowledge (WSK)

CHAPTER 1 INTRODUCTION

Institutional and policy processes of natural resource and forest management are biased towards accepting and implementing Western scientific evidence (Ascher, Steelman, & Healy, 2010; McGregor, 2011; Morgan & Cole-Hawthorne, 2016; O'Flaherty, Davidson-Hunt, & Manseau, 2008). However, Indigenous rights and the role of Indigenous communities in these processes are increasingly being recognized on a global scale (Gratani et al., 2014; Parsons, Nalau, & Fisher, 2017). Thus, it is important that researchers and policy makers find ways to accommodate multiple ways of knowing, such as Indigenous Knowledge (IK), in established and conventional policy processes (Morgan & Cole-Hawthorne, 2016; Wyatt, 2008). Effective and innovative methods are still needed in research to gain an understanding of how different ways of knowing, such as Western Scientific Knowledge (WSK) and IK, may be used together to inform policy processes (Berkes, 2012; Houde, 2007; Robinson & Wallington, 2012).

For the purposes of this thesis, WSK is defined within this research as a body of knowledge characterized by a combination of a "particular set of values with systems of knowing based on empirical temporal observation, rationality, and logic" (Usher, 2000, p. 186). IK is defined as "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission" (Berkes, 2008, p. 7).

In Canada, forestry governance and decision-making have been largely determined by government or industry experts, who create forest management plans that provide detailed information on forestry services, resource use, and objectives of forest activities (Bettinger et al., 2016; Wyatt, Kessels, & Van Laerhoven, 2015). The assumption that only these forestry experts should be involved in this decision-making process has been challenged by the general public and Indigenous people since at least the 1970s (Wyatt et al., 2010; Pearse, 1976). The knowledge of Indigenous communities is grounded in the significant time their members have spent on the land (Berkes, 2012; Berkes & Berkes, 2009; Mazzocchi, 2006). This knowledge and the knowledge systems in which it is embedded may benefit forest planning processes, thereby helping to support more effective and sustainable management decisions (Cummings & Read, 2016; Tripathi & Bhattarya, 2004). However, including Indigenous people and their knowledge is not simply a matter of implementing new actors and information into a

database. Rather, it requires significant consideration about these knowledge systems and how they may be brought together in a way that is mutually beneficial and respectful (Polfus et al., 2014; Robinson et al., 2016; Robitaille et al., 2017).

Issues such as epistemological differences, contextual distinctions, power relations, and ontological challenges are all presented as obstacles that may deter WSK and IK from being successfully brought together (Diver, 2017; Lewis & Sheppard, 2005; Mercer et al., 2010; Nadasdy, 1999; Raymond et al., 2010; Robinson et al., 2016; Robinson & Wallington, 2012). To address these challenges, researchers have suggested that boundary objects, models, or information may have the potential to create a space or common ground to facilitate communication about different knowledges between different social worlds. Boundary objects are objects that have the ability to cross different social worlds and satisfy the needs of each of these worlds (Star & Griesemer, 1989). Geographic Information Systems (GIS) maps may have the ability to be boundary objects in the context of forest and land use planning involving Indigenous people because they have the ability to transfer knowledge across boundaries in a transparent and accessible way (Tripathi & Bhattarya, 2004). These systems are designed to exhibit land use intensity, natural resource use, and socio-spatial information (McLain et al., 2013; Tripathi & Bhattarya, 2004). Therefore, the specific aim of this thesis is to investigate how Indigenous people and forestry experts may come together to develop a collaborative and shared forest management plan.

My study examines the forest management plan (FMP) of the Nisbet Integrated Forest Land Use Plan (IFLUP) in the Province of Saskatchewan and the potential for this plan to include a greater amount of IK, not only in the planning documents but also in implementation processes of forest and land use policies. To evaluate the potential for including IK into the implementation processes of the FMP, I performed a single case study of the Beardy's and Okemasis First Nations (BOFN) community. In doing so, I developed the research question: What are the limits and opportunities of using GIS maps as boundary objects to represent IK in Nisbet Provincial Forest resource planning and implementation processes?

The research objectives are as follows:

1) Identify existing sources of previously collected IK related to BOFN land use;

2) Synthesize the collected IK[1] related to BOFN land use to create a comprehensive visualization of the available IK;

3) Identify potentially missing BOFN IK not previously collected or analyzed;

4) Understand whether and how GIS maps can be used as a boundary object to advance the use of IK in the implementation process of the FMP for the Nisbet Provincial Forest;

5) Develop good practices, including recommendations, on how to represent and implement IK in FMPs, which may allow for long-term sustainability of the forest resources in which multiple stakeholders are vested.

To address these objectives, this research contributes to both the conceptual and applied aspects of IK inclusion within natural resource and forest management in Canada. From a conceptual standpoint, this research explores the contexts of Indigenous engagement and IK knowledge implementation within forest governance. In practice, this research aims to develop an understanding of how GIS maps may act as effective boundary objects to facilitate and meaningfully include IK within an FMP. This research also aims to understand what features may increase a boundary object's effectiveness, how GIS maps may demonstrate these features, and how to improve the implementation of IK within forest planning processes. The overall goal of this research is to create good practice recommendations that suggest methods for how to expand on these theoretical and practical contributions and to advance the sustainability of the Nisbet Provincial Forest by improving the decision-making processes.

In this research, Nicholas Houde's 2007 article Six Faces of Traditional Ecological Knowledge, is used as a conceptual framework for analysis. The Six Faces are: Factual Observations, Management Systems, Past and Current Uses, Ethics and Values, Culture and Identity, Cosmology. By leveraging the Six Faces framework, I categorize previously collected BOFN IK by using defining characteristics of each Face. These categories of knowledge inform the layers needed to create a GIS map. These GIS maps may then act as boundary objects for communicating the land and resource use associated with that specific Face. In this way, Houde's conceptual framework provided the context I needed to collect empirical data and

[1] I use the term IK in my research instead of other terms, such as TEK. The definition I use and my justification for using this terminology is discussed in Chapter 2.

evaluate the opportunities, barriers, and knowledge gaps for implementing IK into the FMP using GIS as a boundary object. The characteristics and categorical process are discussed in more detail in Chapter 2 and 3.

This research was carried out in three phases. First, I conducted a qualitative content analysis by performing an archival document review of the BOFN History Report (2013) and a cache of traditional ecological knowledge (TEK)[2] that had been catalogued by research scientist, Mr. Michael Bendzsak. Then, I performed a categorical process by placing this IK into the Six Faces of TEK[3] outlined by Houde (2007). Second, I attempted to place this categorized IK onto a GIS map. Third, I interviewed BOFN community members and the Nisbet Implementation Team (NIT) members. During the interviews, BOFN participants validated the IK depicted on the GIS maps, and they were also identified the research gaps in my study. NIT participants were able to assess the feasibility of these GIS maps as a way to include IK in a natural resource and forest management context. As well, both BOFN and NIT members were able to provide more knowledge to inform the GIS maps. The interviewing and mapping process are discussed in more detail in Chapter 3. In conjunction with the categorical process informed by the Six Faces, I developed four boundary object criteria to determine the efficacy of GIS maps as boundary objects. These criteria were flexibility, concreteness, joint process, and information need.

This thesis comprises seven chapters, the first being this introduction. The second chapter provides a detailed overview of the relevant literature, research originality, the defining characteristics of each criterion, and the author's position within this study. The third chapter describes the background information for BOFN and the NIT, the three-stage methodological approach, and the interview questions used in this study. The fourth chapter presents the findings of the study, including the modified GIS maps created after the interviewing process, and the limits and opportunities found for using GIS maps as boundary objects. The fifth chapter is a comprehensive discussion that evaluates the findings of this study, ties these findings to the broader literature, and investigates how these findings and GIS maps met the boundary object criteria. The sixth chapter offers good practice recommendations based on the major findings of

[2] This cache was created using the term TEK instead of IK. I use the term IK in my research due to my interpretation of their differing definitions. This is discussed more thoroughly in Chapter 2.
[3] Houde used the term TEK, but I view his work as a conceptual framework in my study and used the term IK instead. Justification is provided in Chapter 2.

this study and the general limitations of this study. Lastly, Chapter 7 states major conclusions and identifies potential areas for future research.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This literature review synthesizes and critiques the literature related my study, exposing the gaps and debates that underpin my research question: "What are the limits and opportunities of using GIS maps as boundary objects to represent IK in Nisbet Provincial Forest resource planning and implementation processes?" First, to understand the context for this study, I define and discuss the terminology used in this thesis, including IK. Second, I address the inclusion of Indigenous perspectives into scholarly research, including limitations that may impact the effectiveness of this knowledge inclusion. Third, I address forest management, land use planning, and natural resource management in Canada before turning to Indigenous perspectives within these management processes and explaining the precedent for these processes in Canada. Fourth, I address Houde's (2007) Six Faces of Traditional Ecological Knowledge (TEK) and my choice of his research paper to provide a conceptual framework for my study. Fifth, I discuss boundary objects, including how they are used from Indigenous perspectives, and the four defining characteristics of effective boundary objects. Sixth, I address GIS, particularly the role GIS plays in forest and natural resource management, ways in which GIS is used as a boundary object, and the perceived challenges of using GIS as a boundary object when implementing IK into a management context. Lastly, I discuss the originality and significance of my own research and how this research may contribute to the literature regarding IK and its effective facilitation across knowledge boundaries.

2.2 Definitions and Context for This Study

The terms referring to different knowledge systems are dynamic and constantly evolving. Knowledge systems and their processes are culturally constructed (Stevenson, 2005) and are valid within their own social/cultural context (Gratani et al., 2014; Mistry & Berardi, 2017; Parsons, Nalau, & Fisher, 2017; Weiss, Hamann, & Marsh, 2013). Therefore, it is important to define the terms used throughout this thesis: Western Scientific Knowledge (WSK), Indigenous Knowledge (IK), and Traditional Ecological Knowledge (TEK).

WSK is defined within this research as a body of knowledge characterized by a combination of a "particular set of values with systems of knowing based on empirical temporal

observation, rationality, and logic" (Usher, 2000, p. 186). IK is defined as "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission" (Berkes, 2008, p. 7). This definition parallels the idea that IK is localized knowledge that is institutionalized and carried through consecutive generations and is the basis for decision making in many Indigenous communities (Berkes, 2008; Nyong, Adesina, & Elasha, 2007). Additionally, IK provides a direct connection between people and their surrounding environment (Berkes, 2008; Nyong, Adesina, & Elasha, 2007).

The definition of TEK used in current studies is almost identical to that of IK. For example, TEK is defined as the "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, 2012, p. 7). When compared to the definition used for IK, the definition of TEK seems to be narrower, specifically focusing only on humans and the ecological environment. Ultimately, this narrower definition for TEK could limit the significance of the findings in my research as not all findings can be considered ecological. Because IK refers to localized knowledge Indigenous communities may have about their environment that is not just of an ecological nature (Berkes & Berkes, 2009), I have thus used this term in my research.

2.2.1 Characteristics of IK and WSK

My study focused on two knowledge systems: IK and WSK. Both knowledge systems are valid and applicable to the people who use them to understand their own realities. Table 2.1 lists the defining characteristics of both IK and WSK. These characteristics distinguish the differences between these knowledge systems and highlight the knowledge boundaries between them. However, subtleties and variations within these knowledge systems exist, and these knowledge systems are not mutually exclusive. By understanding the elements that comprise both IK and WSK, I was able to identify the significance and applicability of my findings within decision-making processes in a forest management context.

Agrawal (2014) argues that, based on current research, IK may be different from WSK in three main ways: substantive, methodological or epistemological, and contextual grounds. "Substantive grounds" refer to differences in the defining characteristics of the knowledge system or the subject matter (p. 9). "Methodological or epistemological grounds" refer to the

differences in worldviews held by either knowledge system and the differing methods each system uses to decipher reality (p. 9). “Contextual grounds” refer to IK’s reliance on a foundation deeply ingrained within the surrounding environment (p. 9). These three main differences are embodied by the defining characteristics depicted in Table 2.1.

Table 2.1. Comparisons between IK and WSK

Category	IK	WSK
Substantive	**Holistic and dynamic** (Aikenhead & Ogawa, 2007; Berkes, 2012; Berkes & Berkes, 2009; Johnson, 1992; Mazzocchi, 2006; Tsuji & Ho, 2002) **Spiritual aspect** (Berkes, 2012; Mazzocchi, 2006; Tsuji & Ho, 2002)	**Based on positivism and reductionism** (Aikenhead & Ogawa; 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Morgan & Cole-Hawthorne, 2016; Tsuji & Ho, 2002) **No spiritual aspect** (Berkes, 2012; Tsuji & Ho, 2002)
Methodological	**Focused on inter-relations between human beings and the environment** (Aikenhead & Ogawa, 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006) **Stimulated by survival** (Aikenhead & Ogawa, 2007; Tsuji & Ho, 2002) **Orally and culturally transmitted through generations, privately held** (Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Tsuji & Ho, 2002)	**Stimulated by scientific curiosity** (Aikenhead & Ogawa, 2007) **Written down and documented throughout peer review, publicly available** (Berkes, 2012; Johnson, 1992; Nursey-Bray, 2014; Tsuji & Ho, 2002)
Contextual	**Accumulated by experience on the land** (Berkes, 2012; Berkes & Berkes, 2009; Johnson, 1992; Tsuji & Ho, 2002) **Information depends on context and local conditions** (Mazzocchi, 2006)	**Accumulated through scientific or research methods and publication** (Berkes, 2012; Mazzocchi, 2006)

These characteristics distinguish IK from WSK in a variety of ways. IK is usually holistic and focuses on the inter-relationships humans have with nature (Aikenhead & Ogawa, 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Tsuji & Ho, 2002). The information comprising IK may be driven by survival and an inter-connection with the environment (Aikenhead & Ogawa, 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Tsuji & Ho, 2002). Due to the idea that IK is stimulated by survival, information is passed down generationally through verbal communication and stories and is usually not recorded in any formal setting, such as academic articles or publicly available books (Aikenhead & Ogawa, 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Tsuji & Ho, 2002). This knowledge may also be held by certain individuals or groups of individuals, and some individuals may have more IK than others, increasing the diversity of IK. There is a strong spiritual aspect to IK, and it may be based on a certain belief system that interprets natural phenomena differently than WSK (Berkes, 2012; Mazzocchi, 2006; Tsuji & Ho, 2002). Lastly, IK is developed over time by the experiences within a certain location (Berkes, 2012; Berkes & Berkes, 2009; Johnson, 1992; Tsuji & Ho, 2002) and is dynamic enough to adapt to changing contexts or conditions of the surrounding environment (Mazzocchi, 2006).

Comparatively, WSK is a different knowledge system than IK. WSK is founded upon positivism and reductionism (Aikenhead & Ogawa, 2007; Berkes, 2012; Johnson, 1992; Mazzocchi, 2006; Morgan & Cole-Hawthorne, 2016; Tsuji & Ho, 2002). This knowledge is built upon studies that maybe guided by hypothetical processes (Aikenhead & Ogawa, 2007) that are continuously tested or refuted based on data collected. This knowledge is assumed to be stimulated by scientific curiosity (Aikenhead & Ogawa, 2007), advancing through the use of technology and exploration rather than within the context of survival in a set location. WSK is typically explicitly written down in journals, academic articles, books, online, and other similar resources (Berkes, 2012; Johnson, 1992; Nursey-Bray, 2014; Tsuji & Ho, 2002). Many of these resources are publicly available or are released to certain groups or individuals. WSK has no spiritual aspect (Berkes, 2012; Tsuji & Ho, 2002) for reasons stemming from the foundational dimensions of this knowledge, which are based upon reasoning, rationalism, and skepticism.

As discussed above, IK and WSK have many distinguishing characteristics that distinguishes them as two different knowledge systems. However, both IK and WSK share

similarities as knowledge systems and the above table contains generalized assumptions perpetuated through the relevant literature of IK and WSK. This table was created to establish the understanding that a knowledge boundary exists between IK and WSK despite the similarities they may share. In the next section I will discuss the role IK has in environmental, forest, and natural resource management and the challenges that may evolve when working with IK and WSK.

2.3 Indigenous Knowledge in Current Research about Environmental Management

On a global scale, IK is increasingly recognized as a significant knowledge source that contributes to environmental policies and management processes (Berkes, 2012; Parsons, Nalau, & Fisher, 2017; Robinson & Wallington, 2012; Tripathi & Bhattarya, 2004; Zurba & Berkes, 2014). This increased recognition of different knowledge sources may be driven by the realization that WSK has dominated Western understanding of the environment and that relevant knowledge may lie outside the WSK realm (Chilvers & Evans, 2009; Löfmarck & Lidskog, 2017; McGregor, 2011). IK is recognized as its own knowledge system with multidimensional elements that could impact policy and planning (Houde, 2007; Mistry & Berardi, 2016; Usher, 2000). IK, which is typically highly detailed and experienced based, may contribute to effective solutions to problems commonly found in socio-ecological systems (Parsons, Nalau, & Fisher, 2017; Polfus et al., 2014). For instance, insights from IK have may lead to growing appreciation for the relationship between humans and their ecological rights and how to create policies based on these relationships (Diver, 2017; Reo et al., 2017; Robinson et al., 2016; Robinson & Wallington, 2012; Wyatt, Kessels, & Van Laerhoven, 2015). Ultimately, research involving multiple forms of knowledge, such as IK and WSK, requires accommodating and translating the diverse values associated with these knowledge systems (Robinson et al., 2016). This accommodation may use different knowledges in a mutually respectful way to address environmental issues and to develop effective management outcomes (Robinson et al., 2016).

Despite the growing recognition of parallel knowledge systems, many academic studies state that IK is viewed as an extension, subordinate, or complementary source of knowledge alongside conventional knowledge systems, such as WSK (Diver, 2017; Parsons, Nalau, & Fisher, 2017). Consequently, academics who traditionally use Eurocentric methodologies have typically viewed Indigenous communities as objects of study (Arnold, 2017; Cruikshank, 2004)

or view the Indigenous perspective as merely culturally significant, which may perpetuate the marginalization of Indigenous communities and their knowledge (Maclean & The Bana Yarralji Bubu Inc., 2015). Directly feeding into this observation is that Indigenous participation is "underrepresented in all professional and academic fields" (Arnold, 2017, p. 479). This underrepresentation could lead to uncertainty of how to deal with the diversity found in IK and how to standardize this knowledge once it has been provided (Mistry & Berardi, 2016; Robinson et al., 2016). Based on the findings of these studies, my study argues that underrepresenting IK may decrease or limit Indigenous community participation and engagement, which could directly decrease the amount of IK available for future research.

IK has not been effectively included in environmental management processes and policymaking (Gratani et al., 2014; Diver, 2017; Reo et al., 2017). Failure to include IK effectively into management processes may not be because of the knowledge itself but rather institutional barriers limiting this knowledge from being included (Gratani et al., 2014; Ross et al., 2016). These barriers may result from limitations in political systems that comprise of separate and distinct legislative and bureaucratic policies derived by the government (Gratani et al., 2014; Ross et al., 2016). For example, consultation processes may be inhibited by the assumptions made by a government or managing group that all communication may go through a limited number of representatives of an Indigenous community, who may also be expected to speak on behalf of the entire community (Ross et al., 2016). This consultation may meet the legal requirements of Indigenous consultation; however, Indigenous community members may view this engagement as inadequate and would disregard it as effective collaboration (Natcher, 2001; Ross et al., 2016).

Indeed, many barriers have inhibited the effective implementation of IK in management processes. These barriers may include limited Indigenous engagement and participation within the decision-making process, limited representation of an Indigenous community, and insignificant IK inclusion within planning and policy processes (Diver, 2017; Gratani et al. 2014; Robitaille et al., 2017; Wyatt, Kessels, & van Laerhoven, 2015). To overcome these barriers and limitations to Indigenous engagement, a greater appreciation for IK is required; as well, there is a need to acknowledge that both IK and WSK are different but equally valid ways of knowing and

understanding the world (Gratani et al., 2014). In other words, if research is to benefit Indigenous communities, they must be actively and meaningfully involved.

New approaches are needed that emphasize the significance of both IK and WSK in creating sustainability solutions under terms beneficial to the communities involved while also promoting active participation by Indigenous communities (O'Flaherty, Davidson-Hunt, & Manseau, 2008; Parons, Nalau, & Fisher, 2017). My study offers a unique and practical tool to acknowledge these barriers to promote the facilitation of IK across knowledge boundaries and effectively implement IK within forest management processes.

Identifying the role of IK in environmental governance allowed me to address challenges likely to arise when using IK in my own research. There is room to learn more about the role of IK and Indigenous people and how they contribute to decision-making processes. This thesis addressed this partial gap in the research in the context of forest planning and management.

2.4 Forest Management, Land Use Planning, and Natural Resource Management in Canada

Forests provide an abundance of products and services to support both the livelihoods of communities and a competitive forestry industry, which contributes a great deal to the economy (MacDicken et al., 2015; Rotherham & Armson, 2016). Recognizing the significance of these services and finding innovative methods to protect these forest resources in perpetuity are the main goals of sustainable forest management (MacDicken et al., 2015). Forests need to be well managed so that sufficient stewardship systems can sustain the health and productivity of forest resources in perpetuity (Rotherham & Armson, 2016). Therefore, the planning processes involved in forest management are important because they outline the activities to be implemented within the forest, explain how these activities contribute to the overall goals of the plan, and describe how these activities may influence other natural resources (Bettinger et al., 2016).

2.4.1 Indigenous Perspectives in Natural Resource Management Processes

The role of Indigenous communities in forest and natural resource management are increasingly being recognized (Crook et al., 2016; Huntington, 2000; Tripathi & Bhattarya, 2004). This recognition may have developed because there is a greater acknowledgement of the intimate knowledge Indigenous communities have of their local environment and its complex socio-ecological systems (Crook et al., 2016; Noble et al., 2016; Polfus et al., 2014). This

knowledge may be highly detailed and comprehensive due to the significant amount of time their community has spent on the land (Berkes, 2012; Berkes & Berkes, 2012). Effective forest management plans require holistic knowledge of regions in which Indigenous communities may reside and to obtain this knowledge, a basic understanding of the IK that these communities possess is needed (Henn, Ostergren & Nielsen, 2011). As a result, knowledge based on extensive experiences of Indigenous communities holds value for these plans and therefore needs to be incorporated into the planning process (Crook et al., 2016; Gratani et al., 2014). As Chilvers and Evans (2009) argue, "knowledge-making is incorporated into governance, and governance influences the making and use of knowledge" (p. 356). Understanding why and how forest management plans are made is important to my research, as it is in this context in which IK and WSK ultimately come together to shape the outcomes for forested land and resources.

An example of Indigenous engagement and inclusion within management processes is Mistik Management Ltd., a "50% Aboriginal-owned forestry company operating in the Boreal forest of Northwestern Saskatchewan" (Chambers, 2004, p. 175). Although faced with challenges such as unequal stakeholder participation, limited government support, and inconsistent funding (Chambers, 2004), Mistik Management Ltd. incorporates public involvement from all communities that depend on the forest, including Indigenous communities. Multiple stakeholder involvement has many advantages, including relationships based on trust, minimal conflict, higher employment, increased community capacity, and more IK used in forest planning and management (Chambers, 2004). Mistik Management Ltd. is an example of how Indigenous participation and IK have been successfully included within a forest management process to promote resource sustainability for more effective decision-making.

Another example of an Indigenous community with authority over resource management is the Haida Nation in Northern British Columbia. The Haida Nation is engaged in an integrated marine planning initiative for the Pacific North Coast Integrated Management Area (PNCIMA) and this initiative is led by the Haida Nation's governing body and Council (Jones, Rigg, & Lee, 2010). This process has allowed for the development of co-governance partnerships between Indigenous and non-Indigenous groups who both support the conservation and sustainable use of marine resources (Jones, Rigg, & Lee, 2010). With an active role held by the Haida Nation, their values and place-based knowledge are integrated into management approaches (Jones, Rigg, &

Lee, 2010). Jones, Rigg, and Lee (2010) argue that a government-to-government process is needed for Indigenous and provincial governments. As shown within the context of ocean governance, the involvement of Indigenous communities in resource management may result in the establishment of a network of protected areas where Indigenous communities may outline its placement and level of protection (Jones, Rigg, & Lee, 2010). Other results may include a shift in planning to a local, place-based management of resources, and management processes that incorporate the principles of social equality and ecosystem justice (Jones, Rigg, & Lee, 2010).

The above are just two examples of Indigenous communities implementing resource management processes. As Cummings and Read (2016) suggest, the decision-making processes for forest management planning may improve when IK is used to inform policy positions. With that being said, there is still a need to bring practical tools to the table to include IK more effectively within a management context and it is in the category of methodological tools that my thesis contributes. Specifically, my research attempts to fill this gap by providing a practical approach for including Indigenous communities in forest and natural resource decision-making through a process that uses a framework to display IK in parallel and collaboration with WSK. This collaboration may influence the implementation processes of decisions made within a management context, and, as a result, allow IK to practically impact decisions made about local natural resources and forest use.

2.4.2 Challenges to Natural Resource and Forest Management Processes in Canada

Forest management planning is now guided by the paradigm of sustainable forest management that strives towards the "production of forest goods and services for present and future generations" (MacDicken et al., 2015, p. 47). Sustainable forest management in Canada is supported by federal, provincial, and territorial laws, regulations, and policies that favor western science-based approaches to decision-making and form the basis of forest management plans (Government of Canada, 2016). Yet, having an FMP does not guarantee that the goals and policies within it will be effectively implemented into management processes and governance (MacDicken et al., 2015). The decision-making process is structured according to Western paradigms (McGregor, 2011) that are heavily reliant on WSK. Local communities, both Indigenous and non-Indigenous, depend on these forest management decisions. The consequences of these decisions may differ depending on whether provincial or federal law is

involved. Provinces and territories are responsible for roughly 90% of Canada's forests, including provincial parks, while the federal government owns approximately 4%, including national parks and land which is reserved for or controlled by Indigenous communities (Government of Canada, 2017b). Approximately 6% of Canada's forestland is privately owned and managed (Government of Canada, 2017b). Forest management plans must be created and approved by the appropriate government before being prepared (Government of Canada, 2017a). Therefore, Saskatchewan's FMP, which applies to land where Indigenous communities reside, may be affected by federal and provincial laws.

Researchers have found that active and influential participation of Indigenous and non-Indigenous forest-based communities to be limited within forest management advisory and decision-making processes (Rotherham & Armson, 2016; Nenko et al., 2018; Nenko, Parkins, & Reed, 2018). In most cases, policy and legislative frameworks isolate and exclude Indigenous communities from forest management (McGregor, 2011; Wilson & Graham, 2005). These frameworks may restrict access to forest resources and limit engagement and participation in decision-making, which would decrease the amount of IK being included within the decision-making process (McGregor, 2011). Overall, the significance Indigenous communities and other forest-dependent communities place on resources may not be fully acknowledged, as primary attention in forest management is given to economic development (Wyatt, Kessels, & van Laerhoven, 2015). This lack of acknowledgement is corroborated by McGregor (2011), who claims that Canadian forestry still predominantly excludes Indigenous communities. Indigenous communities may also hold interest in economic development within forest management (McGregor, 2011; Stevenson, 2005). However, as a result of this limited engagement and participation, these economic interests may not be fully acknowledged or represented.

There exists a tension between the decision-making roles Indigenous communities are legally stated to have and the decision-making power they currently possess and apply. Exclusion from decision-making processes may indicate unequal power relations between Indigenous and non-Indigenous communities, and organizations in Canada (Diver, 2017; McGregor, 2011). These power relations contradict the unique position Indigenous communities hold in forest governance, where their rights are constitutionally protected, and consultation between their community and another governing body must be done on a Nation-to-Nation basis

(McGregor, 2011; Reo et al., 2017; Von Der Porten, & De Loë, 2013). Indigenous communities are currently conceptualized as stakeholders rather than "self-determining nations with inherent rights and governance" (Reo et al., 2017, p. 58), indicating that these communities hold governing positions incompatible with the current practices (Reo et al., 2017; Von Der Porten, & De Loë, 2013). Thus, the potential to influence decision making is possible, but the opportunity is not often exercised. In the same vein, Van Schie and Haider (2015) maintain that current federal policies are inconsistent with the sovereignty of Indigenous communities and the constitutional protection these communities have through Aboriginal and treaty rights.

Wyatt, Kessels, and van Laerhoven (2015) argue that although clearly defined rights and boundaries for sustainable forest management are desired, they may be unattainable, especially if competing claims about ownership exist and if there are various interpretations of what rights are held by which group. These rights include Indigenous communities' proclamations of their traditional rights to land and claims to stewardship established by their own government (Wyatt, Kessels, & van Laerhoven, 2015). The claims to land rights and the diversity of resource use in local environments can create conflict among Indigenous and non-Indigenous actors (Diver, 2017; Wyatt, Kessels, & van Laerhoven, 2015), especially because traditional rights and proprietorship are not fully recognized under Canadian law. As a result, existing forest governance structures and processes may not fully recognize the rights of Indigenous communities, and this lack of recognition could restrain Indigenous community members from benefitting fully from their traditional lands (Robitaille et al., 2017; Wyatt, Kessels, & van Laerhoven, 2015).

This failure to recognize Indigenous rights could lead to further conflicts about the role of Indigenous communities and the inclusion of their knowledge into forest management. Current research is calling for more innovative and collaborative tools that may stimulate policies and planning processes to effectively include different knowledges (Diver, 2017; McLain et al., 2013; Minkin et al., 2014; Olson, Hackett, & DeRoy, 2016; Robinson & Wallington, 2012; Robitaille et al., 2017). These innovations are needed because they could benefit all forest users, allow for the recognition of Indigenous legal rights to land, increase Indigenous inclusion in decision-making processes, and protect the integrity of different knowledge practices (Diver, 2017; McGregor, 2011; Robinson & Wallington, 2012). These benefits include acknowledging

that Indigenous communities use substantial resources and recognizing this significance in the decision-making processes of forest management (Crook et al., 2016; Parsons, Nalau, & Fisher, 2017; Reo et al., 2017).

Without meaningful participation of Indigenous communities, and until effective implementation of their knowledge into strategic planning and decision-making processes are made, forest management plans and policies will continue to be unilaterally shaped by the dominant knowledge framework and actors (Griffith, Diduck, & Tardif, 2015; Robitaille et al., 2017). Efforts to include Indigenous knowledge may be constrained by conflicts, as mentioned above, associated with different knowledge, values, power asymmetries, interests, and political conflicts (Diver, 2017; McGregor, 2011; Robinson & Wallington, 2012; Wyatt, Kessels, & van Laerhoven, 2015).

These challenges establish that a space or mechanism in which Indigenous and non-Indigenous actors can recognize shared interests might bring more IK into sustainable forest management. This space or mechanism may stress the importance of strong relationships between all actors to meet similar management objectives (Lee & Kant, 2006; Kumar & Kant, 2007; Robitaille et al., 2017) and allow Indigenous individuals to express their knowledge in a contemporary context (Diver, 2017). Innovative methods are needed to provide for better opportunities to voice Indigenous ideas and concerns related to sustainable use of natural resources of local environments and increase IK holder engagement in the decision-making and implementation processes (Diver, 2017; McLain et al., 2013; Minkin et al., 2014; Olson, Hackett, & DeRoy, 2016; Robitaille et al., 2017). More inclusive approaches can bring a wider set of values and resource sustainability into environmental management (Crook et al., 2016; Diver, 2017; Gratani et al., 2014; Minkin et al., 2014; Robitaille et al., 2017).

Based on my understanding of the literature analyzed within this thesis, the knowledge of Indigenous peoples about forest and natural resource management planning are increasingly being acknowledged. However, my study contends that the meaningful inclusion of this knowledge using effective and practical tools can be built upon and improved. My study contributes to this body of literature by formulating mechanisms and an improved tool that focuses on how IK may be implemented within a contemporary context. A number of authors, such as Crook et al. (2016), Diver (2017), and Parsons, Nalau, and Fisher (2017), maintain that

Indigenous communities have knowledge that is relevant and valid for inclusion within modern natural resource and forest management.

2.5 Houde's Six Faces of TEK - The Conceptual Framework in the Current Research

The applicability of Indigenous communities' knowledge may be better understood if a framework could help individuals comprehend the complex elements that comprise the knowledge of Indigenous communities. This framework could categorize types of IK to encourage a better understanding of how it might be used in natural resource or forest management. Houde's (2007) Six Faces of Traditional Ecological Knowledge provides a framework that addresses the multifaceted elements that contribute to the complexity of TEK and tries to place this TEK in a categorical format.

Houde's study is a synthesis of typologies and categorical definitions of TEK to understand its complexity and to improve the inclusion of TEK within co-management processes. Houde refers to six distinct "Faces," as indicated in Table 2.2, which are described as follows: Factual observations (Face One), Management systems (Face Two), Past and Current Uses (Face Three), Ethics and Values (Face Four), Cultural Identity (Face Five), and Cosmology (Face Six) (Houde, 2007). Table 2.2 is a list of these Faces and their defining characteristics, while Figure 2.1 is a visual representation of these Faces. Houde's framework is used conceptually in this study because Houde's study uses the term TEK and this study will use the term IK, for reasons stated above on page 1. As Potschin-Young et al. (2018) argue, conceptual frameworks may be used as an organizational structure that may address complex relationships by supporting communication across boundaries. They may also restructure issues and in the context of empirical research, they may also serve as an analytical template (Potschin-Young et al., 2018). By using Houde's framework, the current research accepts the vast range of terminology used in the knowledge of Indigenous communities.

Table 2.2. Characteristics of the Six TEK Faces as Outlined by Houde (2007)

Face 1 - Factual Observations
Knowledge consisting of empirical observations conducted over a long period of time of discrete environmental entities (Castellano, 2000; Freeman, 1992; Houde, 2007; Huntington, 2000; Johnson 1992; Nadasdy, 2003; Neis et al., 1999; Peters, 2003; Simpson, 2001; Turner, M. Ignace, R. Ignace, 2000; Usher, 2000; Wenzel, 1999; Wenzel, 2004). Specifically, dynamic entities that may change at any moment in time. For example, wildlife. (Houde, 2007).
Categorization and classification of discrete environmental entities (Houde, 2007; Johnson, 1992; Neis et al., 1999; Nickels, 1999).
Understanding of the relationships between species, the connections within the environment, spatial patterns, and historical trends (Houde, 2007; Ferguson & Messier, 1997; Freeman, 1992; Johnson, 1992; Nickels, 1999; Neis et al., 1999; Wenzel, 1999).
Face 2 – Management Systems
Practices used to promote the sustainability of natural resources (Houde, 2007).
Face 3 – Past and Current Uses
Understanding of the historical and present environmental uses through oral communication (Houde, 2007; Neis et al., 1999; Peters, 2003; Usher, 2000).
Understanding of past land use, habitation, settlement, and harvest trends (Houde, 2007, Usher, 2000; Wenzel, 1999).
Understanding of where medicinal plants and sites of cultural or historical significance are located. (Houde, 2007; Lewis & Sheppard, 2005). Specifically, non-dynamic environmental entities that do not change locations or adapt to conditions of surrounding environment (Houde, 2007).
Face 4 – Ethics and Values
Internalized value system that dictates the attitudes and actions one may perceive to have towards other humans and entities found within the natural environment (Houde, 2007; Johnson, 1992; Lewis & Sheppard, 2005; Nadasdy, 1999; Simpson, 2001; Stevenson, 1996; Usher, 2000; Wenzel, 2004).
Ethical beliefs that encourage the reflection of environmental usage to avoid exploitation (Houde, 2007).
Organizational structure that presents facts and actions and also acts as a bridge to the fifth face (Houde, 2007; Wenzel, 2004).
Face 5 – Culture and Identity
Past languages and images that act as a foundation for culture (Houde, 2007).
Stories, values, and relationships that contribute to the development, growth, and survival of Aboriginal cultures and identities (Houde, 2007).
Sites or locations of cultural significance that may promote spiritual renewal (Houde, 2007; Lewis & Sheppard, 2005).
Face 6 - Cosmology
The overarching belief system that explains connections between humans and the entities that exist in their reality, including nonhumans (Houde, 2007; Nickels, 1990; Pierotti & Wildcat 2000; Turner, M. Ignace, R. Ignace, 2000; Usher, 2000).
Foundational principles used as reasoning to guide understanding of what part humans play in the world (Houde, 2007; Peters, 2003).

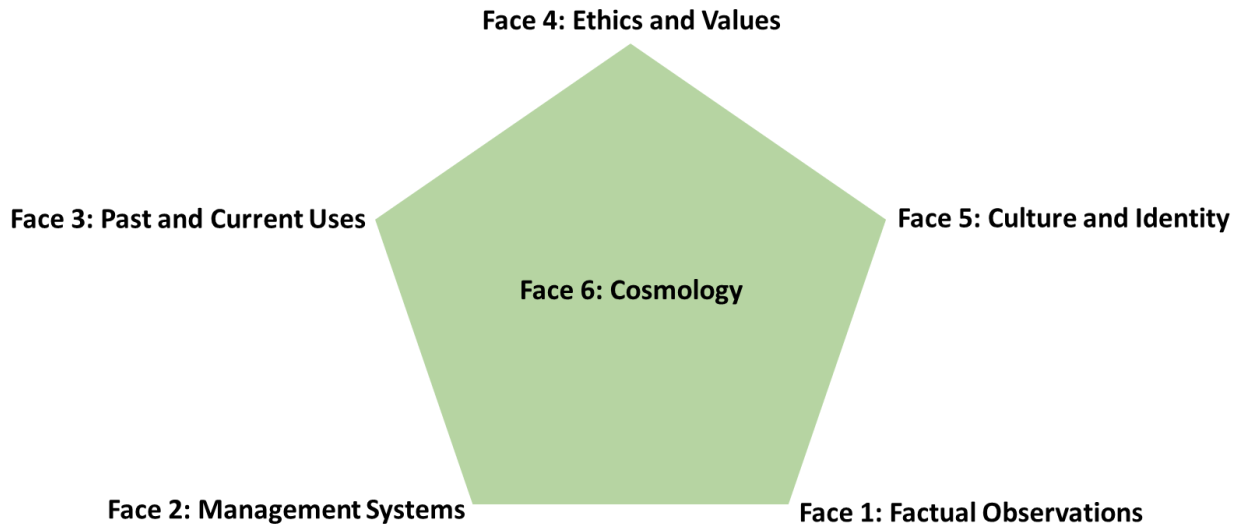

Figure 2.1 The Six Faces of TEK by Houde (2007)

Houde (2007) pushes for Indigenous communities to be involved in natural resource management decision-making processes at their conception, which, he argues, would emphasize strategic Indigenous involvement, giving Indigenous communities more power over their knowledge and increasing the acknowledgement of the activities going on in and around their local environment (Houde, 2007). According to Google Scholar, since Houde's paper was published in 2007, it has been cited 227 times, with 166 of these coming in the last five years. Houde's research, including the framework and categorical process, has been used in similar literature both conceptually and empirically. Houde's typology has been used in many studies that investigate the role Indigenous communities and their knowledge play in natural resource and forest management and strategic planning processes. These studies include those that address power relations, knowledge integration, ecosystem services, ecosystem resilience, cross-cultural themes, resource management, environmental assessments, and climate science (Berbés-Blázquez, González, & Pascual, 2016; Bohensky & Maru, 2011; Gagnon & Berteaux, 2009; Jones, Rigg, & Lee, 2010; Kenter et al., 2011; Leonard et al., 2013; McLain et al., 2013; Poe, Norman, & Levin, 2014; Prober, O'Conner, & Walsh, 2011; Reyes-Garcia et al., 2014; Whyte, 2013). Both conceptual and empirical studies have used Houde's ideas or framework to address the complexity of the knowledge provided by Indigenous communities.

In developing his ideas and framework, Houde (2007) referred to the work of Usher (2000) and Stevenson (1996). Usher (2000) categorized TEK with the aim of implementing this

knowledge into the context of environmental assessment and management. He argued that by clearly defining knowledge and terminology, the knowledge would be more likely to be understood and applied in environmental assessment processes. In earlier work, Stevenson (1996) broke down IK into structural components, examined each component's phases and roles, and addressed the ability of each to be implemented into environmental assessment and management.

Some authors have used knowledge categories similar to Houde's to conceptually specify how IK could be used without testing the efficacy of these approaches. Prober, O'Conner, and Walsh (2011) used a simplified version of TEK classes based on the categorical tables provided by both Usher (2000) and Houde (2007). This research concerned Indigenous seasonal knowledge, a facet of TEK, and focused on an Indigenous ecological calendar reflecting the local climate and environment. The authors argue that the TEK classes could be used as an organizational framework to categorize Indigenous seasonal knowledge and provide baseline information to inform natural resource management. The authors agree with Houde that current approaches fail to acknowledge the values and cosmological context associated with Indigenous people's knowledge and that a categorical table with more comprehensive elements could facilitate a more holistic understanding and application within natural resource management (Prober, O'Conner, & Walsh, 2011). Many authors of both conceptual and empirical studies have addressed the intricate elements of Indigenous communities' knowledge, acknowledging that if aspects of this knowledge were given more attention, the knowledge would be more easily applied within an environmental management context (Gagnon & Berteaux, 2009).

In contrast to conceptual studies, which have largely embraced Houde's framework, empirical studies are limited. In other words, using it in practice is more challenging than exploring it at a conceptual level. Leonard et al. (2013) discussed the role of TEK in monitoring and adapting to dynamically changing environmental conditions. These authors examined the knowledge of the Miriwoong people of the Kimberely region in North West Australia. They categorized Miriwoong TEK into three different categories to establish how TEK could be concisely applied in climate change adaptation strategies. The authors argued that aspects of TEK can contribute to climate change adaptation strategies; more challenging is engaging Indigenous communities to prepare for these changing environmental conditions in an equitable

and effective way (Leonard et al., 2013). Other empirical studies that have referenced Houde (2007) do not necessarily use his categorical framework as a guideline. Instead, they adopt his methodology about identifying the different elements that make up IK and applying these elements that have factual and physical properties (i.e. Face One) (Gagnon & Berteaux, 2009).

The popularization of Houde's research suggests that there is a desire in academia to better understand IK and to learn how to include this knowledge into a larger decision-making context. Houde's framework for categorizing different kinds of Indigenous knowledge helps advance collective understanding of the kinds of knowledge that can be used in various decision-making contexts. Growing understanding about different kinds of IK may help sensitize both researchers and practitioners about the kinds of knowledge that may be used in decision processes and about prioritizing different kinds of knowledge over others.

Ultimately, Houde's ideas have been used conceptually to understand and breakdown the complex elements of TEK to apply this knowledge and its various elements in a larger context, most commonly environmentally related (Berbés-Blázquez, González, & Pascual, 2016; Bohensky & Maru, 2011; Hill et al., 2012; Jones, Rigg, & Lee, 2010; McLain et al., 2013; Poe, Norman, & Levin, 2014; Prober, O'Conner, & Walsh, 2011; Whyte, 2013). Empirically, although Houde's perspectives of TEK and his framework may not have been used in its entirety, these perspectives have been used as a foundation to create condensed versions of categorical processes used to address TEK (Gagnon & Berteaux, 2009; Kenter et al., 2011; Leonard et al., 2013; Reyes-Garcia et al., 2014). As a result, Houde's methodology of breaking down TEK into separated elements and applying these elements within an environmental management context has been adopted by similar literature regarding this knowledge system and its implementation within management contexts.

Based on my current understanding, little work to date has empirically tested Houde's ideas and framework to determine how useful they are in practice. Nor has Houde's framework been used to address the gap between IK and its applicability in a natural resource management context by visually displaying these categories in any other format aside from tables or figures. Visually displaying these categories of IK may create a bridge between IK and WSK that could be applied in a forest or natural resource management context. As will be discussed throughout this study, using this visual display to bridge knowledge systems may be better than other

attempts because it is informed by a categorical framework that aims to preserve the distinctive characteristics of the knowledge system it is categorizing. In that way, the diversity of knowledge may stay intact, creating the possibility of a more comprehensible understanding of the information and values it provides.

2.6 Boundary Objects

Boundaries may be found between knowledge systems, between disciplines, and between knowledge producers and policy creators (Cash et al., 2003; Guston, 2001; Maclean & The Bana Yarralji Bubu Inc., 2015). Boundaries may facilitate or block effective communication between different groups, collaboration between knowledge systems, and/or physical actions or decisions made on the ground (Maclean & The Bana Yarralji Bubu Inc., 2015). My research focuses on knowledge boundaries between IK and WSK and determines how these boundaries may be crossed using boundary objects combined with an integrated conceptual framework.

Boundary objects are objects that have the ability to cross different social worlds, to satisfy the needs of each of these worlds, and to adapt to the context they are used in (Star & Griesemer, 1989). Star and Griesemer (1989) postulate that key to the process of creating and managing a boundary object is developing consistent communication across intersecting social worlds. The authors Maclean and The Bana Yarralji Bubu Inc. (2015) support this claim, as they describe boundary objects as being particularly useful when knowledge is created by different epistemologies. As a result, boundary objects may contribute to the co-production of knowledge (Cash et al., 2003), possibly leading to collaboration between individuals from both sides of the boundary. In the context of water management, Maclean & The Bana Yarralji Inc. (2015) found that creating boundary objects – in their case a research report – influenced the nature of participation as well as processes for environmental governance and management. In short, boundary objects may provide an alternative method to carry knowledge across boundaries that often separate different knowledge systems and groups (Maclean & The Bana Yarralji Bubu Inc., 2015).

2.6.1 Four Defining Characteristics of Boundary Objects

To facilitate communication between boundaries, boundary objects need to effectively carry and transfer information. After a thorough examination of the boundary object literature, this study argues that an effective boundary object may comprise of four main characteristics.

These characteristics are based primarily on the work of Carlile (2002), Star and Griesemer (1989), Star (2010), and Steger et al. (2018). First, a boundary object must establish a "shared syntax or language for individuals to represent their knowledge" (Carlile, 2002, p. 451). This creates "interpretive flexibility" (Steger et al., 2018, p. 154; Star 2010), facilitating communication between two different social worlds (Star & Griesemer, 1989; Steger et al., 2018). To have interpretive flexibility, the boundary object must be both robust and malleable; in other words, it can go "back-and-forth between social worlds" (Steger et al., 2018, p. 154) and "exist in a specific state" (Steger et al., 2018, p. 154) while remaining universally recognizable across disciplines (Star & Griesemer, 1989; Star, 2010; Steger et al., 2018).

To move between different worlds while being universally recognizable, boundary objects need to be sufficiently malleable to address local needs but also "robust enough to maintain a common identity across sites" (Star & Griesemer, 1989, p. 393). Robustness refers to the overall structure of a boundary object, where its framework, whether physical or conceptual, remains unchanging regardless of the information it carries. The boundary object's ability to retain its framework while also being dynamic enough to adapt to changing information allows the object to also stay malleable. A consistent identity gives the boundary object the ability to be recognizable across different knowledge systems and social worlds, making it more likely that the object will be a means of knowledge translation (Star & Griesemer, 1989; Guston, 2001).

Second, a boundary object must provide "a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary" (Carlile, 2002, p. 452). For instance, Carlile (2002) explains that a concrete method may allow individuals to understand a problem in which differences and dependencies of various groups are specified. A structured space in which representatives can elaborate on their concerns would be an ideal concrete method. In this space, scenarios may be anchored, and values assessed (Carlile, 2002). Carlile (2002) also notes that the nature of the problem may determine how concrete a boundary object needs to be. For example, if a critical issue needs to be addressed, the boundary object facilitating information flow, needs to be concrete enough to allow for this facilitation and to develop a solution (Carlile, 2002).

Third, a boundary object must facilitate a joint process for understanding. This is akin to "a process where individuals can jointly transform their knowledge" (Carlile, 2002, p. 452). This

transformation requires individuals to absorb and/or change the information a boundary object carries, apply what is learned, and "transform the current knowledge used at the boundary" (Carlile, 2002, p. 452). For example, maps may be used to show information that can be absorbed, learned from, and transformed by individuals. This transformation of knowledge may be done by any individuals involved (Carlile, 2002). My study argues that this includes individuals within and between communities across the knowledge boundary.

The fourth and last characteristic of a boundary object is that, to be effective, it must develop due to a need for information, and the boundary objects created through this need may "in turn influence the form and structure of dialogue" (Star, 2010; Steger et al., 2018, p. 154). For instance, there could be a strong desire to organize or classify data; a boundary object may arise from this need and, in turn, influence dialogue.

These criteria for boundary objects – flexibility, concreteness, joint process, and information need (Table 2.3 below) – provide a framework for understanding what may or may not make a boundary object effective and what is required for consistent communication across intersecting worlds. By understanding what may limit a boundary object in its effectiveness and how to address these limitations, we may be able to acknowledge what medium works best when translating IK and WSK across boundaries. This acknowledgement is important because many different mediums have been used as boundary objects with varying results in effectively translating IK across boundaries. If the characteristics of boundary objects are evaluated, we may be able to structure a boundary object with a significant chance of effectively facilitating knowledge exchange between the boundaries of IK and WSK. This knowledge could influence natural resource and forest management decision-making processes. Thus, it is important to understand how to clearly translate this information between boundaries.

Table 2.3. Four Defining Characteristics of a Boundary Object

1. Flexibility A boundary object is required to be robust and malleable; in other words, it can go "back-and-forth between social worlds" (Steger et al., 2018, p. 154) and "exist in a specific state" (Steger et al., 2018, p. 154) while remaining universally vague and recognizable across disciplines (Star, 2010; Star & Griesemer, 1989; Steger et al., 2018). This vagueness creates "interpretive flexibility" (Steger et al., 2018, p. 154, Star 2010). Therefore, boundary objects must establish a "shared syntax or language for individuals to represent their knowledge" (Carlile, 2002, p. 451).
2. Concreteness A boundary object must provide "a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary" (Carlile, 2002, p. 452).
3. Joint Process A boundary object must facilitate "a process where individuals can jointly transform their knowledge" (Carlile, 2002, p. 452).
4. Information Need A boundary object must develop due to a need for information, and the boundary objects created through this need may "in turn influence the form and structure of dialogue" (Star 2010; Steger et al., 2018, p. 154).

2.6.2 Boundary Objects and Their Indigenous Uses

Boundary objects may translate critical knowledge from one social world to another, and, in this way, influence this knowledge's inclusion within management and decision-making processes. Engaging Indigenous communities in boundary object development is an approach for increasing the influence of IK in natural resource management (Steger et al., 2018; Zurba & Berkes, 2014). Boundary objects may facilitate the communication of information between Indigenous and non-Indigenous knowledge holders and, in this way, could influence the development of new governance approaches (Maclean & The Bana Yarralji Bubu Inc., 2015; Zurba & Berkes, 2014). This facilitation of knowledge exchange may impact environmental and resource management (Maclean & The Bana Yarralji Bubu Inc., 2015).

Boundary objects have the ability to facilitate the implementation of IK into resource use and to uphold Indigenous rights. For example, authors Zurba and Berkes (2014) describe how participatory art may act as boundary objects where, through a collaborative process, a shared message could be expressed, in which Indigenous groups advocate for their rights and values towards their land and knowledge. In studying the knowledge of the Girringun community in Queensland, Australia, these authors examined whether co-management systems included and reflected Indigenous values. The authors used participatory art to depict the values the Girringun community held for the coastal resources and for environmental stewardship. The end product revealed detail and attributes that would not have been obtained through verbal communication alone (Zurba & Berkes, 2014). The art is viewed as an on-going tool for discussions that may influence future co-management decisions about the surrounding environment. The process of creating this art allowed Girringun individuals to collaborate in communicating their messages to a broader audience and could be applied to other Indigenous communities who may be experiencing similar circumstances (Zurba & Berkes, 2014). The Girringun community were empowered by being given a voice, as these individuals lacked the ability to participate in political practices (Zurba & Berkes, 2014). Therefore, as the example from the Girringun community illustrates, it is important to understand the role boundary objects play in transferring information across boundaries.

2.7 Geographic Information Systems (GIS)

GIS is a program designed to represent the world as geographic layers containing objects and attributes based on a specific conceptualization of space and reasoning (Malczewski, 2004). In a variety of ways, spatial data can be organized, collected, and evaluated by GIS and then visualizations of this spatial data may be presented in the form of digital maps (Beardy's and Okemasis First Nation, 2013; Chingombe et al., 2015; Tripathi & Bhattarya, 2004). This spatial data may influence natural resource management decisions (Sonti, 2015; Young & Gilmore, 2017) by visualizing local communities' resource values. Understanding these values may address local concerns and therefore could be invaluable when used in planning for sustainable resource use and environmental management (Levine & Feinholz, 2015, Wario, Roba & Kaufmann, 2015). These values may be associated with multiple knowledge sources, and GIS has been shown to be an effective tool in combining information from different knowledge

systems to influence environmental governance and management processes (Young & Gilmore, 2017).

In the context of their study, Supernant (2017) states that a prominent critique of GIS is that it is "reductive, environmentally deterministic, and reproducing a disembodied experience of the landscape" (p. 63). However, GIS has been used to explore the multifaceted social conceptualizations about past human experiences (Supernant, 2017). Smith, Ibáñez, and Herrera (2017) refute Supernant's contention, arguing that Western cartography (which is exemplified by GIS) can be used to accommodate different knowledge systems, worldviews, and cultural perspectives. This argument is consistent with Smith et al., (2012), who agree that there is significant recognition that maps "are not objective depictions of reality but rather subjective representations that have a point of view" (p. 119). Therefore, maps can reveal spatial narratives, patterns, and stories that all help to create visual depictions to demonstrate the values and realities held by marginalized communities (Smith et al., 2012).

2.7.1 GIS in Land Use Planning and Forest and Natural Resource Management

As Chambers et al. (2004) note, maps are a significant and familiar format for presenting information about a land and the people that live on this land. Forest management is complex and may contain multiple goals, objectives, and criteria (Bettinger et al., 2016; Sonti, 2015). When used in forest management, GIS can address concerns about the location, condition, and patterns of a forest and its resources (Sonti, 2015; Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). GIS can create visual expressions of a forest, its resources, and biodiversity, all of which can inform decision making (Sonti, 2015). In natural resource management, visualizations produced in GIS can bring together multiple ways of knowing about landscapes and ecosystems (Wright, Duncan, & Lach, 2009). Individuals from Indigenous and non-Indigenous communities may use GIS as a platform because it provides a common basis to visually express different perspectives and values, which may be influenced by different cultural backgrounds (Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). This ability to provide common ground is important because participating individuals may find visual expressions more familiar and accessible than technocratic policy processes (Zurba & Berkes, 2014).

GIS can display spatial (e.g., location of use) and non-spatial (e.g., intensity of use, temporal data) information, both of which can influence the decision-making and planning

processes within the sustainable management of natural resources (Levine & Feinholz, 2015; Sonti, 2015; Tripathi & Bhattarya, 2004). As authors such as Houde (2007), Usher (2000), Leonard et al. (2013), and Stevenson (1996) have shown, IK comprises many elements, several of which may translate into spatial data and be projected onto GIS maps. As Hunt (2014) argues, including IK into geographic processes may result in processes that are "productively confusing" but will embrace a shift in the "relationality, complexity, and circularity of Indigenous knowledge as productive and necessary" (p. 5). For all these reasons, GIS represents an opportunity to meaningfully include IK into forest management and decision-making processes.

GIS and its various applications have been used to facilitate the knowledge of local Indigenous and non-Indigenous communities regarding multi-dimensional human uses relevant to land use planning, forest, and natural resource management (Levine & Feinholz, 2015; Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). For instance, Young and Gilmore (2017) used GIS to depict IK and WSK about the Peruvian rainforest together using GIS as a platform and then presented this platform to the Peruvian government. This translation allowed Indigenous people to directly present their historic information in a format identified as significant by government actors. In aiming to increase the engagement of marginalized people in political processes, these authors argue that geospatial technologies are uniquely capable of encouraging this engagement through dialogue and the integration of multiple perspectives of a shared location. This technology therefore may effectively empower "traditionally marginalized perspectives with governance processes" (Young & Gilmore, 2017, p. 389). In addition to Young and Gilmore (2017), others have suggested that GIS maps allow for clear communication of knowledge between IK and WSK (e.g. Wario, Roba, & Kaufmann, 2015). One reason for this is that GIS maps can place IK within a context that could strengthen and emphasize the relationships and perspectives IK holders have with and towards their environment (Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). In this way, GIS maps have the potential to minimize the misrepresentation and mistranslation of IK as it provides a clear visualization of the data provided (Tripathi & Bhattarya, 2004).

As suggested above, GIS can possibly help Indigenous groups meaningfully include their rights and knowledge about their local environment into planning policies and solutions (Olson, Hackett, & DeRoy, 2016; Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). This potential

exists because GIS maps depict elements of IK significant to an Indigenous community and relevant to the use of natural resources in a local environment (Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). GIS is one of many technological methods that may be used to facilitate conversations with Indigenous communities on issues such as decisions made on equitable land rights, resource access, and knowledge their community may have on local species and surrounding environment (Robinson et al., 2016). The ability to display different information is significant as IK has critical spatial aspects that reflect knowledge of the land and its resources (Berkes, 2012; McCall & Mingang, 2005; Tripathi & Bhattarya, 2004).

Currently, the representation of IK is limited by social, economic, and political constraints (Diver, 2017; McGregor, 2011; Parsons, Nalau, & Fisher, 2017; Young & Gilmore, 2017). These constraints include lack of participation and engagement of Indigenous communities within the political and academic sphere, lack of resources necessary to collect and obtain IK, the implications colonialism and globalization may have had on IK, and the marginalization of Indigenous communities in decision-making processes (Arnold, 2017; Diver, 2017; McGregor, 2011; Parsons, Nalau, & Fisher, 2017; Young & Gilmore, 2017). These barriers can impact planning processes, resulting in the omission of important geographical, historical, and biological knowledge (Diver, 2017; Tripathi & Bhattarya, 2004). That beings said, GIS maps continue to have the potential to display IK and information in a way that moves this knowledge beyond what is currently known about the land, its resources and the people who use it, leading to possibly new opportunities for deeper understanding and proactive collaborative decision-making (Tripathi & Bhattarya, 2004; Young & Gilmore, 2017; Wario, Roba, & Kaufmann, 2015).

2.7.2 GIS as a Boundary Object

Akin to geographical boundaries, boundary objects may separate groups from one another while simultaneously highlighting key points of similarity between these two groups, both actions may aid in stabilizing the relationship between these groups (Harvey & Chrisman, 1998). The four defining characteristics of boundary objects described in Table 2.3 (p. 27) provide a means to evaluate specific GIS products as boundary objects. Based on these theoretical criteria, GIS holds potential as a boundary object, but this theoretical potential needs

to be tested against concrete, empirical examples. As a result, the ability to realise this potential remains under-researched.

The first criterion of an effective boundary object is flexibility. Conceptually, GIS maps have potential as boundary objects because they are both abstract and concrete in their representation of a collection of ideas as physical visualizations (Star & Griesemer, 1989; Steger et al., 2018), thus meeting the criterion for "interpretive flexibility" (Steger et al., 2018, p. 154, Star 2010). Interestingly, the process of creating boundary objects is just as important and significant as the product itself and, like the product, the process must also exhibit flexibility (Star & Ruhleder, 1996). GIS maps are not merely a static visual representation of Indigenous resource use and values; they are a tool for promoting on-going discussions about forest resource management from multiple Indigenous community perspectives (Tripathi & Bhattarya, 2004; Young & Gilmore, 2017). GIS maps visually display boundaries of a shared territory, and, regardless of the content they hold, these boundaries do not change existing, for example, province boundaries, bodies of water, roads, highways, and municipalities. Because they are fixed, these boundaries are robust. As well, the content found in the maps is malleable because it can be changed depending on the individual providing the information. The information GIS maps depict is dynamic and has the ability to change according to the knowledge and information that is inputted (Chingombe et al., 2015; Young & Gilmore, 2017). Therefore, GIS maps are both robust and malleable and so comply with the first criterion, flexibility.

The power of boundary objects lies with their ability to display and thus communicate the knowledge, perspectives, and visions of communities (Beckley et al. 2007). In displaying this information, GIS maps provide interpreters with an opportunity to understand the differences in their knowledge and also to share these differences. In this ability, GIS maps meet the next two criteria: concreteness and joint process.

Authors Star and Griesemer (1989) use a categorical method to sort the different types of boundary objects. These authors argue that boundary objects fall into four analytically distinct but non-exclusive categories: "repositories", "ideal type", "coincident boundaries", and "standardized forms" (Star & Griesemer, 1989, p. 410-411). Star and Griesemer (1989) place maps into the category of coincident boundaries because maps depict boundaries that are the same to all actors involved but have differing internal content. According to Star and Griesemer

(1989), maps represent a single geographic space but allow for multiple interpretations and uses by different groups. These maps may arise because different groups may have "different means of aggregating data" (Star & Griesemer, 1989, p. 452). As a result, boundary objects may allow "work in different sites with different perspectives [to] be conducted autonomously while cooperating parties share a common referent" (Star & Griesemer, 1989, p. 411). Taking these interpretations into consideration, my research proposes that GIS maps may be defined as coincident boundaries. Therefore, GIS maps may allow IK and WSK to interact as parallel knowledge systems by providing information about the resources in a common landscape.

This ability of GIS maps to have coincident boundaries supports the concreteness and joint process criteria. GIS maps are able to meet the demand to visually depict elements of IK concretely, as these elements are constrained by geographical boundaries. By portraying resource use and allowing for multiple interpretations of this use, GIS maps are allowing individuals from both groups to jointly transform their knowledge by being exposed to and providing new information to influence these maps.

The last boundary object characteristic is information need, which specifies that there must be a need for information that may "influence the form and structure of dialogue" (Star, 2010; Steger et al., 2018, p. 154). My research acknowledges that all information on sustainable resource use is needed and that GIS maps may help in that regard, by providing an innovative perspective on the different uses of resources within a certain geographical boundary. GIS maps may meet this criterion by acknowledging the need for information about alternative solutions and practices regarding sustainable natural resource use in the local environment. This acknowledgment may come in the form of visually depicting the multifaceted elements comprising IK that use or value different resources in the environment. My study contends that if there is common understanding of resources being used and the significance they hold, the dialogue about them and the surrounding environment may change. This dialogue may be influenced by and may influence the GIS maps because GIS maps may indicate that a local environment and its resources hold different values and significance for different groups.

2.7.3 Challenges of GIS Maps as a Boundary Object

Although GIS maps have the potential to meet the conceptual criteria of boundary objects, there are also challenges. As Clark et al. (2016) note, successful boundary work focuses

on the mutual production of boundary objects. The success of boundary objects is affected by knowledge diversity and the limiting characteristics of boundary objects. These characteristics, for example, require boundary objects to hold information that may be flexible and jointly transformed. Therefore, this information cannot be static, vague, abstract, or indescribable to the point where it cannot be transferred across boundaries to be grasped by other groups.

Since the information provided by distinct knowledge systems can be diverse, visually depicting this diversity on GIS maps may be difficult (Coombes, Johnson, & Howitt, 2014; Robinson et al., 2016). As described in Table 2.3 (see p. 27), to move between boundaries, effective boundary objects must be inherently vague and flexible (Star 2010; Star & Griesemer, 1989; Steger et al., 2018). These characteristics may complicate how the boundary object is operationalized and mutually understood (Steger et al., 2018). To increase the likelihood that individuals from both sides of the boundary will understand the information, there may be pressure to standardize it; however, standardization may inhibit diverse knowledge types that do not fit neatly into standardized categories (Steger et al., 2018). Although standardization could facilitate the communication of knowledge between boundaries, it could also increase the homogenization or hybridization of knowledge. Louis, Johnson, and Pramono (2012) argue that when using a map to represent IK, map makers create a certain "geographic translation" (p. 77). This translation occurs when the map makers transform "one set of culture-specific measurements to another" (Belyea, 1992, p. 270), with which map users may interpret a map. However, these measurements may be misrepresented, mistranslated, or force IK into a standard, as stated above.

Some authors such as Agrawal (2014) support the idea of this homogenization because it promotes dialogue that may move from labels such as "Indigenous" or "Western" and to the interests of disadvantaged actors whose knowledge may serve their own interests. However, this homogenization could also scientize IK, where information is forced to fit a specific framework defined by scientific characteristics and/or can risk being hybridized with WSK (Löfmarck & Lidskog 2017; Reyes-Garcia et al., 2014; Mistry & Berardi, 2016). In doing so, these scientific frameworks risk depleting the diversity of IK, change its use and applicability, and reduce its ability to address complex socio-ecological issues (Mistry & Berardi, 2016). This homogenization or hybridization of knowledge may counteract the empowerment of Indigenous

communities and instead lead to a continuation of disregarding knowledge that does not match that of scientists and resource managers (Ludwig, 2016). Therefore, innovative methods are needed that reduce the uncertainty created by knowledge diversity but still promote and engage heterogenous knowledge contributions by different actors.

2.8 Research Originality

This literature review has detailed the contributions my research will make to key areas of boundary research. My study aimed to advance the scholarship on using GIS maps as boundary objects to meaningfully include IK into natural resource and forest management processes. Theoretically, I used Houde's (2007) Six Faces as a conceptual framework to address and categorize the different elements that comprise IK. Practically, I used Houde's framework as a base to create and develop GIS maps to visually display the categorized IK. Using the boundary object criteria, I evaluated whether and how the criteria were met in my case study. This provided me with the ability to judge the opportunities and barriers for using GIS maps as a boundary object in an Indigenous and forest management context.

As mentioned above, significant challenges emerge when trying to include IK into natural resource and forest management, including the potential for homogenization, hybridization, and/or subordination of IK to a single knowledge system (Löfmarck & Lidskog 2017; Mistry & Berardi, 2016; Reyes-Garcia et al., 2014). In placing IK based on Houde's framework onto GIS maps, I attempted to avoid these tendencies and investigate whether IK could retain its defining characteristics that distinguish it from other knowledge systems such as WSK.

Integrative research is "research in the context of complexity, with an action imperative" (van Kerkhoff, 2014, p. 146). Van Kerkhoff (2014) describes this approach in the context of sustainability, where integrative research can be separated into two elements: implementing the researcher within the context of a complex socio-ecological system and actively focusing on the innovative process of change within a sustainability context. This approach attempts to counter information fragmentation and focuses on synthesizing this information in a way that leads to action and change within the context of complex sustainability issues. Using technological processes such as GIS to represent information pertaining to a specific culture could benefit Indigenous communities who have or want a decision-making role in resource management

policies. As mentioned above, my research proposed the use of Houde's (2007) Six Faces to act as a conceptual framework to visually depict IK and represent it through GIS maps. Therefore, I attempted to synthesize the available IK within an integrative research context by using an appropriate methodological approach.

Socio-ecological systems contain multifaceted inter-relationships between humans and nature (Fagerholm, Käyhkö, & Van Eetvelde, 2013). Research is needed on how socio-ecological systems can be distinguished based on the characteristics that make up these systems (Opdam et al., 2015). IK may have elements that could provide a perspective of the characteristics of these socio-ecological systems. These characteristics have been used to distinguish between different types of IK that represent different dimensions of socio-ecological systems. This distinction may ultimately allow decision-makers and stakeholders to view complex socio-ecological systems in an innovative way and find justifications for action in the realm of forest management. In the same vein, there is a need for boundary objects to better represent different knowledge systems (Carlile, 2002). By using clear and concise descriptors to describe the Six Faces, GIS maps based on this information may increase IK's representational capacity. Additionally, as Poe, Norman, and Levin (2014) maintain, socio-ecological systems are complex, and a better understanding is required of the range of cultural dimensions within these systems that remain absent or are not viewed as significant. By acknowledging these dimensions, decision-making conversations on the sustainability and conservation of the shared environment may increase. If these conversations do not occur, critical alternatives to sustainability and conservation efforts may be lost, possibly negatively impacting communities that hold these cultural dimensions.

In the context of their study, Grêt-Regamey et al. (2013) note that more research is still needed for GIS to address uncertainties to decision makers and forest managers in a useful way. By visually representing the available IK of an Indigenous community, my research also focused on the IK that has yet to be obtained. Thus, GIS was used to communicate the uncertainty regarding the available IK. This communication is significant because it may allow decision-makers to identify the role the available IK may have in a forest management context. My study used Houde's framework to simultaneously assess the presence and absence of different faces in forest and natural resource management. This assessment may provide an empirical basis for

understanding what may be more systematically omitted or included. Likewise, I have used boundary object criteria to assess what qualities a boundary object may need to effectively facilitate IK between different knowledge systems. The synthesized boundary object criteria and their assessment of how GIS may act as an effective boundary object is a significant and original aspect of my research.

CHAPTER 3 METHODS

3.1 Introduction

The goal of my research is defined by my research question: What are the limits and opportunities of using GIS maps as boundary objects to represent IK in Nisbet Provincial Forest resource planning and implementation processes? My research objectives are as follows:

1) Identify existing sources of previously collected IK related to BOFN land use;

2) Synthesize the collected IK related to BOFN land use to create a comprehensive visualization of the available IK;

3) Identify potentially missing BOFN IK not previously collected or analyzed;

4) Understand whether and how GIS maps can be used as a boundary object to advance the use of IK in the implementation process of the FMP for the Nisbet Provincial Forest;

5) Develop good practices, including recommendations on how to represent and implement IK in FMPs, which may allow for long-term sustainability of the forest resources in which multiple stakeholders are vested.

To answer this research question and address these research objectives, I undertook a case study-based approach, employing three separate phases of research. The case study investigates the decision-making and implementation processes of the Nisbet Provincial Forest and considers how the IK of BOFN may be meaningfully included into these processes. My research focused on forest management within the IFLUP, as I was informed that this plan would benefit most from this kind of study (D. Rinholm, personal communication, February 8, 2015). The three phases of my research were as follows: the categorization of IK combined with a document review, the creation of GIS Maps, and interviews with key informants.

3.2 Case Study Methodology

Case studies allow for the intense analysis of a specific and unique system bounded by space and time and provides a more informed understanding of complex social phenomena (Hancock & Algozzine, 2016; Hays & Singh, 2012; Yin, 2014). The case is analyzed extensively through the qualitative analysis of a case study, where the data may be distinguished by time, location, and activity (Hays & Singh, 2012). Therefore, by creating a case study, a researcher

may gain a deeper understanding of situations and the significance and meaning of the dimensions and people involved (Hancock & Algozzine, 2016). Choosing a case study for my research was justifiable because I was focusing on a specific type of knowledge that may be used in forest management processes. Case study research allowed me to address the topic using an emic approach, which involved understanding the goal of my research from the participants' perspectives and not from my own (Hancock & Algozzine, 2016).

I developed a single exploratory case study. Such studies, as described by Hays & Singh (2012) and Yin (2014), have many variables of interest and multiple sources of evidence, as my study demonstrated. My case study focused on the decision making and implementation of forest management processes within the Nisbet portion of the IFLUP and, specifically, how IK may be included into these processes.

3.3 Methods

3.3.1 Phase 1: Categorizing Indigenous Knowledge

IK categorization was the first phase of my research. This phase sought to address the first research objective of my study, which was to identify existing sources of previously collected IK related to BOFN land use. I reasoned that separating IK into distinct categories may make this knowledge more comprehensible to a broader audience and more easily applied and understood within a shared management context (Houde, 2007). The foundational study for my research is Houde's Six Faces of Traditional Ecological Knowledge (2007). In his study, Houde categorizes TEK into six distinct 'Faces': Factual Observations, Management Systems, Past and Current Uses, Ethics and Values, Culture and Identity, and Cosmology (Figure 2.1, p. 21). The terminology used in my research differs from that of Houde (2007). As discussed in Chapter 2, I specifically used the term IK instead of TEK becaxuse the definition of IK adheres to the purpose of my study more closely. Thus, Six Faces of Traditional Ecological Knowledge provides a conceptual framework for my study.

Document Review

As part of this first phase, I completed a document review. Collecting data from written material may provide "source information critical to understanding a phenomenon" (Hays & Singh, 2012, p. 284). My approach was to search for all available IK from the BOFN

community. My study ultimately synthesized knowledge that was already available in the written record and recognized that using available information was as important as creating new knowledge sources (van Kerkhoff, 2014). I discovered two sources of previously collected BOFN IK – the Beardy's and Okemasis First Nation History Report (2013) and a TEK cache from research scientist Mr. Michael Bendzsak – which I used as a starting point for the rest of my study.

The BOFN History Report (2013) is a collection of information gathered from the BOFN community about their culture, history, the relationship between BOFN and the Canadian government, and traditional activities within the region. BHP Billiton provided financial support for the development of the report, while Dillon Consulting was responsible for the compilation of information that went into the report, as well as its final design (Beardy's and Okemasis First Nation, 2013). In June 2016, I received written permission from Mr. Brian Seesequasis, the Director of Lands at the BOFN band office, to use the spatial information collected in the history report for the purposes of my own research (See Appendix A).

The TEK cache from Mr. Bendzsak contains spatial information relating to the approximation of animal migration patterns, which are adjacent to a potential highway development site. I obtained written permission to use this data from Mr. Alfred Gamble, former GIS specialist at the BOFN band office and main contact to BOFN. Permission from Mr. Gamble was necessary for Mr. Bendzsak to release this spatial information to me, which he did in June 2016 (See Appendix A). The spatial information contained in both sources were used in the first two phases of my research.

The information collected from the BOFN History Report (2013) and the TEK cache was evaluated using document analysis to examine and interpret meaning and significance, and to develop an empirical basis for observation (Bowen, 2009). The main objective of the document analysis was to identify the available IK collected and to categorize this IK into the Six Faces of TEK outlined by Houde (2007). This coding process allowed for the TEK categories to be clear and unambiguous while also providing an understanding of the contextual usage of the content. As a result, the quality of the category descriptions and the coding consistency may be increased (Schreier, 2014).

I also performed a qualitative content analysis on the history report and TEK cache. Qualitative content analysis is defined as a "research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Hsieh & Shannon, 2005, p. 1278). In other words, this analysis described the meaning of qualitative data by categorizing different aspects of data within a coding frame (Schreier, 2014). To understand the contextual use of the words or content, I took a summative content analysis approach, where I identified and quantified certain words or content in the two main IK sources (Hsieh & Shannon, 2005). All data from the IK sources were broken down into some form of text. The keywords in the data provided by the IK sources were compared to and matched with the characteristics of the TEK Faces found in Table 2.2 (p. 20). Subsequently, the TEK Faces acted as the coding frame.

As a result of an exhaustive collective search of BOFN IK that had been documented, I pursued other avenues of data. These pursuits consisted of visits to the band office to speak in person to anyone who may have had any knowledge of previous studies done on the reserve in which their IK was collected. Other pursuits were detailed online searches for online peer-reviewed articles or projects done that included the BOFN community and their IK. The outcomes of these pursuits were fruitful in that they led to the discovery of the BOFN History Report (2013) and the TEK Cache. Other research being done with the BOFN community may be taking place, but from my current understanding, I am unable to access this research because they may be ongoing or unfinished work.

3.3.2 Phase 2: GIS Mapping

The second phase of my research was GIS mapping. This phase allowed me to address the second and third research objectives of my study: to synthesize the collected IK related to BOFN land use to create a comprehensive visualization of the available IK, and to identify potentially missing BOFN IK. The GIS component of my project created visualizations of the available IK provided from the two available data sources – the BOFN History Report and the TEK cache.

The technology and data processing methodology used was ArcGIS 10.3.1© and ArcMap©. ArcGIS is a user-friendly mapping software platform, which enabled analysis and visualization of the land and natural resource use data provided by the IK sources (ESRI, 2016).

A primary component of ArcGIS, ArcMap is a program that allowed me to organize, assemble, and display geospatial data from my two main knowledge sources (Wilbert, 2014). Geospatial data refers to information that has a location component, such as coordinates (Wilbert, 2014). Ultimately, ArcMap and ArcGIS create an interface that allows geospatial data to be organized and displayed in a way that may help facilitate informed decision-making processes (Wilbert, 2014). In this study, I use GIS as an umbrella term that encompasses all the technological programs mentioned above used to create the maps.

In the first phase of my study, the spatial information was placed in different categories or Faces (see Table 2.2, p. 20). The BOFN History Report (2013) and the TEK cache used a Global Positioning System (GPS) to collect and transform the collected IK into GPS coordinates (ESRI, 2016). The GPS coordinates form a data source, which, now containing geographic information, may be saved in a variety of geospatial data formats, one of which is a shapefile (ESRI, 2016). When shapefiles are combined, a map layer is created. Layers are visual representations of geospatial information (ESRI, 2016). Different layers may be made up of different kinds of geospatial information and may subsequently represent different data sets (ESRI, 2016), which may influence what information appears on a map. In my research, the process of visually displaying IK on GIS maps required IK to be transformed into spatial information. All additional IK collected throughout my study had to be transformed via the process explained above.

I ensured the GIS maps were available on the computer and in print because I was uncertain if interview participants would have a preference for one or the other or would have vision issues. I reasoned that if both mediums were present, the interviewees would feel engaged and comprehend the questions I asked during the interviews. Both online and physical copies of the GIS maps were easy to read and manipulate, so participants found it easy to identify locations of interest and to add information by stylus or pencil. During the interviews, participants added different types of information to the maps, allowing this knowledge to be transformed collectively (Carlile, 2002). By using GIS maps as a potential boundary object, I was able to represent qualitative data in the form of IK, which was informed by individual interviews. The details on the effectiveness of using GIS as a boundary object and the challenges associated with this will be addressed in the discussion section.

I mapped Face One, Factual Observations (see Appendix B) and Face Three, Past and Current Uses (see Appendix B). To do this, layers from the maps categorized in Face One were extracted and then combined to create one comprehensive map representing the first Face. Additionally, layers from the maps categorized in Face Three were extracted and then combined to create one map representing Face Three. I concluded that more information was needed for Faces Two, Four, Five, and Six. My research was not able to adequately capture data for these Faces, possibly because I did not acquire adequate information from participants that could be translated into spatial data. As a result, I was unable to create any new maps for these Faces. More IK exists and has the potential to be translated into spatial data to be displayed on a GIS map. However, visually representing these Faces Two, Four, Five, and Six using GIS mapping was beyond the scope of my work. These challenges are addressed thoroughly in Chapter 4 and 5.

3.3.3 Phase 3: Interviews

The last phase of my research was devoted to interviews, which provided information to help answer my research question and address my last two research objectives. The fourth objective was to understand whether and how GIS can be used as a boundary object to advance the use of IK in the implementation process of the FMP for the Nisbet Provincial Forest. The fifth and final objective was to develop good practices, which included recommendations on how to represent and implement IK in FMPs that may allow for the long-term sustainability of the forest in which multiple stakeholders are vested.

Interviews are a "primary source of data in qualitative research" (Merriam & Tisdell, 2015, p. 137). My research involved interviews with participants from BOFN and the NIT. I interviewed BOFN participants to assess the validity of IK being used in the GIS maps, and I interviewed NIT participants to investigate the feasibility of implementing these maps into the FMP. Any additional spatial information provided by participants during the interviews were added to the already created GIS maps. This information included knowledge pertaining to the Nisbet Provincial Forest and its resource use, extraction, land boundaries, or land usage. The data collected in the interviewing process were used to build upon the data already presented in the GIS maps and to inform my study about what IK could be visually represented. The discussions

in the interviews also informed my research of the efficacy of using GIS as a boundary object within a management context and identified values on which good practices could be founded.

3.3.3.1 Semi-structured Interviews

Semi-structured interviews were conducted in my study. This type of interview typically consists of a verbal discussion in which the interviewer attempts to obtain information from the interviewee by asking a series of consecutive and predetermined questions in a conversational manner (Longhurst, 2003). Semi-structured interviews provide opportunities for the interviewer to gather information and it also gives the interviewees a chance to explore issues of personal significance (Longhurst, 2003). When developing my interview questions, I used several sources and considered several factors: the IK I had previously collected from the BOFN History Report (2013) and TEK cache; additional IK that the participants could possibly provide; methods for applying this IK on GIS maps; and possible uses for these GIS maps in the FMP. To address these considerations, two separate interview guides were used: one for BOFN participants and one for NIT participants. Separate guides were used because only the BOFN participants were asked what IK was understandable and comprehensible from the GIS maps provided and what IK may still be provided. The NIT participants were asked a different set of questions, which focused on the applicability of this IK within the FMP and any spatial information that could be added to or taken away from the GIS maps to make them more applicable within the FMP. The interview questions were designed to ensure my research question and objectives could be addressed clearly and effectively. The interview guides are listed in Appendix C.

3.3.3.2 Pilot Interviews

The terminology used to describe the Six Faces were extracted from Houde's (2007) article. It was imperative that all language used was understandable to potential participants. One way to determine the suitability of the language was to conduct pilot interviews. Mistawasis First Nation generously allowed me to enter their community and approach a group of community members to participate in pilot interviews. These pilot interviews were done to assess the appropriateness of language used in the interview questions and to address any issues or concerns that emerged during the interview process. The changes to the interview questions can be found in Appendix C.

3.3.3.3 Participant Demographics

Due to the specific context of this research, which included knowledge of the Nisbet Provincial Forest and resource extraction, participant groups were chosen based on specific criteria. The criteria were used to ensure a consistent approach in the sample. The criteria were also helpful to provide an understanding to participants about why they were being selected for the study. Criteria for participation in the study and ethics considerations may be found in Appendix C. The participant demographics of all individuals including their position within the community (community member or Elder), the nature of the interview (interview or group interview), and the date of the interview are all included in Appendix C. Additionally, due to the engagement of both BOFN and NIT groups, my study used a participatory approach to analyze the contents of the GIS maps. Therefore, my research used participatory GIS as an element in this study. However, my study did not engage in public participatory GIS, as there were specific criteria participants needed to have before being interviewed.

All interviews were audio recorded by two separate recording devices. This was to ensure that all verbally transmitted information given throughout the interview process was captured in case one of the devices failed. Additionally, audio recording the interviews allowed me listen to them multiple times and to attach meaning and context to what was said, including verbal cues such as meaningful pauses or tone. I observed participants throughout the interview process, which enabled me to witness and document any participant commentary or actions significant to my research. Interview observations also allowed me to explore further information or details that could have influenced the data collected and used in my project (DeWalt & DeWalt, 2011).

All interviews were transcribed verbatim, and copies of these transcripts were provided to participants for verification. The interviews took place from December 2016 to May 2017. I received verification of BOFN transcripts throughout March 2017 (March 9, 13, 14, 21, 22 and 30) and May 2017 (May 2, 5, and 11). The last set of transcript verifications were completed on April 4, 2017 after a secondary interview with a group of Elders in which I displayed the edited GIS maps and received extended input. Many of those originally involved signed a secondary release form, while newer members dropped in and out of the group interview session. I received most NIT verifications through email, except for three which were retrieved in person on July 5, 2017. All transcripts were validated as of July 21, 2017.

By the end of the interview process, I had interviewed 21 BOFN community members: 15 Elders and six other community members. Among the sample of BOFN interview participants, there is a mixture of perspectives, including those of Elders, Harvesters, Hunters, band office staff, and council members. Therefore, the different dimensions concerning IK and its application within a management context were addressed from a governance, resource management, and traditional perspective. I was confident that I had reached saturation when I was referred to speak to individuals who were already included in my sample.

Out of the 15 interviews done with BOFN Elders, 13 of them were conducted as a group interview. Group interviews were not originally meant to be part of the semi-structured interviewing process; however, when I began interviewing some of the Elders at the high school, where many community Elders were gathered to perform sweet grass ceremonies, the Elders I initially spoke to suggested answering the questions as a group. They felt that the information they shared would not be altered by the presence of others. Elder engagement within BOFN is strong, especially during the time I was visiting BOFN during the interview process. There are also monthly Elder meetings held in the reserve, and a few Elders I interviewed were also a part of other important studies, such as the BOFN History Report (2013).

I interviewed 10 NIT members. From January 2016 to June 2017, I gave presentations at NIT meetings, where I made it known that I was looking for participants for my study. I also sent out an email to every member of NIT who had an available email address. I made cold calls to those who could not be reached by email. Thus, I did everything I could without breaching privacy or confidentiality rules to garner interest and participation from NIT members. Since the NIT is composed of a wide variety of planners, resource managers, stakeholders, and government representatives, I was able to obtain a broad spectrum of ideas and perspectives from those who did participate in my study.

The validity of my NIT sample was evaluated by analyzing the members of the NIT, determining how many of those members actively went to NIT meetings, and figuring out how many of those active members I had interviewed. There are approximately 27 current NIT members, some of whom may have just recently joined, attended only one meeting, or not come to recent meetings. 12 NIT members attended at least 50% of the six NIT meetings held between November 2014 and February 2017. To the best of my knowledge, no NIT meetings regarding

the FMP were conducted since May 31, 2017, as it was concluded that all policies written in the plan had been achieved (D. Rinholm, personal communication, January 21, 2019). With that being said, all advisory committees are meeting in April and there is a Nisbet meeting on April 9, 2019 (D. Rinholm, personal communication, March 2, 2019).

I was interested in interviewing individuals who had been to at least 50% of NIT meetings because their attendance indicated that they were involved with the conception, knowledge implementation, and decision-making process of the IFLUP and FMP. Mr. Rinholm sent an email on my behalf to all NIT members on their listserv on January 21, 2016. I addressed the committee in person when I attended the NIT meeting in February 2016 to request participation from members who would like to take part in my study. Of those present, 12 NIT members willing to be interviewed, I interviewed eight, or approximately 66% of active NIT members who had attended at least 50% of NIT meetings. Through this process, I was referred to three additional members, giving me a total of 11 NIT members who I successfully managed to interview. As a result, I believe that I achieved interview saturation based on the NIT members that responded to being interviewed and those that met the criteria for participation.

Data analysis of the transcript data was undertaken using NVivo 11©, and this aided in my immersion in the data. I interpreted the interviews while coding, using this software to systematically categorize this information. I conducted inductive and deductive thematic analyses of the interview data. Inductive analysis is driven by raw interview data from which significant themes and patterns may be formulated, creating a basis for theory development and a framework to categorize these themes (Hays & Singh, 2012). Through my inductive analysis, I identified patterns that emerged throughout the interview process, including emergent values associated with IK that BOFN participants would like to see included within a management context. To perform a deductive analysis, I coded the interview data according to pre-specified categories (Elo & Kyngäs, 2008). I created a coding framework that identified key terms and information significantly related to my research objectives and research question. All deductive and inductive themes will be addressed in further detail in Chapters 4 and 5.

3.3.4 Site Visits

Before pilot interviews were done, I made frequent visits to BOFN between June 2016 and August 2016 to begin to get to know the community. I helped with the community gardens

in the plot across from the Beardy's and Okemasis High School. I also volunteered my time at the Beardy's and Okemasis Band Office, where I interacted with staff members and helped with typing up documents and purchasing field equipment. These visits were a vitally important part of my work as they helped me build relationships with individuals from the BOFN community. These relationships were built upon the understanding that I as a researcher was not there for just academic gain. I am truly interested in Indigenous culture and wish to address reconciliation whenever possible. These visits were also significant because many members of the BOFN community became familiar with my presence, name, face, and/or car. This familiarity made it easier to gain interest from potential study participants. The specific dates of my field visits are found in Appendix D.

3.3.5 Summary of Methodological Approach

The first two phases of my methodological approach comprised of IK categorization and GIS mapping. These phases were conducted at SENS on the University of Saskatchewan campus from August to December 2016. The third and final phase – interviewing – was performed on the Beardy's and Okemasis First Nation Reserve and in Prince Albert, SK. The interview process began in June 2016 and ended in March 2017.

Ultimately, the result of this methodological approach and methods are good practices, which include recommendations for effectively implementing IK within a forest management context using Houde's Six Faces (2007) as a conceptual framework. This case study approach is reasonable because creating and implementing a framework that introduces IK within a WSK dominated management context is complex and multifaceted. An approach suitable for such complex research needed to be based on different methods to allow me to appropriately answer my research question and address my research objectives.

3.4 Study Area and Context

3.4.1 The Nisbet Provincial Forest

The Nisbet Provincial Forest is an expansive island forest surrounded by residential and agricultural development (Government of Saskatchewan, 2012). As shown in Figure 3.1, the Nisbet Provincial Forest is vast and accessible to the public. As a result, the IFLUP describes this forest as being consistently exposed to concentrated pressure for resource extraction and recreational activities (Government of Saskatchewan, 2012).

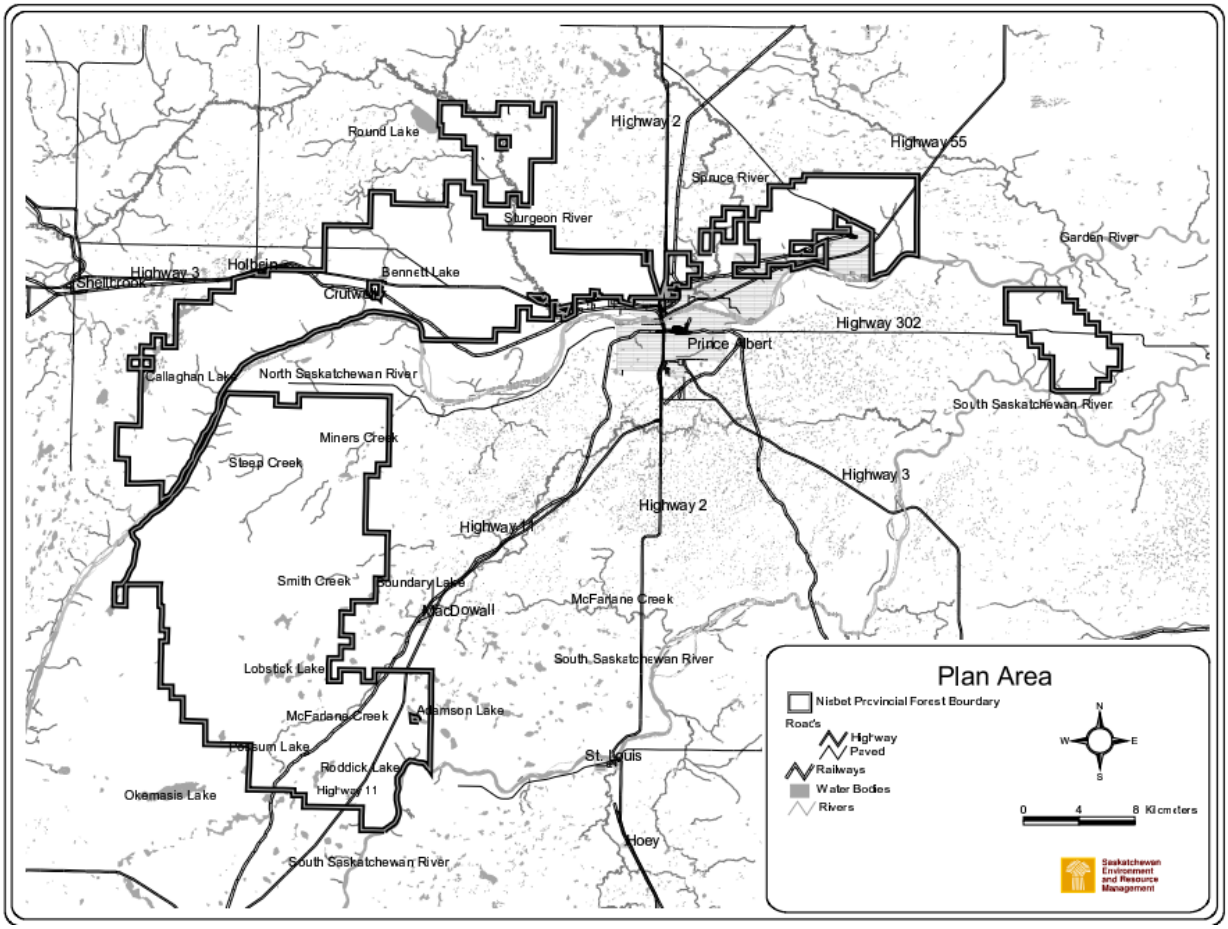

Figure 3.1. The Nisbet Provincial Forest

(Source: Government of Saskatchewan, 2013)

The Nisbet Provincial Forest is approximately 80,000 hectares in size and is the habitat for an abundance of wildlife and botany species with a multitude of routes, roads, and highways that pass in and around the area (Government of Saskatchewan, 2012). The Nisbet Provincial Forest touches six rural municipalities and one urban municipality, with the majority of the forest being within the RMs of Buckland, Shellbrook, Prince Albert, and Duck Lake (Government of

Saskatchewan, 2000). The Nisbet Provincial Forest is administered by the federal and provincial governments, both of which are compartmentalized to have different administrative responsibility for the various activities conducted within the forest (Government of Saskatchewan, 2000). The Nisbet Provincial Forest is characterized as a "Boreal Transition Ecoregion" because it a "transition zone from parkland to boreal forest, which some believe may be the part of the boreal forest that is most likely to show the first signs of climate change" (Government of Saskatchewan, 2012, p. iii). My research was especially concerned with the FMP of the IFLUP.

Created in 2012, the IFLUP is a planning document that aimed to provide a clear and calculated direction for the government and stakeholders when making forest and resource management decisions in order to perpetuate the ecological integrity of the Nisbet Provincial Forest (Government of Saskatchewan, 2012). The IFLUP covers several forests including the Nisbet, Canwood, Fort à la Corne, and Torch River Provincial Forests. Therefore, the Nisbet Provincial Forest is but one of the forests in the overall plan. The NIT plays a prominent role in the IFLUP because the stakeholders it represents are critical to the decision-making and implementation processes that affect all of the forests in the plan. To develop the 2012 plan, the NIT and the Public Advisory Committee (PAC) gathered information for a first draft, which was sent to all stakeholders from the area, before being presented at public meetings where individuals provided additional information on the draft (Government of Saskatchewan, 2000). More than one round of public meetings was held to update the draft before it was sent for review by an independent panel appointed by the Saskatchewan Minister of Environment (Government of Saskatchewan, 2000). The panel ensured that the draft met the requirements set out by The Forest Resources Management Act (Government of Saskatchewan, 2000). Once suggestions were made, the plan was revised and reviewed once more before the strategies identified within the plan were implemented by the appropriate bodies (Government of Saskatchewan, 2000).

Within the IFLUP, there is mention of another management plant known as the First Nation Island Forest Management (FNIFM) plan. The creation of this plan and the discussion of the decisions made in this plan is an indication that there is a form of Indigenous participation

and engagement in forest and resource planning of the island forests. However, upon further investigation, the FNIFM is not relevant to my study.

To summarize, my study context was the Nisbet Provincial Forest and its implementation team for the FMP, which is part of the IFLUP. Within this context, I explored the perspectives of the BOFN community and NIT. My research sought a better understanding of what resources and values within the Nisbet Provincial Forest were significant for NIT and BOFN and how these values might be better expressed within the implementation of the FMP.

3.4.2 Beardy's and Okemasis First Nation

A Cree Nation located just outside Duck Lake, Saskatchewan, BOFN is one of six Indigenous communities surrounding the Nisbet Provincial Forest (Beardy's and Okemasis First Nation, 2013). Historical records document Cree peoples in the Duck Lake area beginning in the early 1640s during the first missionary attempts by the Jesuits in Canada (Beardy's and Okemasis First Nation, 2013). Since then, the Cree have continued to be contacted by other communities for over three centuries (Beardy's and Okemasis First Nation, 2013).

On August 28, 1876, Treaty #6 was signed by Chiefs Beardy, Cutnose, One Arrow, and several others at a location between Fort Carlton and Duck Lake (Beardy's and Okemasis First Nation, 2013). The reserve's boundaries border Duck Lake (Beardy's and Okemasis First Nation, 2013). The North-West Rebellion in 1885 and the development of residential schools both created a chain of long-term consequences that negatively affected BOFN (Beardy's and Okemasis First Nation, 2013). These consequences included the implementation of the pass system, the restriction of treaty rights, decreased rations, and an ultimate loss of culture and language (Beardy's and Okemasis First Nation, 2013). These historical events negatively influenced the transmission of IK within the BOFN community and may act as precursors to the lack of trust BOFN members have with outsiders.

As of 2016, there were 3,050 band members of BOFN, 1,982 living off reserve and 1,068 on reserve ("Population", 2016). Additionally, 60% of the total population is 30 years of age or younger ("Population", 2016). BOFN is actively engaged on a variety of forest management boards. In 2015, they signed a memorandum of understanding (MOU) with the School of Environment and Sustainability (SENS) at the University of Saskatchewan. This MOU allowed

me to enter the BOFN community and embrace a wealth of IK that BOFN members were willing to share.

3.4.3 Nisbet Implementation Team

The key advisory bodies involved in the Nisbet Provincial Forest included the NIT and the PAC, both of which were formed in December 2000. The members of NIT "oversee the ongoing application of the IFLUP and provide advice to the Minister of Environment on the management of land and resources in the planning area" (Government of Saskatchewan, 2015b, p. 1). This planning team comprises individuals from Saskatchewan Environment and Resource Management (SERM) and other government departments, all of whom identify information on the uses and issues of the Nisbet Provincial Forest (Government of Saskatchewan, 2000). The PAC was established in April 2001 and contains representatives from "local municipalities, First Nations, Métis, and stakeholders representing sand and gravel, cattle grazers, forest harvesters, ecotourism, tourism, environmental and recreational interests" (Government of Saskatchewan, 2012, p. 5). The PAC "membership ranged from 24 to 45 people" during the development period of IFLUP, which was between December 2000 to July 2012 (Government of Saskatchewan, 2012, p. 5). PAC members represent stakeholder interests, and these individuals meet to review implementation plans before providing advice and guidance to the ministry (Government of Saskatchewan, 2012). This group provides opportunities for community engagement and participation, Indigenous or otherwise, in the planning area to work with the province of Saskatchewan to influence the direction of the IFLUP (Government of Saskatchewan, 2012).

The creation of these teams and IFLUP were deemed necessary as the Nisbet Provincial Forest is highly accessible to the public use and is extensively used (Government of Saskatchewan, 2012). The cumulative effects of resource use within this forest may be highly significant over time, as there is continuing pressure to develop the forest to sustain human values and uses. Therefore, there is a rapidly increasing need to develop sustainable and adaptive forest land use management strategies, which address these human values and the needs of future generations. The bodies within NIT and PAC are charged with implementing the plan and ultimately have a say on how IK is or is not be used within the plan.

3.5 Limitations of the Study, Validity, and Reliability

My study had several limitations. First, the case study approach imposed certain limitations. My decision to involve the IK of one Indigenous community in one geographical region may have limited the study's generalizability. Second, my status as an outsider to the BOFN community may have limited my understanding of their community. The researcher's limited perspective or bias can put the reliability and validity of qualitative research at risk. If I misinterpreted or misidentified the IK provided to me, I might have inappropriately categorized this knowledge within the wrong TEK Face. This kind of error would reduce the quality of the GIS map created and reduce the validity of my research regarding the representation of IK. To combat this potential challenge, I needed be well aware of my potential biases, but to fully separate myself from this bias would have been impossible as I would have had to been raised in the community to fully understand its cosmology (Hays & Singh, 2012; Houde, 2007). I minimized bias by enlisting the help of Mr. Gamble, who acted as a guide to ensure that my actions and interpretations were not deemed disrespectful or biased. A third limitation is knowledge diversity. To represent diverse views, I interviewed different individuals from both BOFN and NIT. I interviewed Elders, community members, individuals who worked in the band office, men, women, youth, individuals who had extensive knowledge of the IFLUP and FMP, and individuals who did not. By doing so, I was able to secure a varied sample of knowledge that represented two diverse communities. A more detailed discussion of the limitations of my study in a more general context will be discussed further in Chapter 6.

LoBiondo-Wood and Haber (2014) define validity as the "extent to which an instrument measures the attributes of a concept accurately" (p. 290). Comparatively, Leung (2015) refers to validity as the suitability of the methods used and data collected to answer the research question. As discussed, my research predominantly used qualitative research, which required a methodological approach and methods appropriately matched to the research question and objectives. The data used and the results of my study may be considered valid because they address my research question and objectives. The data used in my study was validated through the interviewing process, the IK used was validated by BOFN community members, and the feasibility of the IK displayed by GIS maps was validated by NIT members. The validation of the IK ensured that the maps contained no redundant information and that the IK used was accurate.

LoBiondo-Wood and Haber (2014) define reliability as "the extent to which the instrument yields the same results on repeated measures" (p. 298). These authors then go on to state that reliability is concerned with "consistency, accuracy, precision, stability, equivalence, and homogeneity" (p. 298). In my study, showing the GIS maps to both BOFN and NIT participants provided consistency because both groups were exposed to the same IK and the same visual display on the GIS maps. There is a risk that when creating maps with ArcGIS© and ArcMap©, the maps may not accurately represent the data provided, either due to user error or inconsistent data. To test the reliability of the GIS maps produced, I performed the following process: First, I duplicated the data within each TEK Face. Second, I created a second map based on this duplicated data. By ensuring that the duplicated map was identical to the initial map for each TEK face, I provided a level of redundancy needed to increase the reliability of my study. I also ensured reliability by pilot testing my interview questions with Mistawasis community members and strongly connecting these questions to my research objectives. An additional check on reliability was to have the interviewees review the transcripts of their interviews to increase the accurate representation of information used to inform my study. If the tools and methods of my study were appropriately used, then they may also be used in the future to produce replicable results.

Although reliability and validity are not mutually exclusive concepts in qualitative research (Golafshani, 2003), both are needed for a cohesive qualitative study. I therefore took several steps to ensure that my methods and data were both valid and reliable. The combination of methods I used to study the same phenomenon is known as triangulation. Morse (1991) defines methodological triangulation as the "use of at least two methods, usually qualitative and quantitative, to address the same research problem" (p. 120). I specifically used what Morse refers to as "sequential triangulation," which ensures that "the results of one method are essential for planning the next method" (p. 120). In my research, the methods used were sequential in that I first performed an archival document analysis, which I then used to inform the GIS maps I created using my categorical conceptual framework. These maps were then used in my interviewing process with both the BOFN and NIT groups.

As Golafshani (2003) states, reliability and validity are "conceptualized as trustworthiness, rigor, and quality in [a] qualitative paradigm" (p. 604). When using

triangulation, validity and reliability may be strengthened because triangulation may decrease bias and increase the trustworthiness of the data collected on a phenomenon. Using multiple methods in the triangulation process allows for a diverse collection of data to be evaluated using multiple different interpretations. This evaluation may be rigorous and produce quality data that is accurate, consistent, and replicable. For the reasons described above, I am confident that the triangulation and processes used in my study have produced consistent, accurate, and reliable data.

CHAPTER 4 RESULTS

4.1 Introduction

The aim of this study was to evaluate the limits and opportunities of using GIS maps as boundary objects to implement IK in the Nisbet Provincial Forest FMP. My study focused on the IK provided by the BOFN community. This IK was visually depicted via GIS maps and analyzed by members of both the BOFN community and the NIT during semi-structured interviews.

In this chapter, I use the criteria detailed in Chapter 2 (see Table 2.3, p. 27) to describe an effective boundary object. These criteria are referred to throughout the study and were used to evaluate the GIS maps and the Six Faces of TEK (Houde, 2007). I explore the role of IK in these GIS maps and describe the original maps created and used in the interview process before addressing what was changed in the modified maps. These modified maps were influenced by the new information provided in the interviews by the BOFN and NIT groups. I then discuss the extent to which both the Six Faces of TEK and the GIS maps met the boundary object criteria. I lastly discuss the themes and findings that emerged in the interview process and map creation.

4.2 Boundary Object Criteria

As Table 2.3 shows (see p. 27), through a detailed analysis of boundary object literature, I synthesized four defining characteristics of boundary objects that may encourage the effective use of information between knowledge boundaries. GIS maps were used in this study as boundary objects to visually depict the IK of the BOFN community and to communicate this IK to a broader audience, namely the NIT. By presenting this knowledge to a broader audience, I then assessed the feasibility of the maps used in a management context, primarily the FMP. These criteria will be discussed at length in this chapter and in Chapter 5. The GIS maps used in my research, as well as the Six Faces, are evaluated using each criterion. These criteria helped establish a better understanding of what is needed to create a boundary object that facilitates communication and translation of knowledge between BOFN and NIT.

4.3 The Role of IK in the GIS Maps

My study attempted to determine whether and how the GIS maps met these boundary object criteria, the implications of meeting or not meeting these criteria, and the role of IK in these GIS maps. The GIS maps used in my study attempted to display the spatial components of

different categories of IK. These categories and their characteristics were created by Houde (2007) and are known as the Six Faces of TEK. This framework was conceptually used in my study and is explained in more detail in Chapters 2 and 3. Table 2.2 (see p. 20) lists the characteristics that define each category as set out by Houde to identify the distinct elements found within IK. The data used to create these maps were based on the IK gathered by the BOFN History Report (2013) and Mr. Bendzsak's TEK cache.

4.4 Original Maps

In Appendix B, I discuss the original two maps made based on the spatial information provided by the BOFN History Report (2013) and the TEK Cache by Mr. Bendzsak. These sources are described in greater detail in Chapter 3. Below I explain modifications that were made to the original maps based on the information I received from the individual and group interviews. The changes that were requested addressed Face One and Face Three. The following chapter sections use technical terminology that is commonly used within the ArcGIS software program.

4.5 Face One Modifications

The interviewees predominately provided commentary on wildlife, plants, and activities such as hunting. These comments were usually related to changes in animal behavior they had noticed based on their empirical observations over time. One BOFN interviewee provided a wealth of information for the Face One modified map, including new animal migration patterns and animal sightings, such as elk, deer, moose, cougars, birds, and fish (B1, 2016). This participant also provided new spatial information on nesting sites for birds, habitats for lynx, the health of local plants and trees (e.g., an increase in tree borne diseases), and the tick population (B1, 2016). This BOFN interviewee revealed a growing concern that predator movements of wolves, cougars, and lynxes are moving South and heading towards the reserve, implying that these animals are starting to appear in central Saskatchewan around the reserve and the city. Therefore, this participant provided key information on a change of typical spatial patterns for different animals. This participant also reminded me that BOFN community members "monitor the forest," and he suggested that the changes of animal movement and resource abundance may be "associated with climate change"; he also noted that "stress factors have increased" and that "insects and diseases are starting to play a major role" (B1, 2016).

This information of changing animal movements was corroborated by a number of other BOFN participants who had noticed that spatial patterns of animals are changing, such as bird migratory patterns (B5, 2016). For example, BOFN participants noted that one might observe "going North, you hear geese and cranes…and in the fall, they'll be heading again (B5, 2016). However, "nowadays because of everything of the ice melting and everything…due to global warming…a lot of these animals are migrating South" (B5, 2016). Subsequently, "a lot of animals that you see up North, now you see them all the way down the prairies…moose, elk…even deer, right down to wolves…they're heading South" (B5, 2016).

Other spatial differences included amphibian habitats disappearing and invertebrates such as crickets being "gone" (B10, 2016). This participant commented on the complete silence he now hears as opposed to previous years where he could hear the presence of crickets at night, going on to state that "all these areas where the animals usually are, they're no longer there…I don't know if it has to do with population or with just the change of the ecosystem…it's not as easy as it used to be where they were heading at what time of the year…they're harder to find…their traditional ways they used to travel, their patterns, they're not the same" (B10, 2016). This participant was also helpful in suggesting reasons why species are declining, and movement patterns may be changing. He "noticed that there's areas where there's no trees anymore, it [is] all clear cut…and those were areas where the moose would stay in the fall…I've noticed there's so much of a difference in their…movement patterns (B10, 2016). Lastly, this participant also explained that there was "hardly any frogs…you could hear them, that's something you could count on…this year, none" (B10, 2016).

Additionally, some BOFN participants noted that the seasonal presence of different animals has "shifted" and that "places that never had snow are getting snow" (B12, 2016). These participants noticed that there are animals that "[they have] never seen before…everything is changing" (B12, 2016). These participants also mentioned a change in flora, where there is a disappearance of many species such as crocuses and tiger lilies (B12, 2016).

Although the information on declines of animal populations and species disappearance is useful, especially within the context of climate change and the implications this change may have on biodiversity, it was very difficult to visually depict this information on the GIS maps. As mentioned, interviewees linked these reductions in wildlife and vegetation to climate change and

alternative methods to agriculture. However, there was insufficient spatial information for GIS on the progression of animal movements in Saskatchewan online, and the wildlife information that was provided through the interviews lacked specific locations. Consequently, this information was not included in the GIS maps of this study. However, the interviews demonstrated that BOFN interviewees were strongly interested in animal movements including migrations and/or declines or changes in species. As a result, this interest may be an opportunity for future study.

4.6 Face Three Modifications

As I was modifying these maps, I looked over the BOFN History Report (2013) and the TEK cache once more as a way to validate that I was placing information on the correct map. I double checked this information because the interviewing process provided me with a fresh perspective on the information on the GIS maps, and I was curious to see if my perspective on the categorization of these data may have changed. On further inspection, I noticed that all of the information provided by the TEK cache was added to the Face One map. The reason for placing this information on the Face One map was that I was under the assumption that all of this information was correlated with animal movements impacted by a highway near BOFN on the North-East section of the map. However, after sifting through the information provided and reflecting on the interviews, I found spatial points that belonged on Face Three maps, including points for berries and camps. I therefore transferred this information from the Face One map to the Face Three map, according to their defining characteristics (see Table 4.2, p. 56). Berries are traditionally a staple in the diet of the BOFN community (Beardy's History Report, 2013), and some berries may have medicinal properties and are subject to harvesting. Medicinal berries are a characteristic of Face Three. I increased the size of these points and changed their colors to be more vibrant and easier to see on the map. I was thus able to perform a minor re-categorization of the information, while the rest of the data used in the maps were not affected.

Interviewees also provided new information about spiritual sites to inform Face Three. New information included spiritual and culturally significant sites: Eagle Creek (B3, 2016) and Indian Crossing (B7, 2016). On April 6th, 2018, Mr. Dwayne Rinholm provided me with shapefiles for Indian Crossing, though the name of this location, with some referring to it as "Elk Crossing" or "The Crossing." Mr. Rinholm also provided the shapefiles for Eagle Creek. The location of

Eagle Creek is approximate and referred to as a specific drainage site. Although these sites may have been identified previously as landmarks or bodies of water, their significance is different within the context of this study and are marked on the GIS maps as such.

Medicinal plants were not readily shared, and I was only provided with the general location of these plants due to fear of exposure and abuse of these resources. As one BOFN interviewee stated, “it’s preserved” and a “non-Native person” may come to the location and “ruin it for the animals… [they would] rip up the forest” (B4, 2016). BOFN participants also provided information about new plant species found on the side of the highways leading to BOFN and Saskatoon. This information was the most challenging to find, as I was working off of a description and there seem to be no available GIS shapefiles for botany-related spatial data in the regions I was interested in. The original maps are shown below as Figure 4.1 and Figure 4.2, and both modified maps are shown below in Figure 4.3 and Figure 4.4. To reiterate, I merged the spatial data from the BOFN History Report (2013) into either Face One or Face Three. Therefore, this data and the original maps were created by Dillon Consulting Limited using the information collected through the BOFN History Report (2013). Larger versions of the original and modified maps may be found in Appendix B.

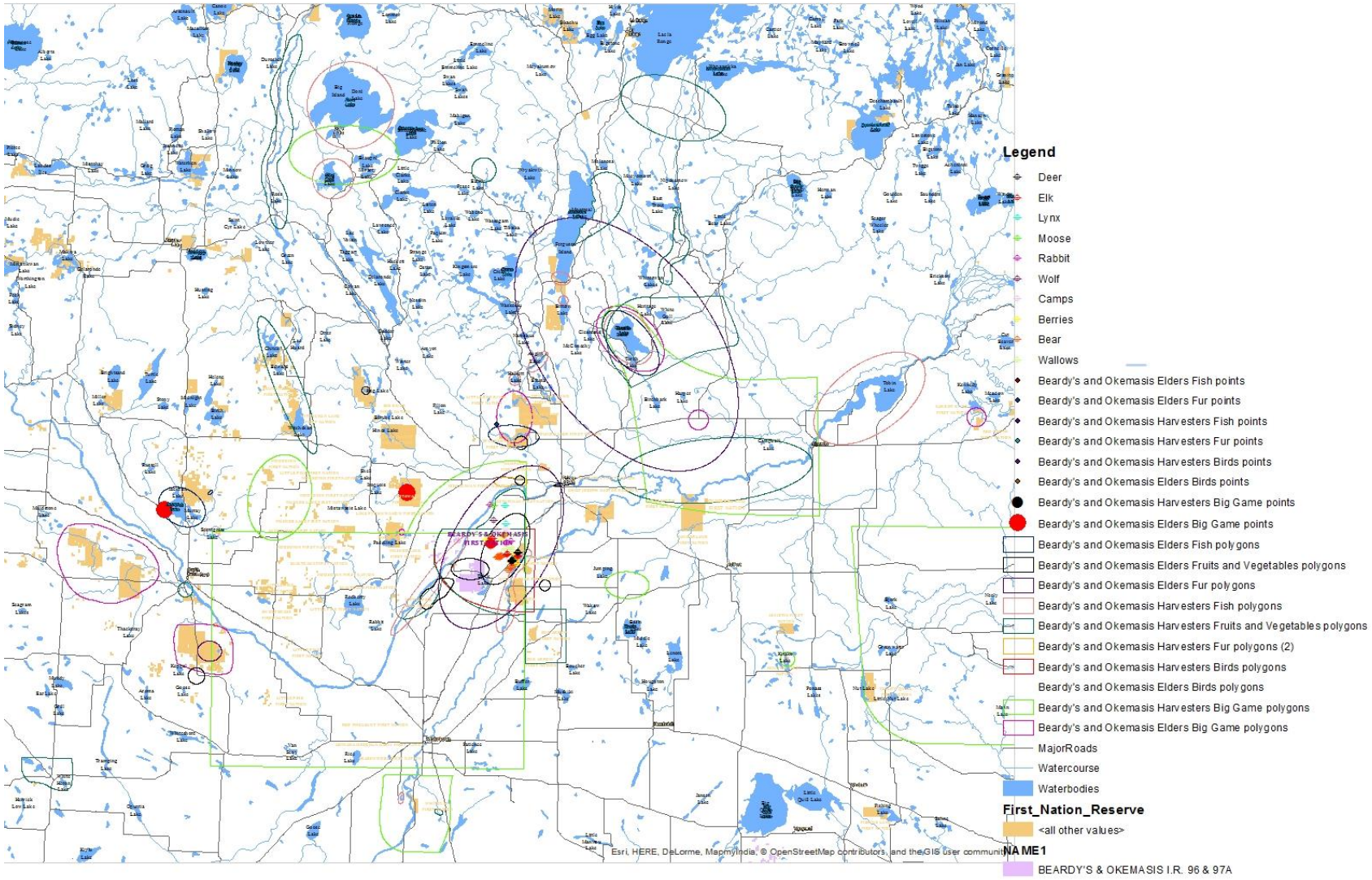

Figure 4.1. Original GIS Map of Face One, Factual Observations

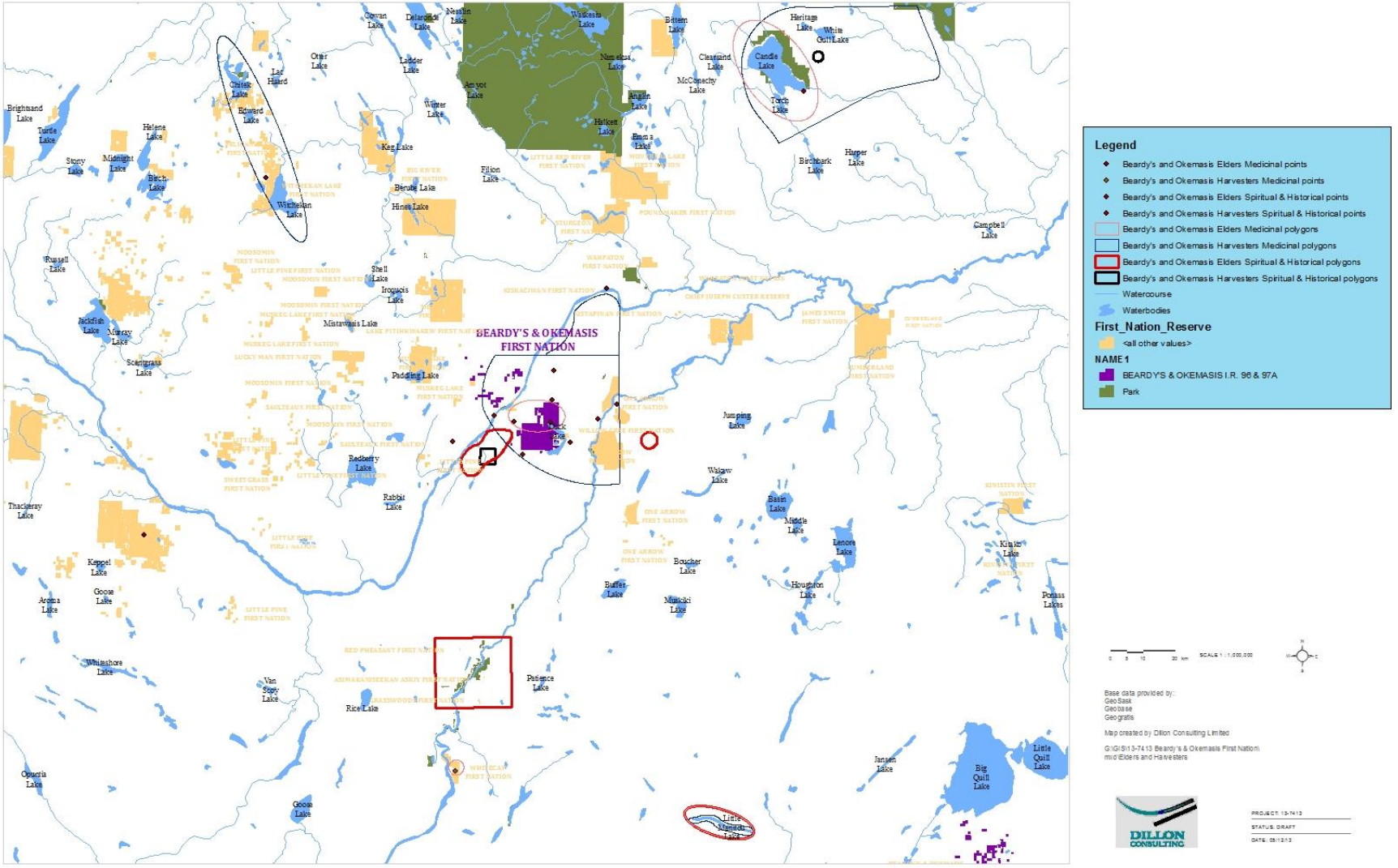

Figure 4.2. Original GIS Map of Face Three, Past and

Factual Observations (Face One, Modified Map)

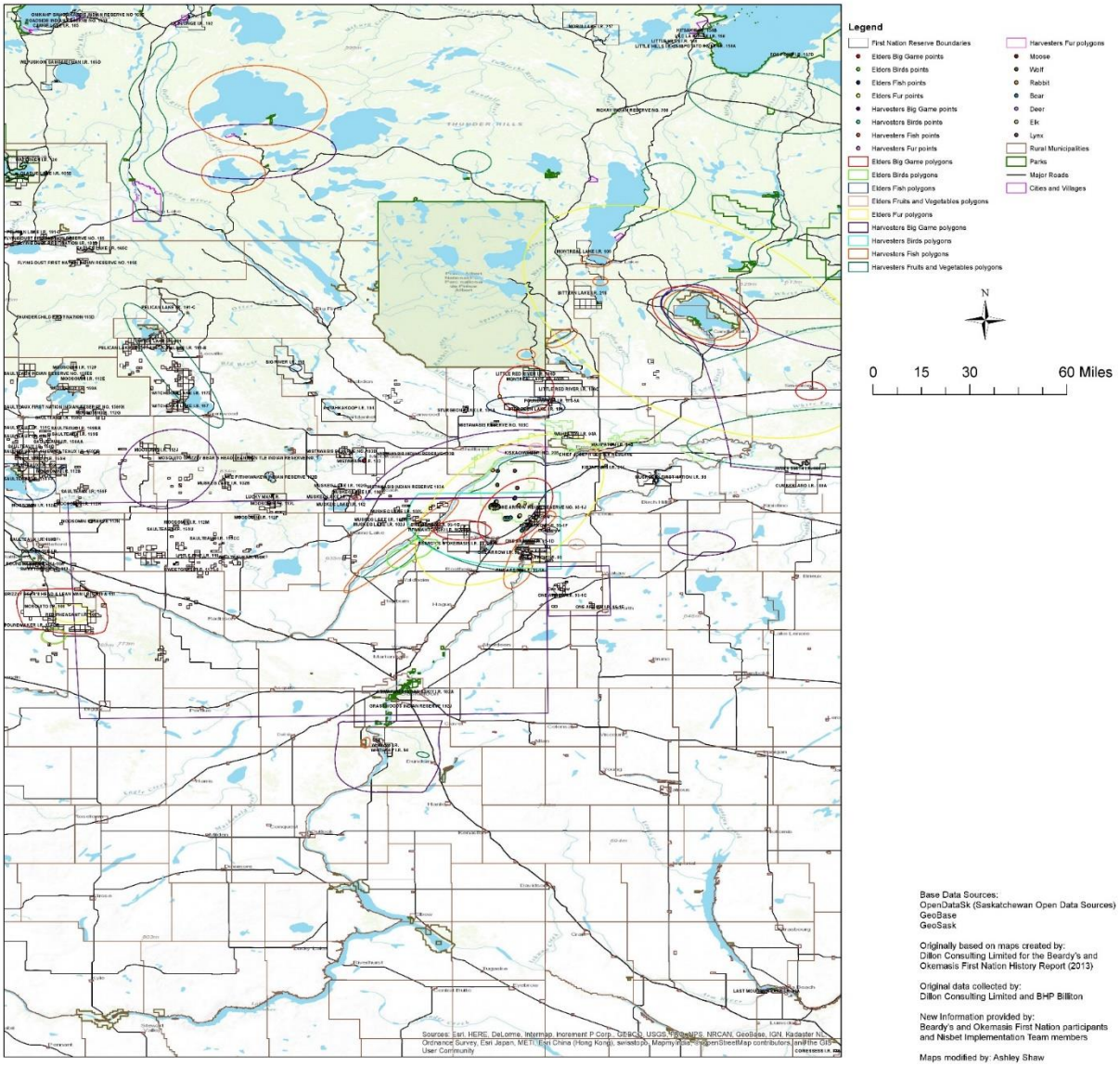

Figure 4.3. Face One, Modified Map

Past and Current Uses (Face Three, Modified Map)

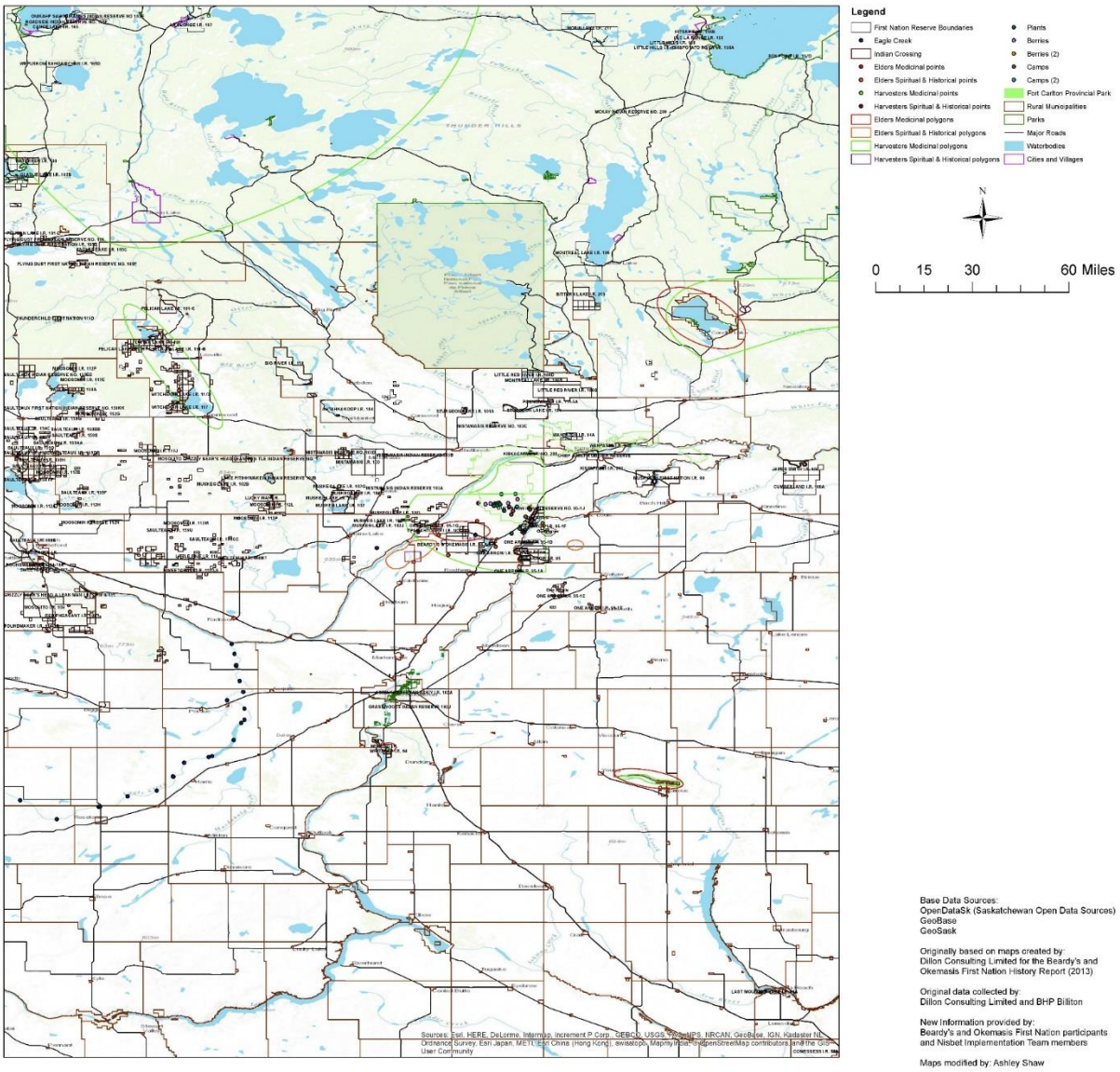

Figure 4.4. Face Three, Modified Map

4.7 The Six Faces, IK, and the Boundary Object Criteria

In my research, I was unable to map several of the Faces described by Houde. These were Management Systems (Face Two), Ethics and Values (Face Four), Culture and Identity (Face Five), and Cosmology (Face Six). Two Faces – Factual Observations (Face One) and Past and Current Uses (Face Three) – were easier to visually display on GIS maps. The ability to create some GIS maps for some Faces rather than others is analyzed in the discussion section.

In this section, I evaluate the Six Faces against the four boundary object criteria. In doing so, I identify what information would be suitable for placement on GIS maps as a boundary object to facilitate communication between NIT and BOFN knowledge boundaries. Below I explore what information (and associated Faces) may potentially limit or encourage GIS maps to act as effective boundary objects due to the criteria the Faces did or did not meet, I elaborate and analyze these findings even further in Chapter 5.

4.7.1 Flexibility

As detailed in Table 2.3 (p. 27), a boundary object is required to be both robust and malleable; in other words, it can go "back-and-forth between social worlds" (Steger et al., 2018, p. 154) and "exist in a specific state" (Steger et al., 2018, p. 154) while remaining universally vague and recognizable across disciplines (Star, 2010; Star & Griesemer, 1989; Steger et al., 2018). This vagueness creates "interpretive flexibility" (Star, 2010; Steger et al., 2018, p. 154). Therefore, boundary objects must establish a "shared syntax or language for individuals to represent their knowledge" (Carlile, 2002, p. 451).

Face One is based primarily on empirical observations of dynamic environmental entities, which may be interpreted in multiple ways by different knowledge holders. This flexibility in interpretation was substantiated by BOFN participants who understood the geographic boundaries provided on the map and the different empirical observations the map depicted. Thus, the information was open to different interpretations, but the geographic boundaries were robust enough that all participants agreed on the same geographic boundaries. These geographic boundaries were primarily the Nisbet Provincial Forest and the BOFN reserve.

Face Two primarily concerns sustainable agricultural methods used by individuals in the Indigenous community. There was insufficient information provided to form interpretive flexibility, where different participants could provide their own knowledge based on a shared syntax. This lack of interpretive flexibility may have occurred because the information provided for Face Two was too insubstantial to be robust and malleable. However, had more time been available, this Face possibly could have been more extensively explored, as individuals who were aware of alternative agricultural strategies were able to provide their own interpretations. For example, one BOFN participant observed logging in the Nisbet Provincial Forest and was

aware that there was “replanting [of] the trees” and this replanting was “pretty good for the harvesters” (B7, 2016). Overall, this is an area for potential future study.

Face Three comprises mainly the knowledge of past and current uses of the environment, including sites of cultural significance and the location of medicinal plants. Thus, the geographic areas of these sites and locations may be robust, and the contents found within these barriers may be diverse and faced with multiple interpretations. Therefore, Face Three may meet this boundary object criterion.

Face Four concerns environmental ethics and the values individuals may hold for wildlife, the environment, and other humans. Some BOFN participants acknowledged the valuation of the Nisbet Provincial Forest by expressing concern for its preservation. For example, one BOFN participant noted, “All we’re trying to do is protect a little forest…to preserve our Nisbet forest” (B5, 2016). Although this concern for the forest may reflect personal values towards environmental sustainability, not enough information was provided by interviewees that was simultaneously robust and malleable enough to allow for interpretive flexibility. Therefore, this Face does not meet this boundary object criterion.

Face Five concerns language and images of the past, stories, important social relations, and the benefits that cultural landscapes provide. One BOFN participant mentioned the importance of language by stating that “I think if we had kept our language alive, those [GIS] maps would look a lot different…[because] places were described using language. So, when you lose a language, you lose an understanding of where a lot of the medicines [are], the good hunting sites, all of this stuff is found in our language…and sadly most of us don’t speak it” (B2, 2016). Another BOFN participant recounted a story containing a significant allusion towards respecting nature and its resources (B3, 2016). Although both these participants provided information that matches the defining characteristics of this Face, neither account provided knowledge that was simultaneously robust and malleable and thus open to interpretive flexibility. Because the information given was interpreted only by the individuals who provided it, this information did not lend itself towards being translated into spatial data. Therefore, more work and time is needed to gather sufficient information to ensure Face Five meets this boundary object criterion.

Face Six is the foundation for all of the other Faces and was the most difficult Face for which to obtain any information or spatial data. This face primarily concerns the assumptions and beliefs individuals have of their surrounding environments and reality. BOFN participants mentioned different ideas and concerns relating to the actions that are currently affecting the integrity of the environment by providing statements such as "Greed is going to kill mankind" (B5, 2016). However, while these concerns are valid and important, none of this information was consistent enough to be converted into spatial data that could be both robust and malleable. Therefore, this Face did not meet this boundary object criterion.

4.7.2 Concreteness

Concreteness alludes to a tangible "… means for individuals to specify and learn about their differences and dependencies across a given boundary" (Carlile, 2002, p. 452). The information provided for Face One and Face Three were concrete enough to create GIS maps that allowed participants to learn of their differences and dependencies on natural resources within their local environment. This concreteness was evident as I was able to create GIS maps based on the solid and consistent information provided in the interviews and by the two original sources of information, the Beardy's History Report (2013) and the TEK cache by Mr. Bendzsak.

The information for Face Two given in interviews was too abstract and was insufficient for mapping. With more time, mapping may have been possible, as many BOFN participants knew of agricultural and forest practices, such as farming, logging, and hunting. This information could contribute to a concrete means for broader audiences to understand resource dependency in their community (B7, 2016). However, the information participants provided did not include specific locations. Much of the information given was based on landmarks found in nearby locations or based on orally transmitted knowledge between community members. Overall, most of the information provided for Faces Two, Four, Five, and Six were based on orally transmitted knowledge, but this knowledge is still abstract and unable to be placed onto GIS maps. Therefore, although Face Two comprises potential spatial elements, the information I was given through my interviews was based on verbal affirmations and land marking of nearby sites without exact locations. Therefore, this is an opportunity for further study.

The information provided for Faces Four and Six was too abstract to create a concrete basis for individuals to understand their differences and dependencies on various natural resources. However, the information in Face Five could potentially meet this criterion as language and stories may provide significance for different resources and values. This significance could allow others a concrete means to learn about their varying dependencies on these resources and values. However, not enough information was provided for this Face to meet this boundary object criterion.

4.7.3 Joint Process

The joint process criterion suggests that a boundary object must facilitate "a process where individuals can jointly transform their knowledge" (Carlile, 2002, p. 452). As stated in Chapter 2, this transformation of knowledge may be done by any individuals involved in the usage of the boundary object (Carlile, 2002). Both Faces One and Three contained enough information to allow BOFN participants to jointly transform their knowledge to understand the original maps. Joint processes that transformed knowledge in Face One and Face Three were interviews in which the original maps were discussed in depth, allowing participants to relate the visual representations of the forest with knowledge they already had about Face One or Three. Jointly transforming their knowledge allowed participants to provide new information with spatial elements that could be added to the new maps. As detailed above, the participants provided this new information based on their understanding of the original GIS maps, as the new information was similar and fit with the characteristics relevant to either Face.

In regards to Face Two, there have already been joint processes of sustainable agricultural methods in the current IFLUP, such as prescribed burns (Government of Saskatchewan, 2000). This practice is based upon traditional practices that embody IK and is a current example of how this Face may meet this criterion. That said, alternative methods of sustainable use of natural resources rooted in IK were not discussed in the interviews to the extent that such information could be translated into spatial information and placed on a GIS map. This may be a possible future opportunity for research.

The information that defines Faces Four, Five, and Six is highly variable among individuals, and the information provided in the interviews was too abstract to allow the participants to jointly transform this knowledge. However, the interviewing process was an

opportunity for a joint process to occur as participants contributed their IK and transformed the IK on the existing maps. Additionally, as I will elaborate on later in this chapter, some emerging themes developed through the interviewing process presented a communal sense of ethics, values, beliefs, and cultural identity. However, these themes and discussions were not substantive enough to provide viable spatial information that could be applied on a GIS map. Therefore, these Faces did not meet this boundary object criterion.

4.7.4 Information Need

Information need was the final criterion considered. A boundary object must develop due to a need for information, and the boundary objects created through this need may "in turn influence the form and structure of dialogue" (Star, 2010; Steger et al., 2018, p. 154). Participants from both NIT and BOFN were eager to learn more about the information the Face One maps were trying to depict. For example, the FMP wanted more information on existing physical entities, such as animals, plants, natural resources or phenomena, within geographic locations in the Nisbet Provincial Forest. Because these entities may already be discussed to an extent in the IFLUP or FMP, forest users and planners may already be familiar with these entities. Learning more about these environmental entities may provide a new and more sustainable perspective on their extraction or uses. NIT participants were also intrigued with the expansiveness of the information in Face One, as it extended North, away from the reserve. Most NIT participants were eager to analyze the Face One map (and the Face Three map) and expressed a desire for more information to learn from and potentially apply in different avenues. Another example of information need was expressed by the BOFN participants who were familiar with the GIS information on wildlife and wanted to learn more about wildlife and their dynamic characteristics. This curiosity expressed by both groups indicates a desire for information on the data provided by Face One.

Face Two may meet an information need for alternatives in agricultural practices. An example of a current primary practice is controlled burning, an Indigenous agricultural method, which is used and documented by the IFLUP and FMP. Since this Indigenous method is already contained in Nisbet Provincial Forest's management plan, there may be interest in other Indigenous methods that could influence further agricultural practices in the IFLUP or FMP.

These Indigenous methods may promote similar values as those outlined in the management plan, such as sustainability and the perpetuity of natural resources.

Both BOFN and NIT participants were interested in the information categorized under Face Three, particularly medicinal plants. As one NIT participant stated, "I'd like to go where these medicinal plants are…just so I would know chewing on this piece of stuff would cure my tummy ache or something, you know?" (N3, 2017). As mentioned previously, the exact location of these sites may be held in confidence within the community and between individuals. Largely because the information was considered confidential, the locations of medicinal plants discussed during the interviewing process were not specific but encompassed large, sweeping regional areas. Currently, there is not a strong demand for information that is broad in description and does not pinpoint a location specifically. Therefore, although there is an interest in medicinal plants, there is a preference for the specific location of these plants. Thus, Face Three does meet the requirements for the information need criterion. However, there exists a preference for specific spatial knowledge that may be categorized under this Face, rather than broad or unspecific spatial knowledge. Additionally, Face Three maps may meet the criterion in another way: the information they contain may direct people's attention to sites requiring preservation due to their cultural importance for an Indigenous community.

For Face Four, both NIT and BOFN participants outlined their values about the forest and the sustainable use of its natural resources. For example, NIT participants stated that their values rested on two tenets, "keeping the forest in perpetuity and not reducing the size [of the forest]" (N8, 2017). The significance of these values for the participants was palpable, but the information they provided was abstract and thus difficult to translate into spatial data to present on a GIS map. That being said, there is a need for more knowledge about this Face in the IFLUP and FMP. Subsequently, this new knowledge may be based on different values held by different knowledge systems. Thus, the new information that could potentially be gathered and used within the management process may perpetuate a different set of values provided by a different knowledge system, such as IK. These values may be strongly similar to the values set out in the IFLUP and FMP, such as sustainability of resources, but may also differ in the methods used to sustain these resources.

To some extent Face Five met the criterion for information need as it was of interest to both NIT and BOFN participants, largely due to grave sites the Face contains. These sites are important locations significant to the history of Indigenous communities and both NIT and BOFN participants wanted to learn more about them. As one BOFN participant stated, "We're going to map all the graves…we lost a lot of people" (B3, 2016). This participant indicated that they were going to use new technology because "they never had that before" (B3, 2016). This active engagement with a project involving graveyards indicates a strong interest in work on grave sites in the BOFN community. This interest was supported by a NIT participant who stated that if grave sites were marked on the GIS maps then "[they] would get more attention" (N4, 2017). This interest is an indication that there is a need for information that makes up Face Five.

Although information on Face Six was difficult to obtain for this study, there may be a need for this information to be classified. For example, as will be detailed below, many interviewees noted that BOFN's younger generation is not seeking and using IK. As mentioned in the literature review, IK is a dynamic system that is constantly accommodating its surroundings. The BOFN community may want to teach their beliefs and values to the younger generation in a way that may be more relevant to current lifestyles. Overall, Face Six meets the information need criterion, as there is a desire to better understand IK and its dynamic characteristics.

4.7.5 Results of IK and Boundary Object Criteria

In summary, Faces One and Three met all the boundary object criteria, while Faces Two, Four, Five, and Six did not meet all these criteria, as shown in Tables 4.3, 4.4, and 4.5 below. Chapter 5 provides an in-depth analysis of why some Faces met certain criteria while others did not and how the ability of these Faces to meet these criteria may impact the effectiveness of boundary objects. It is critical to reiterate that all IK is applicable to individuals who choose to use this knowledge in their lives. Although my study collected inadequate amounts of BOFN IK that could have informed Faces Two, Four, Five, and Six, this does not mean that this information cannot be collected and translated into spatial data. As mentioned in Chapter 3, many limitations were present that may have contributed to the lack of information obtained, such as insufficient time to conduct further interviews, the withholding of specific locations of

medicinal plants, and insufficient questions relating to the Six Faces. These limitations and their implications will be explored in further detail in Chapter 6.

Table 4.1. Boundary Object Criteria against Faces One and Three

Face	**Criteria**			
	Flexibility – interpretive flexibility, shared syntax and language	**Concreteness** – concrete means to learn about differences and dependencies	**Joint Process** – process to jointly transform knowledge	**Information Need** – demand for information, influence form and structure of dialogue
1 – Factual Observations **Primary Data:** animal movement patterns, hunting and nesting sites for big game, fish, and birds **Added Data:** new hunting and nesting sites for big game, fish, and birds. New migration patterns for animals and birds. New species information.	✓	✓	✓	✓
3 – Past and Current Uses **Primary Data:** Locations of spiritually and culturally significant sites. Location of medicinal plants. **Added Data:** New spiritual and culturally significant sites. New information of regions containing medicinal plants.	✓	✓	✓	**✓/ X**

Table 4.2. Boundary Object Criteria Against Face Two

Face	Criteria			
	Flexibility – interpretive flexibility, shared syntax and language	**Concreteness** – concrete means to learn about differences and dependencies	**Joint Process** – process to jointly transform knowledge	**Information Need** – demand for information, influence form and structure of dialogue
2 – Management Systems **Primary Data:** Activities and practices that focus on sustainable use of natural resources such as agriculture and pest control.	**✓/X**	**✓/X**	**✓/X**	**✓**

Table 4.3. Boundary Object Criteria Against Faces Four, Five, and Six.

Face	Criteria			
	Flexibility – interpretive flexibility, shared syntax and language	**Concreteness** – concrete means to learn about differences and dependencies	**Joint Process** – process to jointly transform knowledge	**Information Need** – demand for information, influence form and structure of dialogue
4 – Ethics and Values **Primary Data:** Environmental ethics that support non-exploitive actions, values of respect towards the environment and humans.	**X**	**X**	**X**	✓
5 – Culture and Identity **Primary Data:** the role of language and images within the culture. Stories, values, and social relations associated with the culture.	**X**	**✓/ X**	**X**	✓
6 – Cosmology **Primary Data:** Belief about how things work, how things are connected, and the role humans play in the world.	**X**	**X**	**X**	✓

4.8 Face One and Face Three Modified Maps Ability to meet Boundary Object Criteria

As discussed above, there are many instances where the GIS maps were able to adhere to the boundary object criteria and allow for the effective facilitation of IK across the BOFN and NIT knowledge boundaries. However, through the process of this study, there were instances where participants did not think the GIS maps were effective boundary objects. As mentioned earlier, participants did not always clearly understand what the polygons were supposed to represent and sometimes misunderstood the information the maps were trying to depict. One NIT participant in particular did not like the GIS maps, saying that they "provides very little content" (N9, 2017). My revisions to the maps considered these critiques, as explained in the modified maps section above. The modified maps of Face One and Three met all of the boundary object criteria, while Faces Two, Four, Five, and Six had mixed abilities to meet these criteria.

Below are general critiques as given by both BOFN and NIT participants about the Face One and Face Three maps in general and the ability of these maps to meet the boundary object criteria. In Chapter 5, I will elaborate on the implications of the GIS maps ability to adhere to these criteria within the overall context of my study and the broader literature regarding the effective representation and facilitation of IK.

4.8.1 Flexibility

All BOFN and NIT participants recognized the geographic boundaries outlined on the map, understood the maps' purpose, and the knowledge they portrayed. One BOFN participant stated that the maps were "pretty well accurate" (B9, 2016), a statement corroborated by many other interviewees. Another BOFN participant said that the maps "clearly show…all the areas that the people utilized and still do" (B8, 2016). One NIT participant stated that "it's quite relevant" (N3, 2017).

4.8.2 Concreteness

Many BOFN participants identified areas on the map that they and others in the community depend on for resources. For example, Candle Lake was identified by one BOFN participant as a place where he regularly hunts and fishes (B7, 2016). NIT participants were surprised to learn that resources were being used in more parts of the region than they had realized. For example, one NIT participant learned that communities depended on large expanses of Saskatchewan and other parts of the island forests (N10, 2017).

4.8.3 Joint Process

BOFN participants provided a host of new information on wildlife and plants (B1, 2016; B9, 2016; B6, 2016). NIT participants transformed the IK provided by the maps by adding new information to potentially enhance these maps. Shapefiles were provided to me to update the boundaries of the First Nation reserves and rural municipalities of Saskatchewan. Others had suggestions for enhancing comprehension, such as topographic base maps and stronger colored labels (N9, 2017).

4.8.4 Information Need

Participants from both groups wanted to see more information collected and displayed on the GIS maps to expand the breadth of IK being disseminated. All BOFN interviewees wanted to learn more about the Nisbet FMP, and most viewed the implementation of IK as an effective way to influence decisions made about forest resources. All NIT participants were interested in increasing the IK used in the FMP and wanted to see some IK potentially implemented if proper processes were followed, including Duty to Consult (DTC) and permission for using sensitive data like cultural sites (N1, 2017; N2, 2017; N4, 2017).

4.9 Limits and Opportunities of Using GIS Maps as a Boundary Object: Insight for Best Practices

One of the objectives of my research was to understand the limits and opportunities of using GIS maps as a boundary object. The main limits and opportunities are addressed below and are summarized in Table 4.6. These limitations and opportunities emerged from the inductive and deductive analysis, which is summarized in Appendix E. The main limits include the difficulty of creating shared processes, rigid description criteria and data preference, limited resources and avenues, a decrease of IK reliance, overlap of resource use, trust issues, legal constraints, and limited access to resources. The main opportunities include increased knowledge dissemination, demand for increased knowledge dissemination, the potential for reconciliation, a catalyst for participation, and interest in IK inclusion.

The sections below address these limits and opportunities stratified by the two interview populations, the NIT and BOFN. These limits and opportunities were considered in conjunction with the main research question of my study and the remaining two research objectives. The main research question of my study is: What are the limits and opportunities of using GIS maps

as boundary objects to represent IK in the Nisbet Provincial Forest resource planning and implementation processes? Out of the five research objectives, the fourth objective is: Understand whether and how GIS maps can be used as a boundary object to advance the use of IK in the implementation process of the FMP for the Nisbet Provincial Forest. The last research objective is: Develop a good practice which includes recommendations on how to represent and implement IK in FMP's that may allow for long term sustainability for the multiple stakeholders vested in forest resources. The results of this study address both of these objects and will be discussed below and in Chapter 5 and 6.

Table 4.4. The Limits and Opportunities of Using GIS Maps as a Boundary Object

NIT Limits	**NIT Opportunities**
• *Difficulty of Creating a Shared Process* • *Rigid Description Criteria and Preference for Data Specificity* • *Limited Resources and Avenues* • *Legal Constraints*	• *Interest in IK Inclusion*
BOFN Limits	**BOFN Opportunities**
• *Limited Access to Resources within the Nisbet Provincial Forest and FMP*	• *The Potential for Reconciliation*
Shared Limits	**Shared Opportunities**
• *Decreased IK Reliance* • *Overlap of Resource Use* • *Trust Issues*	• *Increased Knowledge Dissemination, Inclusion, and Engagement/Demand for Increased Knowledge Dissemination* • *Catalyst for Participation*

4.9.1 NIT Limitations

Specific limitations for including IK into the FMP by way of GIS maps emerged in my interviews with NIT participants. These limitations included difficulty of creating a shared process (N1, 2017; N2, 2017; N8, 2017; N10, 2017), rigid description criteria (N10, 2017; N8, 2017) and preference for data specificity (N10, 2017; N9, 2017), limited resources and avenues (N1, 2017; N2, 2017; N4, 2017), decreased IK reliance (N6, 2017), overlap of resource use (N10, 2017), trust issues (N1, 2017; N2, 2017; N8, 2017; N10, 2017), and legal constraints (N4,

2017). Decreased IK reliance, overlap of use, and trust issues will be discussed later as a shared limitation of NIT and BOFN.

4.9.1.1 Difficulty of Creating a Shared Process

Indigenous presence at NIT meetings was inconsistent (N1, 2017; N2, 2017; N3, 2017; N8, 2017; N10, 2017) and individuals in NIT were concerned that this would result in IK being misunderstood. This misunderstanding could lead to the misuse of IK and may weaken the NIT's ability to implement the plan using information in the way it was intended to be used. As one NIT interviewee stated "You can't just attend one [meeting] and then not attend. You have to be there all the time so that they [the other team members] get the drift from point A all the way through it" (N1, 2017). This statement was corroborated by another NIT participant who asked, "how was [he, the participant] supposed to know until they come and say you know what…this is what it is…we could always use some more knowledge" (N8, 2017). This participant felt the attendance of Indigenous representatives was crucial because individuals at the meeting would then become aware of these representatives' knowledge. If Indigenous representation is inconsistent, then information remains either unknown or is misunderstood.

A NIT participant addressed the overall goal of the NIT by stating "the whole point of having an implementation team is that we can then revisit and improve and change if need be…based on new information" (N10, 2017). Therefore, providing appropriate and iterative avenues of implementation are key to the development process of the FMP, but this calls for continuity in attendance to create mutual understanding. Another NIT interviewee supported this idea by stating that "from the very beginning, they [NIT] always held out chairs out for different reserves that touched the land and that they weren't attended well, and they always changed people. You can't have that." (N8, 2017). As a result, this inconsistency may affect the ability of GIS maps to accurately depict IK.

One NIT interviewee provided a possible explanation for the lack of Indigenous engagement in decision-making settings by stating "they haven't been asked possibly…their input hasn't been acted on or moved, there's been no avenue for them, from what I know" (N3, 2017). This suggests an alternative explanation for lack of Indigenous involvement—namely that the information contributed has not been used. These insights speak to the difficulty of creating a shared process for interactive knowledge exchange that is needed for effective boundary work.

4.9.1.2 Rigid Description Criteria and Preference for Data Specificity

The Nisbet FMP uses a limited amount of IK, possibly due to a preference for specific kinds of data in the plan and rigid criteria that relate to the GIS maps used in the plan. The specific information on which FMP focuses seems to be forest harvesting, inventory, and renewal, harvest volume, insect and disease management, non-timber products, grazing, and haying. To match the information needed in the FMP, the criteria for inclusion may be strict and rigid, limiting the knowledge – WSK or IK – included in the IFLUP and FMP. One NIT interviewee said that IK was used in previous planning processes and contributed to the "basis of zoning and creating a sensitive zone that says there is a number of traditional values along this travel route with buffers" (N1, 2017). However, there "[didn't] seem to be anything like that in the [current] Nisbet [process]" (N1, 2017). In other words, previously IK was included in some capacity, but this participant is unaware of any IK being included within the FMP currently.

Another NIT interviewee spoke about how GIS maps may limit the amount of information that can be presented, stating that "[GIS maps] are just static – it's just a picture" (N9, 2017). The concern is that since GIS maps display a fixed state, they cannot fully capture the breadth of knowledge available, such as more in-depth data on belief systems that drive management processes. This kind of information is difficult to translate into spatial data and may be unsuitable for inclusion in GIS and thus missing from the FMP.

Due to the static nature of the maps currently used within the plan, spatial information of specific points and locations has been privileged. Specific data points are preferred over spatial information of large set regions, and this preference influences the data used and visually displayed in the FMP. One NIT interviewee pointed out that "knowing what's on the landscape doesn't matter" (N9, 2017). This statement may refer to the large polygons displayed on some portions of the GIS maps provided during the interview process. Knowing what's in the landscape, such as non-specific areas of medicinal plants, may not matter as much as specific locations represented by points on the GIS maps. Another interviewee elaborated on this preference for specific data points by mentioning that "large sweeping areas…doesn't meet the consultation requirements for specific areas" (N4, 2017) and that providing precise data points is the "only way that [they will] ever be avoided" (N4, 2017). This interviewee may have been discussing a requirement he or she believes is necessary for the legal process of DTC. This NIT

participant believed that if a community wishes to preserve or protect a certain resource, it may need to provide an exact location for this resource as opposed to a large sweeping area. By showing large polygons, such as those on the maps in the interviews, there is a risk that the resources within the polygon will be subjected to human activity.

4.9.1.3 Limited Resources and Avenues

NIT participants discussed that there are limited administrative and financial resources to support the breadth of knowledge that may be available to implement into the IFLUP and FMP. Other NIT participants also acknowledged that there may be a lack of space within the FMP for IK, and this may funnel IK into other areas of the IFLUP. Many NIT participants stated that there are limited avenues for IK inclusion and that the lack of IK in the planning process is not intentional. One reason for this may be that the IFLUP and FMP consist of fast-paced changes established by government representatives in higher decisions-making positions that create an "inability to keep up with the changes and [their] updates of the information of the plan" (N1, 2017). As a result, the meeting cycles of the NIT may not match the changes that take place on the ground. An NIT interviewee also pointed out, there is a "human element" to the planning process as well. This element affects the strength of the plan as there is a lack of resources necessary to implement IK into the plan. There is not "somebody there the entire time. It gets difficult" (N1, 2017). This NIT participant suggests that additional resources, information, and administration services are needed to address new knowledge and its efficient inclusion. Ultimately, then, there are insufficient resources to include the information that the team may obtain. Management plans are supposed to be dynamic and able to constantly adapt to changes. However, the process may move too quickly, and the inclusion of IK into the plan suffers.

Finally, as one NIT participant mentioned, the NIT needs "more teeth" (N8, 2017) to make significant changes in the decision-making process. The NIT are a respected advisory committee and their recommendations on sustainable forest management are considered. However, the NIT has limited power in advising the Saskatchewan Ministry of Environment what to do and what information to implement (N1, 2017; N2, 2017). This limited implementation power may act as another limitation in how IK can be included in the FMP.

4.9.1.4 Legal Constraints

The legal processes necessary for proper consultation and knowledge implementation follow strict guidelines and rigid criteria. This may limit the dialogue regarding what information is needed, wanted, and provided within the IFLUP and FMP and acts as a limitation (N1, 2017; N4, 2017; N8, 2017; N10, 2017). NIT participants spoke about proper and effective consultation with Indigenous communities (N1, 2017; N2, 2017; N4, 2017). One NIT participant remarked at the traditional knowledge information and stated that "it would probably be more triggered at the point of consultation" (N4, 2017). This individual was ultimately concerned that before any actions were to take place, proper consultation would be conducted. Other NIT participants shared this concern for proper consultation. One NIT participant stated if they "were to obtain "[specific] dots or the sites they [BOFN members] were concerned about…" without proper consultation or engagement then "that's going too far" (N1, 2017).

Many NIT participants noted that including more IK may strengthen the process they believe to be part of the DTC, putting the NIT in a better position to address the concerns of Indigenous communities (N1, 2017; N2, 2017; N7, 2017). For example, one NIT participant noted that IK provided by BOFN members would go "through the duty to consult, they're responsible," adding "If this was on the table for us [to] make preliminary decisions on, [that] would definitely help out" (N1, 2017). As N10 (2017) indicated, the DTC and other forms of legislation, such as the treaty signed between BOFN and the Canadian Government, act as political restraints or "political hoops." Another NIT participant concurred, arguing "you've got to go through the hoops…it's always back and forth, so if there's an issue that arises it takes some time to get a solution because of the way it's set up" (N7, 2017). To implement IK, these obstacles must be overcome, which may take time, and this may directly affect the amount of IK implemented in forest management. On September 10, 2018, I discussed the role the DTC may have in the decision-making process of the IFLUP and FMP with Integrated Land Use Planner Mr. Dwayne Rinholm and University of Saskatchewan professor Dr. David Natcher. Mr. Rinholm indicated that whenever an anticipated event or action is being planned in a specific area, all affected Indigenous communities must be contacted and a DTC must be upheld with any Indigenous communities who respond (D. Rinholm, personal communication, September 10, 2018). Dr. Natcher concurred, indicating that language in legislation often specifically states that the government has a responsibility to consult affected Indigenous communities. An NIT

participant added that consent is needed to obtain IK, and if an Indigenous community wishes to disclose further information that may be sensitive, this information may be addressed through the DTC process. Therefore, there are two scenarios that require the legal obligation of performing a DTC with Indigenous communities: using IK provided by an Indigenous community and contacting these communities if an event or action is expected to affect them.

To further support the involvement of Indigenous communities in planning processes, the IFLUP contains a specific statement that describes the role of the DTC within forest management and planning. The preface of the Nisbet IFLUP (2012) states that

> The Provincial Government has a legal duty to consult and accommodate First Nations and Métis communities on matters that have an impact on Treaty or Aboriginal rights. Although this planning process included consultation with many First Nations and the Métis Nation, and this document provides broad information about interests in the area, the Province will continue to consult on individual matters in order to meet its consultation obligations. (p. ii)

> Even more specifically, the Nisbet IFLUP (2012) also states that:

> The ministry has a duty to consult with First Nations and Métis people on resource management decisions. Of particular concern to First Nations are provincial government actions, legislation or policies that may affect their treaty or Aboriginal rights. (p.10)

Thus, the IFLUP acknowledges that the DTC has a significant and active role both in planning and decisions made about the Nisbet Provincial Forest. This DTC process is the responsibility of the Government of Saskatchewan, and consultation has been provided and will continue to be provided to meet consultation obligations. In Chapters 5 and 6, I discuss how the process of DTC may be a legal constraint that inhibits obtaining IK from Indigenous communities.

4.9.2 NIT Opportunities

The interviewees identified additional opportunities for using the GIS maps as more effective boundary objects in the FMP process and for representing places where the NIT and BOFN could build on mutual interests. For example, the IK provided could help identify areas or resources that are of use and significance to BOFN and may be vital to understanding how to better protect and sustain these resources and regions. These opportunities are detailed below and

include increased knowledge dissemination, knowledge inclusion and engagement, catalyst for participation, and interest in IK inclusion. Increased knowledge dissemination, knowledge inclusion and engagement, and catalyst for participation are discussed later in this chapter as shared opportunities between NIT and BOFN.

4.9.2.1 Interest in IK Inclusion

There is definite interest by the NIT in including IK in the FMP, but barriers prevent it from being more effectively implemented. The vast majority of NIT participants expressed interest and optimism towards including IK within a planning and management context. Participants believed that if more IK were provided, then more opportunities could be created to include this knowledge in preliminary decisions about the FMP or other sections of the IFLUP (N1, 2017; N2 2017; N3, 2017; N4, 2017; N5, 2017; N6, 2017; N8, 2017; N7, 2017; N10, 2017). For example, one NIT participant stated that the FMP "could use more" Indigenous knowledge (N8, 2017). When asked if there was room for IK in the FMP, another responded, "There always is" (N7, 2017). Another participant said, "The more information the better" (N3, 2017).

Most NIT participated indicated that the IK depicted in the GIS maps presented could allow for more well-rounded decision making and aid the government in making decisions about the resources in the Nisbet Provincial Forest (N1, 2017; N2, 2017; N4, 2017; N8, 2016; N10, 2017). NIT participants specifically mentioned that visually displaying IK on GIS maps may promote the value of ecological integrity and stewardship of the forest and its resources (N1, 2017; N2, 2017; N8, 2017; N10, 2017). For example, one NIT participant stated that the GIS maps contain information that could be involved in "overarching decision making" in the IFLUP, while another indicated that they could "improve the plan based on [the GIS maps]…there's an avenue there through the implementation team…all this information is about an ecological system…and these activities go on where the forest still has that integrity" (N10, 2017). This willingness to include the GIS maps and the IK they contain may be summed up by another NIT participant, who indicated that "things are going to change without a doubt, but how are we going to make a change the best we can?" (N8, 2017). This NIT member may have been implying that we could be better prepared for these changes if we had more information about how to address these changes, such as the effective portrayal of IK portrayed on GIS maps.

Sustainable forest management is a shared value between NIT and BOFN community members, an idea supported by N5 (2017) who claimed that "everyone on NIT has similar intentions…everybody wants to protect the forest." NIT members are "charged with stewardship" (N8, 2017) and are therefore committed to sustainable resource extraction and use. This shared value may support the inclusion of more IK in the IFLUP and FMP, as both groups value sustainable forest management and may seek innovative ways to reach that goal.

As a committee, NIT has many goals that it would like to achieve if more IK were collected and more values from all knowledge systems were included in the IFLUP/FMP. These goals include increased inclusiveness from different representatives and stakeholders and increased sustainable extraction of natural resources. These goals are consistent with the two main tenets of the NIT, which according to N8 (2017), are to "avoid reducing or fragmenting" the Nisbet Provincial Forest and keeping the "forest [and its resources] in sustainable perpetuity." Based on the views expressed by NIT participants in the interviews, increasing attendance of all representatives at NIT meetings may be a means to achieve these goals.

The desire for increased Indigenous engagement and the acknowledgement of shared values between communities may allow the maps to function as effective boundary objects. This effectiveness is possible because BOFN IK holders and NIT members wish to work together and put IK into use where possible. IK holders are willing to share their knowledge with individuals on the other side of the boundary who have expressed a desire to embrace this IK within a management context where feasible. This desire for a better relationship is summed up by a NIT participant who stated that "it would be helpful to know how to protect and work closer with the First Nations in the area. Not just Beardy's, but there [are a] number of First Nations…[with whom we] should have a better relationship" (N1, 2017).

4.9.3 BOFN Limitations

The BOFN participants identified limitations when providing IK within and outside the BOFN community and implementing IK in the FMP. The two key limitations that emerged in the interviews were lack of trust and limited access to resources in the Nisbet Provincial Forest and the FMP. Trust will be discussed later in this chapter as a shared limitation of NIT and BOFN.

4.9.3.1 Limited Access to Resources in the Nisbet Provincial Forest and the FMP

BOFN participants spoke about limited access to natural resources located in regions of cultural significance for them. This limitation affects their ability to obtain knowledge about these resources and disseminate this knowledge both in their own community and to a broader audience (B4, 2016; B6, 2016; B11, 2016; B2, 2016; B5, 2016; B9, 2016; B10, 2016). As one BOFN interviewee indicated, unless you have appropriate "written permission" to access the location of some areas where natural resources are located, "you can't go in there" (B6, 2016). It was unclear in the interviews if these participants were implying that permission needed to be given by the government or the owners (e.g., farmers or property owners) of the place where the natural resources are. However, these participants indicated that the berries may be located on "private land" (B12, 2016), suggesting that these resources may be located on land that is not accessible to BOFN individuals. In some cases, the participants mentioned, individuals "put up signs that say no hunting…but then you see them hunting. They'd be hunting all season." (B6, 2016). These BOFN participants were referring to individuals outside the BOFN community who use reserve resources for themselves and exclude BOFN community members. These participants did not explicitly state if this was happening in the Nisbet Provincial Forest or on the reserve. However, this statement shows that restricted access to resources limits the IK disseminated because if no hunting is allowed in areas significant to the community, then the relevant IK associated with hunting in that area may decrease over time.

Almost no BOFN participants had prior access to the IFLUP or FMP and very few had limited knowledge of these plans, possibly due to the lack of computer access among the participants, as the plan is publicly available online. As one BOFN participant noted, "I don't think any of us would have known there was a plan for the Nisbet forest. We just, we drive through it every day" (B2, 2016). Also, there was virtually no previous knowledge of the BOFN History Report (2013) or the TEK Cache by Mr. Bendzsak. Therefore, knowledge disseminated in the BOFN community, let alone to a broader audience, has been limited. Except for two BOFN interview participants, everyone else received information of the IFLUP or FMP through Mr. Alfred "Conrad" Gamble, a prominent, active representative of BOFN at NIT meetings, who verbally communicated this information to many BOFN members. When asked if they knew anything about the FMP or anyone involved with it, many said they knew about the plan "through Conrad" (B7, 2016), and they only knew "basically what Conrad told us" (B2, 2016).

Both limited access to natural resources in the forest and to information in the IFLUP/FMP may curb GIS maps' ability to serve as boundary objects. These limitations may have arisen because of lack of trust between the IK holders and the NIT or because other groups outside the BOFN community restrict knowledge sharing. Whatever the reason, withholding knowledge could alter the look of the maps and may limit their effectiveness as boundary objects. As well, if BOFN individuals cannot examine the IFLUP and FMP because they have no computer access, they may not see the use of the maps and, therefore, may choose not to contribute to them. Therefore, the inability to access information used to inform the GIS maps could influence how they are perceived and what new IK may be added.

4.9.4 BOFN Opportunities

BOFN participants provided insight into opportunities for implementing IK in the FMP. These opportunities include demand for increased knowledge dissemination and the potential for reconciliation. Demand for increased knowledge dissemination will be discussed later in this chapter as a shared opportunity between NIT and BOFN.

4.9.4.1 The Potential for Reconciliation

BOFN participants indicated that work towards implementing IK into planning processes like the FMP could be seen as an expression of reconciliation due to the acknowledgement and shared understanding of different knowledge systems. This shared understanding could create collaborative methods towards resource sustainability between Indigenous and non-Indigenous communities.

As one BOFN participant stated,

> We're also getting a better understanding of the multi uses of the Nisbet forest. We're well aware of the pressures and this is a tool that helps alleviate any social issues that may arise from the pressures. As well as of course, reconciling or reconciliating...between Indigenous and non-Indigenous users. It also helps to foster a better understanding where we can actually work to better the health of the Nisbet forest. (B1, 2016)

In other words, according to this BOFN interviewee, GIS maps can be seen as tools to advance reconciliation between Indigenous and non-Indigenous users through a shared understanding of

resource sustainability. This shared understanding may be achieved through increased visualization of IK in the GIS maps and the depiction of resource use by different communities.

To strengthen these claims, another BOFN interviewee indicated that this research could help "build relationships with First Nations people and garner a better understanding of their Elders' interpretation of forest management. I think it's an opportune time" (B2, 2016). A NIT participant corroborated this claim by suggesting that using the maps as boundary objects in the FMP may create "opportunities to [build] the relationship that we really need to have" (N1, 2017). Therefore, the effectiveness of the GIS maps as boundary objects may be influenced by the amount of IK they display, and using these maps as boundary objects may directly influence the relationship between the two communities.

4.9.5 Shared Limitations (NIT and BOFN)

4.9.5.1 Decreased IK Reliance

One NIT participant spoke about the effects of older generations being forced into residential schools and how that reduced the application and reliance of IK in Indigenous communities (N6, 2017). As this NIT participant stated, when his loved one returned home from residential school, "there was no teaching us the language" (N6, 2017). This decreased reliance on IK especially affected the younger generations. Due to these events, less IK is being used in the current day-to-day lives of the younger generation, making it more challenging to include into a planning process like the FMP. The statement provided by this NIT interviewee was corroborated by another NIT participant who mentioned that "they're losing maybe some of that reliance of traditional knowledge" (N3, 2017). The claims by both NIT participants were strengthened by several BOFN participants, many of whom expressed their concerns about the younger generation gradually losing the ability to apply IK in their daily lives. For example, one BOFN interviewee stated that "younger people, they're not as proactive with the traditions and the culture as their grandparents were" (B2, 2016). This statement was corroborated by other BOFN participants who, for example, stated that "our resources are getting very slim…our resources are old people…[we] need to pass [this information] on to the students…we need to get them at the right time…and visit them…give them a little insight…so that they can fuel up their minds" (B5, 2016). Another BOFN interviewee corroborated this statement by mentioning that "our youth aren't totally involved…not like before like our Elders…nowadays you don't see

that" (B9, 2016). The decreased reliance of IK is also something that another BOFN participant recognized by stating that "the [younger] generation…when you try to take them out hunting, they don't have a clue of what they're supposed to do" (B7, 2016). Therefore, the decreased reliance on IK was a significant limitation identified by BOFN and NIT participants through the interview process.

4.9.5.2 Overlap of Resource Use

Different communities use the same resources in the same geographical region for different reasons. Because they use resources differently, communities may disagree on how to manage these resources. They may also prioritize different values for a specific resource, which may limit information by specific knowledge sources from being included within the IFLUP and FMP. For example, one community may use a resource sparingly and would like it to be preserved, while another may frequently use this same resource and would like to see it extracted. Ultimately, the prioritization and overlap of use may limit the IK from being shared. When GIS maps do not display all the IK associated with a certain resource, they probably cannot function effectively as boundary objects.

Many NIT participants spoke about value systems in planning processes and how these systems tend to be prioritized around the ownership or monetary value of resources. An NIT interviewee specifically mentioned that Indigenous representatives may have been reluctant to come forward with information because "they feel it's really proprietary and… knowledge that people don't really want to share necessarily very broadly" (N10, 2017). This statement was supported by BOFN participants, some of whom were apprehensive about providing specific spatial information. As one participant indicated, "If I identify these things, people are just going to go out there and hunt and dig and dive and everything else…we have no right to go there and touch anything there" (B4, 2016). The reluctance to release specific information may be tied to value prioritization regarding resource use in the Nisbet forest. As mentioned, one group or community may use a resource differently from another group or community. For example, one group may want to preserve a patch of berries for ethical or spiritual reasons, while another wants to harvest these berries for economic development reasons. Decision-makers for a certain resource may be influenced by these different uses and prioritized values, and there may be disagreement about how to use the resource. As a result, this disagreement may affect what

information is placed on maps and used in the plan. After evaluating the use of a resource, decision makers decide what values to adhere to, thereby determining what happens to the resource. Thus, the berries will either be picked or preserved, depending on what values the decision makers agree upon.

Individuals involved in the IFLUP and FMP decision-making process can recognize the differing priorities of those affected by these decisions, they may then acknowledge that Indigenous and non-Indigenous communities have overlapping values concerning the land and regions. However, as mentioned, because I did not gather every dimension of IK from all BOFN participants, there may be gaps in the information displayed on my maps. Additionally, competition for the use of resources in the Nisbet forest may make it difficult to develop an effective land use plan. This overlap is approached by planners who try to avoid a conflict of interest by prioritizing values and needs associated with specific resources (N1, 2017; N2, 2017).

4.9.5.3 Trust Issues

The last and possibly most significant limitation to effectively using IK in the FMP is lack of trust. Although trust issues can exist between individuals from both Indigenous and non-Indigenous communities, these issues were brought up in this study to arise between Indigenous and non-Indigenous communities or between individuals within an Indigenous community. Importantly, BOFN participants did not indicate what faction of government or government representatives they were referring to when they spoke about trust. However, many interview participants from both NIT and BOFN wanted the relationship between BOFN and the NIT to be stronger and the trust in this relationship to not be abused (N1, 2017; N2, 2017; N8, 2017; N5, 2017; N10, 2017; B4, 2016; B6, 2016). This issue of trust may impact the ability of GIS maps to function as effective boundary objects because clear communication is needed to promote knowledge transfer effectively between groups.

As mentioned, the information used in the modified maps was affected by the information provided by BOFN participants, many of whom expressed concern about the sensitivity of this information. This concern was centered on the BOFN participants' distrust for the government and the fear that their IK could be used to further degrade the forest's environmental resources. This distrust does not necessarily extend to the NIT, but instead relates to the uncertainty many BOFN participants expressed towards the use of the information they

provided. This uncertainty appears to revolve around what the government or their representatives would do with the information once obtained and how this information would be treated.

One BOFN interviewee spoke about how the forest had already succumbed to increased human activity by stating that "they destroyed the great big grove…the machines there that chop up the ground" (B6, 2016). Other BOFN participants made similar comments, such as "There's not very much land that is undisturbed…most of the land [is] being cultivated or utilized for crops and stuff like that" (B5, 2016). The acknowledgement of this disturbance of nature feeds into the lack of trust between community members and the government. As one BOFN participant said, "It's preserved…they would rip up the forest" (B4, 2016), implying that if BOFN revealed their exact location, these resources could be grossly misused. As this example reveals, trust between Indigenous and non-Indigenous communities affects more than the technical functionality of the maps and may impact the quality and quantity of knowledge contributed that can potentially be used in the boundary object.

One BOFN participant withheld information about natural resources in the Nisbet Provincial Forest during the interviewing process because this participant believed that the information was at high risk of being abused and taken advantage of. This individual was reluctant to provide any specific information because "if I identify these things, people are just going to go out there and hunt and dig and dive and everything else…we have no right to go and touch anything there" (B4, 2017). This restraint was especially prevalent in regard to the specific location of medicinal plants (B4, 2016; B6, 2016). For example, one BOFN participant stated that "if they don't have the knowledge, you don't tell them a thing…because they can just go and uproot it, tell a non-Native person where these things are located exactly (B4, 2016). This individual did not reveal a specific example of this happening, but the reluctance to provide further information on the subject matter was very noticeable during the interviewing process. This fear of information being misused may be summed up when the participant stated that I as a researcher nor anyone else would "take any credit for those people ripping up the forest" (B4, 2016).

Comparatively, one BOFN interviewee indicated that "people don't tell their berry picking spots" (B6, 2016). BOFN participants noted that different families within the community

had access to or knowledge of different medicinal plant locations and did not wish to divulge this information within or outside the community (B6, 2016). This restraint may be due to lack of trust between individuals within the community or to a sense of responsibility to protect different types of knowledge within the BOFN community. Importantly, this reluctance to provide specific locations and data ultimately limited the knowledge that could be displayed on the GIS maps.

4.9.6 Shared Opportunities (NIT and BOFN)

4.9.6.1 Catalyst for Participation

NIT participants spoke to the potential implications for increased recognition, acknowledgement, and inclusion of IK on future participation of Indigenous communities. Several indicated that if there is evidence of an effort to include more IK in the IFLUP or FMP, Indigenous communities may be willing to participate more actively in future NIT meetings (N8, 2017; N10, 2017). Interviewees felt that the work done in my thesis may encourage other Indigenous communities to contribute aspects of their IK in future IFLUP or FMP projects (B1, 2016; B2, 2016; B3, 2016; B5, 2016). This idea was summed up by one BOFN participant who noted that "we need to give people [these] options to pursue if they want" (B2, 2016). By providing Indigenous communities with more opportunities to pursue forest management, more participation may be encouraged.

4.9.6.2 Increased Knowledge Dissemination, Inclusion, and Engagement/Demand for Increased Knowledge Dissemination

NIT participants provided information about where in the FMP the GIS maps could be included and how this knowledge could be applied. As one NIT participant indicated, "It would be helpful to know how we can protect and work closer with the First Nations in the area." (N1, 2017). NIT interviewees discussed various applications of IK in the IFLUP and FMP, including including it as reference material to refer to when investigating a certain region, base knowledge for specific resources, zoning sections of the plan, and within the appendix (N1, 2017; N2, 2017; N4, 2017; N7, 2017).

One NIT interviewee supported the idea that including IK into the GIS maps could visually display potential trail sites for tourism purposes by "lay[ing] out where the trails could be set up" using lines, points, and/or polygons on the GIS maps (N5, 2017). This NIT participant

was possibly suggesting that individuals from other communities may be interested in viewing cultural aspects of the BOFN community to potentially gain a better understanding of their traditional values. Sites identified by IK may subsequently increase activity and foot traffic in the forest, as well as allow the broader public to be more aware of locations and resources important to other communities aside from their own. Since many roads are already depicted on the GIS maps, trails could potentially be outlined indicated the areas of cultural significance. That said, the idea for trail development and tourism was not discussed by other NIT participants.

Both NIT and BOFN participants desire more information about unmarked burial sites in and surrounding Indigenous communities (N4, 2017; N8, 2017; B3, 2016). Grave sites hold significance to all communities involved in the Nisbet Forest, and the locations of marked and unmarked burial sites are given priority in conservation efforts (N4, 2017). As one NIT participant stated, large regions on a map "aren't going to get much attention unless you're talking about grave sites" (N4, 2017). Therefore, these locations would be conserved and avoided if development efforts were to be considered in that particular region of the forest. Although it was not revealed in the interviews why little is known about grave sites, one BOFN participant said they were involved with a project concerned with locating these sites. This BOFN interviewee stated that "we're going to map all the graves…there are different graves all over the place" (B3, 2016). This interviewee was specifically speaking about grave sites that held victims of a smallpox outbreak. This desire to learn more about grave sites is a key area where more work can be done, and this is clearly significant to BOFN community members.

The inclusion of IK may offer new topics for discussion at NIT meetings. NIT participants commented that engaging Indigenous representatives and their communities to more fully explain IK may help strengthen the relationships between NIT and the surrounding Indigenous communities (N1, 2017; N2, 2017; N8, 2017; N6, 2017; N7, 2017; N10, 2017). One NIT interviewee highlighted an important aspect of IK inclusion: IK is information that "belongs to Beardy's and Okemasis [First Nation] …they need to be stewards of it" (N10, 2017). Thus, all communities may need to commit to being responsible for the knowledge. This responsibility may foster a sense of authority over IK and its role in the sustainable use of resources. In an attempt to disseminate this knowledge, to garner respect for it, and to explain the significance of resource use, BOFN participants showed an interest in providing more IK. By providing their IK

to a broader audience and making it available for decision making, BOFN members may promote the use of their value system in sustainable resource management.

BOFN participants prioritized IK dissemination within their community and to a wider audience, especially towards the younger generation (B1, 2016; B2, 2016; B3, 2016; B5, 2016; B7, 2016; B11, 2016). As one BOFN interviewee noted, we need to "educate our youth because they're our future" (B5, 2016). This statement is corroborated by another BOFN interviewee who noted that the GIS maps would be a physical copy displaying resource use and that we should "share with the youth so that way they'll always have their hands on [it]" (B5, 2016). As these comments indicate, there was a collective sense of urgency to pass on IK to their youth.

This BOFN participant also indicated that the GIS maps are "a great way of approaching the management utilizing knowledge that preserves and protects the Nisbet but yet can maximize the efficiency and uses of the Nisbet [Provincial] Forest and its resources" (B1, 2016). Lastly, this participant also mentioned that the GIS maps were "a great tool to actually see the intricate relationships with the entire surrounding environment and how important the Nisbet forest is with these relationships." This participant also noted that the maps could be a beneficial tool

> to help alleviate stress factors associated with the different user groups…It's also a great tool of getting that information and that knowledge to all the various user groups. And not only for us, but also for our future generations, especially our youth here in this forest. We try to teach them the values of respecting the Nisbet [Provincial] Forest, limiting the pressures associated with it. So, it's a good tool for all of us. (B1, 2016)

Other BOFN participants agreed that if more IK was disseminated, practices such as hunting or medicinal plant gathering may develop in accordance with this knowledge. (B2, 2016; B3, 2016; B5, 2016). For example, one BOFN interviewee noted that when the younger generation are brought "out hunting, they don't have a clue of what they're supposed to do" (B7, 2016). If more IK was available, then "their grandkids and their kids are going to have kids and they'll build and pass that knowledge down to them" (B7, 2016). BOFN also interviewees mentioned that alternative agricultural practices were of interest and Elder workshops/camping trips could be used to help disseminate IK to a wider audience (B1, 2016; B2, 2016; B3, 2016; B7, 2016).

Overall, there is a strong desire in this study context for representatives from non-Indigenous and Indigenous communities to come to a mutual understanding that can be shared through their different knowledges. As one NIT participant indicated, the knowledge of the Nisbet Forest reflects "the different types of data that you have that need to be considered [while] making your decisions on what values you end up protecting" (N1, 2017). An increase in IK dissemination and implementation into the IFLUP and FMP would allow more diverse data to be considered when decisions are made about what values and resources should be sustained and managed.

CHAPTER 5 DISCUSSION

5.1 Introduction

My research investigated the limits and opportunities of using GIS as a boundary object to represent IK in the FMP of the Nisbet Provincial Forest. The rationale for the study is based on observations that IK is ineffectively and inadequately incorporated in forest and resource decision-making processes (Diver, 2017; Reo et al.; 2017; Robitaille et al., 2017), that these processes would benefit from deeper cross-cultural understanding (Reo et al., 2017) and that boundary objects could help deepen this understanding (Robinson et al., 2016; Star & Griesemer, 1989). Boundary objects may aid in mutual understanding because they have the ability to facilitate information across boundaries from one group to another (Star & Griesemer, 1989; Steger et al., 2018). Research has suggested that using GIS to visually represent IK on maps may lead to more inclusive solutions to sustainability issues of shared land (Parons, Nalau, & Fisher, 2017; Young & Gilmore, 2017). In this study, I combined document analysis, GIS mapping, and semi-structured interviews as a way to bring together practical and theoretical knowledge to increase the engagement of Indigenous communities in natural resource and forest management decision-making processes. My study used GIS maps to depict the locations and practices where the IK of BOFN may apply in the Nisbet Provincial Forest and surrounding region.

My study had four main findings. First, GIS maps have the potential as boundary objects to effectively represent IK in resource planning and implementation. Second, not all of the Six Faces used to inform the GIS maps had the ability to adhere to these criteria at the time the knowledge for these Faces was collected. Third, some Faces were not suitable to include in the GIS maps, partly as a result of not meeting all the criteria and limitations due to the data that were collected. Fourth, the criteria suggest specific ways to improve on the current barriers inhibiting greater use of IK in GIS maps such that they can function as effective boundary objects. This chapter discusses these four key findings in the context of the literature relating to boundary objects, GIS maps, and IK inclusion. First, I explain the boundary object criteria and how they apply to the Six Faces. I then suggest conditions needed to create effective boundary objects using GIS maps. Finally, I analyze how the limits and opportunities that came out of the inductive and deductive themes of this study met the boundary object criteria.

5.2 GIS as a Boundary Object Applied to Four Criteria

The term boundary object in this thesis is based on the descriptions provided by Star and Griesemer (1989). They define boundary objects an item that is capable of being adaptable and resilient: the adaptability of this item allows them to be shaped to meet local needs, and their resilience allows them to be used by groups to develop a shared understanding. I found that GIS maps that act as boundary objects may be more effective if the maps adhere to the four criteria: flexibility, concreteness, joint process, and information need. These criteria were developed through research on boundary objects and their effectiveness by Carlile (2002), Steger et al., (2018), Star and Griesemer (1989), and Star (2010). These boundary object criteria were used to evaluate what attributes GIS maps may need to effectively facilitate IK across knowledge boundaries. To categorize IK, I used Houde's Six Faces of TEK. See Table 2.2 on p. 20 for the characteristics of the Six Faces. This section evaluates the Six Faces according to each of the four criteria.

5.2.1 Flexibility

Flexibility is the first criterion I used to evaluate GIS maps that serve as boundary objects. Star and Griesemer conceive of a boundary object as an item that can change its form to suit the situation. A basic feature of a boundary object is its ability to represent different things to different groups: "to tack back-and-forth between ambiguous and specific meanings" and to resist structure (Steger et al., p. 154). Thus, Steger et al. (2018) and Star and Griesemer (1989) all argue that it is important for boundary objects to be vague and loosely structured for general use while simultaneously being specific and strongly structured for individual or local use. Achieving this constant shift may be challenging, especially when the knowledge used to inform these boundary objects is subject to standardization (Steger et al., 2018). Therefore, when used as boundary objects, GIS maps with IK need to be flexible enough to be used both by the Indigenous communities that created the knowledge and by ecosystem administrators, such as the managers of Nisbet Provincial Forest.

In my research, Face One (Factual Observations) and Face Three (Past and Current Users) both met the flexibility criterion. The IK categorized in Faces One and Three is based primarily on empirical observations and comprises fixed physical entities and sites, which tend not to change condition or location (Houde, 2007), such as the location of wildlife, medicinal

plants, and historical sites. When these items from Face One and Three appeared on maps, they seemed sufficiently flexible to be interpreted and used by local groups and sufficiently general to be interpreted and used by other knowledge groups. Both the BOFN and NIT interviewees confirmed, for example, that from looking at the GIS maps containing IK, they could understand hunting sites for animals. Thus, users from both knowledge systems could interpret and use the IK from Faces One and Three as depicted on the GIS maps.

Unlike Faces One and Three, Face Two (Management Systems) did not fully meet the criterion for flexibility. Face Two comprises strategies and practices that support the sustainable use of natural resources (Houde, 2007). For Face Two to meet this criterion, the knowledge provided for this Face would have had to be malleable enough to be interpreted and used in one way by BOFN in their community and in another way by NIT. However, although some of the information developed through the interviewing process and in the BOFN's History Report (2013) and the TEK cache could be spatially represented, the IK was not robust enough to be interpretively flexible. BOFN and NIT interviewees alike indicated that most of the IK categorized under Face Two was too abstract to be included in a GIS map. One reason why the interviewees' considered Face Two information too abstract and unspecific may have been because no map of Face Two was available to show the interview participants. In other words, participants were unable to point to anything specific on the map as they talked about this knowledge. Another reason may have been that the interview questions were too vague for participants to grasp what they were being asked concerning Face Two. Overall, the result was that I did not use IK categorized under this Face in a GIS map. However, it may be possible for future research to reconsider IK from Face 2 on a GIS map as the interviewees did provide some information for this Face, and with more time and resources, more information could possibly be collected.

None of the remaining Faces (Four – Ethics and Values, Five – Culture and Identity, and Six – Cosmology) fully met the criterion for flexibility. Since the contents of these Faces are largely abstract – expressions of values, beliefs, stories, language, and worldviews – placing them in spatial form on a GIS map is difficult. Additionally, although my study asked clear interview questions, the BOFN participants were unable to provide enough geospatial information for Faces Four, Five, and Six to meet the indicators for robustness and malleability

of the flexibility criterion. For this reason, IK from these Faces was not entered on any GIS maps. Without enough tangible and specific geographic locations for abstract concepts, it is difficult to develop a Face that can be adapted for different knowledge users or even for a single knowledge user. Additionally, ideas about the values and beliefs may differ among individuals. These differences may affect the interpretive flexibility of Faces Four, Five, and Six, making it not only difficult to depict this IK on a GIS map but also to use within a management framework.

5.2.2 Concreteness

The second criterion by which a boundary object can be evaluated is concreteness. The information must be real, definite, and tangible so that multiple users can access, learn, and understand the knowledge and use it to understand other groups' perspectives. The IK used for Faces One and Three allowed these Faces to meet the concreteness criterion, as I was able to use the Beardy's History Report (2013), the TEK cache by Mr. Bendzsak, and information provided by the interviewees to successfully map these Faces. The ease with which IK from Faces One and Three could be mapped is attributable to this information's spatial and concrete qualities. Once this IK is mapped, it is recognizable by both individuals and groups, enables them to learn about IK and natural resources in their environment, and gives them a concrete means of understanding their differences with and dependencies on these entities. Another way in which Faces One and Three met the concreteness criterion was in the terminology, concepts, and language used, all of which were familiar to both groups and contributed to these two Faces being more readily understood. Thus, Faces One and Three met the criterion for concreteness, as interviewees concurred that the knowledge for these Faces presented on the GIS maps was tangible, useful, and practical.

Tangibility can lead to understanding between groups as both can easily focus on concrete items that can be spatially or easily represented on a map by a symbol (Lewis & Sheppard, 2005). An example of shared understanding between BOFN and NIT participants based on concreteness was specific areas of resource extraction used by individuals by both communities for different purposes. For example, berry bushes from a specific geographical area shown on a map may be used by one community for food and another for spiritual purposes.

Both groups shared an understanding that this specific area is important to their community for different reasons.

Face Two did not fully meet the concreteness criterion because sufficient information needed to fulfill this criterion's requirements was not provided during the study. For this reason, I did not create a GIS map for Face Two, as mentioned earlier. However, even in the absence of a map, Face Two has the potential to partially meet the criterion for concreteness because it associates IK with tangible properties, such as geographical locations, physical properties, and activities, such as agricultural practices, all of which can be fairly easily represented on a map. By identifying practices and locations, such as agricultural practices, within a geographical boundary, individuals and groups may be able to specify and learn about how other groups are different and learn more about how their activities depend on others. At present, Integrated Forest Land Use Plan (IFLUP) and FMP have information on agricultural practices, which could be placed on maps, so groups from both knowledge systems could share this information. For example, planners wishing to evaluate and include diverse agricultural practices within a management context would undoubtedly find this information useful. Thus, further research is recommended for Face Two IK, with the expectation that because the IK the category contains is concrete, it could be mapped.

Just as they did not meet the flexibility criterion, Face Four, Face Five, and Face Six generally failed to meet the concreteness criterion, largely for the same reasons: they contain orally transmitted and abstract knowledge that is difficult to represent on a map. Visually depicting the IK for these Faces on GIS maps challenges the concreteness criterion because this information does not provide a tangible means for participants to understand differences in their knowledge. For example, I was unable to transform the environmental ethics characterized in Face Four or worldview in Face Six into pictorial or spatial elements. This lack of pictorial depictions was also a barrier in the communication between myself and participants, as I was unable to link spatial data to the information provided for Faces Four, Five, and Six. These Faces, then, did not meet the concreteness criterion because the foundation for participants to learn about knowledge differences could not be developed. That being said, Face Five may contain some concrete information that could have spatial elements associated with it. For example, the Face may identify landscapes and images that provide spiritual renewal for

individuals or associate important stories to a specific location where they stories took place. However, spatial attributes for Face Five were not obtained during the course of my study.

5.2.3 Joint Process

The third criterion by which a boundary object can be evaluated is "joint process." According to Carlile (2002, p. 452), this criterion is "a process where individuals can jointly transform their knowledge" in order to address boundary issues. In other words, people must work together both to transform their knowledge systems, so they are understandable to other groups and to understand the knowledge and perspectives of others. Knowledge cannot be transformed if one cannot create a joint or collaborative process to access that knowledge. Faces One and Three met the joint process criterion because interviewees were able to understand the perspectives used to inform the knowledge included within the GIS maps for Face One and Three. Therefore, interviewees were able to alter and change the information in the GIS maps by providing new information based on their collective understanding, and the GIS maps were further informed by this new knowledge. Some sustainable strategies that may be used to characterize Face Two have already been implemented within a management context (i.e. prescribed burns). Thus, this Face has demonstrated the ability to meet the joint process criterion. With that being said, more strategies of sustainable use of natural resources rooted in IK were not discussed in adequate depth during the interviewing process of this study. Therefore, this information did not lend itself to being translated into spatial data and implemented within a GIS map. Consequently, Face Two only partially meets the joint process criterion.

The other Faces did not fulfill the joint process criterion because participants were unable to provide sufficient IK to transform into spatial information on a GIS map. Meeting this criterion has been an ongoing challenge in any boundary scenario involving IK. As seen consistently in the literature analyzed within this study, it is challenging for IK to be successfully transferred from Indigenous groups to others. As a result, IK may be viewed as subordinate or supplementary to WSK, an object of study, or ineffectively included within forest and natural resource management decisions (Arnold 2017; Cruikshank, 2004; Diver, 2017; Parsons, Nalau, & Fisher, 2017; Rotherham & Armson, 2016).

5.2.4 Information Need

The fourth and last boundary object criterion is information need. This criterion evaluates the degree to which a boundary object addresses a need for information (Steger et al., p. 154; Star 2010). Steger and colleagues indicate that this need typically emanates from a desire to establish procedures, such as a wish "to classify or organize data" (p. 154). They add that the boundary objects create a response to such needs and "in turn [they] influence the form and structure of dialogue" (Star, 2010; Steger et al., p. 154). All Six Faces met this criterion in my study because both the NIT and BOFN participants could use this information for different reasons. The NIT may desire more information to inform their planning processes and policies; BOFN may seek to disseminate their knowledge to a larger audience, especially the younger generation. BOFN may also be interested in seeing their knowledge applied within a management context that affects the resources they use. Using GIS maps to portray this knowledge may allow both NIT and BOFN to visualize this information within a context that makes it comprehensible and caters to their multiple information needs.

5.2.5 Summary of the Criteria and the Six Faces

Faces One and Three met all of the boundary object criteria, allowing both Faces to be mapped. Face Two had the potential to meet the flexibility criterion, but did not meet the concreteness and joint process, meaning Face Two could not be mapped. Faces Four, Five, and Six did not meet the criteria for flexibility, concreteness, or joint process, although Face Five had the potential to meet the concreteness criterion. Because I had insufficient information to meet the boundary object criteria or to translate this IK into spatial data, these Faces were not developed into GIS maps. The Faces containing abstract, personal, and varying IK did not meet many of the criteria and therefore could not be mapped. In contrast, those Faces containing empirical observations, cultural and historical sites, medicinal plant sites, and sustainability practices met many, if not all, of the criteria because the information contained within these categories is tangible, widely agreed upon by BOFN members, and has spatial attributes. Please refer to Table 4.1, 4.2, and 4.3 in Chapter 4 (p. 72 – 74) for reference.

5.2.6 Analysis of Findings about the Six Faces and the Criteria

Several factors must be considered when analyzing the Six Faces, including establishing why they did or did not meet the boundary object criteria and determining the implications of these findings for using GIS as a boundary object to represent IK in the FMP of the Nisbet Provincial Forest. First, as we have seen, because of their abstract nature, the IK in Faces Four, Five, and Six lacked the spatial attributes to allow a GIS map to display this IK. GIS maps depend on geospatial information, and this dependency may limit the use of these maps as effective boundary objects because not all the IK categorized in the Six Faces has sufficient spatial elements to be visually portrayed. As noted, the Faces that rely more heavily on empirical observations with geographic or spatial associations, such as Faces One, Two, and Three, may be easier to display on a GIS map. Thus, if IK lacks the spatial attributes to form a robust Face open to multiple interpretations, then there may be insufficient information to build a concrete foundation on which to learn about knowledge dependencies. Without sufficient spatial information, it may be difficult to transform knowledge, so it can be mapped and used by others.

A second related factor concerns the flexibility criterion. Interestingly, the Faces that met the flexibility criterion concern place-based knowledge attached to physical entities within a shared environment recognizable to a larger audience. As a result, this knowledge may be the easiest to spatially represent on the GIS maps, which may facilitate the movement of this knowledge across boundaries, allowing this knowledge to be both variously interpreted and jointly transformed. If the flexibility criterion is not fully met, it is difficult to meet the criteria for concreteness and joint process, and thus the knowledge provided may not be solid enough to allow individuals to identify this knowledge across a distinct boundary. Consequently, this may inhibit individuals from identifying their differences and dependencies on resources associated with that distinct knowledge.

A third factor to consider is that the maps for Faces One and Three were both created and developed before the interviews. In other words, the Beardy's and Okemasis History Report (2013) and the TEK cache by Mr. Bendzsak supplied enough spatial information for me to create these maps. Having these maps during the interviews may have made it easier for BOFN participants to understand this information and transform their knowledge based on these maps, rather than simply provide new information with no visual aids, as they did for Faces Two, Four,

Five, and Six. Had visual illustration been available for the latter Faces to aid BOFN participants in conceptualizing their knowledge, then they may have been able to provide more information.

Fourth, sensitivity within the communities may have limited the kind and extent of knowledge shared. If the type and amount of information displayed on the map is limited, the map may not function as a boundary object. The literature addressed within this study suggests that Indigenous communities may only partially share their IK and that this may affect the inclusion of IK into natural resource and environmental planning (Brosius, 2006; Houde, 2007; Gratani et al., 2014). The sensitivity about releasing knowledge was supported by some BOFN interviewees, who repeatedly mentioned that certain information was off limits to the public or other individuals within their communities. For example, information on locations of medicinal plants, berries, and spiritual sites was largely restricted. As one BOFN participant maintained, "People don't tell their berry picking spots" (B6, 2016), and her statement was supported by others in the room. For knowledge to be jointly used, it cannot be held back.

Fifth, the potential diversity of ideas represented by the Faces must be considered. In other words, each Face may represent an accumulation of ideas and perspectives that are different among individuals within the BOFN community. This diversity may limit the application of the GIS maps because some information may be significant to one BOFN individual but not for another.

5.2.7 Improving GIS Functioning as a Boundary Object

The information provided to me in the interviews was extremely useful, valid, and significant. The values associated with this knowledge were evident and are described in more detail in the following sections. Notably, I was able to transform more information into spatial data for the Face Three map than for the Face One map, possibly because the information provided for Face One did not necessarily have explicit locations associated with the data. The locations of many of these sightings could have been more accurately identified if I had been able to travel to the specific locations that these participants identified. However, many BOFN participants did not remember the locations of their observations, and my study was limited by time and resources.

To improve GIS functioning as a boundary object, it may be necessary to correlate spiritual values with a tangible object or geographic location, so these values can be placed on a

GIS map and applied to a forest-management context. As discussed in Chapter 4, many BOFN participants failed to provide knowledge associated with spatial attributes. As a result, this knowledge was not mapped. If the abstract knowledge in the Six Faces is assigned a visual symbol, it can be placed on a map. In this way, GIS maps may be effective boundary objects because, with such knowledge depicted on a map, IK holders may find it easier to include other information considered hard to map. However, as implied by Lewis and Sheppard (2005), even information that cannot be represented visually may still be considered and used to inform decision-making processes within a forest management context.

5.3 The Criteria and Study's Themes

Common themes were raised by both BOFN and NIT interviewees: trust, overlap of resource use, catalyst for participation, and increased knowledge dissemination. Arguably, these themes are the most critical because they were raised by participants on both sides of the knowledge boundary. These and other reoccurring themes that emerged from the interviews were organized into two categories: the limits and opportunities of using GIS maps as boundary objects. This section discusses the key themes in relation to the Faces and boundary object criteria.

5.3.1 Limitations

Eight limitations were found that could impede the creation and use of GIS maps as boundary objects: the difficulty of creating a shared process, rigid description criteria and preference for data specificity; limited resources, knowledge, and policy processes; decreased reliance on IK; overlap of resource use; trust; legal restraints; and limited access to resources. Figure 5.1 visualizes these limitations and connects them with boundary object criteria.

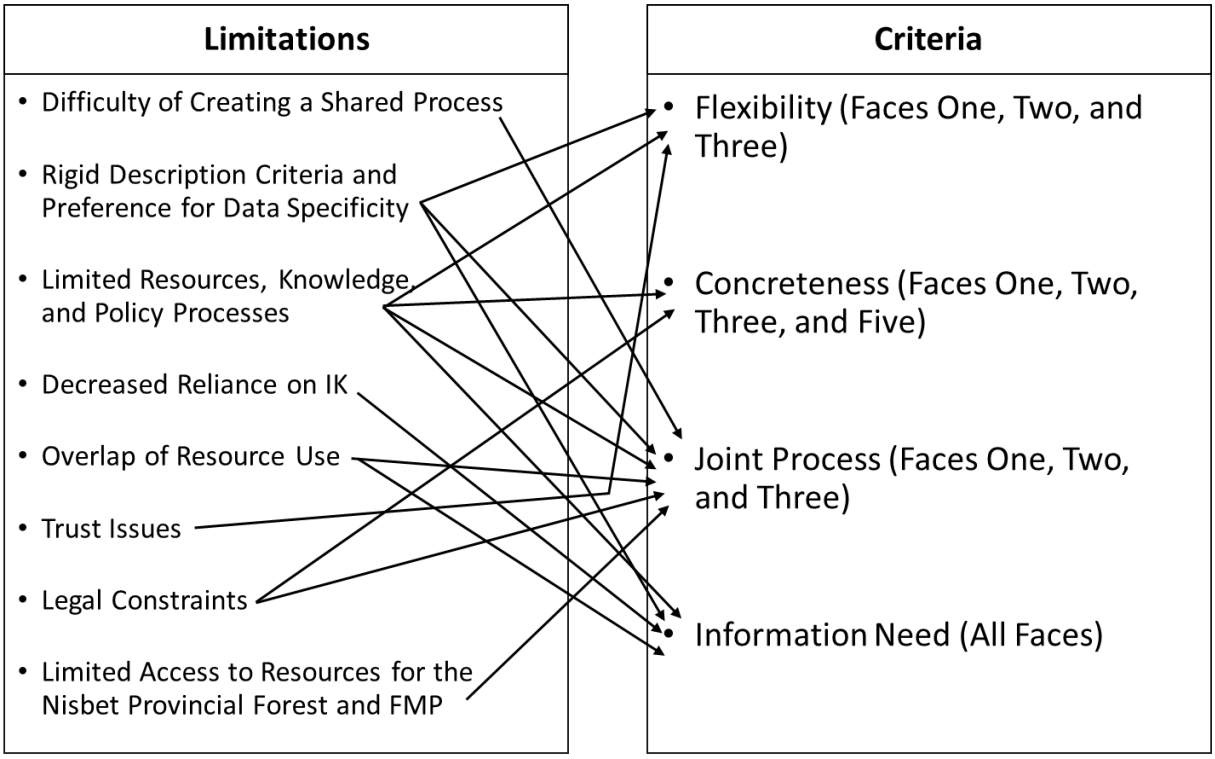

Figure 5.1. Visualization of the Limitations and Their Connection with Boundary Object Criteria

5.3.1.1 Difficulty of Creating a Shared Process

The difficulty in creating a shared process in forest-management decisions and processes may be rooted in inconsistent Indigenous representation at meetings. With little Indigenous representation, IK may not be often considered and is less likely to be used in decisions. This limitation would impede knowledge transformation, making the joint process criterion difficult to meet. Without Indigenous representation at meetings, other impacts are also likely to be seen. Although the IFLUP and FMP have Face One and Face Two information, for example, the sites of potential agricultural practices, with no Indigenous representative present, IK risks being excluded from management plans. As authors such as McGregor (2011), Reo et al. (2017), and Von Der Porten and De Loë (2013) argue, if Indigenous representatives are not present in the governance context, their voices are unlikely to be heard and their different knowledge systems unlikely to be understood. Thus, Indigenous presence is required for joint process to occur.

To address the lack of Indigenous representation in natural resource and forest management decision-making processes, co-management practices need to be established. Co-management is the shared responsibility of resources between those that are dependent on its

consistent availability (Natcher, Davis, & Hickey, 2005). Co-management may be referred to as systems that consist of joint authority based upon agreements made between resource users and managers that are used to inform the decision and policy-making processes that guide resource management (Natcher, Davis, & Hickey, 2005). Therefore, through this management practice, Indigenous governments could have more authority over their land, resources, and the representation of IK in natural resource and forest management decision-making processes.

Co-management is challenged by such problems as unequal gender representation and participation (Natcher, 2013). For example, inadequate female representation may influence decision-making within co-management boards (Natcher, 2013), and sustaining co-management relationships between Indigenous communities and governments may be difficult due to cultural differences and historic tensions (Natcher, Davis, & Hickey, 2005). Equitable collaboration may be challenging, and improved communication between groups may need to be prioritized (Natcher, Davis, & Hickey, 2005).

5.3.1.2 Rigid Description Criteria and Preference for Data Specificity

Another limitation is that IFLUP and FMP's preference for specific data may affect multiple boundary object criteria, including flexibility, joint process, and information need. FMP contains a limited amount of IK, possibly due to its strict requirements for the way data is used in its plans. For example, the GIS maps used in the FMP are very specific and the spatial information used to inform these maps may pertain only to these specific maps. This information may refer to specific points and locations easily identified on a GIS map. Specific geospatial information that refers to fixed locations may be preferred over large sweeping geographical regions with fewer or not specific geospatial points. This preference may influence the data that is visually displayed in the IFLUP and FMP GIS maps, directly limiting the knowledge that is robust and adaptable enough to be interpreted in different ways and thus failing to meet the flexibility and joint process criteria. Lastly, perpetuating the preference for specific data may limit the amount of information obtained, thus failing to meet the criterion of information need. If only a certain type of information is needed by management, then the dominant dialogue found in the management plan will continue unchanged. Rigidity makes it highly unlikely that the criteria for the Faces Four, Five, and Six – and the abstract knowledge they contain – will be met.

The literature analyzed within this study confirms that inflexibility inhibits the use of IK in resource and environmental management. As supported by Diver (2017) and Vaughan, Thompson, & Ayers (2017), even when agencies want to include IK into environmental management, the policy frameworks may be too rigid for this inclusion to be meaningful. As mentioned, boundary objects must be flexible and adaptable to move between boundaries, but these characteristics may complicate how the boundary object is operationalized and mutually understood (Steger et al., 2018). To make a boundary object easier to understand, there is pressure to standardize. However, this standardization may limit or exclude diverse knowledge that does not fit within the set categories (Steger et al., 2018; Mistry & Berardi, 2016). As a result, standardization could hinder knowledge facilitation provided by boundary objects (Steger et al., 2018). Overall, standardizing the collection of IK may reduce the diversity of knowledge obtained, risking reducing the distinctiveness of IK (Mistry & Berardi, 2016).

Another problem connected with rigidity in processes is that because Indigenous actors are underrepresented, IK is at risk of being homogenized, hybridized, or standardized within a scientific or Westernized framework (Löfmarck & Lidskog 2017; Mistry & Berardi, 2016; Reyes-Garcia et al., 2014). As Arnold (2017) argues, Indigenous groups are particularly underrepresented in academic and professional settings; as a potential result, IK may conflict with WSK and is subject to standardized collection, characterized as data collection with rigid criteria and a preference for a specific type of data (Mistry & Berardi, 2016). This standardization may, for example, limit Indigenous engagement and decrease IK dissemination to a broader audience. Standardization also impacts ideologies within conservation science, which as Mistry and Berardi (2016) argue, may be heavily influenced by a Westernized framework. Although this framework may include IK, its underpinnings are largely scientific. My study has acknowledged the distinctiveness of IK. A recommendation for future work is to start with an IK framework and then seek relevant scientific knowledge to support this framework. (Mistry & Berardi, 2016). Although my study attempted to do this by using Houde's Six Faces of TEK, the relevancy of WSK to BOFN's IK may still present as a challenge. Mistry and Berardi (2016) suggest that using WSK to support IK could increase the relevance of WSK to the "societies it seeks to support, while critically promoting social justice and establishing self-determination as a key principle of engagement" (p. 1275).

5.3.1.3 Limited Resources, Knowledge, and Policy Processes

Lack of resources creates barriers for implementing IK within FMP processes. Insufficient financial resources hinder the creation of a dynamic plan, and, as NIT participants acknowledged, limited space in FMPs for IK is also an issue. Another limitation is the knowledge itself. If the knowledge is abstract, individuals may be unable to interpret it. As we have seen, because abstract knowledge is not robust or malleable, it fails to meet the flexibility criterion. It is neither concrete enough to enable individuals to understand their different uses of resources within a given boundary nor stable enough for individuals to transform it into new information. Therefore, abstract knowledge fails to meet the criteria for concreteness and joint process. Furthermore, if this knowledge cannot be collected and disseminated, individuals may not believe this information is needed, making it unlikely that the information need criterion will be met. Another limitation is policy processes that do not sufficiently represent Indigenous communities and may exclude these communities from engaging and participating in decision making thereby limiting the amount of IK included within these processes (McGregor, 2011; Wilson & Graham, 2005). Diver (2017) maintains that more inclusive policy-making would allow Indigenous communities to represent themselves in decision-making processes, thereby better positioning IK within the dominant knowledge frameworks and enhancing perspectives on sustainable relationships between humans and nature.

Although many working in forest management are interested in implementing IK into decision-making processes, these processes are mostly structured on Western scientific paradigms (McGregor, 2011). Even if IK is included into these processes, these paradigms may continue to exclude Indigenous groups regardless of their rights to decisions involving their lands. This exclusion may continue as a result of inequitable power relations between Indigenous and non-Indigenous communities and organizations in Canada (McGregor, 2011). As Berbés-Blázquez, González, and Pascual (2016) state, power relations control the accessibility, usage, and management of ecosystems, and this power may also shape the values placed on these ecosystems.

5.3.1.4 Decreased Reliance on IK

If individuals do not recognize the need to include IK into their lives, then reliance on IK may diminish and be considered less often in FMP decisions. A decreased reliance on IK would

affect IK from all of the Six Faces, including the quantity of IK available to use in planning. In my research, interviewees from both BOFN and NIT expressed concern that the younger generation is ignorant of certain practices well known to the older generation. These practices may rely on specific IK. If this IK is not perpetuated, it will not be used in boundary objects such as GIS maps. The decreased reliance on IK among younger people at BOFN meant that my research lacked sufficient IK. Since I received insufficient information for Faces Two, Four, Five, and Six, I was unable to convert it into spatial data and transform these Faces into GIS maps.

The literature relating to the usage of IK within communities corroborates this decreased reliance on IK, especially among the younger generation. For example, younger generations around the world are relying less on the knowledge and values of their traditional communities (Giday et al., 2003; Ragupathy et al., 2008; Srithi et al., 2009). Srithi et al. (2009) synthesizes the works of authors who had similar findings. For example, these authors describe research done by Ragupathy et al. (2008) who state that younger people in the Velliangri holy hills in India lack interest in their community's traditional knowledge. Srithi et al. (2009) discusses another example by Voeks and Leony (2004), who note that some young adults in Brazil, who may be aware of their community's knowledge, do not use it in their current lifestyles. Several factors may account for why young people are unlikely to practice the knowledge rooted in their traditional communities: advances in modern medicine, the opportunities of industrialized jobs, Elders withholding information, or, simply, lack of interest (Huang, Pei, & Long, 2004; Ragupathy et al., 2008; Srithi et al., 2009). Other reasons for decreased reliance on IK may be that younger generations do not regularly undergo experiential learning within their traditional land, may no longer be fluent in their community's traditional language that would allow communication with Elders, and may be focused on educational opportunities in the Western tradition (Sefa-Dei, Golden-Rosenberg, & Hall, 2000).

5.3.1.5 Overlap of Resource Use

Both NIT and BOFN participants mentioned that both groups overlapped in their use of resources and that the groups also assigned different priorities to the resources they used. Both groups recognized that resources in Nisbet Provincial Forest were shared and therefore used in a variety of ways by individuals in different communities. The different values associated with the

resources was linked to the knowledge systems of the groups. For example, BOFN members may value the medicinal use of specific berry bushes, whereas the IFLUP may value the land where these berry bushes are found. These conflicting values could make it difficult to adhere to the joint process and information need criteria because there may not be a clear understanding of the multiple uses of a singular resource, and the need for information on this resource may not be required if its use is not prioritized within the IFLUP or FMP. The use of IK in all Six Faces is affected by overlapping of resource use and different values. Prioritizing certain values associated with resource use may prioritize knowledge systems associated with these values.

Indigenous communities may not always benefit from the resources on their land. However, as Wyatt, Kessels, and Laerhoven (2015) argue, although Indigenous communities have rights to forestland, these rights do not necessarily allow them to access the benefits associated with these resources. These authors also note that Indigenous communities may continue to assert their rights independent of government approval and that this may result in uncertainty regarding forest boundaries and rights. In other words, rights are sometimes theoretical but may not be applied on the ground and in forests (Ribot & Peluso, 2003). One challenge may be competing interpretations of rights to forests and resources, resulting in uncertainty and tension between Indigenous and non-Indigenous communities (Wyatt, Kessels, & Laerhoven, 2015). Noble et al. (2016) acknowledge this tension, arguing that Indigenous communities need to be actively involved in environmental management to balance competing needs and values. Effective consultation on management decisions and changes within policies may be best achieved with Indigenous participation through approaches such as co-management and the meaningful inclusion of IK (Natcher, Davis, & Hickey, 2005; Noble et al., 2016).

5.3.1.6 Trust Issues

The theme of trust was critical to my study. Trust affects the entire process of giving, receiving, translating, and transforming information from one individual to another or from one community to another. If trust is limited, the flexibility criterion is unlikely to be met. If information is restricted based on a lack of trust between groups, this information may then be too abstract to be both robust and malleable. If the knowledge provided is limited and abstract, it may not be concrete enough for individuals to address, substantial enough to influence or jointly transform the form or structure of dialogue, or flexible enough to be subject to multiple

interpretations. Thus, a boundary object's effectiveness may entirely depend on the trust between communities and individuals across a given boundary. As Natcher, Davis, and Hickey (2005) argue, "by failing to manage group interaction effectively, it is likely that intergroup tension, competitiveness, and distrust will result in perpetuation of historical conflicts thereby impeding future management efforts" (p. 248). As these authors suggest, without trust, little is likely to change for the better. Additionally, Houde (2007) notes that Indigenous individuals are circumspect of speaking about IK because there may be a high risk of misinterpretation by others and a potential lack of control over this knowledge.

Trust may be difficult to establish if relationships between Indigenous communities and the dominant society has been marked for centuries by distrust. Burnette and Sanders (2014) contend that relationships between Indigenous and non-Indigenous communities are based on historical oppression, exploitation, and harm. Lyons (2011) concurs, arguing that Indigenous' attitudes have been shaped by marginalization, isolation, colonialism, and dehumanizing research practices. As a result, distrust between the two communities has developed. This distrust could be seen in my research when some BOFN participants acknowledged having restricted the IK they revealed because they did not trust non-Indigenous individuals. As Lyons (2011) contends, for mutually beneficial partnerships to develop between Indigenous and non-Indigenous groups, a safe space needs first to be established. In my study, boundary objects may have the ability to stimulate a safe discussion about IK and its application towards forest resources.

5.3.1.7 Legal Constraints

Legal constraints are a limitation that may affect both the BOFN and NIT communities and may play a role in meeting the concreteness and joint process criteria. Both groups have legal obligations. These obligations may restrict the transfer of knowledge between boundaries. For example, the NIT has an obligation to perform the process of DTC. A DTC may be performed under two conditions: when a proposed event or action may affect an Indigenous community, or when an Indigenous community would like to disclose sensitive information. The DTC may affect how IK is included in the decision-making process. For example, if IK is being considered in management planning, then the DTC applies. As well, any information that may be deemed sensitive would ultimately trigger a DTC process. Information obtained that did not go

through the DTC may not be considered or acknowledged because this legal obligation was not fulfilled. Consequently, the process of a DTC may minimize the conversation around IK and its implementation within the decision-making process. The facilitation of IK across borders may also be affected because, as discussed in the interviewing process, many NIT participants were unsure if a DTC would be needed. This uncertainty led many NIT participants to hesitate and clarify the process of knowledge obtainment before critiquing the GIS maps. As a result of such uncertainties, legal constraints such as the DTC may restrict individuals from developing a concrete means to identify their differences and dependencies within a given boundary or to jointly transform this knowledge across boundaries.

This limitation may primarily affect Faces One, Two, Three, and Five. Arguably, of all the Six Faces, these four contain the majority of tangible knowledge, and this concrete knowledge may be easiest to apply in a management context. However, if legal constraints restrict access to this knowledge, the IK received may be too abstract and insufficient to be jointly transformed. This inadequacy may impact the GIS maps, which may portray incomplete knowledge. Thus, the efficacy of these GIS maps as boundary objects is impacted by this limitation.

Scholars seem to have unanimously deemed the current process of legal consultation ineffective in stimulating Indigenous participation and engagement (McGregor, 2011; Natcher, 2001; Negi & Nautiya, 2003; Ross et al., 2016; Van Schie and Haider, 2015). Reo et al. (2017) and McGregor (2011) argue that consultation and Indigenous engagement must be on a government to government or nation to nation level. Indigenous communities have constitutionally protected rights, such as self-governance, and these rights are protected in Canada (McGregor, 2011). Therefore, the rights of Indigenous communities and their role as decision makers may be more apparent if these communities are viewed as nations instead of stakeholders or interest groups (Reo et al., 2017; McGregor, 2011). Consequently, by conceptualizing Indigenous communities as stakeholders, collaboration between Indigenous and non-Indigenous communities may be detrimentally affected because the ability of an Indigenous community to self-govern itself and hold power over its resources may be ignored (McGregor, 2011; Nenko, Parkins, & Reed, 2018; Reo et al., 2017; Von Der Porten, & De Loë, 2013). In the

same vein, Simpson (2001) also stresses the importance of acknowledging the rights Indigenous people have to the land and meeting Indigenous communities as self-governing nations.

5.3.1.8 Limited Access to Resources in the Nisbet Provincial Forest and FMP

BOFN members may not have full access to information on the Nisbet Provincial Forest and FMP, may lack information on natural resources in key regions, and may not have access to computers. Without this information and these tools, BOFN members are unaware of the information in GIS and FMPs, and, indeed, may not even know that an FMP exists. Furthermore, they cannot know how their IK used in the FMP is perceived and what new IK needs to be added. These limitations affect their willingness to share IK, their ability to obtain knowledge about resources, and their interest in disseminating this knowledge in their community and to a broader audience, all of which create difficulties in meeting the joint process criterion. With little or no knowledge of FMPs, how can BOFN members know how important their IK is to management plans, decisions, and processes, or of the need to provide sufficient information to be jointly transformed? IK holders who lack access to IK used within a management context or ideas of how it would be used in such a context cannot share it. This limitation may affect Faces One, Two, and Three the most. Interestingly, these Faces comprise the most tangible knowledge of the Six Faces, as well as the knowledge most likely to be used in the IFLUP and FMP.

5.3.1.9 Impact of Limitations

The issues identified above limit the movement of knowledge across boundaries. Knowledge holders monitor and restrict the release of IK, and problems with the system likely limit information from being considered and used in decision-making process. With such limitations of the collection and movement of IK, it would be challenging to meet the criterion for joint process. However, knowledge holders may possess sufficient robust, adaptable and tangible knowledge to meet the criteria for flexibility and concreteness criterion. The blockage seems to be in facilitating this knowledge transfer across the boundaries, so it can be used by another group.

As mentioned, key limitations identified in the study were as follows: the overlap of resource use between BOFN and NIT, the different values ascribed by the two groups to these overlapping resources, decreased IK reliance, and trust issues. These limitations were brought up by both BOFN and NIT participants, indicating that the communication between the groups may

be heavily impacted by the current lack of trust in their relationship. My research showed the available IK through depictions on the GIS maps. I had originally intended to create one GIS map for each Face, but I was only able to map Face One and Face Three. Not all GIS maps were developed because information contained in some of the Six Faces was too abstract for mapping and did not meet the criteria. However, by gathering further IK, reducing uncertainty surrounding IK, and developing pictorial representation for abstract concepts, there may be opportunities to eventually develop all the maps in the future.

The limitations discussed above are substantiated by Gratani et al. (2014), who note that non-Indigenous interviewees mostly blame internal governance structures, such as bureaucratic administration, for the lack of effective engagement with Indigenous people and their IK in resource management. As discussed in Chapter 4, some NIT participants indicated similar issues with past attempts at implementing IK into the IFLUP and FMP. In their study, Gratani et al. (2014) also observed that Indigenous interviewees mainly attributed insufficient IK inclusion and engagement to their community's lack of empowerment when dealing with communities other than their own. Many BOFN participants indicated that they did not trust outsiders and would consequently not share knowledge that could have been applied to the GIS maps. They attributed this lack of trust to previous abuses of this knowledge.

5.3.2 Opportunities

Five main opportunities were found for creating and using GIS maps as boundary objects: increased knowledge dissemination; demand for increased knowledge dissemination; catalyst for participation; interest in IK inclusion; and the potential for reconciliation. This section analyzes these opportunities in relation to the Houde's Six Faces and the boundary criteria. Figure 5.2. below shows the visualization of the opportunities uncovered in the study and the corresponding boundary object criteria.

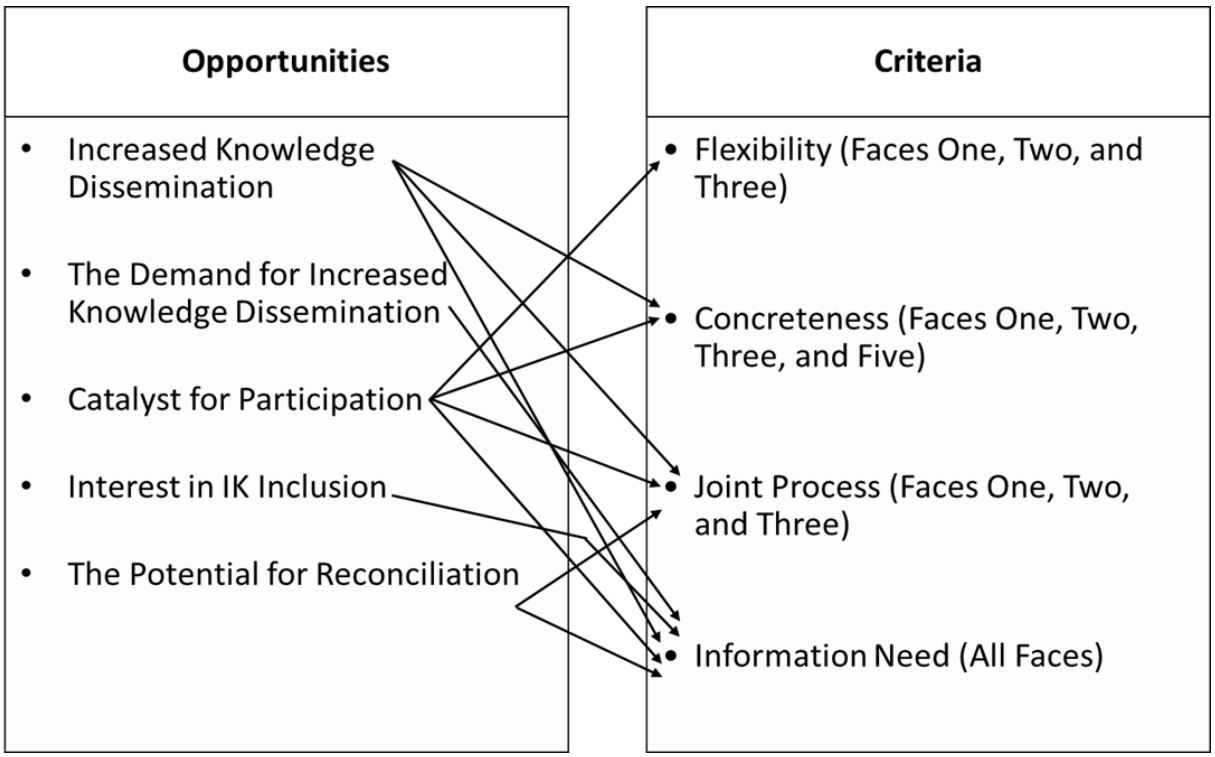

Figure 5.2. Visualization of the Opportunities and Their Connection with Boundary Object Criteria

5.3.2.1 Increased Knowledge Dissemination

Both the BOFN and NIT participants indicated that mapping IK on GIS maps represents a significant opportunity for knowledge dissemination. Participants from both groups suggested that disseminating IK to broad audience matters for several reasons. For example, BOFN participants wanted knowledge to spread to the younger generation to encourage its use in daily life. They also wanted to see more IK used in forest management. This opportunity is linked to another major theme, the demand for increased knowledge dissemination. I choose to bring these two themes together within this discussion because their goal is the same: to increase the acknowledgement and use of IK with a larger audience. Interestingly, the increased opportunity for knowledge dissemination correspond with the concreteness, joint process, and information need criteria, while the demand for increased knowledge dissemination may correspond only with the information need criterion.

The first opportunity, increased knowledge dissemination, could be realized in increasing the exposure of IK to a larger audience, thus enabling individuals to acknowledge the wider

application of this knowledge. With knowledge dissemination, individuals and groups may also be able to identify IK as belonging within a set geographical boundary and to therefore associate this IK with a resource or region familiar to them. For example, Indigenous groups and individuals may be able to identify their own IK in relation to the other information shown on a GIS map, permitting them to identify their dependencies on specific resources and their own IK. If IK on maps is put to such uses, then it might be more likely to meet the criterion for concreteness. By having a concrete means to establish their own IK, individuals may then be able to work with others to jointly transform their knowledge, thus complying with the joint process criterion.

5.3.2.2 The Demand for Increased Knowledge Dissemination

Having engaged in the process of joint knowledge transformation, individuals may share additional IK and encourage others to do the same, collecting more and better information to disseminate to a larger audience, driving up demand. The demand for increased knowledge dissemination may mean meeting the criterion for information need. Those who wish information to be disseminated to a wider audience may indicate that more information is needed to disseminate, thus generating further information may allow a boundary object to develop out of this need. Because the demand for IK to be spread to a larger audience was a strong recurring theme within this research, this demand may subsequently influence the form and structure of dialogue around what the IK may be used for. In this instance, the IK that would be most relevant and needed would concern the resources and land of the Nisbet Provincial Forest.

Both increased knowledge dissemination and increasing demand for this dissemination make it more likely that the four criteria will be met for the IK in all Six Faces. If there is a demand for more knowledge to be disseminated to a larger audience, then restrictions in place on what can be disseminated may be lifted, making it more likely that IK from all Six Faces will reach individuals and that a shared understanding of this knowledge will develop. Thus, in spreading IK to a larger audience, more information may be collected and used to inform GIS maps. In this way, the efficacy of GIS maps as a boundary object may be strengthened, and the information they contain may cross the knowledge boundary.

Another advantage arising from increasing knowledge dissemination is that IK is more likely to be included in resource and environmental management and processes without losing its

significance. GIS maps may enable IK to be used in a resource management context using a framework familiar to the IFLUP/FMP. A framework already exists on GIS maps, which show the zoning of Nisbet Provincial Forest, including important roadways and areas subject to agricultural processes. This framework could be used to include IK and applied in parallel to WSK. Using this existing framework combined with IK from Houde's Six Faces may place IK in a unique position in the FMP. Additionally, the maps themselves allow larger audiences to see the significance of BOFN's IK on a broader scale unrelated to the boundaries of the reserve.

One benefit of Houde's Six Faces is that they allow IK to be categorized according to distinct characteristics. This simple descriptive breakdown may enable a broader audience to understand the varying components of IK, as well as highlight comparisons of IK and other knowledge systems, a comparison that may ultimately challenge the homogenization of IK and WSK. The categorization of IK's specific characteristics may mean that it can be more easily implemented into management processes. If specific types of IK are placed on GIS maps, managers, resource planners, and other users may be more likely to use this information when planning and making decisions.

The Six Faces distinguish IK as its own knowledge system, while simultaneously demonstrating its applicability within the wider framework dominated by WSK. As Chambers et al. (2004) state, IK needs to be formatted and displayed in a way that is meaningful to its intended audience. These authors indicate that maps are widely recognized and used for communicating information about the land and combining multiple knowledges about a specific area, noting that, with maps, IK may be "disseminated more widely than is possible by traditional oral means or even through written languages" (p. 21). These authors also note that despite the challenges associated with mapping IK, it must be done in ways that are respectful to the culture and social systems that the IK is based from. Extending from the perspectives of this study, these statements may justify the use of GIS maps as boundary objects to disseminate BOFN's IK to a larger audience.

5.3.2.3 Catalyst for Participation

Catalyst for participation refers to the potential for increased recognition, acknowledgement, and inclusion of IK by Indigenous communities. Both BOFN and NIT participants referred to the importance of IK use in these communities. BOFN interviewees noted that if they have more opportunities to be involved with forest management decisions, then they will encourage further participation. The more that BOFN's IK is acknowledged and included within the decision-making process, the more likely that this IK will continue to be used and interpreted by management. If forest resource managers acknowledge the applicability of IK, other Indigenous communities may become engaged and provide their own knowledge. Thus, increasing use of IK in forest management serves as a catalyst for increasing Indigenous communities' participation, bringing IK into discussions and processes. In this way, both BOFN and NIT would be affected: BOFN may be provided with opportunities to discuss its IK in a variety of contexts, while NIT may be given alternative options and information to inform decision-making processes that could benefit the forest and its surrounding communities.

The catalyst for participation opportunities may meet all four boundary object criteria. Large amounts of information that has enough spatial information to be mapped using GIS may be open to multiple interpretations. If more individuals participate in contributing their own IK, the information placed within the GIS maps may grow. As a result, this information may be placed within a set geographical boundary and still be diverse enough to be malleable. Meeting the flexibility criterion.

The IK collected and placed on a GIS map may create a concrete means for individuals to identify their own IK and dependencies on resources to which this IK relates. When this occurs, the concreteness criterion is met. With increasing information and engagement, the facilitation of knowledge may increase, allowing individuals to jointly transform their own knowledge. If Indigenous communities increase their participation in decisions about the forest, they may influence the form and structure of dialogue about land and resource use within the area. As more IK holders share their knowledge, an influx of information may result, much of which may be concrete. As a result, GIS maps may contain better and less abstract IK, which wider audiences may understand.

Active and influential Indigenous engagement is key to effective IK inclusion in natural resource and forest management decision-making processes (O'Flaherty, Davidson-Hunt, & Manseau, 2008; Parons, Nalau, & Fisher, 2017; Robitaille et al., 2017). Using methods such as GIS may increase an Indigenous community's participation in such processes by challenging the common practice of having minimal Indigenous representation present when decisions are made (Ross et al., 2016). Increased engagement may foster a level of interaction with communities that goes beyond a chosen few individuals, possibly increasing diverse interpretations and increasing the IK disseminated. Environmental management literature concurs that developing human connections can lead to better decisions, which ultimately benefit the human and natural environment (Poe, Norman, & Levin, 2014). Within the context of their study, Crook et al., (2016) argues that increased engagement and collaboration between Indigenous and non-Indigenous communities may provide a wealth of benefits. However, to improve collaboration, a shift in thinking and deeper engagement is required (Crook et al., 2016). Based on my findings, my research has led me to recommend that engagement of Indigenous communities should shift from consultation to their active involvement in the forest planning process.

5.3.2.4 Interest in IK Inclusion

Within the NIT, the interest in IK inclusion was a recurring theme. Interviewees were eager to learn about Indigenous communities and IK and discussed opportunities for increased IK acknowledgement and engagement in IFLUP and FMP. With this level of interest, the information need criterion is likely to be met. In fact, IK from all Six Faces may be involved, as the interest may not be restricted to a certain type of information. NIT interviewees expressed interest in empirical observations, practices, physical locations of significance, ethics, values, beliefs, stories, images, and cosmological thinking. This interest may lead to the generation of IK with spatial elements that can be mapped, thus providing an inclusive depiction of IK.

BOFN interviewees were also interested in generating IK as they wanted to have access to more of their own IK to include in their activities, such as hunting (B2, 2016; B7, 2016). Additionally, BOFN interviewees expressed a strong desire to see studies done on different issues within the BOFN community. These issues mainly concerned water security, food sovereignty, the adaptation and application of policy to the BOFN community, and the dissemination of IK to the younger generation (B1, 2016; B2, 2016; B5, 2016; B7, 2016; B11

2016). For example, a BOFN interviewee did not see a sustainable future with current agricultural practices and foresaw agricultural practices embodying more traditional aspects of IK (B5, 2016). As Cummings and Read (2016) argue, using IK to inform policy may benefit forest management decision-making processes and lead to the clear identification and knowledge of ecosystem services within a given landscape. IK may also serve as a basis for understanding landscape values and providing justification for alternative conservation or management strategies (p. 52-53).

5.3.2.5 The Potential for Reconciliation

This last opportunity originates with the BOFN participants, who expressed that using GIS maps as a boundary object to display IK may encourage a shared understanding and collaboration across boundaries, and, ultimately, increased acknowledgement and implementation of IK in forest management. Taken a step further, this shared understanding and collaboration may contribute towards practices that reflect the values of reconciliation. First, shared understanding and collaboration could facilitate a joint transformation of knowledge. This transformation of knowledge may be between individuals involved with the usage of the boundary object (Carlile, 2002), including individuals within and between communities. As individuals and groups discuss values that may lead to reconciliation, the need for more information to collaborate and share may arise, thus influencing the structure of dialogue around resource and land use in the Nisbet Provincial Forest and also around the respectful uses of IK within these processes. In this way, this opportunity may positively influence the use of GIS maps to facilitate IK across boundaries.

The potential for reconciliation may involve all Six Faces. As individuals share understanding of knowledge and encourage collaboration, restrictions on the type and amount of knowledge provided may lift, and information may then move more smoothly across boundaries. More and better knowledge may then be available for GIS maps, which would portray a more inclusive depiction of IK, thus enhancing their efficiency as a boundary object.

In addition to playing a role in reconciliation, the depiction of IK in GIS maps may also improve resource sustainability. BOFN participants were mainly interested in Nisbet Provincial Forest's attempts to acknowledge the need for resource sustainability (B1, 2016; B2, 2016; B3, 2016; B5, 2016; B7, 2016). This finding is supported by one BOFN participant who claimed that

the maps created a "multifaceted approach" that "includes both the social and economics, the recreational use …" and that "also helps allow us to understand the intricate web of the entire ecology of the Nisbet forest and how the Nisbet forest actually contributes to the overall climatic observations of this whole region" (B1, 2016). Another BOFN participant noted that the information on the maps could "help [us] see where the animals migrate and where medicines are picked" (B7, 2016) and it shows "how much the people travel and use the Nisbet forest…shows the distance that they traveled to acquire…hunting and gathering" (B8, 2016). The GIS maps may hold knowledge familiar to those from both knowledge systems. This familiarity could potentially bridge these two knowledge systems so that those from both groups can see how their knowledge applies to resource use of the forest in new or diverse ways.

As Noble et al. (2016) argue, collaborative research partnerships between Indigenous communities and contemporary management agencies may develop trust and empower Indigenous communities to create long-term relationships to address environmental issues as equals. Equitable long-term sustainability may be mutually beneficial to actors on both sides of the knowledge boundary. Simpson (2004) argues that applying dimensions of IK in a contemporary context may allow Indigenous individuals to release themselves from the "oppressive control of colonizing state governments" (p. 373). However, colonialism and its influence on the development of BOFN's IK needs to be critically analyzed. From this analysis may come educational opportunities that could take the form of classes researchers and planners may take to understand the traditions rooted in the history of Indigenous communities and to stimulate the values that guide reconciliation.

5.4 Summary of GIS as a Boundary Object

The resulting knowledge developed from collaboration between Indigenous and non-Indigenous actors may improve the relationship between these communities, their economic interests, and the protection of the environment (Popova, 2014). Smith et al. (2012) notes that maps may be described as "indispensable tools for analyzing the complex interactions between peoples and landscapes" (p. 119). These authors argue that maps can present subjective representations that demonstrate a specific point of view and may include multiple ways of thinking (Smith et al., 2012). In this way, maps may be used to fight marginalization and to help

Indigenous communities identify and manage key resources in their community (Smith et al., 2012; Young & Gilmore, 2017).

The idea that GIS maps, not being static, can represent dynamic and adaptive knowledge and information is supported in literature that uses these maps as a tool for knowledge facilitation (Elwood, 2006; Hunt, 2014; Supernant, 2017; Smith et al., 2012). As Gratani et al. (2014) argue, implementing IK into natural resource management needs to be done holistically, not by taking only pieces of IK. The holistic inclusion of IK was a challenge for this research, as many intangible aspects of BOFN's IK did not translate spatially onto GIS maps. However, as Lewis and Sheppard (2005) maintain, there are some ways that spiritual values can be made tangible enough to work with. This conversion may be possible based on shared understandings of "physical, spatial and visual requirements associated with particular spiritual practices and beliefs and their enabling ecological resources" (p. 918). As mentioned, the next step towards including this type of IK would be to assign spatial elements to the IK of the higher Faces: Four, Five, and Six.

Overall, GIS maps appeal to a broad audience by representing data visually (Tripathi & Bhattarya; 2004). In addition to being available online, GIS maps can be printed out and physically disseminated. The content of GIS maps may be easily manipulated for those who cannot read or have vision issues. Also, GIS maps may give community members an opportunity to disseminate their IK, rather relying on the attendance of a small number of representatives who may have limited interpretations of their community's IK (Escott, Beavis, & Reeves, 2015; Ross et al., 2016).

As a boundary object, GIS maps have other benefits. They may represent IK in a way that shifts the focus from unbridgeable to complementary differences (Ludwig, 2016). GIS maps as a boundary object may engage Indigenous perspectives in alternative ways to manage resources (Robinson et al., 2016; Tripathi & Bhattarya; 2004; Young & Gilmore, 2017). In fact, the process of developing GIS maps as a boundary object is as important as the product itself (Zurba & Berkes, 2014) because the process may promote long-term discussions about Indigenous values and natural resources (Young & Gilmore, 2017).

The process of attempting to develop these GIS maps into boundary objects may be a result of, as Hunt (2014) maintains, the "unsettling nature of engaging Indigenous knowledge in

processes that are rarely clear, neat, linear, or straight-forward, but are instead productively confusing" (p. 5). Overall, my study has explored the limits and opportunities of using GIS as a boundary object to represent IK in natural resource and forest management. Through the analysis of these limits and opportunities, my study has developed an informed understanding of what factors and improvements may be needed for GIS maps to be effective boundary objects to facilitate IK across boundaries.

CHAPTER 6 GOOD PRACTICE AND LIMITATIONS OF STUDY

Canadian forest planning and natural resource management is largely founded on decision-making made within a framework that is primarily focused on the values and knowledge of Westernized society (Ascher, Steelman, & Healy, 2010; McGregor, 2011; Morgan & Cole-Hawthorne; 2016). Consequently, these planning and implementation processes may restrict the ability of other knowledge systems to significantly influence the decisions made. As a result, there is a need for more practical tools that effectively include other knowledge systems, such as IK, into environmental management and policy processes. The extent to which IK and WSK may be effectively collaborated and used within a natural resource and forest management decision-making context is constantly evolving and these ideas are explored by academics, forest planners, and resource managers throughout the world.

As addressed in the literature analyzed within this study, IK is ineffectively and inadequately included within environmental management processes and policy-making (Diver, 2017; Reo et al., 2017; Robitaille et al., 2017). Therefore, my study argues that these processes would benefit from having deeper cross-cultural understandings, and boundary objects may help develop this understanding. Boundary objects may be able to facilitate information from one group to another, and by using a GIS map to visually represent IK, more inclusive solutions towards forest management may be developed. Thus, my study investigated the limits and opportunities of using GIS maps as a boundary object to represent IK in forest resource planning and implementation processes. The efficacy of GIS maps as boundary objects were evaluated according to four boundary object criteria: flexibility, concreteness, joint process, and information need.

I used Houde's Six Faces of TEK (2007) to categorize the IK of the BOFN community according to distinct characteristics. Leveraging this framework may allow a broader audience to understand the diversity and varying components of IK. This categorization allowed the multifaceted elements that comprise IK to be comparable to other knowledge systems, like WSK, while still keeping its distinctiveness as a knowledge system intact. In doing so, the risk of homogenizing or standardizing IK with WSK decreased. If homogenization or standardization were to occur, the knowledge facilitation provided by boundary objects may be restricted and the diversity of IK would decrease (Mistry & Berardi, 2016; Steger et al., 2018). Therefore, using

the Six Faces of TEK as a conceptual framework may allow IK to be more easily included in management processes by promoting IK as a distinct knowledge system. Additionally, if specific types of IK are represented by GIS maps, mangers, resource planners, and other users may be more likely to use this information when planning and making decisions.

The limitations and opportunities of using GIS as an effective boundary object was developed through the course of this research. As a result, these findings allowed me to develop recommendations that could meaningfully include IK in a natural resource and forest management context in a more effective and influential way. The limitations of using GIS maps as a boundary object affect the joint process of knowledge transformation criterion the most, indicating that the effective collaboration needed for the facilitation of knowledge between boundaries is restricted. The findings from my study indicate that the desire for this information and knowledge is strong. Therefore, conceptual recommendations may need to focus on innovative methods to improve these collaborative processes to facilitate IK across knowledge boundaries and cater to this information need.

6.1 Good Practice Recommendations

6.1.1 Elder Engagement

The results of this study revealed that the reliance on IK is decreasing in younger Indigenous generations. The literature relating to the usage of IK within communities corroborates this finding by stating that this decreased reliance may be due to the technological advancement and modernity of society, the lack of awareness of IK, or lack of interest (Huang, Pei, & Long, 2004; Ragupathy et al., 2008; Srithi et al., 2009; Voeks & Leony, 2004). A more holistic understanding of BOFN IK may subsequently be held by the Elders of the community. As a result, there is a knowledge boundary within the community between Elders and the younger generation and the available BOFN IK may decrease as a direct result of the decreasing number of Elders within the BOFN community. With that being said, BOFN interviewees expressed an interest in learning more about BOFN IK, having this IK spread to the younger generation, and seeing more of this IK within forest management. This desire links back to the opportunities outlined in this study as increased knowledge dissemination and demand for increased knowledge dissemination.

This dissemination was viewed as a significant priority, especially by the BOFN participants who were Elders. These insights lead to the recommendation of engagement programs with youth and Elders using GIS maps as a method to display and facilitate BOFN IK. These engagement programs may be camps or events where younger people may be able to access experiential learning on the land while the GIS maps may be a technological platform that younger generations may be more familiar with; others have recommended similar approaches (see Sefa-Dei, Golden-Rosenberg, & Hall, 2000). As a result, the GIS maps may present IK in a way that is relevant and useful to younger audiences and using these maps may encourage discussions about the knowledge used to inform these maps. Additionally, by making these maps available through Elder engagement programs, communication with Elders may be stimulated and the younger generation may be able to familiarize themselves with additional cultural resources.

6.1.2 Knowledge Archive

My study found that even information that cannot be represented visually may still be considered and used to inform decision-making processes within a forest management context. Therefore, if the collected IK is too abstract and spatial data cannot be assigned at the time it is collected, such as the IK within Faces Four, Five, and Six, a knowledge archive may be created. The creation of a knowledge archive has been suggested by authors such as Eisner et al., (2012) who state that the stored knowledge may be accessible to members of the local community for further individual interpretations for their own purposes. The storage of knowledge into an archive has been corroborated by other authors such as Gardiner et al. (2011). As a result of this archive, spatial attributes may eventually be associated with this IK. Also, by storing this information instead of discarding it, the diversity and distinctiveness of IK may be preserved and not forced to fit into a standardized form of knowledge. The stored IK may also include traditional language or terminology that is significant to the BOFN community. Additionally, future research may be influenced by the stored IK and this knowledge may be included in future studies. Thus, the creation of a knowledge archive may improve the process of knowledge collection and could be stored in the forms of audio, visual, or typed material that could then be used to associate with a specific cultural resource or geographical area.

6.1.3 Increased Physical Copies

BOFN interviewees have very limited access to the technological resources that details the IFLUP, forest and natural resource legislation, and consultation processes relevant to the Nisbet Provincial Forest. Due to this limited access, it is recommended that physical copies of the IFLUP be made available for the BOFN community to access freely. Other resources that could be physically printed or copied could be: past or current activities done in the area, the role Indigenous communities have in consultative processes, similar academic research done involving BOFN or IK inclusion, and legislation regarding the current position Indigenous communities may be granted in forest and natural resource governance. It is suggested that these resources be available to the BOFN community at their band office at any time to garner a collective understanding about the management of their surrounding environment and its resources. Access to these resources may address the gap in this study presented by BOFN participants who had limited knowledge of current practices within the Nisbet Provincial Forest and of the policies surrounding the management of forest resources.

Some physical copies of resources have been made available via the BOFN band office, but it is not widely accessible to the broader community and is usually confined to one copy in a binder. After returning a copy of the interview validation form and interview to each respective participant, I also presented each interviewee with a physical copy of the FMP. I did this because the majority of BOFN participants did not have access to the IFLUP due to a lack of computer access and awareness that there was a forest management plan. At the end of this thesis, the GIS maps created were returned to the BOFN community as an ongoing resource for a demonstration of BOFN IK and its wide applicability. I intend to print large poster versions of these maps to be displayed for the members of the BOFN community to interpret, along with physical copies of my thesis.

In addition to this recommendation, my study acknowledges that other Indigenous communities may also face restricted access to resources regarding forest and resource management processes. The broader lesson is that a commitment to the dissemination of physical copies of these processes may need to be prioritized. This commitment may be stimulated by the awareness that many communities dependent on forest resources may not have the technological capacity to access the management plans of these resources.

6.1.4 Using GIS maps as a Boundary Object

A final practical recommendation that may be used by BOFN and NIT groups is potentially using GIS maps as boundary objects to represent IK within the implementation processes of the Nisbet Provincial Forest. The boundary object criteria provide a better understanding of what elements may be needed to improve the ability of GIS maps to be better boundary objects. Taking these improvements into consideration, GIS maps still have many benefits. First, they appeal to a broad audience by representing data visually (Tripathi & Bhattarya; 2004; Sonti, 2015). Second, they are widely accessible online or printed out. Third, they may be relatively easy to manipulate for those who cannot read or have vision issues. Finally, they may give community members an opportunity to disseminate their IK, rather relying on the attendance of a small number of representatives who may have limited interpretations of their community's IK (Escott, Beavis, & Reeves, 2015; Ross et al., 2016).

Therefore, the GIS maps have the potential to act as tools for BOFN members to use as a template to visually demonstrate the spatial dimensions of their IK to other members of their community and to a broader audience. NIT members may be able to use the GIS maps as tools to aid in effective communication with BOFN and other Indigenous communities in the applicability of IK within a forest and natural resource management context. The GIS maps, in combination with the criteria and conceptual framework of Houde's Six Faces of TEK, may be replicable for future research endeavours. Practically, both BOFN and NIT participants will have access to these maps and this thesis and may use these as tools in whichever way that they may deem appropriate.

6.1.5 Transparent Communication, Indigenous Representation and Active Consultation

By conceptualizing Indigenous communities as stakeholders, collaboration between Indigenous and non-Indigenous communities may be detrimentally affected because the self-governing aspects of an Indigenous community are passively ignored. Therefore, in theory, moving Indigenous communities into a nation-to-nation decision-making role in natural resource and forest management would allow these communities to include their IK within these management processes more equitably, effectively and efficiently. Using GIS maps as a tool to encourage transparent communication of resource use by Indigenous communities may aid in IK implementation within these management processes. This transparent communication may

stimulate discussion around resource use and culturally significant areas that may be subject to protection by forest and resource management plans, such as the IFLUP. However, these discussions may be hindered by trust issues. These issues are a significant limitation as both BOFN and NIT participants noted that communication between their communities may be impacted by the lack of trust in their relationship. As a result, GIS maps that are informed by IK may be restricted in what knowledge they portray, limiting their effectiveness as boundary objects.

Therefore, trust may be needed to strengthen relationships between communities and to effectively obtain and implement IK in contexts outside of the Indigenous community (Burnette & Sanders, 2014; Lyons, 2011). My study recommends that these trust issues must be thoroughly addressed and remedied, should IK continue to be shared between different groups using GIS maps. Increased Indigenous representation, engagement, and effective consultation processes may address these trust issues. Both recommendations require communication between different groups and GIS maps portraying IK may be a tool to do so. For example, Indigenous representatives at decision-making meetings for forest management may use GIS maps as a tool to portray their IK. In doing so, these representatives are using a familiar format to portray the applicability of their knowledge in a comprehensible way to a wider, non-Indigenous audience that may encourage a shared process of understanding.

As discussed in my research, the majority of BOFN participants were unaware of the IFLUP and the FMP. Additionally, the current literature on Indigenous engagement notes that Indigenous communities may not take the decisions made in management processes seriously because the small amount of representatives they have for their community may not embody their knowledge system as a whole (Escott, Beavis, & Reeves, 2015; Ross et al., 2016). This unawareness and lack of effective representation may lead to IK and Indigenous participation being underrepresented in current academic research and policy processes (Arnold, 2017). Due to these issues, consultation practices may need to be adjusted to encourage active engagement and promote deeper engagement with Indigenous communities.

Facilitators, such as forest planners, could meet with Indigenous individuals within their community by holding open discussions about decisions regarding forest management. These meetings could be attended by multiple Indigenous individuals who would like to learn more

about the forest and resource management practices that are being conducted within their surrounding environment. As noted by Popova (2014), knowledge derived from collaboration between Indigenous and non-Indigenous actors may improve the relationship between these communities, their economic interests, and the protection of the environment. Additionally, based on the literature analyzed in this paper concerning Indigenous engagement, my study argues that these meetings may also be enhanced by physical Indigenous representation.

As argued by Acheson (2005), seeing an Indigenous person that other Indigenous individuals may relate to can help build trust. These Indigenous individuals may be members who are already involved in the forest management process and can aid in the transfer of knowledge between groups. GIS maps may be an effective boundary object in this situation, as these maps may create a safe space for the discussion of IK implementation within a forest and resource management context, a space which is of critical importance in collaborative research (Lyons, 2011). Therefore, my study recommends active consultative meetings with Indigenous community members who want to learn more about the forest management decision-making process. In doing so, increased active engagement may develop a level of interaction that goes beyond having these single representatives and allows for the development of diverse interpretations and an increase in knowledge dissemination.

In working with Indigenous communities, the barrier of the DTC needs to be addressed. The DTC is a consultation process that may be ineffective and act as a barrier that limits the interaction between Indigenous and non-Indigenous communities (Van Schie & Hairder, 2015). For example, many NIT participants were initially uncertain about the knowledge obtained to inform the GIS maps. This uncertainty led to hesitation and clarification before critiquing the GIS maps. As a result of this uncertainty, legal constraints like the DTC may restrict individuals from developing a concrete means to identify their differences and dependencies with a given boundary or jointly transform this knowledge across boundaries. However, by encouraging active engagement, a shared understanding and collaborative process may be developed. This shared understanding may stimulate discussions around the values of reconciliation. As groups and individuals collaborate, the need for more information may arise, thus influencing the structure of dialogue around resource and land use as well as around the respectful uses of IK within those processes.

6.1.6 Educational Opportunities

As mentioned above, the desire for information is strong, but the universal understanding of this information may be a barrier. The Six Faces of TEK characterizes IK and GIS maps depicts this knowledge. In doing so, the GIS maps may encourage a deeper understanding of this knowledge within a socio-ecological system, such as the Nisbet Provincial Forest. The four boundary object criteria may enhance the Six Faces framework by specifying what basic elements are needed for a boundary object to effectively facilitate knowledge across boundaries. However, my study found that some information may not lend itself to being translated into spatial data, or there was not a sufficient amount of knowledge to categorize into a Face. Consequently, my study found that some IK used to inform the Faces may be too abstract to be adequately represented in a GIS map. To address this issue, my study identified barriers and opportunities associated with different knowledge types, according to the boundary object criteria, as a potential path forward for a more effective implementation of IK into GIS maps.

One way to gain a better understanding of IK is through education. As mentioned in the practical recommendations, educating the younger generation of an Indigenous community may promote the perpetuation of their IK (Dweba & Mearns, 2011). However, researchers and students may also benefit from educational opportunities that establish an understanding of IK and its use in academic research. These educational opportunities could take the form of lessons in the curricula or as classes where researchers may better understand the historical relations Indigenous communities have with the world and the unique characteristics of their IK. Understanding the historical relationships Indigenous communities have with Western society may help establish the next steps towards reconciliation (Simpson, 2004) as researchers may be better equipped with the necessary understanding of issues regarding IK obtainment and implementation. Additionally, the Six Faces may foster a better understanding of these characteristics and allow individuals to identify differences between knowledge systems.

Ultimately, this recommendation is under the premise that Indigenous communities and their knowledge warrants continued effort to be respectfully understood if their knowledge is to be used more effectively in forest and other natural resource management processes. As a result of this recommendation, educational opportunities that showcase IK may subsequently stimulate

its use in a broader range of research. Below in Table 6.1 is a summary of the recommendations that could improve how these GIS maps are used.

Table 6.1. Good Practice Recommendations

Elder engagement programs	Use GIS maps as a tool for transparent communication
Knowledge archive of unused IK	Increase Indigenous representation and engagement in decision-making processes using GIS maps as boundary objects
Introduce physical copies of management plans and research to Indigenous community	Active consultation with Indigenous facilitators
Use GIS maps as boundary objects to represent IK in forest and resource management planning	Educational opportunities to understand the historical foundation of Indigenous communities and their IK

6.2 Limitations of Study

In Chapter 3, I discussed limitations of which I was aware before starting my research. Below are limitations that I acknowledge now my research has been completed. It is critical to address the potential factors that may have influenced the success of this study. Addressing these limitations may also allow me to acknowledge the significance of my study and to understand what future research may improve.

6.2.1 Difficulty Obtaining Concrete Information

This research argues that GIS is not static and can be used to represent Indigenous rights and knowledge. However, one major limitation is that spatial data or attributes of IK are likely required to display the IK on a GIS map. In my study, the IK provided for Faces Two, Four, Five, and Six were too vague and were not represented spatially. Therefore, these Faces did not meet the first three boundary object criteria (flexibility, concreteness, and joint process) and were not transformed onto GIS maps. Not having spatial data for the information provided reduced the amount of IK I could place on GIS maps, thus decreasing the effectiveness of GIS as an effective boundary object.

6.2.2 Criteria Not Fool-Proof

Even if the IK on the GIS maps met all four boundary object criteria, GIS cannot be guaranteed as an effective boundary object. These criteria were developed based on my understanding of the boundary object literature and interpretations of effective boundary objects. These criteria may act as a framework for future research on GIS used as a boundary object to meaningfully include IK into forest management. However, these criteria are unlikely to stay static and may continuously be improved based on evolving situations and contexts.

6.2.3 Lack of GIS Expertise

I am not professionally trained in GIS programming, nor is GIS the only way to facilitate and visually portray IK. I acknowledge that the GIS maps could have been better, but these improvements were beyond my abilities as a student with no formal training or experience with ArcGIS or ArcMap. That being said, although my knowledge of GIS and its functionalities as a mapping program are limited, I tried to present BOFN's IK in a way that made sense to me and addressed my research question and objectives. In this way, I connected this IK to the capacity of GIS maps to be effective boundary objects and analyzed the limits and opportunities of doing so.

6.2.4 Trust

Trust was a major limitation in this study, which can be seen in my inability to collect and depict the IK of the BOFN community. The only information shown on the GIS maps is the information that was given to me through the interviewing process and information that I had permission to use. IK is a vast knowledge system rooted in Indigenous communities for centuries. As previously mentioned, some IK was not disclosed to me, such as specific berry picking locations. Due to this, not all the IK from the BOFN community was acquired and depicted. However, any information that was willingly provided is a step towards including more IK and improving Indigenous engagement in decision-making processes. The FMP is a living document, and IK is a dynamic knowledge system, qualities that may indicate opportunities to add more information as resource use changes and as time progresses.

6.2.5 Participant Engagement, Uncertainty, and Knowledge Validation

Another limitation was participant engagement, exacerbated by a short timeline and a communication barrier between myself and some BOFN participants. With more time and funding, more interviews could have produced further information to display on the GIS maps.

Communication barriers between BOFN participants and myself meant that I found some concepts hard to understand and some types of IK easier to obtain than others, affecting the amount of IK used to inform the GIS maps. Some interviewees were more comfortable answering certain questions than others. Additionally, interviewees from both NIT and BOFN, particularly those who lacked knowledge of FMP, were uncertain about the usefulness of their information and thus may have limited the information they shared. Although I tried to clarify that any information provided would be valid and significant, many interviewees felt overwhelmed and did not know how to convey their knowledge.

This study was created based on the idea that IK is applicable in contexts familiar to WSK such as forest management planning. As Gratani et al., (2014) noted in their own study that many local practitioners need to validate IK prior to applying it. Therefore, the need for validation of IK may be a limitation because this validation may require practitioners such as NIT participants to see this knowledge applied in a format they understand before they consider including this knowledge within a forest management context.

CHAPTER 7 FUTURE RESEARCH AND CONCLUSIONS

7.1 Future Research

There is a need for more inclusive policy-making to allow Indigenous communities to represent themselves in a forest and natural resource management context, potentially in the context of self-governance and self-determinism (McGregor, 2011; Reo et al., 2017; Von Der Porten, & De Loë, 2013). This inclusivity is a constitutional right of Indigenous communities in forest governance. However, as Wyatt, Kessels, & Laerhoven (2015) state, the acknowledgement of the rights of Indigenous communities in forestry governance is not the issue. The physical application and practice of these rights is the challenge, and this challenge may lead to uncertainty and tension. My study has tried to identify and apply an innovative approach that may move us in the direction of facilitating the use of Indigenous communities' knowledge in these processes for enhanced roles of self-governance and decision-making. Facilitating this knowledge may be inhibited significantly by issues between Indigenous and non-Indigenous communities originating from historical conflicts, exploitation, oppression, and marginalization (Burnette & Sanders, 2014; Natcher, Davis, & Hickey, 2005). The proper acknowledgement of these issues and how they may affect the self-governance of Indigenous communities in forest governance in Canada is an area for continued research.

If a certain type of information is needed by forest and natural resource management, then the primary dialogue found in the management plan will continue to be unchanged. The information within the IFLUP contains knowledge that conforms to rigid descriptive criteria that includes distinct geographical locations and tangible data. This rigidity makes it highly unlikely that the criteria for Faces Four, Five, and Six and the abstract knowledge they contain will be met. As a result, developing information that is tangible and concrete so that others may learn and understand this knowledge may be challenged by abstract knowledge conceptions and the inaccessibility of knowledge within the Indigenous community. Therefore, improving GIS functioning as a boundary object and to increase the applicability of IK within this dominant framework may be necessary to correlate spiritual values with geospatial data, so these values can be placed on a GIS map and applied to a forest and resource management context. Thus, future research is needed to assign tangible, geospatial data to IK primarily found in Faces Four, Five, and Six.

With that being said, another way to include IK within forest and resource management is to start with a framework guided by IK and then seek relevant WSK to support this framework (Mistry & Berardi, 2016). In this way, the dialogue of the framework will be changed, and the information used to inform this framework may be expanded to include abstract concepts of knowledge. Although my study attempted to use Houde's Six Faces of TEK as a framework that focused primarily on IK, future work is still needed as the relevancy of WSK to BOFN's IK may still present as a challenge.

The use of GIS maps as boundary objects to effectively implement IK within a decision-making context could also be adopted into management systems, such as adaptive or co-management. Although co-management is out of the realm of research for this study, it is suggested that future studies may replicate the methodological process of this study for future attempts of knowledge inclusion.

Face One and Three had GIS maps created based on their IK before the interviewing process. My study argues that had visual illustration been available for the latter Faces to aid in BOFN participants in conceptualizing their knowledge, then they may have been able to provide more information. Therefore, future research is needed to create base maps that represent Faces Four, Five, and Six that may prompt Indigenous participants to share their IK that is comprised of abstract concepts. To do this, perhaps future work may use a basic GIS map that only shows the geographic boundary of a specific region. It is hoped that this visual stimulus may encourage a discussion to obtain more knowledge from IK holders. Also, my study argues that future research may benefit by reconsidering IK from Face Two on a GIS map, as interviewees did provide some information for this Face. With more time and resources, more information for Face Two could have possibly been collected, and the collection information on alternative methods of the sustainable use of natural resources rooted in IK may subsequently increase.

7.2 Conclusions of Study

My study assessed the limits and opportunities of using GIS maps as a boundary object to represent IK in resource planning and implementation processes. The objectives of my study were to collect BOFN IK, synthesize this IK into GIS maps, identify missing BOFN IK, understand whether and how GIS maps can be used as a boundary object, and develop good practice recommendations on how to better represent IK in an FMP. Through the progression of

this study, four boundary object criteria were derived from an exhaustive analysis of the boundary object literature and used to evaluate the limits and opportunities of GIS maps to act as boundary objects: flexibility, concreteness, joint process, and information need.

My study produced four main findings. First, GIS maps have the potential as boundary objects to effectively represent IK in resource planning and implementation. Second, not all of the Six Faces used to inform the GIS maps had the ability to adhere to these criteria at the time the knowledge for these Faces was collected. Third, some Faces were not suitable to include in the GIS maps, partly as a result of not meeting all the criteria and limitations due to the data that were collected. Fourth, the criteria suggest specific ways to improve on the current barriers inhibiting greater use of IK in GIS maps such that they can function as effective boundary objects.

Faces One and Three met all four boundary object criteria and were comprised of a substantial amount of tangible geospatial data. Thus, they interpreted by both BOFN and NIT participants to the extent that both Faces were able to be produced into GIS maps. Face Two had the potential to meet the flexibility and concreteness criteria as it associates IK with physical properties such as geographical locations and agricultural practices, all of which were represented on a map. However, this information was not collected within this study. Also, Face Two did not meet the joint process criteria. As a result, Face Two did not meet all four boundary object criteria fully and was not mapped. Faces Four, Five, and Six did not meet the criteria for flexibility, concreteness, or joint process, although Face Five had the potential to meet the concreteness criterion. These Faces did not meet all four boundary object criteria and were not mapped.

Faces One, Two, and Three all have IK that is widely agreed upon among BOFN members, dependent on empirical observations, and contain a sufficient amount of tangible, geospatial information. My study suggests that due to the tangibility of this information, these Faces may be easier to display on a GIS map. Faces Four, Five, and Six may contain IK that is abstract, personal, and varying among individuals. These Faces were not able to be mapped because there was not a substantial amount of geospatial information that could be assigned to the IK within each Face. Therefore, if there is a lack of spatial attributes to assign IK to form a robust Face that is open to multiple interpretations, then there will be insufficient information to

build a concrete foundation on which to learn about knowledge dependencies on resources. Consequently, developing a GIS map for this Face and dynamically adapting this Face for different knowledge users may be challenging. Thus, my study concludes that without adequate geospatial information, it may be difficult to transform knowledge in a way that it can be mapped and used by others.

To meet the flexibility criterion, a Face needs to have enough tangible data to be robust enough to withstand multiple interpretations. My study has shown that Faces that met the flexibility criterion fully were able to meet the other boundary object criteria. This may be because the information and knowledge were substantial enough to also create a concrete foundation for users to understand their differences and dependencies on resources thereby encouraging a collaborative process between groups across the boundary to transform this knowledge. Therefore, my study argues that the flexibility criterion is the most important boundary object criterion a Face must adhere to.

To conclude, IK is a dynamic and vast knowledge system that may provide a nuanced understanding of the benefits forest ecosystem services provide, thus directly influencing sustainable natural resource and forest management plans (Cummings & Read, 2016; Parrotta, Yeo-Chang, & Camacho, 2016). Effectively implementing IK in environmental management and policy decisions may act as a catalyst for robust conversations on the sustainability of resources (Parsons, Nalau, & Fisher, 2017). Therefore, using GIS maps as a boundary object may effectively facilitate IK across the knowledge boundary. IK holders may be able to visually identify significant resources within a geographical area while WSK holders may be better able to understand where these resources are located and what options are available to preserve or protect these locations. Thus, using the GIS maps in this way may be an effective tool that may be used to address the different knowledge contributions made by local actors and to improve on the interactions between Indigenous and non-Indigenous communities. These interactions may support transparent communication between communities on either side of the knowledge boundary and stimulate improved methods on consultative, representative, and engagement processes. My research contributed to this understanding by evaluating how GIS maps may be used as a boundary object to represent and illustrate the available IK of an Indigenous community as a way of highlighting the beneficial knowledge of resources this community has

of the surrounding environment. My study attempted to use the four boundary object criteria as a mechanism to understand how improvements may be made to increase the efficacy of GIS maps to perform better as boundary objects. With these criteria in mind, my study concludes that this approach has the potential to effectively represent IK and its associated values and may aid in the active engagement of Indigenous communities within a forest and resource management context.

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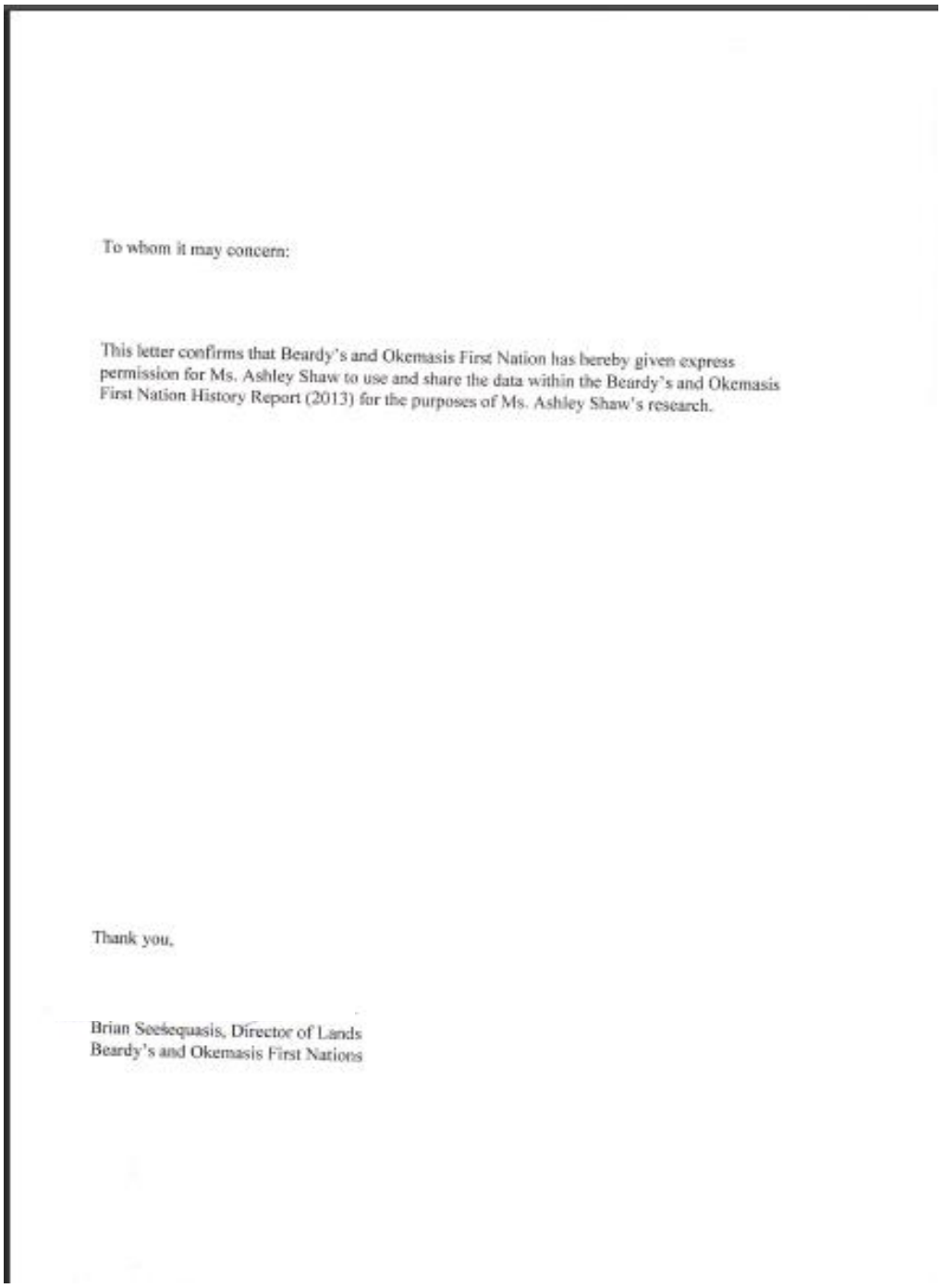
Zurba, M., & Berkes, F. (2014). Caring for country through participatory art: Creating a boundary object for communicating indigenous knowledge and values. *Local Environment*, *19*(8), 821-836. https://doi.org/10.1080/13549839.2013.792051

APPENDIX A



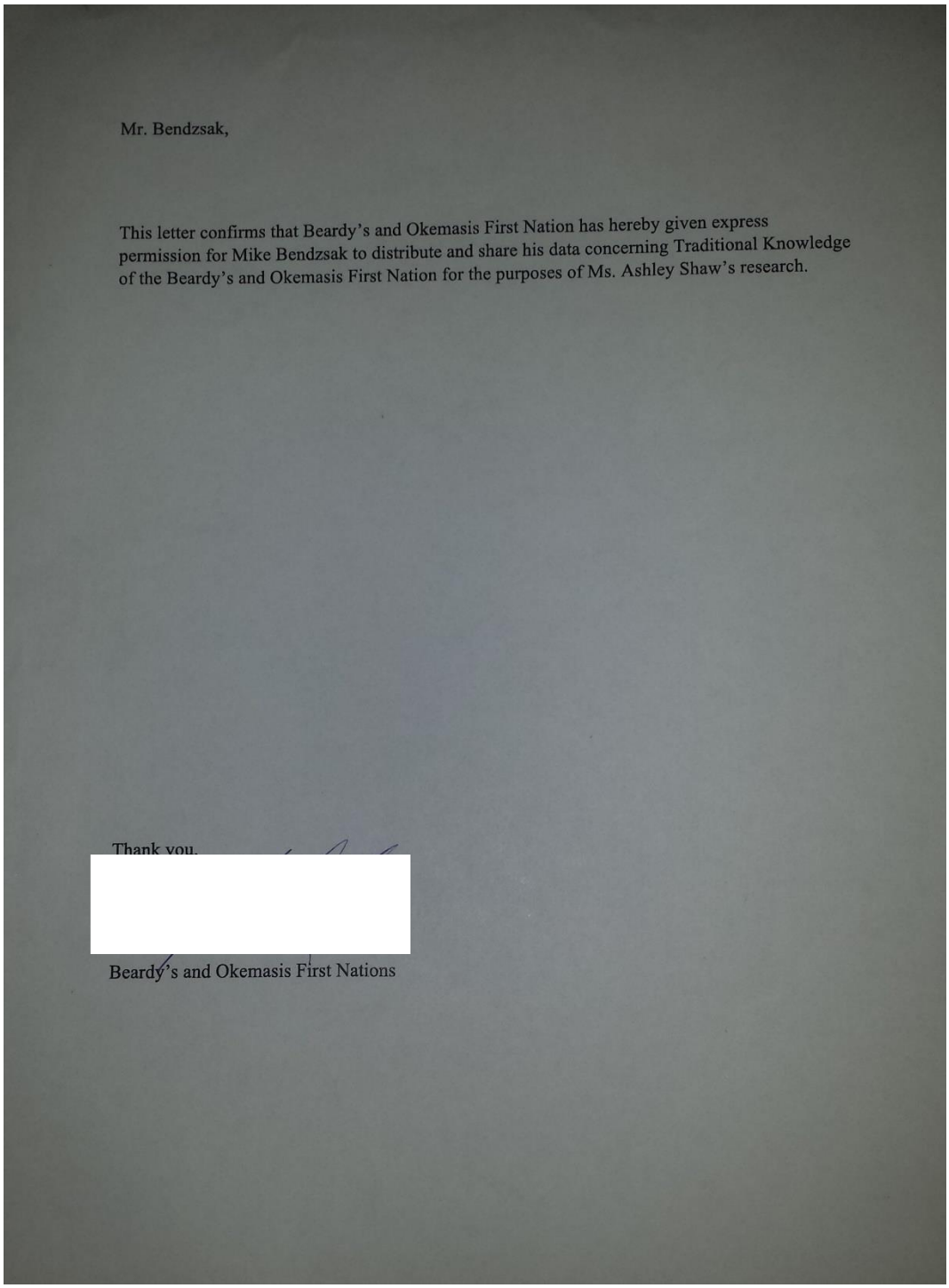
To whom it may concern:

This letter confirms that Beardy's and Okemasis First Nation has hereby given express permission for Ms. Ashley Shaw to use and share the data within the Beardy's and Okemasis First Nation History Report (2013) for the purposes of Ms. Ashley Shaw's research.

Thank you,

Brian Seesequasis, Director of Lands
Beardy's and Okemasis First Nations

Figure A.1. Copy of Permission of Use for the BOFN History Report (2013)



Mr. Bendzsak,

This letter confirms that Beardy's and Okemasis First Nation has hereby given express permission for Mike Bendzsak to distribute and share his data concerning Traditional Knowledge of the Beardy's and Okemasis First Nation for the purposes of Ms. Ashley Shaw's research.

Thank you.

[redacted]

Beardy's and Okemasis First Nations

Figure A.2. Permission of Use for Data from BOFN History Report (2013) to be Released by Mr. Bendzsak

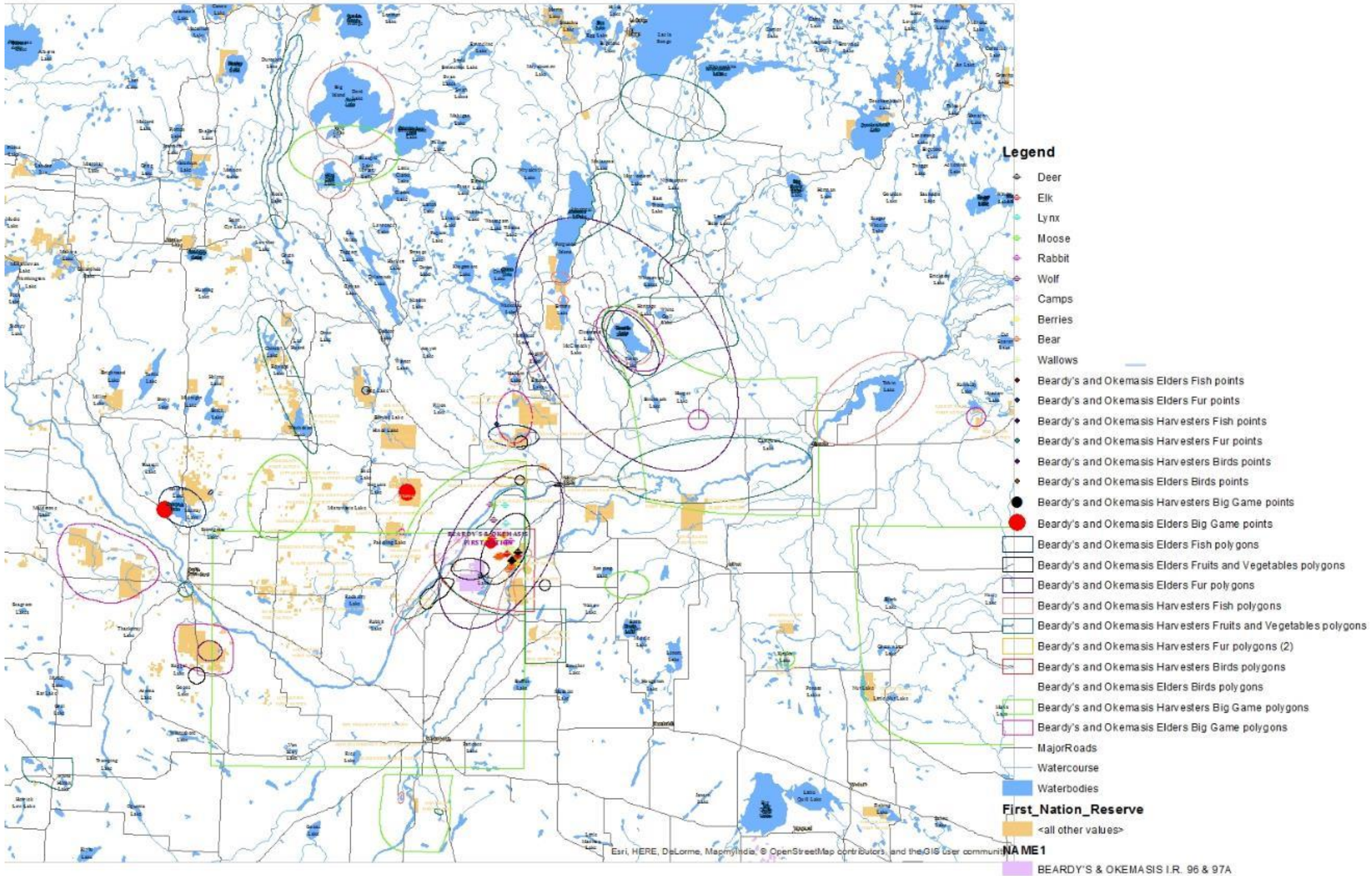


Figure B.1. Enlarged Original GIS Map for Face One, Factual Observations

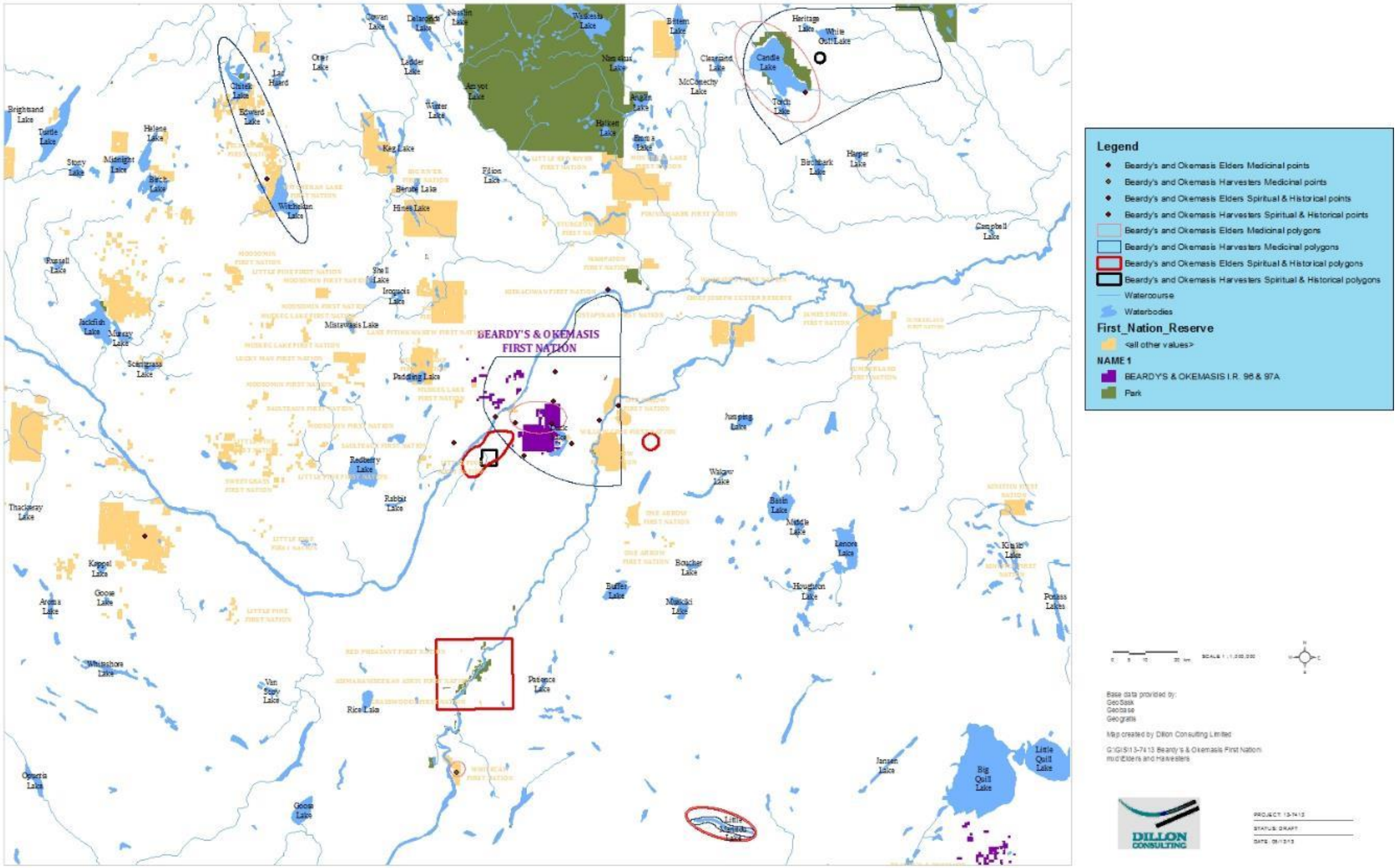


Figure B.2. Enlarged Original Map for Face Three, Past and Current Uses

Factual Observations (Face One, Modified Map)

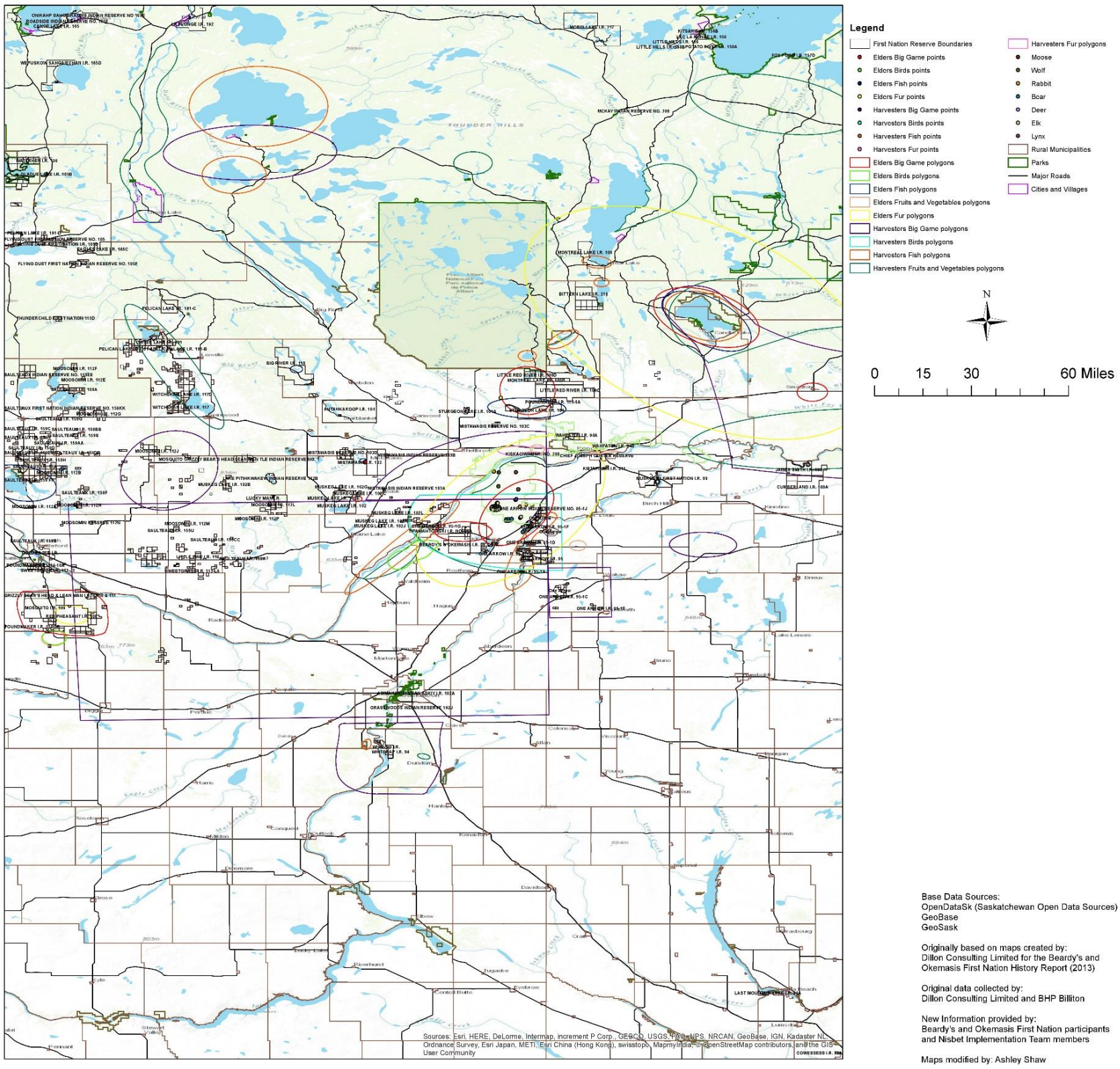


Figure B.3. Enlarged Modified GIS Map of Face One, Factual Observations

Past and Current Uses (Face Three, Modified Map)

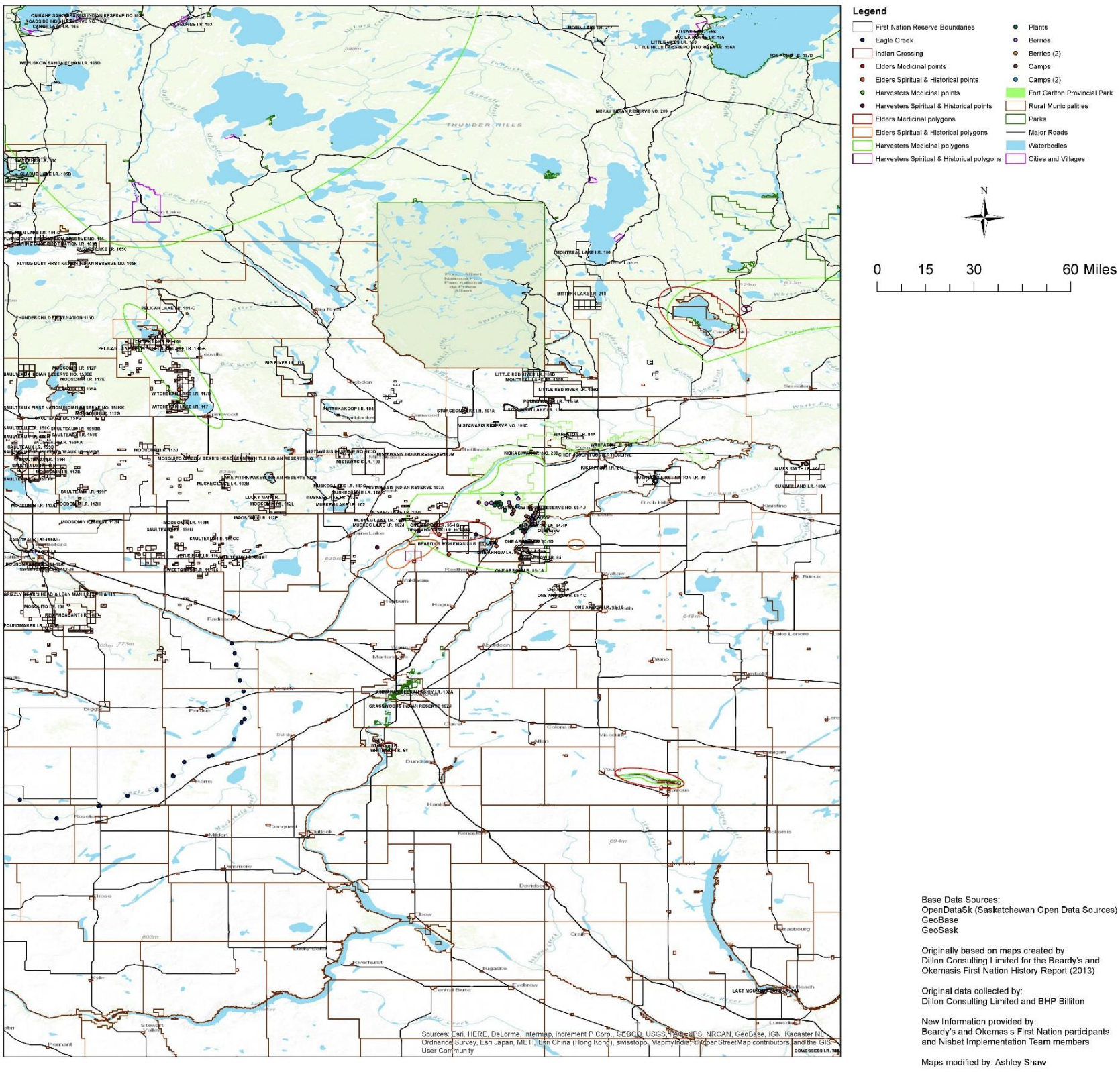


Figure B.4. Enlarged Modified GIS Map of Face Three, Past and Current Uses

Face One – Factual Observations

Factual Observations are primarily characterized by empirical observations, the categorization of discrete environmental entities, and the inter-relationships between species (Houde, 2007). Factual Observations include information such as the migration patterns of animals, hunting and fishing sites, nesting areas for birds, and changes in animal movement patterns (Houde, 2007).

To create the first version of Face One (See above), I transferred the geospatial files, including all mxd and base map files, from the BOFN History Report (2013) and the TEK Cache. This was done by creating new destination folders on my own computer and inputting all geospatial information that was relevant to Face 1 onto one map. This geospatial information included anything relating to hunting and fishing sites for big game, fur bearing animals, birds, and fish. It also included information on spatial movements of animals and spanned the northern most area of the province to the city of Saskatoon. The legend of the map updated automatically. All points and polygons were left the same to preserve the visual integrity of previously collected data. The maps were made visually appealing by changing the color of Beardy's and Okemasis First Nation to purple, changing all major forest areas to a dark green, and by removing the large gray areas representing cities and towns. These changes were made in an attempt to increase readability without comprising the visual integrity of the original information. All credits for Dillon and BHP were kept for both maps and their logo was kept at the bottom of the page, as they were instrumental in funding and developing the Beardy's History Report (2013).

The spatial data in the Face One maps combined large shapes, such as the big red dots indicating "Elder Fur Points," and usually blocked a label or boundary. This blockage made it difficult to situate oneself on the map. The polygons were large and circled large water bodies that naturally led the eye to look at that information and part of the map first. These polygons tended to circle the same water bodies more than once and it was not very clear what that meant. Some information from the history report and TEK cache was depicted as points, as shown below in all four figures. This is because the information provided to make that point was for that precise location. Other data from the BOFN history report (2013) and the TEK cache created polygons. These polygons indicated that the datum source was referring to a wider location that could not be precisely marked by a dot. The shape of these polygons was determined by the

specific GIS coordinates associated with the data provided. This explains why some may look like circles while others may look like ovals. Also, there were no lines provided by either the history report or the TEK cache. Lines would typically be used to indicate major roads on the map. Many of the colors used to describe a specific datum source was automatically reset to a default color. These colors made it hard to differentiate between the different points and polygons.

Additionally, the size of the points and the width of the curves used to make the polygons are hard to see when one is not zoomed in specifically to that area of the map. For example, when zoomed out, the points are clustered together and hard to differentiate. Also, as mentioned above, the legend was downloaded automatically. This legend was condensed, long, and took on the technical names for all of the data, leaving some participants confused. For example, <NAME_1> was included in the legend, indicating a sub-layer in the First Nations Reserve layer file, which labelled the various First Nation reserves located in Saskatchewan. However, including this information in the legend was not necessary. Additionally, this specific layer was colored a pastel yellow, and the labels were also a pastel yellow, making the maps visually unappealing and extremely difficult to read, especially on the paper printouts.

Face Three – Past and Current Uses

Past and current uses are primarily characterized by sites of spiritual significance and medicinal plant sites (Houde 2007). These are environmental entities that do not change locations over time and may adapt to change over time (Houde, 2007).

To create this map (See above), I again transferred all .mxd files and base maps from the Beardy's History Report (2013) and the TEK Cache to a new destination folder on my own computer. Face Three map was created from any information collected on cultural and historical sites and medicinal plant sites. This geospatial information spanned from the northern most part of the province down to Saskatoon. The legend for the map updated automatically. Beardy's and Okemasis First Nation was changed to purple, the large forest areas were changed to dark green, and all large gray blocks representing cities and towns were removed to make the colors more visually appealing. These characteristics relate specifically to both Face One and Face Three maps. Also, I did not use the numbering system in the Beardy's History Report (2013) in which the specific locations of sites were numbered because the numbers added visual clutter to the

map. This point system was consistent with the report's own interview data and was not relevant to my own study. I removed this feature by going to the Table of Contents, right-clicking on the layer feature, and removing the numbered points. All of these changes were made to enhance readability for the interview participants and were intended to be minor improvements that would not compromise the visual integrity of the original data. The credits for Dillon and BHP were kept on both maps and their logo was kept at the bottom of the page as they were instrumental in funding and developing the Beardy's History Report (2013).

Face Three had less information to depict than Face One. This significantly decreased the visual clutter and truncated the legend. That said, many of the critiques mentioned above for Face One applied here as well. There were shapes that obstructed different points that blocked the view of labels and boundaries. There were small points that were very hard to see on a printed map, and the polygon width size was insufficiently large to differentiate between the different colors effectively. Also, the labels provided by the First Nation Reserve layer file were too hard to read due to their extremely light color. However, much of the map was free of clutter, allowing participants to have a better view of the overall extent of Saskatchewan, and many interviewees found it easier to view this map than the Face One map.

Modified Maps

Interviewees identified new spatial information that was applicable to the Face One and Face Three maps. This new spatial information included new migration patterns of animals, one new spiritual site, one new cultural site, and the boundaries for the Nisbet forest and First Nation reserves. All these new data were obtained through the interviewing process when participants were asked if they could provide any new information in relation to the maps that were shown or on any of the other categories provided by Houde's Six Faces of TEK. In the sections below, I use quotations from the interviews as evidence that participants provided my research with new knowledge for both Face One and Face Three.

Modifications to Both Maps

The changes I made to the Face One (See Figure 4.3, p. 63) and Face Three (See Figure 4.4, p. 64) maps were based on the suggestions that emerged in the interviews. New information and any other changes made were influenced by the interviews and are justified by quotations

from different participants who indicated expressed why these changes needed to be made. I implemented new terrain base maps with labels and boundaries for the Nisbet Provincial Forest, Prince Albert, and Indigenous communities in both new maps. These changes made the maps easier to visually comprehend, and many NIT participants suggested or supported the idea of including boundaries for the forest and Indigenous reserves (N1, 2017; N2, 2017; N4, 2017; N10, 2017; N8, 2017; N9, 2017). NIT participants explicitly suggested that "the forest outline…the provincial forest" (N4, 2017) or "the reserve boundary…the forest boundary" (N1, 2017) would be very beneficial to add to the GIS maps. These boundaries would give readers the ability to situate themselves within the region the GIS maps were trying to portray.

I was provided with the boundary shapefiles for the Nisbet Provincial Forest by Mr. Dwayne Rinholm on February 13th, 2017. These base maps provided a few key features for a GIS map and included a labeled foundation to work upon. This foundation included boundaries that surrounded not just the Indigenous communities in Saskatchewan but also the Nisbet Provincial Forest. This foundation directly provided boundaries in the forest that are familiar to all participants to some extent and subsequently allowed the maps to become easier to comprehend. Most of the new spatial information given to me by interviewees was provided verbally, meaning that I had to search online resources to find the geospatial files of this information to add to the maps. Many websites were used. Most commonly I examined data from ArcGIS online, the University of Saskatchewan GIS library, the Saskatchewan Government Ministry of GIS, Canadian GIS, Saskatchewan Open Data Sources, and map services online. It was very difficult to find information about the IK described to me. This difficulty may speak to the need for translating more IK into the form of geospatial information in Saskatchewan.

There were a number of visual and aesthetic issues with the original GIS maps that I and interview participants had identified. For example, the print outs for original map for Face One were too wide and elements of the map, such as the credits or north arrow, did not appear in the physical copies and do not appear on letter sized Microsoft Word© documents. As mentioned in Chapter 3, the maps were also available via computer screen where these elements were visible after scrolling the map to the side. These visual issues were addressed in the modified maps for both Faces. I manually changed the legend to reduce the label length, and I changed the map scale to approximately 17 x 11 inches to make the map larger. I changed the scale, so the

elements of the map would be easier to see and its conversion to an image or pdf would be larger. This made the visual elements more comprehensible and identifiable by the legend. The topography of the map is now more easily spotted and the overall aesthetic of the maps looks a little less complicated. I also switched the page from landscape view to architectural view, allowing the maps to take up more room on the page instead of being scaled down to fit the frame. These changes were made because many interviewees had a difficult time viewing the maps, as they were small both on paper and on screen. By enlarging the map scale size, the readability of the maps increased.

To ensure the maps were easier to visually comprehend and to reduce clutter, I saw that no objects were filled in with color. This ensured large points could be seen and allowed participants to see all labels and boundaries. Many BOFN participants had a difficult time reading some of the labels on the maps, stating that "I can't even see the writing on these [maps]" (B6, 2016). To elaborate, many participants found reading the labels on the original maps to be challenging because they were not showing up clearly, either due to its light color or the small, blurry font sizes. The small points were increased in size, so they could be seen without having to zoom in on the map. Polygon width sizes were increased and changed to vibrant colors, so they could also be seen more easily. I removed shading from the polygons as well to decrease visual clutter. These changes were made because multiple BOFN participants initially expressed having a challenging time situating themselves on the maps. This difficulty was not because of the information but because of the coloring and size of the points and polygons. For example, some BOFN participants stated that the yellow coloring was "really light…we can't see where they [the reserves] are" (B6, 2016). The participants then proceeded to suggest that changing the coloring to black would improve the readability of this information. Other BOFN participants noticed that there "are different colored dots…[but] they all look kind of the same color" (B6, 2016).

The First Nation Reserve layer was static and would not change its color, name, or font size. I had to export this layer and rework its properties. By doing so, I was able to change the color of the labels to black and space these labels out, making them easier to read and identify on the maps. To improve visual comprehension, I also used an outline color instead of shading. These labels were superimposed on one another, making the labels very difficult to read. I

searched online resources for open data sources on First Nation Reserve labels and the necessary shapefiles. This information was provided by the Saskatchewan Government open data sources. Both modified maps now have these labels with the reserves clearly outlined. I manually modified the legend, and I renamed every layer present to reduce the length of the labels. I also ensured that all the data present were color coded. Dillon and BHP were added to the credits, and I placed their logos at the bottom of maps. I added acknowledgements for the BOFN community, NIT, and the University of Saskatchewan because the modified maps were based on a collaborative effort supported by individuals from all of these communities. A scale bar, North arrow, and credit sources were also added to the bottom of these maps.

APPENDIX C

Pilot Interview Modifications

To ensure that the questions being asked were as clear as possible and to minimize ambiguity, I conducted three separate pilot interviews with three Mistawasis community members on October 4, 2016. After the three pilot interviews, changes were made in the specific terminology used in the interview questions. These changes allowed for a more direct and clear explanation as to why I was interested in this information and what this information would be used for. Specifically, terminology was generalized e.g., the term "incorporated" was changed to the phrase "included in" in question 3. The term "empirical" was changed to "physical observations" in question 5, and "sustainable resource use" was changed to "the long-term maintenance of resources" in question 6. Additionally, the term "ethics" was replaced with "morals" in question 8. In addition to carrying out pilot interviews, I also visited Beardy's and Okemasis First Nation for a final review of the interview questions. This meeting was with Mr. Gamble on November 21, 2016.

Table C.1. Interview Questions for BOFN Community Members

Questions for BOFN Community Members *Map 1 = Factual Observations (Face 1), Map 2 = Management systems (Face 2), Map 3= Past and Current uses (Face 3), Map 4 = Ethics and Values (Face 4), Map 5 = Culture and Identity (Face 5), Map 6 = Cosmology (Face 6)*
1) Are you familiar with the Nisbet Integrated Forest Land Use Plan? a. What do you know about it? b. Do you know anyone in your community who has been involved in the IFLUP or, more specifically, the forest management plan (FMP)?
2) If yes to #1: In your opinion, what are the strengths of the FMP? What are its weaknesses?
3) If yes to #1: Do you believe that traditional knowledge from your community has been included in the FMP? a. If so, what kind of knowledge do you think is included in? b. Did you provide any knowledge when the plan was created? If not, do you hold traditional knowledge that you think should be used in how the Nisbet Provincial Forest is managed?
4) If yes to #1: Are you satisfied with how traditional use/ TEK has been represented in this plan?
5) How has the category of **physical observations of wildlife and plants** been depicted?
a. Can you show me on the map?
b. Is this description accurate?
c. Might you add any additional information about wildlife and plants?
6) How has the category of **strategies promoting the long-term maintenance of resources** been depicted?
a. Can you show me on the map?
b. Is this description accurate?
c. Might you add any additional information about strategies promoting the long-term maintenance of resources?
7) How has the category of **past and current uses of the environment, including cultural and historical sites,** been depicted?
a. Can you show me on the map?
b. Is this description accurate?
c. Might you add any additional information about strategies promoting past and current uses of the environment?
8) How has the category representing the **morals and values incorporated within the knowledge of BOFN** been depicted?
a. Can you show me on the map?
b. Is this description accurate?
c. Might you add any additional information about the morals and values within BOFN knowledge?
9) How has the category of **stories, values, and social relationships, which contribute to the culture and identity of BOFN,** been depicted?
a. Can you show me on the map?
b. Is this description accurate?

c. Might you add any additional information about the stories, values, and social relationships contributing to the culture and identity of your community?
10) How has the category of the **beliefs and assumptions regarding the connections between humans and nature** been depicted?
a. Can you show me on the map?
b. Is this description accurate?
c. Might you add any additional information about the beliefs and assumptions related to the inter-relationships between humans and nature?
11) Do you have any recommendations on how to collect more knowledge related to any of the categories?
12) Are these maps easy to understand? Are they a useful tool for you? Why? Why not?
13) Is there any information that I missed that you think needs to be added?
14) Do you have any questions for me?

Table C.2. Interview Questions for NIT Members

Questions for NIT Members *Map 1 = Factual Observations (Face 1), Map 2 = Management systems (Face 2), Map 3= Past and Current uses (Face 3), Map 4 = Ethics and Values (Face 4), Map 5 = Culture and Identity (Face 5), Map 6 = Cosmology (Face 6)*
1) In your opinion, what are the strengths of the Forest Management Plan of the Nisbet Integrated Forest Land Use Plan (IFLUP)? What are its weaknesses?
2) Do you believe that knowledge from the BOFN community has been incorporated into the FMP? a. If so, what kind of knowledge do you think is incorporated? How is this knowledge being incorporated into the FMP? b. If not, are there any reasons why this knowledge hasn't been implemented?
3) Are you satisfied with the knowledge incorporated within the FMP? a. If so, why? b. If not, can you identify where there is room within the FMP to incorporate other forms of knowledge?
4) Do you think other forms of knowledge would be useful in forest management and planning? Why or why not?
5) Is the information represented in Maps 1 - 6 easy to understand?
a. If so, please identify which ones were easy to understand and why? Is the language used within the map understandable?
b. If not, please identify which ones were easy to understand and why?
6) Compared to the previous maps used in the IFLUP, do these new maps influence how you think about the management decisions made in the FMP? a. How do they influence how you think about management decisions? b. If so, in what direction? c. If not, why?
7) In your opinion, can any of these maps be implemented within the FMP?
8) Can you identify any barriers that may arise by using these maps or this kind of knowledge in the FMP?
9) Can you identify any opportunities that may arise by using these maps or this kind of knowledge in the FMP?
10) Is there any information that I missed that you think needs to be added?
11) Do you have any questions for me?

Criteria for Participation

Criteria for participation in the study were different for BOFN and NIT members. It was key to ensure that the information gathered during the interview process represented valid IK of the BOFN community. The criteria for BOFN participants were as follows: first, participants must be recognized Elders or IK holders as well as individuals with expertise in Western Scientific Knowledge (WSK) or similar knowledge systems; second, they needed to be BOFN community members; finally, they needed to be familiar with the IFLUP and/or the forest management section, as well as land use planning and/or natural resource use in the Nisbet Provincial Forest. Although not a criterion for selection, spending extended time – more than one month – in the forest was considered an asset. Criteria for participation by NIT member were as follows: first, participants needed to be a member of the NIT; second, they needed to have some familiarity of the FMP within the IFLUP; finally, they needed to be familiar with land use planning and/or natural resource use within the Nisbet Provincial Forest.

Table C.3. Participant Demographics

BOFN Participants		
Date	**Community Member or Elder**	**Interview or Group Interview**
01/12/2016	Community Member	Interview
05/12/2016	Community Member	Interview
	Elder	Interview
06/12/2016	Elder	Interview
	Elder	Group Interview 1
	Elder	Group Interview 1
	Elder	Group Interview 1
06/12/2016 AND 08/03/2017	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
	Elder	Group Interview 2 & 4
10/12/2016	Community Member	Interview
12/12/2016	Community Member	Interview
	Community Member	Interview
	Community Member	Interview
16/12/2016	Elder	Group Interview 3
	Elder	Group Interview 3

NIT Participants	
Date	**Interview or Group Interview**
23/01/2017	Group Interview
	Group Interview
25/01/2017	Interview
	Interview
	Interview
31/01/2017	Interview
	Interview
03/03/2017	Interview
09/03/2017	Interview
	Interview

Ethics Considerations and Documents

One of the stipulations set by the Ethics Board at the University of Saskatchewan was that to identify all BOFN interview participants, I was to work through Mr. Alfred Gamble, former GIS specialist of the BOFN band office. This requirement was reasonable as Mr. Gamble had a consistent and strong bond with the BOFN community and its members. Mr. Gamble was also employed as the Indigenous Mentor in Residence in the School of Environment and Sustainability (SENS) at the time. Therefore, all BOFN participants, at the requirement of the Ethics Board, were chosen through the filter of Mr. Gamble. I also worked briefly with a BOFN community coordinator, Ms. Joanne Cameron. Both Mr. Gamble and Ms. Cameron used the criteria to help select individuals who could best answer the interview questions and critique the GIS maps provided. Due to other employment opportunities that had emerged, Ms. Cameron unfortunately stepped down from being the community coordinator at the end of November 2016. As a result, I worked with Mr. Gamble and independently to finalize the interviewees for the research. The work I did independently did not violate the Ethics Board's direction because Mr. Gamble was involved in all decision making regarding BOFN interview participants and was foundational in providing communication and locations for contact with said participants. I received ethics approval on September 30, 2016.

APPENDIX D

Table D.1. Site Visits

Name and Location	**Date**
BOFN Community Garden, BOFN	27/06/2016
BOFN Community Garden, BOFN	26/07/2016
BOFN Community Garden, BOFN	12/08/2016
NIT Meeting, Prince Albert	20/1/2016
NIT Meeting, Prince Albert	08/02/2016
NIT Meeting, Prince Albert	20/06/2016
NIT Meeting, Prince Albert	10/12/2016
NIT Meeting, Prince Albert	06/06/2017
BOFN Transcript Release, Duck Lake and BOFN Reserve Land	24/02/2017
BOFN Transcript Release AND Secondary Interview, BOFN Reserve Land	08/03/2017
BOFN Transcript Release, BOFN Band Office	13/03/2017
BOFN Transcript Release, Duck Lake and BOFN Band Office	21/03/2017
BOFN Transcript Release, BOFN Band Office	22/03/2017
BOFN Transcript Release, BOFN Band Office and BOFN Health Center	30/03/2017
BOFN Transcript Release, BOFN Reserve Land	04/04/2017
BOFN Transcript Release, BOFN Band Office	06/04/2017
BOFN Transcript Release, BOFN Reserve Land	11/04/2017
BOFN Transcript Release, BOFN Band Office	25/04/2017
BOFN Transcript Release, BOFN Band Office	27/04/2017
BOFN Transcript Release, BOFN Band Office and BOFN High School	05/05/2017
NIT Transcript Release, Duck Lake and Prince Albert	05/07/2017

APPENDIX E

Table E.1. Inductive and Deductive Themes

BOFN	
Inductive Themes	**Deductive Themes**
• *Trust Issues* • *The Potential for Reconciliation* • *Demand for Increased Knowledge Dissemination*	• *Limited Access to Resources within the Nisbet Provincial Forest and FMP*
NIT	
Inductive Themes	**Deductive Themes**
• *Increased Knowledge Dissemination, Knowledge Inclusion, and Engagement* • *Catalyst for Participation* • *Interest in IK Inclusion* • *Difficulty of Creating a Shared Process* • *Rigid Description Criteria and Preference for Data Specificity*	• *Limited Resources and Avenues* • *Decreased IK Reliance* • *Overlap of Resource Use* • *Trust Issues* • *Legal Constraints*