

DIVERSE ECOLOGICAL EPISTEMOLOGIES AND ADAPTIVE CO-
MANAGEMENT: LEECH LAKE DIVISION OF RESOURCE MANAGEMENT
AND CHIPPEWA NATIONAL FOREST

A Thesis
SUBMITTED TO THE FACULTY OF
THE UNIVERSITY OF MINNESOTA
BY

John A Bussey

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

Advisor: Mae A Davenport

June 2013

ACKNOWLEDGEMENTS

I owe an enormous debt of gratitude to the numerous individuals that made this report possible.

First and foremost I would like to thank Mae Davenport, my advisor. The energy, guidance, resources, and opportunities that you have provided have been fundamental in my development as a researcher and student. I count myself extremely privileged to have been able to study with you.

Thank you also to my graduate committee: Kristen Nelson, Pam Jakes, and Clint Carroll. Each of you has contributed uniquely to the research process that this document reports upon. Your input has been instrumental and your enthusiasm for this work has provided continual encouragement.

Thank you as well to Amanda Sames, my fellow research assistant and collaborator on this project. I'm in debt to you not only for your work on this project but also for your guidance throughout my experience here in graduate school.

Thanks also to Marla Emery of the USDA Forest Service and to Shirley Nordrum of the Leech Lake Tribal College. You have both been essential in making this work happen and in grounding it in respect and utility.

I have great appreciation also for the staff of the Leech Lake Division of Resource Management and of Chippewa National Forest. You welcomed Amanda, Mae, and me with graciousness and flexibility. I have tried my best to honestly tell your stories and I sincerely hope that this product, and the others that emerge from this research, more than adequately repays your hospitality.

Thanks, too, to Amit Pradhananga, Bjorn Olson, Vanessa Perry, Paula Guetter, and Christine Yaeger, who together make up the rest of Team Davenport. It's been a pleasure to work in such a creative, dedicated, and fun environment.

Last but far from least, to my friends and family who have encouraged me through the past two years, thank you. Everything I have done has depended on your support.

ABSTRACT

Around the world a trend has begun toward greater engagement of local, cultural, and traditional knowledge in the collaborative management of natural resources. In the United States one of the ways this trend has manifested itself has been through greater empowerment of traditional ecological knowledge generated and held by Native American communities. One particularly exemplary case of this trend involves the Leech Lake Band of Minnesota Chippewa, or the Leech Lake Band of Ojibwe.

The management jurisdictions of the Leech Lake Band of Ojibwe Division of Resource Management and the USDA Forest Service Chippewa National Forest overlap significantly; together they are responsible for a patchwork of forest and water in north-central Minnesota of over 1000 square miles. Between the two organizations interagency tension has been a consistent theme, despite periods and management activities characterized by significant, positive collaboration.

One driver of both interagency conflict and coordination has been the two agencies' engagement of distinct types of ecological knowledge: traditional ecological knowledge (TEK) and western scientific ecological knowledge (WSEK). The utilization of these two ways of understanding the non-human world has both enriched the management of their jointly controlled forest and served to exacerbate conflict between the organizations. This report focuses on the characteristics of these two distinct ecological epistemologies and the dynamics

between them, paying special attention to the ways in which they manifest themselves in forest management.

This is a study in the grounded theory tradition; it reports on 23 in-depth, semi-structured interviews of staff representing both agencies seeking to faithfully tell their stories and represent their perspectives. Key findings include that WSEK and TEK provide cohesive lenses through which to understand the forest, that both TEK and WSEK partially consist of influential worldviews, that both TEK and WSEK are perceived to have significant limitations, and that individuals possess the capability to move back and forth between the two ecological epistemologies. These findings inform both theory and management practice related to the role that ecological epistemologies play in the intercultural cooperative management of natural resources.

TABLE OF CONTENTS

Acknowledgements	i
Abstract	ii
List of Tables	iv
List of Figures	v
Body	
Chapter 1 Introduction	1
Chapter 2 Literature Review	7
Chapter 3 Study Methodology	19
Chapter 4 Ecological Epistemology in Intercultural Environmental Collaborative Management	37
Chapter 5 Discussion	74
References	80
Appendices	88
Appendix A – Map of Leech Lake Indian Reservation and Chippewa National Forest	
Appendix B – Full Project Description	
Appendix C – Abridged Project Description	
Appendix D – Email Recruitment Script	
Appendix E – Interview Guide	
Appendix F – Interview Consent Form	
Appendix G – Interview Background Information Form	
Appendix H – Request for Input Email	

LIST OF TABLES

Table 1: Key information: Leech Lake Indian Reservation	22
Table 2: Key information: Chippewa National Forest	24
Table 3: General research timeline	27
Table 4: Participant profiles	29
Table 5: Participant profiles	49
Table 6: Example Interview Questions	50
Table 7: Knowledge generation and content	59
Table 8: The limits of TEK and WSEK	60

LIST OF FIGURES

Figure 1: Model of traditional ecological knowledge generation and content (Berkes 1999)	9
Figure 2: Model of the relationship between TEK and WSEK (Barnhardt & Kawagely 2005)	10
Figure 3: Map of Leech Lake Indian Reservation and Chippewa National Forest	20
Figure 4: Model of traditional ecological knowledge (Berkes 1999)	42
Figure 5: Selected themes of Barnhardt and Kawagely (2005) model	44
Figure 6: Individual knowledge integration	70
Figure 7: A fifth level for Berkes' (1999) model	71

CHAPTER ONE

INTRODUCTION

In both the United States and elsewhere, a general trend toward greater empowerment of local stakeholders in natural resource and environmental decision-making has begun, reversing centuries of greater control of environmental decisions by non-local governments. The incorporation of local communities in natural resource management is taking numerous forms: the engagement of commercial fishermen in fish stock management task forces in British Columbia (Pinkerton 1999), the devolution of the power to monitor and adjust stream flow levels to riverside communities in Thailand (Baird 2005), or the cooperative management of wetlands by local and regional authorities in Sweden (Hahn et al. 2006).

The recognition of local, culturally sensitive knowledge as a source of information, wisdom, and direction for resource management systems is purported to be desirable for numerous distinct reasons. Griggs (1999) describes several of these reasons: (1) the empowerment of local knowledge could become a global organizing paradigm for environmental sustainability; (2) durable environmental policies must be sustained by local people and they are more likely to do so if they have a hand in creating them; (3) numerous potential conflict drivers are minimized through local environmental management; (4) cultural knowledge is local knowledge, which is the best kind for locally appropriate management; (5) colonial and neocolonial knowledge systems have led to incredible environmental damage and alternatives should be seriously

considered; (6) traditional, cultural knowledge inherently takes into account and respects socioecological dynamics; (7) cultural knowledge is inherently to be treasured.

One subset of local, cultural ecological knowledge is that knowledge, information, and wisdom generated and utilized by indigenous communities. These knowledge systems, or epistemologies, built by indigenous communities to explain and understand the world have been called traditional ecological knowledge, traditional local ecological knowledge, indigenous knowledge, and indigenous wisdom, along with several other permutations by authors and researchers who wish to stress a certain aspect, strength, or limitation. For the purposes of this report the term traditional ecological knowledge (TEK) will be used, primarily as it relatively general and widely accepted.

While similar in many ways to other forms of local environmental knowledge, TEK is of interest to researchers and managers because it is, in many ways, the most local epistemology. Common to many types of local ecological knowledge, and less common in non-local ecological knowledge, is respect for personal experiences with the non-human world, frequent observation of environmental phenomena, social institutions linked to environmental processes, and ecologically informed values or spiritual perspectives. Imagine the fisherman who has trolled the same three ocean bays at four in the morning six days a week for the last 30 years or the mountaineer who has camped in every type of weather at the base of the Grand Teton for 20 seasons. TEK has similar characteristics but often goes even further. TEK not only values personal

ecological experience but respects generations of oral histories of personal experience in a specific area. Not only does TEK consist of values and social institutions connected to ecological processes, but some indigenous groups have for centuries maintained spiritual traditions that are directly based on local environmental experience.

Despite the potential for more pragmatic and more just natural resource management through engagement with traditional ecological epistemologies, several challenges exist. Principal among these challenges are that environmental decisions are frequently the subjects of collaboration; ecological policy is created and implemented not by one or two individuals but by groups of agencies working together. This dynamic, often referred to as collaborative management (or co-management), can be characterized by significant, complex social, cultural, economic, political, and spiritual barriers (Jacobson et al. 2006).

In the United States, nowhere are the opportunities for the engagement of TEK greater and the challenges of co-management more significant than on and near Native American reservations. In many of those places American Indian groups continue to generate, utilize and cherish TEK - knowledge, information, processes, and wisdom about humans and the natural world that is significantly different than that which is brought to the table in the conference rooms of many federal and state resource management agencies. Tragically, many American Indian reservations are also economically, socially, and politically depressed places; poverty rates on many reservations are extraordinarily high, Native Americans on reservations are at a higher risk for alcohol and substance

dependence than any other demographic group in the country, and educational opportunities for youth and adults are lacking for many tribal members on reservations (Miller 2012).

The project on which this thesis reports was designed to explore the intercultural collaborative management of natural resources. To do so, it has focused on one co-management arrangement: that between the Leech Lake Band of Ojibwe Division of Resource Management and the USDA Forest Service Chippewa National Forest. As will be described in depth later in this report, these two organizations are together responsible for more than one thousand square miles of forests and waterways in north central Minnesota. Their relationship constitutes a unique case; the type of relationship that exists between them is common to many other entities around the United States but the degree to which their management activities overlap is rare. Thus their co-management arrangement constitutes a case study whose examination informs both theory and management practice related to the intercultural cooperative management of natural resources.

Specifically, this project investigates six related research questions.

1. How do tribal and non-tribal resource managers describe their relationship with the forest?
2. What are tribal and non-tribal resource managers' knowledge and perceptions of ecological change on the forest?
3. How do tribal and non-tribal resource managers define successful forest

management?

4. What are tribal and non-tribal resource managers' perceptions of one another's resource management approaches, and what informs those perceptions?
5. What co-management strategies are being used to address ecological change in areas where tribal and non-tribal jurisdictions overlap, and how successful have these strategies been?
6. What do tribal and non-tribal resource managers need to enhance adaptive co-management of the forest?

This paper addresses these six research questions by focusing on dynamics that exist related to the various ecological epistemologies held by staff of the Leech Lake Division of Resource Management and Chippewa National Forest. This approach is taken because, through the research process, the ways in which knowledge is generated and the information, knowledge, values, and narratives held by individuals within both organizations were identified as critical to understanding intra- and inter-organizational relationships, forest management goals, activities, and strategies, perceptions of ecological change, collaborative management processes, and several other dynamics of interest.

Following this introduction, a review of the relevant academic literature is presented. The literature review focuses principally on the existing body of knowledge associated with TEK and WSEK and the challenges and opportunities associated with cooperative management. Chapter three reports on study

methods by giving an introduction to the Leech Lake Division of Resource Management and Chippewa National Forest, a summary of data collection and analysis procedures, and a presentation of the study's key limitations. Chapter four is presented as a stand-alone research article reporting on one particular grouping of study findings. It describes the knowledge and information unique to TEK and unique to WSEK that is utilized in the management of Chippewa National Forest and the Leech Lake Indian Reservation, the perceived limitations of each of these ecological epistemologies, and the ways in which individual resource managers draw upon both WSEK and TEK. The final chapter presents a discussion of the project overall, examines management implications, and suggests direction for future research.

CHAPTER TWO

LITERATURE REVIEW

Traditional Ecological Knowledge

The characteristics and sources of traditional ecological knowledge have, in the past fifteen years, received significant academic attention. Berkes (1999) offers one definition of TEK that has been widely cited and built upon: “Traditional ecological knowledge is a 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” (p. 7) Importantly, this definition can be broken down into two parts: TEK is defined both by mode of production and dissemination (“evolving by...cultural transmission”) and also by subject and type (“cumulative body of knowledge, practice and belief; about the...with their environment”).

The production and dissemination of TEK requires time and local experience and permits no substitute for these elements (Berkes & Turner 2006, Barnhardt & Kawagely 2005). It moves from generation to generation by oral history, demonstration, and continuity of practice (Barnhardt & Kawagely 2005, Deloria Jr. 2004). Despite this long-term orientation of TEK generation, or perhaps because of it, knowledge of specific disturbances, their causes, and their effects can be generated quickly by comparing current experience to historical observation (Parlee, Berkes, & Teetl’it Gwich’in Renewable Resources Council 2006). Finally, TEK often has strong ties to societal practices and thus is

culturally perpetuated, linking TEK to broad community involvement (Barnhardt & Kawagely 2005, Murray, Wieckowski, Hurlburt, Soto, & Johnnie 2011).

Regarding the latter half of his definition, that TEK consists of and is about certain subjects, Berkes (1999) proposes a model, positing that TEK can be conceptualized as consisting of four types of knowledge. These types can be represented by concentric ellipses with the centermost being the most tangible and the outermost the most nebulous yet pervasive. From the center outward his four categories are: (1) local knowledge of animals and land (2) land and resource management systems, (3) social institutions, and (4) worldview. That many (though not all) North American indigenous groups possess an understanding of holistic ecosystem dynamics (Medin, Ross, Cox, & Atran 2006, Ross, Medin, & Cox 2007), have developed effective environmental management systems (Trosper 2007, Murray et al. 2011), maintain ecological connections in many social institutions (Murray et al. 2011, King 2004), and view humans' relation to the non-human world in a less anthropocentric manner than many non-native Americans (Hart 2010, Krech III 1999, LaDuke 2005) is well documented, adding credibility to Berkes' model.

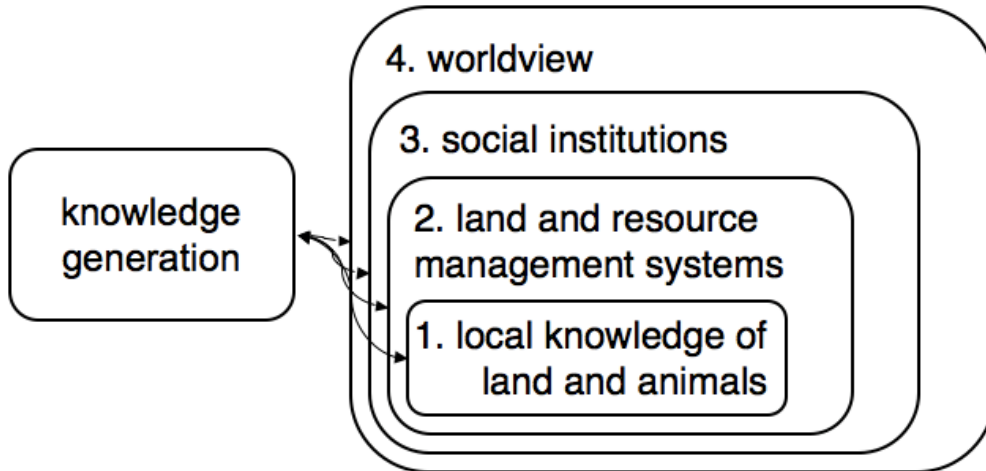


Figure 1: Model of traditional ecological knowledge generation and content (Berkes 1999)

TEK is particularly interesting as an alternative to WSEK. Though WSEK, like TEK, can be conceptualized as knowledge that is generated in certain ways and is about certain things there are significant differences between the two knowledge systems. In contrast to the generally holistic, integrated, and spiritual environmental worldview described as TEK, some have described WSEK as anthropocentric, atomistic, and aspiritual (Callicott & Nelson 2004, Deloria Jr. 2003, LaDuke 1999). As expressed in these terms it is hard to escape the sentiment that TEK is, in some important way, better than WSEK. However, in recent years concentration has shifted away from the discussions of better or worse and concentrated instead on less value laden similarities and differences. Distinguishing between TEK and WSEK in this manner accepts that both environmental worldviews provide a lens through which legitimate ecological knowledge can be gained and that both modes of thought have strengths and weaknesses (Barnhardt & Kawagely 2005, Ross et al. 2007, Murray, Neis, &

Johnson 2006, Murray et al. 2011). Barnhardt and Kawagely (2005) present TEK and WSEK as alternatives that share much in common while diverging in important ways.

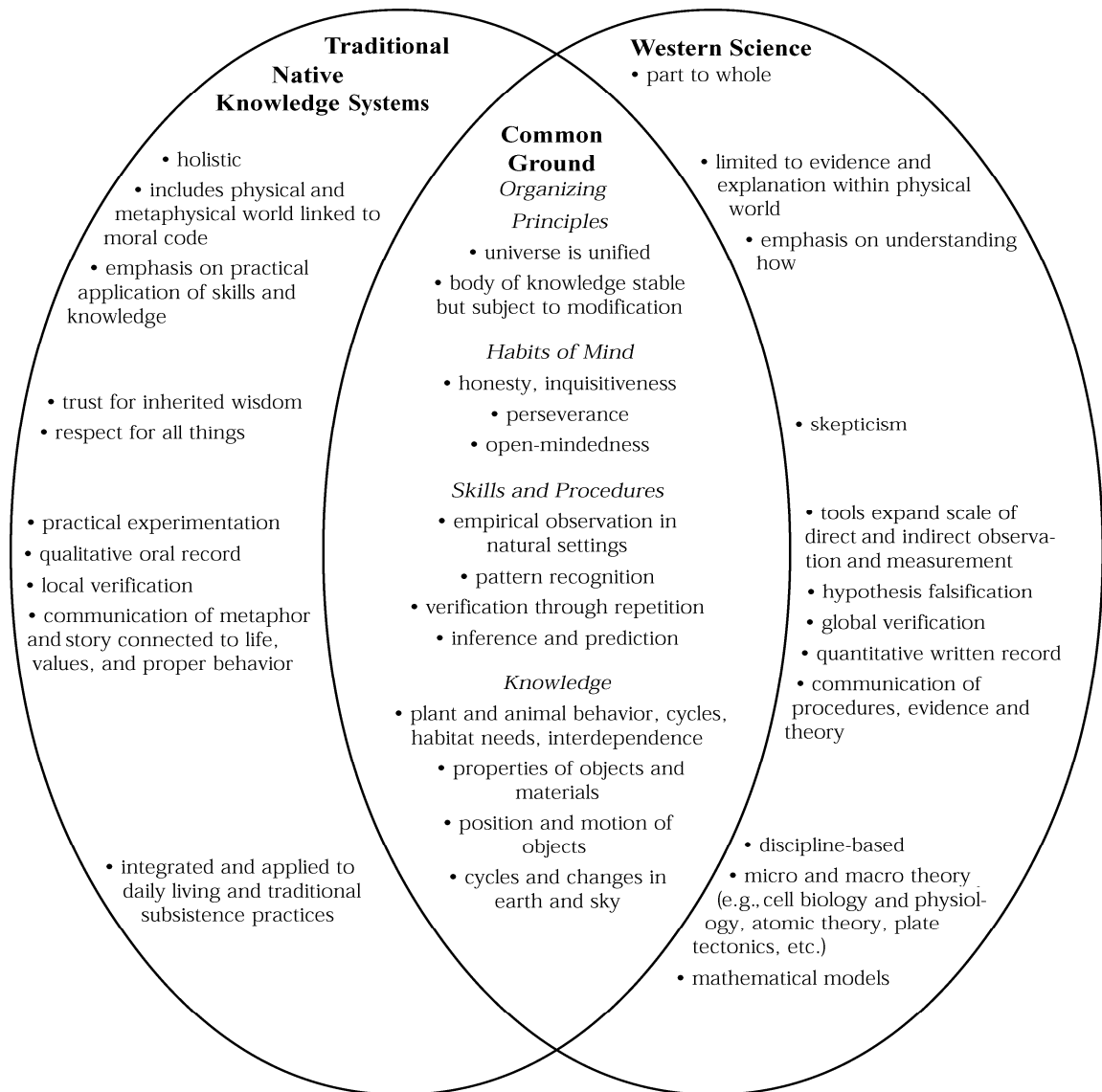


Figure 2: Model of the relationship between TEK and WSEK (Barnhardt & Kawagely 2005)

One particular dynamic related to TEK and WSEK that has attracted attention has been the relationship between environmental worldview and

adaptation/response to environmental disturbance. In what ways do possession of TEK or WSEK relate differently to an individual or community's ability to respond to ecological change? Several authors posit that a mindset that privileges TEK bears some distinct advantages in relation to ecological disturbance. The immediacy with which TEK is generated regarding local, specific environmental disturbances (Trosper 2007, Parlee et al. 2006), the privileging of holistic/ecosystem level thought (Trosper 2007, Callicott & Nelson 2004, LaDuke 2005, Murray et al. 2006), and the community involvement entailed in TEK dissemination (Parlee et al. 2006) are all acknowledged as response-relevant characteristics unique to TEK.

On the opposite hand, other authors (and some of the same ones) suggest ways in which a primarily WSEK mindset enables individuals and communities to deal most effectively with environmental change. These mechanisms and characteristics include the emphasis on rigorous research design (Krech III 2005, Murray et al. 2011), the peer review process (Krech III 2005, Hart 2010), the global scope of knowledge generation (Murray et al. 2006), and the isolation of disciplines that separates science from religion (Krech III 2005).

Suffice it to say that most authors (though not all, see Deloria 1999) who have written recently on the relationship between TEK, WSEK and adaptation to change acknowledge that each environmental worldview brings different tools to the table (Murray et al. 2006, Krech III 2005, Lewis 2010, Hart 2010). The process of utilizing these various tools, however, needs to be well thought out.

Nadasdy (1999) asserts that TEK should not simply be a new data source to be drawn upon by resource managers who use predominantly WSEK-based approaches. Integration of that sort does not benefit from the depth of wisdom and experience that exists with traditional epistemologies and concentrates power in the hands of non-traditional resource managers. Extraction of traditional knowledge of this sort is a political action and, rather than a positive step toward the union of diverse knowledge traditions, is seen by many as a continuation of political dominance and cultural exploitation (Nadasdy 1999, Natcher et al. 2005)

Co-management and adaptive co-management

That TEK and WSEK can contribute uniquely to effective ecological management is one reason that researchers and practitioners alike have become increasingly interested in collaborative management of natural resources. Definitions of co-management vary, this is inevitable given the plethora of co-management schemes in existence, but they generally have three key points. First, co-management arrangements exist concerning natural resources that are valuable to two or more stakeholder groups (Berkes 1991, Plummer & Fitzgibbon 2004). Commonly these are resources that are inherently difficult to divide such as fish stocks or wildlife, that have multiple uses such as forests and waterways, or confound clear management delineation such as large ecosystems. Second, co-management describes relationships in which rights and responsibilities are shared between distinct cultural groups or organizational levels (Plummer & Fitzgibbon 2004, Berkes 1991). Typical co-management schemes may involve federal governmental agencies, local governmental agencies, stakeholder

associations, and indigenous groups. Importantly, rights and responsibilities typically vary between co-managing partners based on the characteristics and skills of each entity (Zimmerer 2000, Castro & Nielsen 2001). Finally, co-management schemes are often adaptive in nature; they are frequently designed to be iterative, structured, and learning-focused in order to achieve the best possible long-term results (Berkes 2007).

As previously mentioned, that the inclusion of both TEK and WSEK (and non-traditional local environmental knowledge) allows more knowledge to be incorporated into resource management decisions is one attraction of co-management; several others exist and three are highlighted here. Importantly, acknowledging the rights of and devolving responsibility to local groups, particularly those that have been historically disenfranchised, can help in healing the wounds of cultural conflict (Griggs 1999, Campese & Borrini-Feyerabend 2011, Barnhart 2011). This aspect of co-management is particularly significant in management relationships that involve historically disenfranchised tribal groups and pertain to traditionally significant resources. Secondly, it is possible that co-management may be more cost-effective than top-down, single manager approaches. Though not all agree with this point, those who posit that co-management is more cost efficient than its alternatives point to long term savings related to compliance and enforcement (Plummer & Fitzgibbon 2004, Pinkerton 1999). Finally, several argue that co-management may promote more durable solutions to resource management problems, particularly as it tends to produce solutions that are more sensitive to local cultural norms (Griggs 1999, Plummer &

Fitzgibbon 2004). Griggs (1999, p. 3) writes, “Any policy of sustainability must be maintained by the local people. Local culture is more significant to environmental sustainability than written laws and distant bureaucrats.”

Unfortunately, significant barriers exist that inhibit the effective operation of co-management arrangements. Jacobson et al. (2006), based on a metastudy of 44 articles, suggest a framework for barriers to general collaborative management that includes six groupings: logistical (e.g., goals, money, time...), communication (e.g., teamwork, stakeholder support, clarity...), attitudinal (e.g., perspectives on data, fear of change, misunderstanding of needs...), institutional (e.g., agency culture, low flexibility, near-term time frame...), conceptual (e.g., lack of systems view, inadequate information, complex information...), and educational (e.g., lack of scientific knowledge, lack of management training...).

With the involvement of multiple cultures many barriers noted by Jacobson et al. (2006), such as differing goals and perspectives on time, become more pronounced while new ones emerge. For instance, worldview differences may lead to vastly different understandings of particular management alternatives as culturally discordant individuals privilege different sources of knowledge (Atran, Medin, & Ross 2006, Medin et al. 2006, King 2004, Barnhardt & Kawagely 2005, Bengston 2004). Research also suggests that bias and racial stereotyping, both conscious and unconscious, on the part of planning professionals and other stakeholders may confound cross-cultural understanding (Beebeejaun 2006, Bengston 2004). Lack of intercultural trust is another prominent barrier, particularly in the context of a negative historical relationship, (LaFever 2008,

Debebe 2008, Hahn, Olsson, Folke, Johansson 2006, and Leach 2011).

Relevant models and frameworks

As noted earlier, over the past two decades our understanding of the role of TEK in natural resource management has grown significantly. This growth has been due to research done by resource managers, social scientists, historians, anthropologists and other thinkers from all cultures. One result of this rising interest has been the proliferation of models and frameworks related to various components and functions of TEK and ACM. The final paragraphs of this review present a sample of currently prominent models related to these themes, several of which have already been introduced while others appear here for the first time in this review.

As defined by Berkes (1999), TEK is characterized by its mechanisms of generation and dissemination and by its subject and type. Berkes and Turner (2006) and Barnhardt and Kawagely (2005) provide succinct models for these characteristics respectively. Berkes and Turner (2006) posit that TEK generation can be understood either through the depletion crisis model or the ecological understanding model. According to the former, knowledge related to conservation is acquired through trial and error. It describes overexploitation and subsequent resource deficits as the primary teacher; human groups that exist in equilibrium with key natural resources understand the importance of doing so only because they know the consequences of reckless consumption. According to the ecological understanding model “the elaboration of environmental

knowledge by a group [leads] to increasingly more sophisticated understanding of the ecosystem in which they dwell” (p. 482).

Regarding the subject and type of TEK, Barnhardt and Kawagely (2005) provide a model that compares and contrasts the key characteristics of TEK and WSEK. It combines their experience with Alaskan Native knowledge systems with existing literature on the subject. Their model is a Venn diagram that illustrates those areas in which TEK and WSEK diverge and those in which they overlap with regard to four central themes: organizing principles, habits of mind, skills and procedures, and knowledge (Figure 2).

Plummer and Fitzgibbon (2004) and Jacobson et al (2006) offer summary models of various dynamics of collaborative natural resource decision-making. Plummer and Fitzgibbon depict co-management as a set of three components, connected via a linking mechanism, and existing within a context. More specifically, the three components are described as “antecedents or preconditions”, “characteristics”, and “outcomes” and the linking mechanism is described as “collaboration as an emergent inter-organizational process” (p. 879). The context in which these components and linkages exist consists of “characteristics of the resource”, “property rights regime”, and “claim of property rights” (p. 879). Though this model is useful in theory, it offers little practical direction to resource management professionals. Jacobson et al (2006) builds upon the model created by Plummer and Fitzgibbon (2004) to create a typology of barriers to collaborative management.

Jacobson et al (2006) performed a metastudy of 44 case studies of resource management through a collaborative management framework. From their study they constructed a framework of six families of barriers: logistical (e.g., goals, money, time), communication (e.g., teamwork, stakeholder support, clarity), attitudinal (e.g., perspectives on data, fear of change, misunderstanding of needs), institutional (e.g., agency culture, low flexibility, near-term time frame), conceptual (e.g., lack of systems view, inadequate information, complex information), and educational (e.g., lack of scientific knowledge, lack of management training).

One final model relevant as background to this study is that provided by Ross et al (2011). The indigenous stewardship model describes the ideal resource management relationship between indigenous communities and non-tribal resource managers. The model consists of four categories consisting of eleven total elements: Active indigenous stewardship on tribally controlled land (indigenous ecology, subsistence lifestyle access, promoting economic self-sufficiency, connections to the land), community outreach to support indigenous stewardship (indigenous ethnobotany, community input, indigenous pedagogy), co-management (validation of indigenous knowledge systems, strategies for genuine collaboration), and consensus building and conflict management (indigenous decision-making process, indigenous decision-making collaboration). These elements interact with one another, facilitating indigenous stewardship of natural resources specifically on tribally controlled lands.

All of these models illuminate some aspect of the relationship between TEK and collaborative management: Berkes and Turner (2006) describe mechanisms of TEK generation, Barnhardt and Kawagely provide a useful framework for understanding TEK with regard to WSEK; Plummer and Fitzgibbon (2004) suggest a theoretical model for co-management; Jacobson et al (2006) present a typology of barriers to adaptive management; and Ross et al (2011) present their ideal description of collaboration for indigenous resource management. Together these models offer insight into the relationships between TEK and collaborative management; they set the stage for this study.

CHAPTER THREE

STUDY METHODOLOGY

Study Area

This project focuses on the relationship between the Leech Lake Band of Ojibwe Division of Resource Management (LLDRM) and the USDA Forest Service Chippewa National Forest (CNF). These two entities are of interest because they generate and act upon distinct types of knowledge, they communicate with one another on a regular basis, their jurisdictions overlap significantly, and their relational history is characterized by both collaboration and tension. Importantly, these two entities are similar in management structure. Both are hierarchical bureaucracies that are made up of numerous departments and consist of large, diverse staff bodies

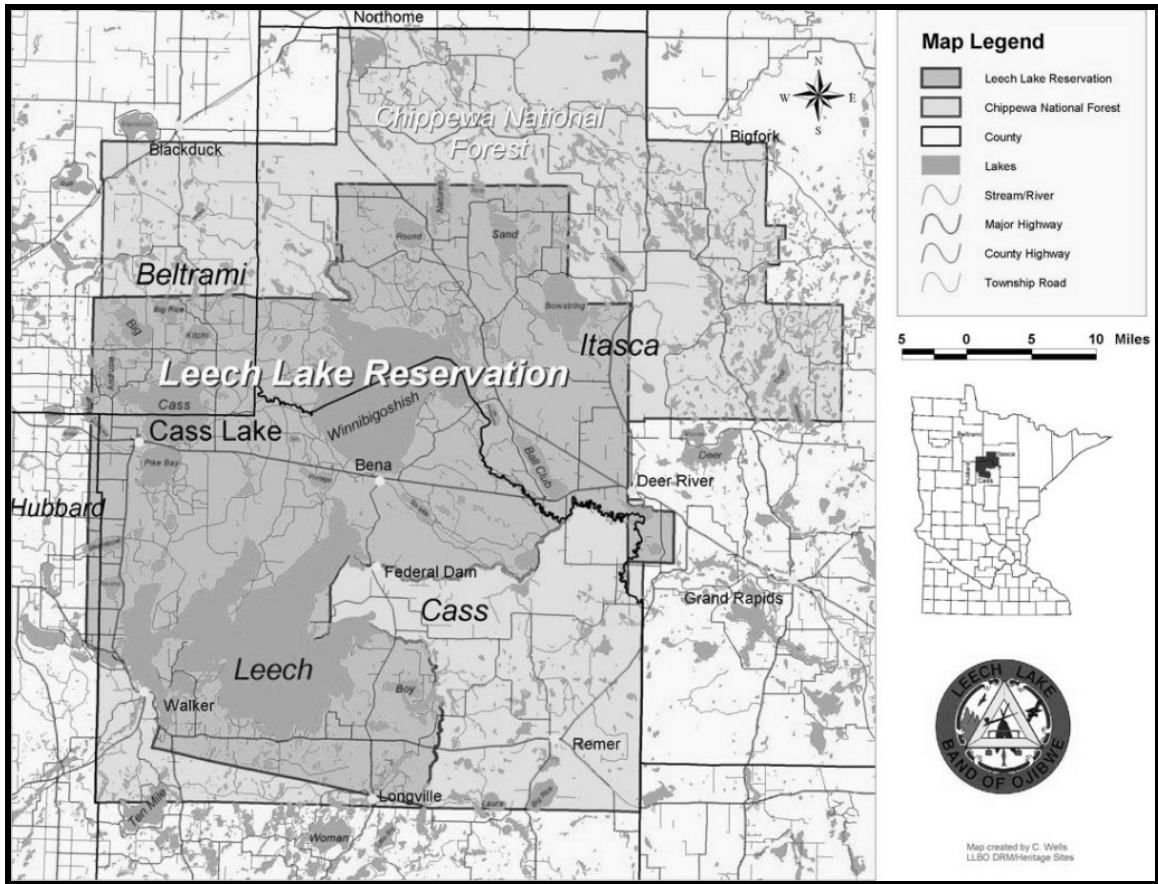


Figure 3: Map of Leech Lake Indian Reservation and Chippewa National Forest (LLDRM 1985)

The history of the Leech Lake Band of Ojibwe in what is now northern Minnesota is long, complex, proud and tragic, with residence in Leech Lake Indian Reservation, the sovereign territory of a sovereign nation, constituting the most recent chapter. Initially inhabiting areas further north and east, the Pillager and Mississippi Bands of the Ojibwe, the historic constituents of the Leech Lake Band, moved into the area surrounding Leech, Cass, and Winnibigoshish Lakes in the mid-to-late eighteenth century. There, in the area that would later become Leech Lake Indian Reservation, they joined and displaced Dakota who occupied

the area previously. The core areas of the Reservation, initially existing as three parcels, were established by treaty in 1855. The Indian Reorganization Act of 1934 combined those parcels, creating the greater Leech Lake Indian Reservation that we know today. It is beyond the scope of this brief historical review to discuss the effects of the Dawes Act, the degradation of the boarding school era, the role of the Ojibwe in the American Indian Movement or the modern American Indian political awakening, or other events of the past hundred years that remain highly relevant to this day. Suffice it repeat what was written above, that the modern history of the Ojibwe is long, complex, proud, and tragic. See Warren & Schenck (2009) and Peacock & Wisuri (2009) for further information.

In its present form, the Leech Lake Indian Reservation contains portions of four North-Central Minnesotan counties: Cass, Itasca, Beltrami, and Hubbard. It is the largest of all Minnesota Indian Reservations in terms of total area, though given the size of several reservation lakes it is second to nearby White Earth Indian Reservation in land area. Leech Lake Indian Reservation is also the most populous reservation in Minnesota, with 10,660 inhabitants as of the 2010 US Census. Cass Lake, Ball Club, and Inger are, in descending order, the reservations three largest communities. On February 2, 2012, then-Chairman Arthur LaRose summarized the state of the Leech Lake Band before the Senate Committee on Indian Affairs: We have retained a strong and vibrant culture and continue to exercise and protect our treaty rights to hunt, fish, and gather on the lands promised as our permanent homelands. While our culture and way of life

remains strong, our community faces high unemployment, concerns with substance abuse, and challenges in providing adequate health care and education to our people (US Senate Committee on Indian Affairs 2012).

Table 1. Key information: Leech Lake Indian Reservation

Total Area	838,336 acres; 1309 square miles
Area outside of Chippewa National Forest	Approx. 131 square miles
Area inside of Chippewa National Forest	Approx. 1179 square miles
Population	10,660 reservation residents, 8,861 tribal members
Date of establishment	1855 (Treaty with the Chippewa), 1934 (Indian Reorganization Act)
Division of Resource Management Administrative Office	6530 US Highway 2 NW Cass Lake, MN, 56633

Source: LLBO (2013)

The LLDRM, previously the Leech Lake Conservation Department, came into existence in 1982 and over the past 30 years the Division has grown to manage forest resources, water resources, fisheries, wildlife, and tribal historic preservation on the reservation. At present, the LLDRM defines its role as: dedicated to the protection of the water, land, forest, fish, wildlife, plants and other natural and cultural resources present upon the Leech Lake Reservation: “Among our many duties are to enforce fish and game laws, regulate logging, wild rice harvesting, plant resources, and generally protect the Band's many resources for the use of future generations” (Leech Lake Band of Ojibwe n.d. a). Importantly, the LLBO sovereign territory and CNF boundaries overlap: 50% of the USDA Forest Service designated forest boundary lies within the sovereign

territory of the LLBO and approximately 90% of the sovereign territory of the LLBO lies within the USDA Forest Service designated forest boundary (USDA Forest Service n.d. b).

CNF traces its roots to the Morris Act of 1902, which created a Minnesota Forest Reserve at Cass Lake. That Forest Reserve was folded into the National Forest system after the creation of the USDA Forest Service in 1908 and continued to grow, acquiring formerly Native American lands through the Weeks Act of 1911. It was finally in 1928 that the USDA Forest Service gave the reserve its current name to honor the area's original inhabitants. See USDA Forest Service (n.d.a) and Brady (n.d.) for further information on the history of CNF.

CNF currently encompasses a total of 1,599,660 acres, of which 666,620 acres are actively managed forest. The Forest Service presents the Forest's uniqueness along four themes: aquatic landscapes, human history, biodiversity, and ecosystem diversity. As is the Forest Service's approach with all National Forests, CNF is managed for multiple uses. Cultural, economic, biological, scientific, recreational, and social values are all incorporated into the 2004 Final Forest Plan for CNF, which continues to be the Forest's guiding document (USDA Forest Service 2004).

Table 2: Key information: Chippewa National Forest

Total Area	1,599,660 acres; 2,500 square miles
Area outside of Leech Lake Indian Reservation	Approx. 1321 square miles
Area inside of Leech Lake Indian Reservation	Approx. 1179 square miles
Date of establishment	1902 (as Minnesota Forest Reserve)
Forest Supervisor's Office	200 Ash Avenue NW Cass Lake, MN, 56633

Source: USFS (2013)

Shared boundaries between the LLBO and CNF have led to cooperative forest management efforts. These efforts can be divided into three focus areas. First, CNF recruits members of the LLBO and neighboring bands to work and volunteer in Forest Service programs: tribal youth volunteer through Youth Conservation Corps programs, CNF rangers mentor area high school students, CNF hosts interns from Leech Lake Tribal College, and, in conjunction with the Department of Labor and Elder Circle, CNF has provided job training for local Tribal Elders who aim to re-enter the workforce. Second, CNF partners with various private and public tribal organizations. These partnerships have included CNF road decommissioning, roads maintenance, trail development, chainsaw operation training and heritage survey work. Finally, CNF participates in cultural outreach activities. These have included recruitment events for students at Leech Lake Tribal College, joint awards programs for environmental stewardship, and forest heritage assessments (see USDA Forest Service, n.d. b, for in depth descriptions of all of these activities).

Yet, as this study will show, disagreement and discord between the two agencies persist in some areas. To a large degree conflict is related to the complex interactions between the organizations' mandates and jurisdictional overlap. While the LLDRM is charged with maintaining the basic treaty rights of hunting, fishing, and gathering on all reservation lands, the agency only actively manages 7% of percent of the forest inside the borders of the tribe's sovereign territory. On that 7% the LLDRM is charged with managing, in compliance with federal and state environmental policies, forested parcels on behalf of three distinct entities: the Minnesota Chippewa Tribe, the LLBO, and heirs to forested allotments—units of land transferred from general tribal ownership to private ownership by tribal individuals by the Dawes Act of 1887. Similarly, CNF has numerous management influences and constraints. On land inside both LLIR and CNF it is the responsibility of CNF to adhere to federal ecological management policy, coordinate with other land managers in Minnesota, maintain the LLBO's treaty rights, promote multiple (at times competing) forest uses, and incorporate the management preferences of the LLDRM, the Tribal Council and Local Indian Councils. Despite efforts on behalf of both the LLDRM and CNF to coordinate and balance these various management influences, contentious issues such as timber harvesting and forest disturbance management (e.g., blowdowns and invasive species) continue to drive conflict.

Research design, data collection, and data analysis

In recent years the USDA Forest Service has identified the need to better understand co-management arrangements in general and specifically communication and collaboration between the managers of National Forests and tribal natural resource managers. CNF and Leech Lake Indian Reservation were chosen for this study due to this developing interest, because the relationship between the managers of the two areas is characterized by political, economic, social, and environmental dynamics common to intercultural co-management arrangements around the country.

The research team for this project was led by primary investigator Mae Davenport, associate professor in the University of Minnesota's Department of Forest Resources, in collaboration with Marla Emery, research geographer with the USDA Forest Service Northern Research Station. Two University of Minnesota graduate students, John Bussey and Amanda Sames, served as research assistants. Numerous other collaborators assisted at points throughout the project, including Shirley Nordrum, University of Minnesota Extension Educator and adjunct biology instructor with the Leech Lake Tribal College, Darla Lenz, Forest Supervisor of Chippewa National Forest, and Rich Robinson, Director of the Leech Lake Division of Resource Management.

I chose a qualitative, interview-based, grounded theory approach for this project. Crooks (2001) describes grounded theory as ideal for exploring integral social relationships and the behavior of groups where there has been little exploration of the contextual factors that affect individual's lives. The precise

ways in which this methodological choice drove the research process are described throughout this methods section.

Table 3: General research timeline

Fall 2012	Research design Literature review Stakeholder and partner outreach Interview guide development
Winter 2012/2013	Continued stakeholder outreach Research interviews Data coding
Spring 2013	Continued data coding Category and theory development Report drafting

After selecting the research area and method, I began to review the literature on the relationship between traditional ecological knowledge, western scientific ecological knowledge and cooperative management, as well as the history of the relationship between Leech Lake Band and Chippewa National Forest. As a grounded theory based study the literature review is not meant to be exhaustive or to assist in the development of hypotheses. Rather, the literature review serves to help the researcher develop 'theoretical sensitivity' the capacity to see what concepts and categories may constitute important pieces of any emerging theory (Glaser 1978).

The project's principal investigator was largely responsible for forging the connections necessary with the LLDRM and CNF. Individuals at those two organizations, as well as at the USDA Forest Service Northern Research Station, the Leech Lake Tribal College, and the University of Minnesota were all essential

in pointing the project in a useful, respectful direction and in facilitating entrée into the LLDRM and CNF communities.

The individuals representing the above mentioned organizations were also critical in the development of our research tool, an interview guide of 26 open-ended questions (Appendix E). The guide was written with the intention of eliciting the perspectives and experiences of staff of both the LLDRM and CNF - the same guide was used for all participants - on a range of issues, including perspectives on change in the area, sources of knowledge and information, dynamics that exist between the two agencies, and ecological narrative.

Leaders within the LLDRM and CNF were key in the selecting of interview participants. The research team shared their goals with organizational leaders at both agencies and those decision-makers suggested individuals who, collectively, represented a variety of perspectives and experiences. This process worked well. Although standard theoretical sampling in grounded theory is typically iterative - further cases are chosen as categories begin to emerge from initial cases (Corbin and Strauss 1990) - this approach assured us that if categories were there to be found, we would have the breadth of data to identify them. This approach also ensured that the most important individuals were identified and interviewed; within both the LLDRM and CNF organizational leaders were unable to identify interviewees that would provide unique perspectives beyond those interviews that we conducted.

Table 4: Participant profile

Agency affiliation	LLDRM	14
	CNF	9
Years with agency	0-4	6
	5-9	9
	10-19	6
	20+	1
Years of residence in the local area	0-4	4
	5-9	4
	10-19	5
	20+	9
Age	20-29	1
	30-39	5
	40-49	7
	50-59	8
	60-69	1
Ethnicity/race	Native American	13
	Non-Native American	10
Gender	Male	15
	Female	8

Interviews with staff of the LLDRM took place in a conference room chosen by leaders of the agency at the organization's headquarters, a private space. Staff of CNF were interviewed in their offices, similarly confidential places. Participants were welcomed one at a time by the research team, a group of either two or three. The interview team was trained in research interview techniques (Rubin & Rubin 2011). Prior to beginning each conversation interviewers explained of the purpose and context of the project, the anticipated format and length of the interview, and the concept of informed consent, emphasizing the interviewee's rights. Each participant was given two copies of a consent form (Appendix F), one to sign and return and one to keep, that further explained concepts important to understanding interviewees' rights and provided

contact information for the project's principal investigator and the University of Minnesota Research Advocates Hotline.

Interviews progressed in a semi-structured manner, with the interviewer following the interview guide but occasionally asking for clarification or further exploration of certain concepts. Interviewees were given adequate opportunity to expound on ideas that he or she deemed important. Interviews were not audio-recorded. Rather, the interview team took extensive notes by hand and/or on a laptop, documenting as much as possible in the participants own words (i.e., direct quotes) and paraphrasing portions of the conversation in other instances. Note takers were careful to distinguish between those portions of their summaries that were direct quotes and those that were paraphrased. To conclude, interviewees were probed for any content that may have been missed, asked for feedback on the process, and solicited for the best ways to get results of the study back to the community. Participants were also asked to fill out a one-page background information sheet (Appendix G).

Interviews typically took between 45 minutes and an hour and a half and were completed in five full days, spread over the course of several weeks during February and March of 2013.

After the completion of the interviews, interview notes were compiled by the researchers into one interview summary per interview. During this process, again, care was taken to distinguish between paraphrased content and the direct quotes of interviewees. Interview summaries were then confidentially returned to each interviewee accompanied by an email requesting their input (Appendix H).

Participants were asked to edit those portions that they felt did not correctly represent what they intended to communicate and were permitted to add content if they felt it needed. Interviewees then returned their edited summaries to the research team. In total, 7 participants made adjustments to their summaries while 16 did not.

Interview notes for this project were analyzed using a grounded theory approach, which Charmaz (2006) defines as, "a method of conducting qualitative research that focuses on creating conceptual frameworks or theories through building inductive analysis from the data" (p. 187). Consistent with this approach data analysis began with a first round of open coding (Corbin and Strauss 1990). During open coding interview summaries are evaluated line-by-line, with each "unit of meaning" labeled. It is through this process that the building blocks of emerging theories, categories that unite the observations, experiences, and perspectives of interviewees, begin to emerge. Per the suggestion of Ryan and Bernard (2003), special attention was paid to repetition, indigenous typologies and categories, metaphors and analogies, transitions, similarities and differences, linguistic connectors and missing data. Throughout this process every effort was made to remain open-minded with respect to the data to let potential categories and connections between categories emerge (Charmaz 2006, Corbin and Strauss 1990)

In order to limit any personal biases and their affect on the open coding process, two members of the research team independently performed the first round of coding on two interview summaries. The codes and categories

generated by those two members of the research team were compared and found to be substantively similar, thus providing evidence for the coders' methodological fidelity. A single coder proceeded with analysis independently after the first two interviews.

After codes and categories had been established the researchers moved on to the next phase. Whether labeled as theoretical coding (Glaser 1978, Charmaz 2006) or axial and selective coding (Corbin and Strauss 1990) the steps that come after open coding are when the researcher "conceptualizes how the substantive codes may relate to each other as hypothesis to be integrated into a theory" (Glaser 1978, p. 72) At this stage, concepts were linked together and dynamics expressed by the participants were explored. During this highly iterative process the coder was immersed in the interview summaries, recording his initial and developing thoughts in memos, short notes on potential developing theories.

In the axial coding process several dominant themes began to emerge, including intercultural communication, conflict drivers, perception of history, forest management goals, and ecological epistemologies. From these the researchers needed to choose one - a core category. Glaser (1978) describes this necessity: "the generation of theory occurs around a core category. Without a core category an effort of grounded theory will drift in relevancy and workability" (p. 93). The research team decided that ecological epistemology explained a significant portion of the difference in decision-making between the LLDRM and CNF, explained a large degree of variety in the participants' experiences and

perspectives, and would lead to results informative to both theory and management.

Ecological epistemology was also a good choice as saturation had been reached regarding that category. Saturation means that "no additional data are being found whereby the [researcher] can develop the properties of the category" (Glaser and Strauss 1967, p. 61). It is possible that if the research team were to wish to develop further categories related to this research, say to build a theory regarding intercultural trust or intra-agency conflict, it would be necessary to head back into the field.

The theory developed through this process is evaluated according to Glaser's (1978) definition of theoretical 'rigor'. He presents fit, modifiability, and workability as the key components of rigorous theory building. The results presented in this report are evaluated well by this construct - the categories here are faithfully derived from the interview data, the numerous important subcategories have been connected well to one core category, and the theory can be altered as new relevant data comes to light.

Limitations

Qualitative research allows for the collection of rich, context-relevant data that represents the constructed understandings of study subjects (Seidmann 2006), data that would be difficult to gather via other methods. Accompanying this advantage, however, are certain limitations.

First, the number and diversity of participants that can be involved are significant limits of research based upon in-depth, one-on-one interviews. Although researchers involved in interviewee recruitment attempted to recruit as many individuals with diverse perspectives as possible and were assisted in this process by the leaders with LLDRM and CNF, the degree to which an interviewee readily offers his or her perspective is still a personal decision. Researchers were particularly aware of intercultural and organizational pressures related to this dynamic; a high risk of miscommunication exists for numerous reasons in intercultural research and employees may feel pressure to represent the perspectives of their superiors over their own. The interview team did their best to cope with this issue by welcoming interviewees warmly, emphasizing confidentiality, and explaining well each interviewee's rights, including emphasizing that discontinuation of interviews was perfectly acceptable for any reason.

Second, it is impossible to completely remove the investigator from the research process in qualitative inquiry such as was performed for this project. Research question formulation, recruitment contacts, interview guide development, the interview process, and data analysis are just a few points in the

research process where the researcher may influence the research process in undesirable manners (Charmaz 2006). Though this issue cannot be eliminated, the effect of the researcher may be minimized. Choosing interview environments acceptable and comfortable to interview participants, maintaining a consistent interview guide from interview to interview, neither endorsing nor condemning perspectives shared during interviews, and asking clarifying questions when appropriate are mechanisms that can help minimize researcher bias during the interview process (Cohen, Manion, & Morrison 2007). Explicitly addressing biases that may be held by researchers, data analysis by multiple investigators, and the use of quotes in the context of systematic grounded theory analysis can reduce the influence of the researcher on the data after it has been collected (Cohen et al. 2007, Corbin & Strauss 2008, Charmaz 2006).

Third, unique barriers exist to investigation in which the primary researchers and research subjects are affiliated with culturally distinct groups. These barriers may relate to historically rooted distrust (either general or research specific), power imbalance, and communication difficulties (Cook-Lynn 2000). This project used two mechanisms for overcoming the intercultural-related barriers it encountered. First, the primary researchers are familiar with the most common problems associated with intercultural research; we are not beginning the process naively. Secondly, and more importantly, this project was carried out in consultation with several important advisors. In particular, one key advisor associated with the Leech Lake Tribal College assisted us in study design and interview guide development and later coached us on intercultural sensitivity.

CHAPTER FOUR – ECOLOGICAL EPISTEMOLOGY IN INTERCULTURAL ENVIRONMENTAL COLLABORATIVE MANAGEMENT

Abstract

This paper investigates the use, structure and dynamics of ecological epistemologies in forest management as exhibited by tribal and non-tribal natural resource managers in Minnesota. The Leech Lake Band of Ojibwe Division of Resource Management (LLDRM) and the USDA Forest Service Chippewa National Forest (CNF) are two agencies responsible for managing a 260,000 hectare patchwork of forest and water resources in north central Minnesota's boreal forest. The co-management arrangement poses distinct challenges for both agencies in conserving the forest and its multiple ecological, cultural and economic values and in adapting to forest change. Two distinct ecological epistemologies have been identified in the literature: traditional and western scientific ecological knowledge (TEK and WSEK). The case study presented here investigates the relevance of existing ecological knowledge frameworks in better understanding and informing co-management arrangements. Data were gathered through 23 semi-structured interviews with personnel from both agencies. Interviews explored participants' connections to the area, their perceptions of the forest and forest change, and their beliefs about the knowledge and information needed and used in forest management. Key findings are that both TEK and WSEK are used by the resource managers of the LLDRM and CNF, that those resource managers perceive both TEK and WSEK to have significant limitations, and that individual resource managers do not strictly

subscribe to one ecological epistemology but rather use both TEK and WSEK in forest management.

Keywords

Traditional Ecological Knowledge, Western Scientific Ecological Knowledge, Intercultural Communication, Collaborative Management, Ecological Change

Introduction

Within the past 50 years a global trend has begun to reverse itself. The responsibility for the management of natural resources of all types, responsibilities that had for centuries been increasingly consolidated in the hands of higher and higher levels of government, has begun to be devolved back to more local groups. The empowerment of local stakeholders in natural resource management holds promise for numerous reasons including the potential for engagement of diverse ecological beliefs, values and knowledge for more sustainable, productive, and just resource management.

This opportunity is particularly evident in those places and situations in which the traditional ecological knowledge of local indigenous groups continues to exist. All around the world in the last decade, policy and strategies evolving out of the interplay between traditional and western scientific environmental knowledge have led to more sustainable, more productive and more locally acceptable environmental management, including that of fisheries (King 2004), wildlife (Berkes and Turner 2006), and forests (Troster 2007) to name just a few examples.

In the United States these opportunities commonly arise where the sovereign territories of Native American nations abut and overlap the management jurisdictions of national, state, local, and private natural resource management agencies. It is in those places where the potential for collaboration is greatest, where tribal and non-tribal resource managers can bring to the table knowledge and values from both traditional and western scientific ecological epistemologies.

However, the simultaneous engagement of traditional and western scientific ecological values, knowledge, and practices for cooperative management of natural resources is not simple. Significant and complex barriers exist related to social, cultural, economic, political, and spiritual dynamics (Jacobson et al. 2006).

In this paper we first examine existing literature relevant to ecological epistemologies and the collaborative management of natural resources. Next, we set the context for the case study including the management arrangement between the Leech Lake Division of Resource Management and the Chippewa National Forest and the study's research methodology. Then we describe results related to the structure of ecological epistemologies, including how the presence of multiple competing ecological epistemologies affects individuals and the agencies they work for, are shared and discussed. Finally, we discuss the implications of the study findings for research and practice.

Research Questions

Overall, this study was conducted to better understand the use and nature of ecological knowledge in cross-cultural collaborative forest management arrangements. The project's qualitative research approach reflects the researchers' wish to simultaneously point the study in a certain direction but to also remain open to learning about unexpected phenomena and dynamics.

Three specific research questions are central to this paper:

- What types of knowledge and information are used by the resource managers at the LLDRM and CNF?
- How does the privileging of different types of knowledge and information by different resource managers affect collaborative forest management?
- How do resource managers perceive and relate to the existence of multiple ecological epistemologies in the context of collaborative forest management.

Relevant Literature: Ecological Epistemologies and Collaborative Management

The characteristics and sources of traditional ecological knowledge (TEK) have, in the past 20 years, received significant academic attention. Berkes (1999) offers one definition of TEK that has been widely cited and built upon: "Traditional ecological knowledge is a 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." Importantly,

this definition can be broken down into two parts: TEK is defined both by mode of production and dissemination (“evolving by...cultural transmission”) and also by subject and type (“cumulative body of knowledge, practice and belief; about the...with their environment”).

The production and dissemination of TEK requires time and local experience and permits no substitute for these elements (Berkes & Turner 2006, Barnhardt & Kawagely 2005). It spreads from generation to generation by oral history, demonstration, and continuity of practice (Barnhardt & Kawagely 2005, Deloria Jr. 2004). Despite this long-term orientation TEK generation, or perhaps because of it, knowledge of specific disturbances, their causes, and their effects can be generated quickly by comparing current experience to historical observation (Parlee, Berkes, & Teetl’it Gwich’in Renewable Resources Council 2006). Finally, TEK often has strong ties to societal practices and thus is culturally perpetuated, notably linking TEK to broad community involvement (Barnhardt & Kawagely 2005, Murray, Wieckowski, Hurlburt, Soto, & Johnnie 2011).

Regarding the latter half of his definition, that TEK consists of and is about certain subjects, Berkes (1999) proposes a model. He posits that TEK can be conceptualized as existing at four levels of analysis, presented by him as concentric ellipses. From the center outward his four categories are: (1) local knowledge of animals and land (i.e., species characteristics and interspecies dynamics); (2) land and resource management systems (i.e., landscape manipulation for human or non-human benefit); (3) social institutions (i.e., natural

resource related economic, social, spiritual, and governmental structures); and (4) worldview. While each of these four levels informs and affects the others to some degree, it is the outermost layer, worldview, that is most subtly influential. Worldview consists of those values and beliefs regarding humans' role in the world, thus constituting the foundation upon which other ecological knowledge is built.

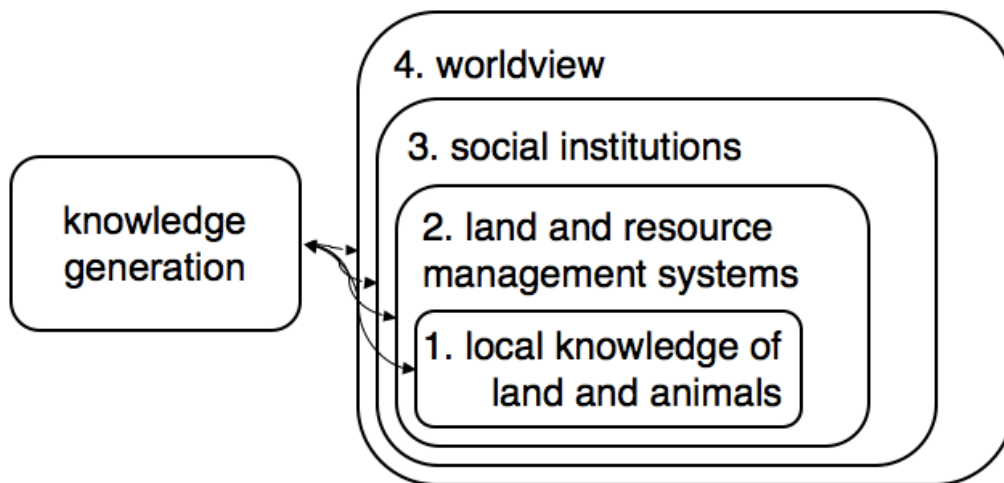


Figure 4: Model of traditional ecological knowledge (Berkes 1999)

That many (though not all) North American indigenous groups have demonstrated a holistic understanding of ecosystem dynamics (Medin, Ross, Cox, & Atran 2006, Ross, Medin, & Cox 2007), have developed effective environmental management systems (Trosper 2007, Murray et al. 2011), maintain ecological connections in many social institutions (Murray et al. 2011, King 2004), and view humans' relation to the non-human world in a less anthropocentric manner than many non-native Americans (Hart 2010, Krech III 1999, LaDuke 2005) is well documented, adding credibility to Berkes' model.

TEK is particularly important as an alternative to western-scientific environmental knowledge (WSEK). In contrast to the generally holistic, integrated, and spiritual environmental epistemology described as TEK, some have described WSEK as anthropocentric, atomistic, and amoral (Callicott & Nelson 2004, Deloria Jr. 2003, LaDuke 1999). As expressed in these terms it is hard to escape the sentiment that TEK is, in some important way, better than WSEK. However, in recent years concentration has shifted away from discussions of better or worse and focused instead on less value laden similarities and differences. Comparing and contrasting TEK and WSEK in this manner accepts that both environmental epistemologies provide a lens through which legitimate ecological knowledge can be gained and that both modes of thought have strengths and weaknesses (Barnhardt & Kawagely 2005, Ross et al. 2007, Murray, Neis, & Johnson 2006, Murray et al. 2011). Increasingly, researchers have posited that TEK and WSEK are, in very important ways, more similar than they are different (Barnhardt and Kawagely 2005).

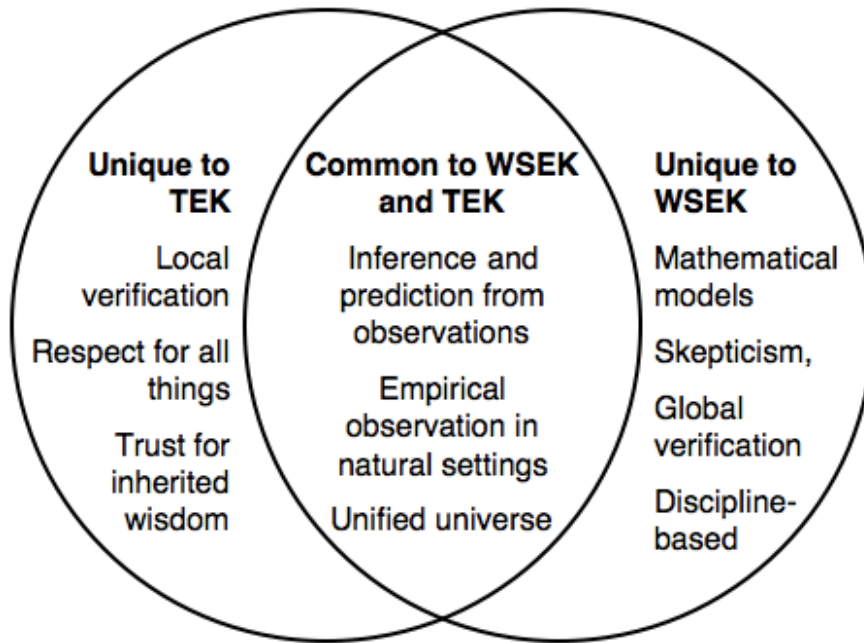


Figure 5: Relationship between TEK and WSEK (adapted from Barnhardt and Kawagely 2005)

One particular dynamic related to TEK and WSEK that has attracted attention has been the relationship between environmental epistemology and adaptation/response to environmental disturbance. Several authors posit that a mindset that privileges TEK bears some distinct advantages in relation to ecological disturbance. The immediacy with which TEK is generated regarding local, specific environmental disturbances (Trosper 2007, Parlee et al. 2006), the privileging of holistic/ecosystem level thought (Trosper 2007, Callicott & Nelson 2004, LaDuke 2005, Murray et al. 2006), and the community involvement entailed in TEK production and dissemination (Parlee et al. 2006) are all acknowledged as resilience-relevant characteristics unique to TEK.

In contrast, other authors (and some of the same ones) suggest ways in which a primarily WSEK mindset enables individuals and communities to most

effectively respond to environmental change. These mechanisms and characteristics include the emphasis on rigorous research design (Krech III 2005, Murray et al. 2011), the peer review process (Krech III 2005, Hart 2010), the global scope of knowledge generation (Murray et al. 2006), and the isolation of disciplines that separates science from religion (Krech III 2005).

Many authors (though not all, see Deloria 1999) who have written recently on the relationship between TEK, WSEK and adaptation to change acknowledge that each environmental worldview brings different tools to the table (Murray et al. 2006, Krech III 2005, Lewis 2010, Hart 2010). The process of utilizing these various tools, however, need be thoughtfully done. Nadasdy (1999) asserts that TEK should not simply be a new data source to be drawn upon by resource managers who use predominantly WSEK-based approaches. Integration of that sort does not benefit from the depth of wisdom and experience that exists with traditional epistemologies and further concentrates power in the hands of non-traditional resource managers. Extraction of traditional knowledge of this sort is a political action and, rather than a positive step toward the union of diverse knowledge traditions, is seen by many as a continuation of political dominance and cultural exploitation (Nadasdy 1999, Natcher et al. 2005).

Study site

The Leech Lake Indian Reservation, the largest and most populous American Indian reservation in Minnesota, is a land of forests and water. It is the sovereign territory of the Leech Lake Band of the Minnesota Chippewa Tribe (or Leech Lake Band of Ojibwe, LLBO), whose story of migration and settlement in

what is now central Minnesota is long, complex, proud, and tragic. In its present form the reservation occupies portions of four counties and contains the third, fifth, and tenth largest lakes wholly in Minnesota. On February 2, 2012, then-Tribal Chairman Arthur Larose summarized the state of the Leech Lake Band before the US Senate Committee on Indian Affairs: “We have retained a strong and vibrant culture and continue to exercise and protect our treaty rights to hunt, fish, and gather on the lands promised as our permanent homelands. While our culture and way of life remains strong, our community faces high unemployment, concerns with substance abuse, and challenges in providing adequate health care and education to our people” (US Senate Committee on Indian Affairs).

The challenge of managing natural resources on behalf of the LLBO is the responsibility of the Leech Lake Division of Resources Management (LLDRM). Originally the Leech Lake Conservation Department, over the past 30 years the LLDRM has grown substantially. At present, the LLDRM defines its role as “dedicated to the protection of the water, land, forest, fish, wildlife, plants and other natural and cultural resources present upon the Leech Lake Reservation. Among our many duties are to enforce fish and game laws, regulate logging, wild rice harvesting, plant resources, and generally protect the Band’s many resources for the use of future generations” (Leech Lake Band of Ojibwe, n.d. a).

The complex role of the LLDRM includes the direct management of forest parcels not only on behalf of the LLBO, but also on behalf of the Minnesota Chippewa Tribe and on behalf of heirs to forested allotments - units of land transferred from general tribal ownership to private ownership by tribal individuals

by the Dawes Act of 1887. Together these three types of parcels constitute roughly 7% of the forest within the boundary of the reservation; the rest is owned and managed by state, federal, and private entities. Still, it is the responsibility of the LLDRM to maintain treaty rights (the rights to hunt, fish, and gather) on all lands within the reservation no matter the land-managing agency or organization.

Chippewa National Forest (CNF) is the smaller of the two units of the USDA National Forest System in Minnesota and overlaps significantly with the Leech Lake Indian Reservation. Nearly 50% of the National Forest lies within the bounds of the LLBO's sovereign territory; 90% of the reservation is a part of the National Forest. CNF traces its roots to the Morris Act of 1902, which created the Minnesota Forest Reserve at Cass Lake nearly fifty years after the core areas of what would become the Leech Lake Reservation were established through the Treaty with the Chippewa (aka the Treaty of Washington).

The USDA Forest Service (USFS) presents the Forest's uniqueness along four themes: aquatic landscapes, human history, biodiversity, and ecosystem diversity. As is the USFS's approach with all National Forests, CNF is managed for multiple uses. Cultural, economic, biological, scientific, recreational, and social values were all incorporated into the most current Forest Plan (USDA Forest Service, 2004).

Not surprisingly, the relationship between CNF and the LLDRM is an interesting one, characterized at times by collaboration and at times by confrontation. Both independently and collaboratively they manage forestlands that lie within the sovereign territory of the LLBO (implying the treaty rights to

hunt, gather, and fish on all lands on the reservation), are subject to tribal, federal and state laws and regulations, and are managed by numerous distinct agencies and organizations. While many opportunities for working together have been seized and many more opportunities exist, significant cultural, political, interpersonal, and economic constraints persist.

Methods

The research design for this study was interpretive and deductive in nature. The process involved the purposeful selection of a small number of participants, in-depth semi-structured interviews, and grounded theory data analysis procedures (Corbin and Strauss 1990). This approach fit well the research objectives as it allowed the researchers to focus on those individuals most central to their concepts of interest while allowing the interviewees to tell their stories and express their perceptions in rich detail. This methodological choice gave the researchers the opportunity to encounter and document unexpected social phenomena and, in the end, generate new theories to explain what was learned.

In total, 23 individuals were interviewed, including 9 staff of CNF and 14 individuals associated with the LLDRM, 12 of which were current agency staff. Within both CNF and the LLDRM, individuals were chosen with distinct professional, racial, and cultural characteristics so that the diversity of perspectives within each agency could be observed. This process proceeded smoothly with both agencies' administrators facilitating entrée and suggesting a diverse set of potential interviewees.

Table 5: Participant profile

Agency affiliation	LLDRM	14
	CNF	9
Years with agency	0-4	6
	5-9	9
	10-19	6
	20+	1
Years in residence in local area	0-4	4
	5-9	4
	10-19	5
	20+	9
Age	20-29	1
	30-39	5
	40-49	7
	50-59	8
	60-69	1
Ethnicity/race	Native American	13
	Non-Native American	10
Gender	Male	15
	Female	8

University of Minnesota research personnel, in consultation with representatives from the Leech Lake Tribal College and the USDA Forest Service, developed an interview guide of open-ended questions. Key topics addressed through the interview included area history and characteristics, forest change, the generation and use of knowledge and information, the approaches of various agencies to forest management, and interagency relationships. Several example questions are provided in Table 6. Interview participant shared their perspectives openly and were interrupted by interview facilitators only to be asked to clarify or expand upon what they had shared.

Table 6: Example Interview Questions

What story would you tell someone who has never been here before about this place? Or, how would you describe the forest to someone who has never been
--

here before?

What are some important things to know about the relationship people have with this place?

What sources of information and knowledge does your agency use in managing the forest?

How would you describe your agency's approach to forest management?

Is your agency's approach to forest management similar to or different from other agencies that manage this forest? Please explain.

Interviews took place over the course of five days during two visits to Cass Lake and were facilitated by a team of either two or three researchers. They averaged one hour in length. Interviews were not audio recorded, but rather the research team took extensive interview notes that were combined into interview summaries after the conversations. Those summaries, which included and differentiated between paraphrase and direct quotation, were then sent back to the interview participants for member checks. After participants had the opportunity to approve the summaries or make edits, including additions or deletions of content, the summaries with all participant edits were treated as analysis-ready research data consisting of verified direct quotes and agreed-upon paraphrases.

Interview summaries were then interpreted using grounded theory procedures (Corbin and Strauss 1990), an iterative, interpretive process of textual coding (labeling) that allows concepts and connections to emerge from the data. During the first round of coding analysis was limited; words, phrases, and sentences were simply assigned descriptive labels. All data were coded, including direct quotes and paraphrases. As coding progressed, categories and

subcategories are identified and linked to form the initial, most basic components of potential theories. Initially, this coding process was performed independently by two researchers. They then compared codes and notes to ensure, to as high a degree as possible, that the emerging codes and categories were independent of the individual researcher.

After the initial round of coding was completed, the interpretation of the newly created codes and categories began. While researchers remained sensitive to previously unnoticed meanings, during the second and third rounds of textual coding their focus turned to the connections that existed between concepts. Researchers broke conceptual categories down into subcategories and organized categories according to their relationships with one another, all the time returning to the original text to ensure that models created continued to faithfully represent the perspectives of interview participants. Only after the relationship between traditional ecological knowledge and western scientific ecological knowledge in the context of intercultural collaborative management of ecological change was identified and described as a core, shared element of interview participants subjective experiences did researchers return to the existing literature on the subject to find where this study fits best.

Results

Presented here are three central findings of this study. First, the staff of the LLDRM and CNF shared a diverse range of ecological perspectives, beliefs, and values relevant to forest management; many of these were assessed to be characteristic of TEK and others of WSEK. Prominent among these perspectives,

beliefs and values were worldview relevant concepts associated with both TEK and WSEK. Second, interviewees shared perspectives on processes and attitudes associated with TEK and WSEK that demonstrated limitations of both epistemologies. Third, interview analysis indicated that individuals within both the LLDRM and CNF frequently respect knowledge generation and content characteristic of both TEK and WSEK; individuals from both agencies demonstrated the ability to engage with and appreciate both epistemologies.

Throughout this section excerpts of participants' direct quotes and paraphrased comments are provided to demonstrate emergent themes and important concepts. Direct quotes appear in quotation marks with standard formatting while paraphrased content appears in quotation marks and is italicized. As noted in the methodology section of this article, interview summaries including all quotations and paraphrased content were reviewed by participants who attested that both the quotes and paraphrases faithfully represented their views.

TEK and WSEK Model Fit

Interview analysis revealed both Barnhardt and Kawagely (2005) and Berkes (1999) models to be generally a good structural fit for the epistemologies expressed in the interview data. Themes, patterns and relationships consistent with existing characterizations of TEK and WSEK (Barnhardt and Kawagely 2005) were identified. These themes were easily categorized as knowledge generation and knowledge content and were indicative of concepts, processes and beliefs unique to TEK, common to both TEK and WSEK, and unique to WSEK. Knowledge content categories emerged consistent with Berkes (1999) and encompassed knowledge of local plants and animals, knowledge of land and resource management systems, knowledge of social institutions, and ecological worldview.

Regarding the generation of ecological knowledge, TEK-relevant themes emerged such as respect for person-to-person passage of ecological wisdom from one generation to the next, the sentiment that personal ecological experience is essential for the attainment of meaningful ecological wisdom, and reliance on primarily local knowledge generation processes (see Table 8: knowledge generation). One interviewee expressed a perspective relevant to several of these themes by describing several important sources of ecological knowledge: *“Some I’ve learned through my heritage, some through talking with elders, through being a part of talking circles, from my grandmother, and just being associated with spiritual advisers.”* In contrast, several WSEK-related themes emerged such as academic research as a key knowledge generation

process as well as the perspective that information is easily communicable without personal experience. One LLDRM staff member expressed the importance of research: “Do we really know what a hardwood stand looks like?... We need to do research to find out what the definition of a northern hardwood forest is or what it looked like”

Related to Berkes’ first level of knowledge content, “knowledge about local land and animals,” some individuals shared perspectives typically unique to TEK. These perspectives included personification of non-human species and were characterized by intimate knowledge of traditionally gathered species. Themes assessed as unique to WSEK included scientific modeling, the use of GIS, the application of universal ecological principles, and a focus on commercially important species (see table 8: knowledge content – local knowledge of animals and land). One resource manager emphasized the strength of special modeling, “What are they gathering? We look at a map and we know what is out there. That’s a difference. They assume what’s out there. We know we have GIS and do inventory.”

At Berkes’ second level of analysis, “land and resource management systems,” individuals once again shared perspectives alternatively unique to TEK and WSEK. Those themes uniquely related to TEK at this level included a preference for less active forest management, inter-species respect as the basis for the management that did occur, and local management based primarily on local observations. Conversely, management based on industry standards, organizational policies, an emphasis on maximum sustained yield, and

management goals related to multiple human uses emerged as WSEK-related themes:

“We look to harvest over-mature aspen and jack pine; we have plenty of it on Tribal lands. We also have moved into Tribal plantations and have moved to thin the pine to a level where they are free-to-grow, improving timber quality and aesthetics at the same time.”

“Social institutions,” Berkes’ third layer, was another level of ecological knowledge analysis at which specifically TEK and specifically WSEK themes emerged from participant perspectives. Concerning the former these themes included natural resource related ceremonies, subsistence hunting, gathering, and fishing of traditional, often spiritually significant, species, and reliance on the forest for medicinal plants. One individual told us about the Mississippi River Walkers: *“Because we’re healing waters in our own way; we’re doing our part. We do ceremonies like the Mississippi Water Walkers ceremony. We get together with the healers. The women carry the water. The men carry the staff.”* Concerning the latter, themes included commercial dependence on the forest, aspiritual natural resource related festivals and tournaments, and non-subsistence hunting, fishing, and gathering.

At the Berkes’ fourth level of analysis, “worldview,” several subcategories were identified including ecological values, ecological narrative, and beliefs about the nature of knowledge.

Ecological values: Respondents from both the LLDRM and CNF shared perspectives that researchers assessed as expressing the inherent value of

things, concepts or processes. Statements of these sorts related to how things “should” be and what is “right” and were made by both LLDRM and CNF staff members. Commonly inherently valued within TEK were maintaining certain traditional practices, the lives of plants and animals, and balance while both TEK and WSEK were found to value the future, personal exposure to nature, sustainability, and community self-sufficiency. No concepts were identified as inherently valuable within WSEK but not valued within TEK. Instead, participants associated WSEK with the propensity to compare and weigh distinct values and attempt to maximize good in the long-term.

Ecological narrative: Participants told stories about their own, their communities', and their agencies' histories in relation to the natural world. In some cases these stories included spiritual elements while others were a-spiritual; in all cases these stories provided context through which individuals understood events taking place around them. Common elements of traditional ecological narratives included balance between humans and non-humans, human resource use as increasingly excessive, spiritual connection to the land, a sense of loss occurring in recent time, and conflict between indigenous and non-indigenous groups. One comment exemplified several of these themes:

“Everything we ever needed or wanted was right here on this place the creator gave us. Everything was here. But over time because of commercial harvest and digging mining pits, people started moving in. There was development and resort building. All those things over time

collectively have impacted the resources. And now you have invasives and climate change piled on top of that.”

The narratives associated with WSEK emphasized all people using natural resources in roughly similar ways, human needs as generally more important than non-human needs, that human use of natural resources is normal, and focused on western science based organizations such as the Civilian Conservation Corps and the USDA Forest Service. One participant expressed several of these concepts when questioned about the highlights of the area:

“We have a lot of beautiful pine stands because of the CCC influence. We had a nursery up on the edge of Cass Lake that grew seedlings back during that era, and the CCC constructed our Supervisor’s office.”

Beliefs about the nature of knowledge: Interviewees expressed a variety of attitudes on the characteristics of knowledge. That knowledge is synonymous with wisdom, that knowledge is understood with the heart, that meaningful knowledge is difficult to communicate, and that the earth is wiser than humans emerged as typically associated with TEK. One individual expressed this last concept by saying:

“We think mankind has more knowledge than mother earth, and that is wrong. Instead we get information from our books, someone put it on a filmstrip...People talk about global warming, climate change, but that’s because they’re not listening to mother earth. Mother Earth will take care of herself, but mankind thinks he knows best. They say thousands of years ago it used to be this, how do they know?”

That knowledge is roughly synonymous with information, that knowledge is gained through study and research, that knowledge and information exists within silos, and that knowledge is easily communicated emerged as typically associated with WSEK. For example, when asked what types of information is used by his organization a participant noted, “We use a variety of information that is put together in our Forest Plan, our guiding tool. We use a lot of data provided by DNR, federal agencies like the United States Geological Survey, the Fish and Wildlife Service, and others.”

Table 7. Knowledge generation and content

Traditional Ecological Knowledge	Western Scientific Ecological Knowledge
Knowledge Generation	
<p><i>Themes:</i> knowledge and wisdom is passed down generation to generation; personal experience is essential; meaningful knowledge is disseminated person to person.</p> <p>“I had a good relationship with... an elder who lived to 110. <i>Imagine the changes she saw. When I first came here, I would talk to her and she would tell me the places to go...</i> She had an observation spectrum of 100 years; the changes she’s seen must have been unbelievable.”</p>	<p><i>Themes:</i> knowledge is easily communicated and stored; new knowledge comes through research; meaningful knowledge is universally applicable.</p> <p>“<i>We say we’re going to go into this project area and we want new stand data on the area. We may get info on hundreds of stands. ... We do [forest inventory] through contracting; the successful bidder will go out and do the work. Then we update our database to reflect that new information. And the use of those data depends on what the Forest Plan says.</i>”</p>
Knowledge Content	
<i>Local knowledge of animals and land</i>	
<p><i>Themes:</i> intimate knowledge of human-non-human interaction; personification of plants and animal species; focus on traditionally used species.</p> <p>“Red maple is replacing sugar maple. And you can tap it, but it’s not as efficient. Maple sugar is a natural sugar. Our tribal members can eat it all day long and not get diabetes.”</p>	<p><i>Themes:</i> local knowledge is primarily applied general knowledge; emphasis on scientific modeling; focus on commercially relevant species.</p> <p>“<i>We know that jack pine is a species that won’t do well in climate change scenarios, but we have a plan that has us investing in establishing jack pine. So does it make sense to do this?</i>”</p>

Land and resource management systems

Themes: focuses on traditionally used species; based upon respect for non-human species.

“We need to keep track of what is going on around us. My mom told me she was told by her father, an elder, that if you don't use something and use it right, it would be taken from you. *Blueberries are like that. We were out with the DNR and county, and we saw blueberry bush and there were no berries. They were scratching their heads.* Now we have blueberry plants but no berries on them because we haven't used them right and they were taken away...”

Themes: local management systems are based on industry standards; emphasis on multiple-use; emphasis on maximum sustained yield.

“*The state of Minnesota puts out this Gold Book that provides structure for all agencies in Minnesota. We all follow that; and that's a good thing. It gets us speaking the same language.*”

“To see a fully stocked stand that has come back after it's been harvested - especially the pine because we battle the deer, the deer are just incredible so it's a real challenge - that's my favorite thing is to see a fully stocked pine stand that's regenerated.”

Social institutions

Themes: natural resource related ceremonies; hunting, fishing and gathering of many species; medicinal use of wild species.

“We have a list of about 24 to 25 resources that are still out there that are still routinely gathered. Our major one is wild rice. Then there's also a lot of hunting and trapping...”

“*The loss of sweetgrass would be a concern.* It's used in religious practices and ceremonies. That has always been a real significant resource here for our native people. Other native people come here just to gather resources.”

Themes: hunting, fishing and gathering of a few species; natural resource related tournaments; natural resource focused economy.

“*We also have a lot of people who come up from the cities and points south of there who come back to the same spot year after year. A lot of that has to do with hunting; the hunting is interesting to watch...* The hunters are getting older with fewer young ones. It is very family based and you have these groups that come back to the same place every year for a week in the fall to do this family traditional thing.”

Worldview – ecological values

Themes: maintaining traditional practices; the lives of plants and animals; balance between humans and the non-human world.

“Are you here to live with our gifts? All on equal footing? Or are they here for us to use how we want? It is not a waste to have trees blown down; trees have been blown down forever. The forest is a gift but it is not just here for us to use.”

Themes: utilitarian comparison of values.

“[If I can balance] social, economic, and environmental values then everything is fair game. And then it’s a matter of figuring out the best combination. We can’t get outside the triangle. This is my starting place.”

Worldview – ecological narrative

Themes: balance between humans and non-humans; human resource use as increasingly excessive, spiritual connection to the land; sense of loss in recent time; conflict between indigenous and non-indigenous groups.

“I’d say this is the final destination of our prophecy. It was ours as Anishinaabe people, not just Leech Lake people. The government has that divide-and-conquer mentality. But this was our place to be, and our story is about this place.”

Themes: indigenous and non-indigenous natural resource use is similar; human needs are more important than non-human needs; western science based organizations have historically been the prominent environmental managers.

“That is the beauty of the area - the diversity of cultures living together and the opportunities for people to come here and derive a livelihood from the resources either through logging, commercial fishing, or whatever else.”

Worldview – beliefs about the nature of knowledge

Themes: knowledge is synonymous with wisdom; knowledge is understood with the heart; that meaningful knowledge is difficult to communicate.

“Anishinaabe traditional teachings clash with forestry management. Forestry is what, 90 years old? A maple basswood stand might be 1000. To me it’s just a theory.”

Themes: knowledge is roughly synonymous with information; knowledge exists within silos; knowledge is easily communicated.

“What we do in natural resource management is a science. Every department has their science where they are expected to provide their expertise: soil, water, forestry, wildlife, botany. Relying on the science [and] allowing people to use their expertise in their fields and trusting their decisions - the results could be phenomenal.”

The Limits of TEK and WSEK

Participants shared what they perceived to be limits of each epistemology at all levels of Berkes' (1999) model. At times these perceived limitations were expressed through sharp critiques of one epistemology or the other while at other times perceived limits were expressed simply as challenges that exist to a higher degree within one epistemology than within the other. Some of these limitations were highly specific, related to particular processes, institutions or beliefs, while others were more general, related to how an entire ecological epistemology functions. Moreover, some participants' descriptions suggested strong emotional responses to the knowledge systems. While both TEK and WSEK were perceived to be deficient in specific ways, participants were most explicit and emotionally expressive in describing general deficiencies of WSEK.

Many of the limitations of TEK identified by interviewees concerned knowledge generation and dissemination. Some individuals asserted that TEK was not produced via replicable methods, incorporated subjective spiritual or personal perspectives to too high of a degree, and was antiquated. The communication of TEK was also cited as a significant limitation. TEK bearers were said by some to be hesitant to share their wisdom and, as it is not readily written, TEK was acknowledged by some to be difficult to accurately disseminate broadly. Finally, numerous individuals posited that some of the important social and spiritual components of TEK have significantly eroded. This is not only a limitation of TEK because it is through those social and spiritual dynamics that the relevance of TEK is continually asserted, but also because social and

spiritual connection with natural resources is a core component of the epistemology:

"When I was 13 or 14 years old we would peel poplar and had to go out into the woods to get it... That whole family structure is really gone. You have to pay your kid 20 dollars just to cut the grass... The lifestyle of our tribe members has gotten further and further away from using resources to survive. The spiritual connection is gone, it really is."

Limits of WSEK were frequently associated with the worldview of that epistemology. "Disrespectful," "arrogant," and "too focused on economic gain" were several of the ways that individuals described the WSEK mindset. Others asserted that WSEK based management could not be trusted because it was too new and had caused significant ecological destruction. Others suggested that WSEK thought is, compared to TEK, devoid of values and can lead to over-exploitation of natural resources for human benefit: "*Prior to the treaty, the tribe had the right to hunt, fish and gather and we didn't abuse the resources, we didn't shoot 30 deer or 100 ducks.*"

Table 8: The limits of TEK and WSEK

Knowledge Generation
<p><i>Limits of TEK:</i> not produced via replicable methods; difficult to communicate.</p> <p>“Knowledge from healers is used but, it’s a really tough thing to talk about or research, it needs to be made more accessible... It’s a difficult thing to talk or write about, traditional knowledge.”</p> <p><i>Limits of WSEK:</i> disrespectful to other species; too recently developed to be trusted; disregarding alternative methods of knowledge generation.</p> <p>“We consult with elders, and the Forest Service has ignored advice from elders telling them that a project will fail because of cyclical water flows. Thinking back to times when we bring the elders in to make their comments, it doesn’t work. The elders are not giving scientific advice. The Forest Service sometimes ignores what they say.”</p>
Knowledge Content - Local knowledge of animals and land
<p>Limits of TEK: antiquated; not always trustworthy.</p> <p>“What is traditional use? What are they gathering? We look at a map and we know what is out there. That’s a difference. They assume what’s out there. We know we have GIS and do inventory.”</p> <p>Limits of WSEK: not sufficiently place-based; has little emotional component; always entails uncertainty; focuses too much on specific species and too little on ecosystems.</p> <p>“You have to understand the tribal perspective here. This is their home, they’ve got nowhere else to go. For the Forest Service this is a training ground of sorts. <i>It’s hard for the Forest Service to understand, because they’re used to turnover and moving. But tribal people don’t have anywhere else to go if this land isn’t taken care of.</i>”</p>
Knowledge Content - Land and resource management systems
<p>Limits of TEK: personal opinions are difficult to disprove or discredit; too “hands off”.</p> <p>“We’re not wrecking the forest; we are fixing it. The forest is broken. <i>Wood barons took all the pine when they came through so many years ago, leaving a huge void in the seed source and effectively changing stands to a point where they cannot restore themselves without assistance.</i>”</p> <p>Limits of WSEK: too focused on specific species; based heavily on economic assessments; arrogant; too active; too focused on the present generation.</p> <p>“The idea that man can change things and make them better than Mother Nature. That is so backward... When I make a decision, I look on it as sometimes us humans can do more for those generations down the road by the less we do.”</p>

Knowledge Content - Social institutions

Limits of TEK: some social institutions have ceased to exist in a meaningful way.

“The DRM has a database where they keep track of probably 450 species that were traditionally gathered that we don’t really gather anymore.”

“The lifestyle is primarily what has changed around here. We are getting further and further from the woods. We’re not really using the woods anymore.”

Limits of WSEK: some social institutions are overly extractive or disrespectful; ignores some important social institutions.

“We still value traditional use. This is a livelihood for some tribal members; there are resources in the forest like food and medicine. That makes the DRM approach way different than the Department of Natural Resources or the Forest Service who see it as a tree crop and recreation, but not a livelihood.”

Knowledge Content - Worldview

Limits of TEK: subjective and spiritual components inhibit rational assessment.

“There is a lot of complaining that we are destroying the earth, destroying what used to be there; traditional, cultural resources. But that’s just a difference of opinion.”

Limits of WSEK: arrogant; disrespectful; separates humans from non-human world; purports to be the sole legitimate knowledge system.

“Western science is more corruptible. People make good money making claims they can’t be certain about. Western science gives way to economic means. *It’s susceptible to funding.* Western scientists start with a problem thinking they pretty much know almost all of it. I look at it and think I know very little about it.”

“It’s western science versus traditional knowledge and views. A tribal member will look at a turtle and see it for what it is. That’s my brother. A white man scientist will go pick it up, turn it over, pull its leg, poke its eye, touch its teeth. That’s not respect. I wouldn’t want to be treated that way.”

Individual Knowledge Integration and Application in Forest Management

Despite the assertions by many interview participants that a significant divide exists between TEK and WSEK, interviewees also provided evidence that the usefulness of this dichotomy is limited in its ability to describe individuals.

Specifically, no individuals interviewed provided evidence that they exclusively respected and accepted TEK or exclusively respected and accepted WSEK;

participants respected processes, beliefs and values associated with both TEK and WSEK.

For one interview participant who worked with the LLDRM, important sources of information included tribal elders as well as genetic research. Another participant, an employee of the CNF, shared that personal experiences in the woods and on the lakes in the area as well as relevant academic research were important to decision-making. Another interviewee shared that traditional gathering and ceremonial sites were deeply valuable and should not be touched by forest management activities and later expressed the attitude that infrastructure development near traditional sites was at times acceptable and that logging may be necessary.

Several interviewees linked the capacity to respect or understand multiple ecological epistemologies with a person's ability to step back from one's own worldview. One participant, despite previously expressing distaste for timber harvest, stated, "I know they have to do some harvesting." Another expressed that timber harvest produced material for the public good, even though the process was one that the participant found distasteful: "I can see both sides, both points of view. This timber is a lot of people's livelihoods and they would be poverty stricken without the timber industry."

Several mechanisms by which individuals grew to accept more than one epistemology were expressed. Some interviewees described direct intercultural communication as a mechanism through which to build trust and understanding: "Obviously it is critical for our relationship that we maintain open

communications, build trust with one another, and foster that sentiment in new employees that come here.”

Diverse personal experiences, often related to travel, professional changes, and education, were also cited as mechanism by which individuals come to understand other points of view. One individual shared that a new job led to ecological epistemology adjustments:

“My perception about Potlatch and logging was basically like everybody else. I thought forestry was bad, that it just strips forests of the trees; that it doesn’t help. But after working here, now I realize we need to manage because it’s not like it was before Europeans got here. Once the Euro-Americans cut the trees down forestry management was needed to ensure the continuation of our forests.”

Finally, participants in this study did not connect organizational position with capacity to understand alternative points of view. Instead, interviewees expressed admiration for all individuals, including both those in leadership positions and non-decision makers, that were “sincere,” “believable,” “honest,” “open,” “direct,” “willing to see other lives and cultures,” and whose “glass of knowledge isn’t full.” Participants criticized leaders at multiple levels within both the LLDRM and the CNF who “are unwilling to listen,” and who “think [they] know everything.” These perspectives support researcher observations that those individuals in professional positions that required a high degree of inter-organizational collaboration, such as fire management, moved very smoothly between expressing TEK and WSEK related perspectives.

Discussion

Theoretical implications

In the relevant literature section of this article Berkes' (1999) model of TEK was presented. His model describes the two central features of TEK as a certain mode of knowledge generation and as a set of ecological information, values, beliefs, and processes. The findings of this study suggest that Berkes' model is not a framework only of TEK but of ecological knowledge in general. This means, and the findings of this study support, the perspective that worldview is not only an important component of knowledge in traditional epistemologies; western science carries with it an influential worldview as well.

Further, the perspectives shared by interviewees throughout this study suggest that the ecological worldview component of Berkes' model is comprised of three subcategories: ecological values, ecological narrative, and beliefs about the nature of knowledge. This subdivision reflects participant responses concerning both TEK and WSEK. WSEK not only entails an ecological worldview, but its worldview can be described as a set of ecological values, an ecological narrative, and a set of beliefs about the nature of knowledge. These are not elements that have typically been acknowledged to be a part of WSEK.

Also presented in the relevant literature section of this article was Barnhardt and Kawagely's (2005) model of TEK and WSEK, a model that suggested that the two epistemologies are unique in some important ways while also sharing much in common. The professional resource managers interviewed for this study lent credibility to that model by sharing many perspectives in

common but also emphasizing the distinctions between important values, beliefs, and practices associated with TEK and WSEK. Both through direct critique and through value-laden differentiation between TEK and WSEK participants revealed perceived deficiencies in both epistemologies.

Still, the resource managers interviewed do not consistently subscribe to only TEK or WSEK despite the assertions of many that each epistemology has serious failings. This indicates that individuals, whether they have explicitly acknowledged it or not, understand that the fullest understanding of the ecological world comes from embracing both WSEK and TEK instead of exclusively subscribing to one. Furthermore, the ability to utilize multiple ecological epistemologies can be developed, exists most in those who have consistent intercultural contact, was not acknowledged to be inherently present in leaders, and is widely respected and appreciated. Figure 6, an image based upon the Barnhardt and Kawagely (2005) model of TEK and WSEK presented in this article's literature review (Figure 5) visually presents these concepts. It shows the Venn diagram of TEK and WSEK overlaid with a circle representing the knowledge that an individual resource manager relies upon. It illustrates that an individual is not bound to one ecological epistemology but rather may generate and utilize both TEK and WSEK.

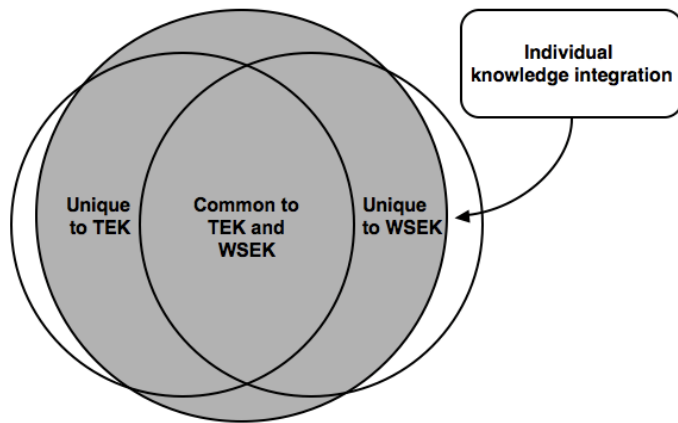


Figure 6: Individual knowledge integration

These findings also suggest that Berkes' (1999) model of TEK (or of ecological knowledge, as suggested above) could also be adjusted by adding a fifth level of analysis on top of his original four levels. This level, perhaps titled "epistemological reflexivity" consists of one's perspective on one's own ecological epistemology. At this level an individual answers the question: "is my way of seeing the world the only appropriate way, or are others equally valid?" The response of participants in this study suggest that this fifth level could be extremely important as it provides the lens through which both one's own and others' ecological epistemologies are evaluated.

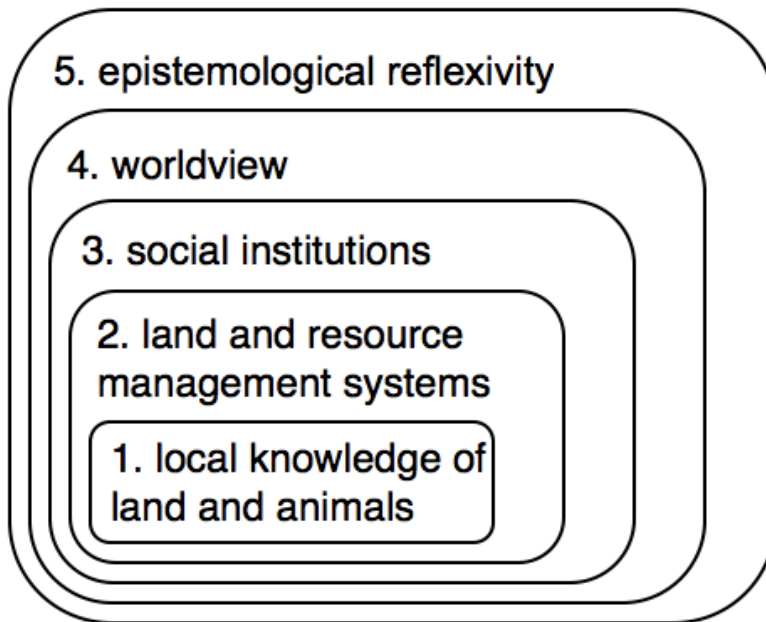


Figure 7: A fifth level for Berkes (1999) model

The capacity of an individual to embrace both TEK and WSEK suggests a weakness in the existing body of literature surrounding these epistemologies. Specifically, it suggests that the duality between the two ecological epistemologies need not be absolute. While it may well be possible that individuals exist that operate wholly within one epistemology or the other, that the resource managers who participated in this study integrate both ways of knowing indicates that there is no reason to assume that the duality exists as strictly as it has been described by recent literature on the subject. An ecological epistemology is one cohesive lens through which to understand the natural world but there is no reason that individuals need exclusively adhere to only one. Ecological epistemology is not synonymous with individual ecological perspective.

Managerial Implications

These findings are highly relevant for leaders of environmental management agencies for, at least, three reasons.

First, they emphasize the importance of recognizing the ecological epistemologies in which individuals and agencies operate. This is of particular importance for individuals and agencies that consider themselves associated primarily with a western-scientific knowledge framework. This research points out that, like TEK, WSEK includes a powerful worldview that consists of ecological values, ecological narrative, and beliefs about the nature of knowledge. It is essential to recognize this.

Secondly, that limitations of both TEK and WSEK were identified at all levels of analysis indicates that best management may be the product of decision-making processes that incorporate the knowledge generation approaches, the observations, the management systems, and the worldviews of both TEK and WSEK. While selectively picking information from one ecological epistemology to add to the other may provide a degree of greater understanding for managers, the depth of difference between the two epistemologies suggests that the richness from each knowledge system cannot simply be skimmed off the top. Rather, the greatest benefits are likely to be gained through genuine engagement between TEK and WSEK at all levels of analysis.

Finally, these findings reaffirm that personal cross-cultural experience is an essential component to personal and professional development. Participants consistently hailed diverse educational, professional, and personal experiences

as the key in the development of individuals who understand how their ecological epistemology relates to those of others and affects their work.

Conclusions

This article has focused on the relationship between two distinct ecological epistemologies, traditional ecological knowledge and western scientific ecological knowledge, as they relate to the management of natural resources by the Leech Lake Division of Resource Management and the USDA Forest Service Chippewa National Forest. Key theoretical findings are that Berkes' (1999) model of TEK is better presented as a model of ecological knowledge generally, that both TEK and WSEK are perceived to have significant limitations, and that individuals respect multiple ecological epistemologies and are poorly described if labeled with only one. Management implications relate to the importance of recognizing worldview in all ecological epistemologies, the value of genuine engagement between WSEK and TEK, and the significance of direct intercultural contact.

CHAPTER FIVE – DISCUSSION

The previous chapter of this report discussed several interesting results that have already come from this study. On a theoretical level, those results suggest that WSEK and TEK are structurally similar, that ecological worldview can be described as consisting of values, narrative, and beliefs about knowledge, that both TEK and WSEK are perceived to be deficient in key ways, and that individuals do not subscribe to only one ecological knowledge system and can change over time.

On a natural resource management level these findings mean several things. Among them are that personal ecological epistemology should be recognized and appreciated, that management can be bettered through the engagement of both TEK and WSEK, and that individuals can come to understand different ecological epistemologies by being exposed to them.

Future research

Ecological epistemology was chosen as the core category for this report for several reasons; most prominent among these was that the interview coding process revealed that interview participants connected ecological epistemology clearly and in interesting ways to other key concepts. The data analysis process also revealed that several other core categories could be developed.

In the immediate future, two directions for further investigation exist. The first relates to place identity among resource managers. The managers with whom we spoke shared with us their personal histories, including extensive

reflections on their relationships with the area. In short, their relationships varied enormously, from those who had just relocated to the area and still commuted miles to work to those who had lived in Cass Lake for many decades. Dynamics associated with place identity are lent even more importance in light of many interviewees perception that CNF staff turnover and lack of connection to the area was a significant conflict driver.

Secondly, many interviewees shared interesting perspectives on forest change and forest health. These ranged from perceptions of no ecological change whatsoever to rapid change and from perceptions that linked forest health both to thoughtful forestry and to the absence of all forest management activities. In the context of climate change, increasing urban pressures, increasing demand for forest products, and ever northward marching invasive species the various perspectives of tribal and non-tribal managers is extremely important.

Conflict drivers, management influences, intra-agency relationships, and interagency communication are a few more potential core categories. Unlike place identity and perceptions of forest change/forest health, these categories may require further data analysis or further interviews with resource managers. Nonetheless, concentration on any one of these concepts could lead to theoretical and management insights as important as those presented in this report.

A further, yet still natural next step would be to conduct a similar grounded theory study of the USDA Forest Service's relationship with another tribal or local

forest management agency elsewhere in the country. This approach could focus in on how the USDA Forest Service collaborates with different types of organizations. It would add depth to the study presented in this report by suggesting the degree to which the lessons learned by studying the relationship between the LLDRM and CNF are generalizable.

Reflection upon methods

The methods for this study were appropriately chosen. The grounded theory approach allowed the researchers to remain open to new and novel ideas in a way that other research methods simply do not. One slight adjustment that may be of interest to future researchers doing similar work may be the incorporation of word-association research. It was evident from the responses given by several interviewees that words mean different things to different people. In fact, one said nearly exactly that:

“We try to use the terms that the Forest Service uses, but we’re thinking something differently when we use their words. Maybe there are some misconceptions in those concepts that we’re trying to talk about and they’re trying to talk about and that’s creating a disconnection in our communication.”

All individuals that we interviewed were quite familiar with the jargon associated with forestry and natural resource management. Nonetheless, it is possible that despite using common terms, individuals ascribed different value to words and phrases and that by not probing specifically for word meaning we missed this level of depth. Taking the time to probe not only interviewees’

perspectives but the words that they use to express those perspectives would undoubtedly reveal interesting dynamics.

Information dissemination

The results of this study will be of interest to many people, particularly those interested in the relationships between distinct ecological epistemologies and collaborative management of natural resources. But they will also be of intense interest locally, to the staff of the LLDRM and CNF who so enthusiastically and generously gave their time and energy to this process. As decisions regarding further interview analysis are made, the research team will also need to concern itself with getting the information gained through this study into the hands of those who can use it, both locally and otherwise.

One avenue for disseminating the results presented here, and the results of future analyses, is through various forms of publication. Beyond the submission and electronic distribution of this thesis this will be done in at least three ways. First, the results section of this paper was written with the intention that it could be extracted from the document and submitted for publication. Human Ecology has been chosen as the most relevant journal, and that portion of this paper will be submitted. Secondly, the results presented here will also be trimmed down and revised, removing those contents not of interest for an audience of managers. That paper will be distributed through Treesearch, the USDA Forest Service's internal research distribution system, as well as directly to staff of the LLDRM and CNF. Finally, a single page executive summary of research findings will also be distributed directly to staff and stakeholders with

the LLDRM and CNF.

While a thesis, an article, and an executive summary will make the results of this study available and usable for many individuals, one other option for results dissemination may be of interest. The last question of each interview, asked informally as interviewees were filling out their demographic background forms, was, "how can we get this information back into the hands of people here in Cass Lake who will use it best?" Overwhelmingly participants from both the LLDRM and CNF suggested that a workshop or focus group in Cass Lake would potentially be of interest. Given the nature of many of the perspectives presented in this document and the continually evolving nature of the relationship between the LLDRM and CNF, an in-person presentation and facilitated discussion would be a delicate proposition. Nonetheless, the research team should connect with the leadership at the LLDRM and CNF to pursue this option.

Conclusion

This report has examined the relationship between the Leech Lake Band of Ojibwe's Division of Resource Management and the USDA forest Service Chippewa National Forest. Specifically it has focused in on how two distinct ecological epistemologies, traditional ecological knowledge and western scientific ecological knowledge, relate to the management of natural resources. Key theoretical findings are that Berkes' (1999) model of TEK is better presented as a model of ecological knowledge generally, that both TEK and WSEK are perceived to be significantly deficient in some ways, and that individuals respect multiple ecological epistemologies and are poorly described if labeled with only

one. Management implications relate to the importance of recognizing worldview in all ecological epistemologies, the value of genuine engagement between WSEK and TEK, and the significance of direct intercultural contact.

REFERENCES

- Atran, S., Medin, D., & Ross, N. O. (2006). The cultural mind: Environmental decision-making and cultural modeling within and across populations. *Psychological Review*, 112(4), 744–776.
- Baird, I. G., & Flaherty, M. S. (2005). Mekong River fish conservation zones in southern Laos: Assessing effectiveness using local ecological knowledge. *Environmental Management*, 36(3), 439-454.
- Barnhart, Shauna (2011). Advancing human rights through community forestry in Nepal. In Sikor, T., & Stahl, J., *Forests and People* (85-98). New York, NY: Earthscan.
- Barnhardt, R., & Kawagely A. O. (2005). Indigenous knowledge systems and Alaska Native ways of knowing. *Anthropology and Education Quarterly*, 36(1), 8–23.
- Beebeejaun, Y. (2006). The participation trap: The limitations of participation for ethnic and racial groups. *International Planning Studies*, 11, 3-18.
- Bengston, D. (2004). Listening to neglected voices: American Indian Perspectives on Natural Resource Management. *Journal of Forestry*, 1, 48-52.
- Berkes, F. (ed). (1989). *Common property resources: Ecology and community-based sustainable development*. London, UK: Belhaven Press.
- Berkes, F. (1999). *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*. Philadelphia, PA: Taylor & Francis.

- Berkes, F. (2012). *Sacred Ecology: Traditional Ecological Knowledge and Resource Management (Volume Three)*. Philadelphia, PA: Taylor & Francis.
- Berkes, F., & Turner, N. J. (2006). Knowledge, learning and the evolution of conservation practice for social-ecological system resilience. *Human Ecology*, 34(4). 479-494.
- Brady, Tim (n.d.). The Real Story of Chippewa National Forest. *Minnesota Conservation Volunteer: Minnesota DNR*. MNDNR.
<http://www.dnr.state.mn.us/volunteer/novdec04/chippewanf.html>.
- Campese, J., & Borrini-Feyerabend, G. (2011). Human rights-based approach to conservation: promise, progress...and pitfalls? In Sikor, T., & Stahl, J., *Forests and People* (47-62). New York, NY: Earthscan.
- Callicott, J. B., & Nelson, M. P. (2004). *American Indian Environmental Ethics: An Ojibwa Case Study*. Upper Saddle River, NJ: Pearson.
- Castro, A. P., & Nielsen E. (2001). Indigenous people and co-management: Implications for conflict management. *Environmental Science & Policy* 4, 229–239.
- Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. Thousand Oaks, CA: Sage Publications.
- Crooks DL (2001) The importance of symbolic interaction in grounded theory research on women's health Health Care for Women International 22,11-27.

- Cohen, L., Manion, L., & Morrison, M. (2007). *Research methods in education* (6th Ed.). New York, NY: Routledge.
- Cook-Lynn, Elizabeth (2000). How scholarship defames the native voice... and why. *Wicazo Sa Review*, 15(2), 79-92.
- Corbin, J., & Strauss, A. (2008). *Basics of qualitative research* (3rd Ed.). Los Angeles, CA: Sage Publications.
- Davenport (forthcoming)
- Debebe, Gelaye (2008). Cross-cultural competence and power-based rules: A Native American case study. *International Journal of Intercultural Relations*, 32, 399–414.
- Deloria Jr., Vine (1999). *For This Land: Writings on Religion in America*. New York, NY: Routledge.
- Deloria Jr., Vine (2003). *God is Red: A Native View on Religion*. New York, NY: Putnam Publishing Group.
- Glaser, B, Strauss A (1967) *The discovery of grounded theory: Strategies for qualitative research* New York: Aldine de Gruyter.
- Glaser, B (1978) *Theoretical sensitivity*, California, The Sociology Press.
- Glaser, B (1992) *Basics of grounded theory analysis Emergence vs. forcing* California: Sociology Press.
- Griggs, Richard A. (1997). The cultural dimensions of environmental decision-making. *Independent Projects Trust*, n.p.
- Hahn, T., Olsson, P., Folke, C., & Johansson, K. (2006). Trust-building, knowledge generation and organizational innovations: The role of a

bridging organization for adaptive comanagement of a wetland landscape around Kristianstad, Sweden. *Human Ecology*, 34(4), 573-592.

Hart, Michael. A. (2010). Indigenous worldviews, knowledge, and research: The development of an indigenous research paradigm. *Journal of Indigenous Voices in Social Work*, 1(1), 1-16.

Indian Affairs Council. (n.d.). "Tribes: Leech Lake." Indian Affairs Council: Minnesota. Retrieved from:
http://www.indianaffairs.state.mn.us/tribes_leechlake.html.

Jacobson, S. K., Morris, J. K., Sanders, J. S., Wiley, E. N., Brooks, M., Bennetts, R. E.... & Marnowski, S. (2007). Understanding barriers to implementation of an adaptive land management program. *Conservation Biology*, 20(5), 1516–1527.

King, Leslie (2004). Competing knowledge systems in the management of fish and forests in the Pacific Northwest. *International Environmental Agreements: Politics, Law and Economics*, 4, 161–177.

Krech III, Shepard (1999). *The Ecological Indian: Myth and History*. New York, NY: W.W. Norton & Company, Inc.

Krech III, Shepard (2005). Reflections on conservation, sustainability, and environmentalism in indigenous North America. *American Anthropologist*, 107, (1), 78–86.

LaDuke, Winona (2005). *Recovering the Sacred*. New York, NY: South End Press.

- LaFever, Marcela (2008). Communication for public decision-making in a negative historical context: Building intercultural relationships in the British Columbia treaty process. *Journal of International and Intercultural Communication*, 1(2). 158-180.
- Leach, Amy J. (2011). Assessing Yukon's current approach to regional land use planning: Perspectives from the North Yukon planning process. University of Alberta, Alberta.
- Leech Lake Band of Ojibwe (n.d. a). "About Us: Division of Natural Resources." Retrieved from: <http://www.ildrm.org/subnav/aboutus.html>.
- Leech Lake Band of Ojibwe (n.d. b). "Leech Lake Band of Ojibwe: Homepage" Retrieved from: <http://www.llojibwe.com/>.
- Lewis, David R. (2010). American Indian environmental relations. In Sackman, D. C. (Ed.) *A Companion to American Environmental History*. UK: Blackwell Publishing Ltd.
- Medin, D., Ross, N., Cox, D., & Atran, S. (2006). Why folkbiology matters: Resource conflict despite shared goals and knowledge. *Human Ecology*, 35, 315-329.
- Medin, D. L., Ross, N. O., Atran, S., Cox, D., Coley, J., Proffitt, J. B., & Blok, S. (2006). Folkbiology of freshwater fish. *Cognition*, 99, 237-273.
- Miles, M., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage publications.
- Miller, R J. (2012). Reservation "Capitalism": Economic development in Indian country. ABC-CLIO.

- Murray, G., Neis, B., & Johnson, J. P. (2006). Lessons learned from reconstructing interactions between local ecological knowledge, fisheries science, and fisheries management in the commercial fisheries of Newfoundland and Labrador, Canada. *Human Ecology*, 34(4), 549-571.
- Murray, C., Wieckowski, K., Hurlburt, D., Soto, C., & Johnnie, K. (2011). Incorporation of traditional and local knowledge and values in fisheries management. Final Report. Prepared for the Pacific Resource Conservation Council, Vancouver, BC, by ESSA Technologies Ltd., Vancouver, BC, 92 pp.
- Parlee, B., Berkes, F., & Teetl'it Gwich'in Renewable Resources Council (2006). Indigenous knowledge of ecological variability and commons management: A case study on berry harvesting from northern Canada. *Human Ecology*, 34(4), 515-528.
- Peacock, T., & Wisuri, M. (2009). *Ojibwe: We Look In All Directions*. Afton, MN: Afton Historical Society Press.
- Pinkerton, E. (1999). Factors in overcoming barriers to implementing co-management in British Columbia salmon fisheries. *Conservation Ecology*, 3(2).
- Plummer, R., & Fitzgibbon, J. (2004). Co-management of natural resources: A proposed framework. *Environmental Management*, 33(6), 876–885.
- Ross, N., Medin, R., & Cox, D. (2007). Epistemological models and culture conflict: Menominee and Euro-American hunters in Wisconsin. *Ethos*, 35(4), 478–515.

- Ross et al. (2011). *Indigenous Peoples and the Collaborative Stewardship of Nature*. Walnut Creek, CA: Left Coast Press, Inc.
- Rubin & Rubin (2011). *Qualitative Interviewing: The Art of Hearing Data. Third Edition*. Thousand Oaks, CA: SAGE Publications.
- Ryan, G. W., & Bernard, H. R. (2003). Techniques to identify themes. *Field Methods*, 15(1), 85–109.
- Seidman, I. (2006). *Interviewing as qualitative research: A guide for researchers in education and the social sciences (3rd Ed.)*. New York, NY: Teacher's College Press.
- Silvano, R. A., & Valbo-Jørgensen, J. (2008). Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. *Environment, Development and Sustainability*, 10(5), 657-675.
- Trosper, Donald L. (2007). Indigenous influence on forest management on the Menominee Indian Reservation. *Forest Ecology and Management*, 249, 134–139
- US Census Bureau (2012). "2010 Census Data - 2010 Census." Retrieved from: <http://2010.census.gov/2010census/>.
- US Senate Committee on Indian Affairs. Legislative hearing to examine S. 1739, the Minnesota Chippewa tribe judgment fund distribution act. By Arthur LaRose. 2 Feb. 2012. <http://www.indian.senate.gov/>.
- USDA Forest Service. (2004). *Land and Resource Management Plan: Chippewa National Forest*. Chippewa National Forest, MN.

USDA Forest Service (n.d. a). "History and Culture." USDA Forest Service:
Chippewa National Forest. Retrieved from:

<http://www.fs.usda.gov/main/chippewa/learning/history-culture>>

USDA Forest Service (n.d. b). "Tribal Relations." USDA Forest Service:
Chippewa National Forest. Retrieved from:

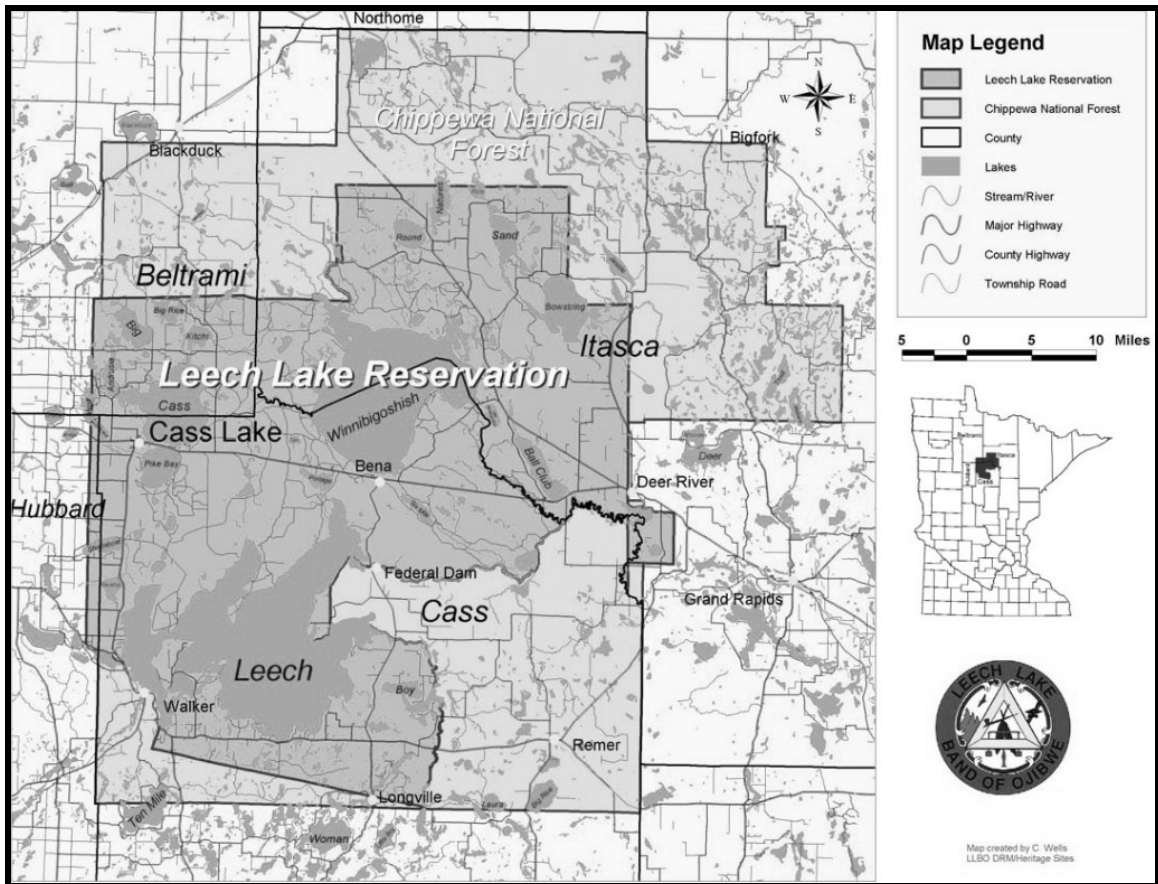
<http://www.fs.usda.gov/main/chippewa/workingtogether/tribalrelations>.

Warren, W., & Schenck, T. (2009). *History of the Ojibway People, 2nd Edition*.
Minneapolis, MN: Minnesota Historical Society Press.

Zimmerer, K. S. (2000). The reworking of conservation geographies:
Nonequilibrium landscapes and nature-society hybrids. *Annals of the
Association of American Geographers, 90*, 356 –369.

APPENDICES

APPENDIX A – MAP OF LEECH LAKE INDIAN RESERVATION AND CHIPPEWA NATIONAL FOREST



SOURCE: (LLDRM 1985)

APPENDIX B – PROJECT DESCRIPTION

Project Title: Tribal and Non-tribal Responses to Forest Change in Northern Minnesota

Principal Investigator: Mae Davenport, Ph.D., Department of Forest Resources, University of Minnesota, e-mail: mdaven@umn.edu, voice: 612-624-2721

Project Timeline: August 2011 – December 2014

Project Description:

The primary goal of this project is to explore the management of forest change across tribal and non-tribal resource management agencies in northern Minnesota. In partnership with the USDA Forest Service Northern Forest Research Station, researchers in the Department of Forest Resources at the University of Minnesota are conducting a series of interviews with natural resource professionals in state, federal and tribal natural resource management agencies about forest change, responses to change, and communication between agencies in forest management.

Adaptive management requires learning from the past, co-creating new knowledge, and using innovative problem-solving to address environmental problems. Most research on adaptation in the U.S. has focused on *western scientific ecological knowledge* and its application; indigenous ways of generating and using *traditional ecological knowledge* differ significantly from western scientific approaches and have been far less studied. This study will document diverse perspectives on the creation, dissemination, and application of ecological knowledge in forest management.

Researchers will initiate the project by building partnerships with local leaders and resource management professionals. These representatives will provide input on study design and implementation and will identify key project outcomes of relevance to their community. Data will be gathered through in-depth interviews with tribal and non-tribal resource professionals. Interviews will investigate (1) general ecological knowledge, (2) characterizations of forest change and agency responses to change, and (3) perceptions of communication processes and relationships between resource management agencies.

We aim to identify the knowledge and problem-solving strategies that tribal and non-tribal resource managers can use to enhance their ability co-manage forest ecosystems. We also will develop an assessment tool that can be used to evaluate and enhance a community's ability to respond to environmental stressors or threats that may include flooding, windstorms, wildland fire, forest health impacts, water quality impairments, invasive species, or loss of habitat.

The tool will enable local stakeholders (e.g., community leaders, resource professionals, educators, and extension agents) to assess and build capacity to adapt to ecosystem change. This information will help local leaders and resource professionals build resources that are critical to emergency responses, ecological planning and management, and community visioning and goal setting. It will also inform policy decisions associated with reducing community vulnerabilities to ecological change.

APPENDIX C – ABRIDGED PROJECT DESCRIPTION

Project Title: Tribal and Non-tribal Responses to Forest Change in Northern Minnesota

Principal Investigator: Mae Davenport, Ph.D., Department of Forest Resources, University of Minnesota, e-mail: mdaven@umn.edu, voice: 612-624-2721

Project Timeline: August 2011 – December 2014

Project Description:

The primary goal of this project is to explore the management of forest change across tribal and non-tribal resource management agencies in northern Minnesota. In partnership with the USDA Forest Service Northern Forest Research Station, researchers in the Department of Forest Resources at the University of Minnesota are conducting a series of interviews with natural resource professionals in state, federal and tribal resource management agencies about forest change, responses to change, and communication between agencies in forest management. Data will be gathered through in-depth interviews with tribal and non-tribal resource professionals. Interviews will investigate (1) general ecological knowledge used in forest management, (2) characterizations of forest change and agency responses to change, and (3) perceptions of communication processes and relationships between resource management agencies. Project findings and recommendations for enhancing co-management strategies and responses to forest change will be communicated back to resource managers.

APPENDIX D – EMAIL SCRIPT

Tribal and Non-tribal Responses to Forest Change in Northern Minnesota Department of Forest Resources, University of Minnesota **Email Contact Script**

Hello [name],

My name is [name]. I am a graduate student conducting research on the management of forest change for Mae Davenport, Assistant Professor in the Department of Forest Resources at the University of Minnesota. The primary goal of this project is to explore the management of forest change across tribal and non-tribal resource management agencies in northern Minnesota. To do this, I have been conducting interviews with professional natural resource managers in the area of the Leech Lake Indian Reservation and Chippewa National Forest. I am hoping you would be able to assist me by participating in the study and sharing your perspectives with me. The interview takes about one hour. Would you be willing to participate?"

To let me know if you would be willing to participate, or if you have any questions about the project or the interview don't hesitate to contact me at buss0215@umn.edu or 612-418-1125 or the Research Supervisor, Mae Davenport at 612-624-2721 or mdaven@umn.edu.

Thank you,

[name]

APPENDIX E – INTERVIEW GUIDE

Tribal and Non-tribal Responses to Forest Change in Northern Minnesota Department of Forest Resources, University of Minnesota **Interview Guide – 3/12 – 3/14, 2013**

To begin, I have a few general questions about your connection to this community and your experiences with natural resources.

- 1. Tell me a little bit about your connection to the community here.**
2. What are a few of the things that you like most about this area?
- 3. What are your primary responsibilities in your current position?**
4. What do you like most about your job?
5. What do you like least about your job?

Next, I'd like to describe this area and any changes you have observed.

- 6. What story would you tell someone who has never been here before about this place?**
 - a. [If don't know...] How would you describe the forest to someone who has never been here before?
7. What are some highlights about the history of this place?
- 8. What are some important things to know about the relationship people have with this place?**
9. Is this place unique from other areas in Minnesota today? Please explain.
 - a. If not, how is it similar?
- 10. Has this area changed since you first got to know it? Please explain.**
 - a. [If changes...] What do you think has caused the changes you described?
 - b. What sorts of consequences have these changes had for the ecosystem?
 - c. What sorts of consequences have these changes had on the people here?

Next, I have some questions for you about forest management.

- 11. How would you describe [your agency's] approach to forest management?**
 - a. **How does [your agency] define success in forest management?**
- 12. What sources of information and knowledge does [your agency] use in managing the forest?**
- 13. How is [your agency] addressing the forest changes you described earlier?**
 - a. What type of activities or programs is [your agency] leading?
 - b. What activities or programs does [your agency] do independently? Please explain.

- c. What activities or programs does [your agency] do in cooperation with other agencies?

14. Is your agency's approach to forest management similar to or different from other agencies that manage this forest? Please explain.

The next set of questions asks about your perspectives on other agencies' management of the forest and your relationship with those agencies.

15. How would you describe the approach to forest management of the other agencies that manage this forest?

- a. How does [agency 1, agency 2...] define success in forest management?
- b. Do any differences in approaches between [your agency] and [agency 1, agency 2...] pose challenges in managing the forest at an ecosystem scale? Please explain.

16. How would you describe the relationship between your agency and [agency 1, agency 2...]?

- a. In what ways is the relationship good?
 - a. Are there specific management activities in which your agency works very well with the [agency 1, agency 2...]? Please describe. What makes this work?
- b. In what ways is the relationship not so good?
 - a. Are there specific management activities in which your agency and [agency 1, agency 2...] does not work so well together? Please describe. What makes this not work so well?

Finally, I'd like to look forward and ask you a few questions about forest management into the future.

17. Are you concerned about the effects of climate change on the forest? Please explain.

18. Is your agency taking steps to prepare for climate change?

- a. If so, what types of things is your agency doing?

19. Has your agency collaborated with the CNF/LLDRM in preparation for the effects of climate change? Please explain.

20. How important do you believe it is that the CNF and the LLDRM work together to manage the forest in the future?

21. In what ways could the relationship between the two agencies be improved?

- a. What would be needed to make those changes happen?
- b. Are there barriers to improving the relationship between the two agencies? Please explain.

22. Would improving the relationship between the two agencies affect forest management?

23. To close, is there anything else I should know about your agency, its approach to forest management, or the relationship between the CNF and the LLDRM?

Thank you so much for your time. Before you go could you please do two things. First, could you fill out this demographic information sheet – as with other aspects of this research you will be completely anonymous. Second, could you share any ideas you have about how to make the conclusions of this study useful to the resource managers in this area? While we have a few ideas of how that could be done, we'd love to hear yours.

APPENDIX F – CONSENT FORM

Tribal and Non-Tribal Responses to Forest Change in Northern Minnesota Department of Forest Resources, University of Minnesota **Consent Form (version February 8, 2013)**

You are invited to participate in a research study of natural resource management responses to forest change in northern Minnesota and communication between agencies in managing change. You have been selected to take part because you are a natural resource professional working in Minnesota's forests. This study is being conducted by Mae Davenport, Associate Professor at the Department of Forest Resources, University of Minnesota.

Background Information

The primary goal of this project is to explore the management of forest change across tribal and non-tribal resource management agencies in northern Minnesota.

Procedures:

If you agree to be in this study, we would ask you to do the following things: Participate in an interview, lasting approximately 60 minutes. The interviewers will take notes throughout the interview. Within two weeks of your interview, you will be provided with a copy of a summary of the interview. At that point you will be given the opportunity to expand upon or clarify ideas or descriptions presented in the summary.

Risks and Benefits of being in the Study

Risks associated with this study are minimal, responses are confidential and names will not be linked to any information in any publications. Benefits of participation include increased awareness of diverse perspectives on forest management. Study results in the form of a technical report will be made available to study partners, participants and the public.

Confidentiality:

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Interview notes will not have personal identifying information on them.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is: Mae Davenport. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at address: 115 Green Hall
1530 Cleveland Ave. North, St. Paul, MN 55108-6112, phone: 612-624-2721,
email: mdaven@umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

"I agree_____ I disagree_____ to have my responses documented"

"I agree_____ I disagree_____ that Mae Davenport may quote me anonymously in her papers"

Signature:_____ Date:

Signature of Investigator:_____ Date:

APPENDIX G – PARTICIPANT BACKGROUND FORM

Tribal and Non-tribal Responses to Forest Change in Northern Minnesota
Department of Forest Resources, University of Minnesota
Demographic Information (Version February 8, 2013)

1. What is your current position with your organization? _____

2. How many years have you been in this position? _____

3. How many years have you been with your organization overall? _____

4. In what community do you live? _____

5. How many years have you lived in this community? _____

6. What is your age? _____

7. What is your gender? _____

8. What is your race and/or ethnicity? _____

9. What is the highest level of formal education you have achieved? _____

10. We would like to send you a copy of your interview summary for your review.
What contact information should we use to send it to you (e.g., address or e-mail)?

11. Would you like to receive a copy of the final study report? Yes ____ No

APPENDIX H – REQUEST FOR INPUT EMAIL

Hello [Participant],

I am writing to follow up with you on the research interviews that we performed two weeks ago. We sincerely appreciated the time you took to meet with us.

As we discussed with you then, we would like to give you the opportunity to review a summary of our interview with you. The three of us did our best to document your perspectives. However, we'd like you to review the summary for accuracy and provide us with any feedback you might have or fill in any gaps. Our goal is to represent what you shared with us in the interview as faithfully as possible.

Attached to this e-mail is a summary of the interview in MS Word format. It also includes more detailed instructions and information to keep in mind as you review the summary.

If you have edits or feedback, please send that to us by April Nth (that's two weeks from today). If we don't receive a response from you within two weeks, we will assume that you do not wish to make any revisions to the summary.

Please feel free to contact me via this email address or call me at 612-418-1125 if you have any questions or concerns.

Thank you.

Sincerely,

John Bussey