SOCIAL, CULTURAL, AND ECOLOGICAL SYSTEMS' INFLUENCE ON COMMUNITY HEALTH AND WELLBEING

SOCIAL, CULTURAL, AND ECOLOGICAL SYSTEMS' INFLUENCE ON COMMUNITY HEALTH AND WELLBEING

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Lay Abstract

The goal of this doctoral dissertation was to develop a better understanding of how social, cultural, and ecological systems impact community health and wellbeing in various contexts. Findings indicate climate and shipping changes impact Chesterfield Inlet, Nunavut through the relationship between food security, cultural continuity, and community health and wellbeing. Relatedly, harvesting activities, access to country food, satisfaction in Inuit governance, and community involvement all increase the probability that an Inuk living in the Arctic has good or great self-rated health. Additionally, Locally Managed Marine Areas, an approach to marine resources management that includes community members as key stakeholders, not only aligns with existing local and Indigenous management practices, but can also support biodiversity and increased catch of various species. Finally, by representing these research results in a single model called an ontology, we can make educated guesses about how these different studies are interconnected. The insights gained from this work can be adopted by decision-makers to create supports for and remove barriers to improved community health and wellbeing and community efforts to adapt to changes.

Abstract

An individual's health is influenced by more than just the health care system, but also in large part by the social determinants of health. People exist within broader social, cultural, and ecological systems which influence their health outcomes through the social determinants of health. This doctoral dissertation examines social, cultural, and ecological systems to understand several factors that support and hinder community health and wellbeing to inform future policy. This dissertation incorporates a mix of methodological approaches across four interrelated research studies to better understand direct and indirect factors influencing community health and wellbeing. In doing so, this thesis is divided into four research chapters.

Study 1 consists of a community-based research project that examines how food security, cultural continuity, and community health and wellbeing are connected through the sharing of harvested country food in Chesterfield Inlet, Nunavut, Canada. Based on this understanding we can demonstrate how climate change and increased shipping along the inlet affects the community as a result of changes in marine mammals and harvesting activities.

Study 2 presents a logistic regression that models how cultural continuity variables impact self-rated health for participants living in Inuit Nunangat in Canada. This model uses the Arctic Supplement questions of the Aboriginal Peoples Survey to compare measures of cultural continuity to traditional measures based on government services. This study demonstrates an important link between cultural continuity and self-rated health for Inuit living in Inuit Nunangat.

Study 3 contains a case study of different implementation successes and challenges of Locally Managed Marine Areas globally. These cases are used to understand how community member involvement as stakeholders in marine resource decision-making not only aligns with existing local and Indigenous ways of management, but also can enhance biodiversity as well as local livelihoods.

Finally, Study 4 uses ontology engineering methods to represent the results from the first three studies. This study demonstrates how this novel method can be used to illustrate the interconnectedness of results from different disciplines using diverse data sources and through the creation of different scenarios.

Taken together, these studies provide timely insights regarding the ways policy can support or hinder efforts to improve community health and wellbeing and adapt to climate changes.

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Family is a really important part of community in Chesterfield Inlet and their inclusive ways of defining family really resonated with me. There are a number of families who supported me along this journey in life so far, both within and beyond the confines of this PhD. From a young age my family was embraced by the Wood and Howes families who, along with the Vollmer family, Bob, Alan and Marlyn Newell, shaped the person I am today and my dreams for the future for which I am eternally grateful. During my PhD time it was my 541 family, Joslin's family, UNU-WWB and Health Policy families that kept me sane throughout this process. Thanks especially to Neil Barr and Lydia Garland, without whom I couldn't have seen the light at the end of the thesis tunnel. And thanks to the many friends over the last four years who have kept me busy outside of school so that I always came back to my research feeling refreshed.

Without a doubt, my committee was another really important family that made this thesis possible. Each committee member – Drs. Lisa Schwartz, Nidhi Nagabhatla, and Michelle Dion – contributed unique knowledge, skills, and important support that kept me going throughout the process. A huge thanks goes

out especially to Dr. Nancy Doubleday, my supervisor and mentor. You pushed me to be an independent researcher, knowing when to back off and when I needed more support. I can never thank you enough Nancy for helping me build a strong foundation for my career to grow upon.

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Table of Contents

List of Figures

List of Tables

List of All Abbreviations and Symbols

APS – Aboriginal Peoples Survey
ASEAN – Association of Southeast Asian Nations
BMU – Beach Management Units
CCA – Community Conservation Areas
CCG – Co-management Committees (Mozambique)
CCP – Fishing Community Councils (Mozambique)
CORDIO – Coastal Oceans Research and Development Indian Ocean
CRM – coastal resource management
DL – Descriptive Logic
EAFM – ecosystem approach to fisheries management
EAWLS – East African Wildlife Society
FFI – Flora and Fauna International
FLMMA – Fiji Locally Managed Marine Area Network
HS – high school
IA – Inuit Ancestry
ICM – integrated coastal management
ICZM – integrated coastal zone management
IPBES – Intergovernmental Platform on Biodiversity and Ecosystem Services
ITK – Inuit Traditional Knowledge or Inuit Tapiriit Kanatami
IUCN – International Union for Conservation of Nature
KCWA – Kuruwitu Conservation and Welfare Association
LMMA – Locally Managed Marine Area
MPA – marine protected areas
MSP – marine spatial planning
RS – Residential School
SES – socio-ecological system
SI – Self-identify as Inuit
SIDS – Small Island Developing States
SLiCA – Survey of Living Conditions in the Arctic
SWOT – Strengths, weaknesses, opportunities, and threats analysis
UNU-INWEH – United Nations University Institute for Water, Environment, and Health
WCS – Wildlife Conservation Society

Declaration of Academic Achievement

This dissertation is comprised of four original research studies (Chapters 2-5), as well as an introduction (Chapter 1) and conclusion (Chapter 6). I, Sarah Newell, am the lead author of these chapters. I was responsible for the conception and design of each of the four studies in collaboration with my primary supervisor, Dr. Nancy Doubleday. I completed all data collection and analysis for these studies, and prepared the drafts for all chapters. Dr. Doubleday contributed to the analysis and provided feedback on the written chapters. Dr. Michelle Dion contributed to the analysis and provided feedback for Chapter 3 and Dr. Nidhi Nagabhatla contributed to the analysis and provided feedback for Chapter 4. Drs. Dion and Nagabhatla, along with my other PhD supervisory committee member – Dr. Lisa Schwartz – provided comments and suggestions for Chapter 5 and on various drafts, which were incorporated into subsequent revisions and the final version of the dissertation.

Chapter 1
Introduction

This chapter introduces the original research studies contained within four chapters that make up the doctoral dissertation, along with a concluding chapter. The introduction lays out the context of social, cultural, and ecological systems that influence community health and wellbeing within which the dissertation is situated, followed by identification of the current gaps in the existing knowledge base. Next, the dissertation's overarching research question, objectives, and the theoretical framework are presented. Finally, the details of Chapters 2, 3, 4, and 5 studies are outlined to demonstrate how they address the gaps and needs outlined in this chapter.

Background/Context

> "The way most people talk about health doesn't capture a big enough picture. The conversation takes too narrow a focus on treating illness instead of preventing illness and addressing its root causes. As a result, what we really have is a sickness care system and not a health system at all." (Association of Ontario Health Centres, n.d.)

In a similar way, health policy should not be a field limited solely to the study of policies surrounding the health care system; rather the broader structures within society that influence an individual and community's health and wellbeing. Community health and wellbeing is a concept that is broader than the sum of health and wellbeing for all community members, it includes the broader system within which we survive and thrive, such as our social, economic, environmental, cultural, and political circumstances. As a result, it is important to consider this broader social, cultural, and ecological system when analyzing factors that influence

community health and wellbeing. It is only once we understand which factors strengthen communities that we can leverage them through appropriate policy supports. In addition, by also understanding those barriers we can ensure that policy is not part of the limitations communities have to overcome.

Community wellbeing is used internationally to go beyond health indicators to get a more accurate understanding of the quality of life of those individuals living within a community or country (Wiseman & Brasher, 2008). This is in response to a growing recognition that the biomedical model neglects many of the factors which influence an individual's health, factors often described as the social determinants of health (Inuit Tapiriit Kanatami, 2007; Marmot, Friel, Bell, Houweling, & Taylor, 2008; Morrissey, 2003; Richmond, 2009; Wilkinson & Marmot, 2003). It is only when addressing these broader social determinants of health that policy can build and support community health and wellbeing.

Socio-ecological system (SES) frameworks are often used to understand those factors which influence community wellbeing (Cote & Nightingale, 2012; Lebel et al., 2006; Leslie et al., 2015; Olsson, Folke, & Berkes, 2004; Ostrom, 2009). At its core, the SES framework examines how social, economic, and political settings interact with related ecosystems through resource and governance systems and through the people which make up these systems and use these resources (Ostrom, 2009). This framework has been used in a wide range of studies to develop indicators, understand resilience to disasters, and support adaptive management to various changes, such as loss of marine resources (Bavinck et al., 2017; Binder,

Hinkel, Bots, & Pahl-Wostl, 2013; Glaser, Krause, Ratter, & Welp, 2008; Sterling et al., 2017; Walker et al., 2002).

Despite the progress made with using the SES framework to include broader factors that influence health, this framework is missing the important factor of culture, which was essential to this dissertation in particular. Culture can be understood as the shared values, practices, experiences, social norms, and knowledge that unite a group of people. Researchers have argued that the coupling of social, cultural, and ecological systems is essential to adequately understand dimensions of wellbeing (Kassam, 2010; Poe, Norman, & Levin, 2014). Culture is not a factor which can be ignored or collapsed into other parts of the SES framework; rather it is important to separate out as it often influences how communities view ecological resources and make economic decisions (Poe et al., 2014). If we do not consider the cultural factors that influence decisions communities make about how they interact with their environments, we are at a loss for understanding why they make these decisions and how we can create appropriate policies that compliment rather than contradict these important influences.

In this dissertation, the expansion of the SES framework to include culture is essential to building the overarching theoretical framework described below. Two studies involve Inuit in the Canadian Arctic, where culture was an essential part of the data and results that emerged. Additionally, within the chapter about Locally Managed Marine Areas, culture is demonstrated to be an important factor in the success of implementing this resource management and governance approach.

Gaps Identified in the Current Literature

When reviewing the current literature surrounding community health and wellbeing and how policy can be informed by research in this field, there were several gaps, which this dissertation aims to address:

1. While research has often linked food security and culture, or food security and community wellbeing, there are few frameworks linking all three concepts (Council of Canadian Academies, 2014). (Study 1)
2. Limited research has been conducted with the community of Chesterfield Inlet, specifically research focusing on the impacts of shipping on community wellbeing. (Study 1)
3. Currently, understanding is limited regarding the social determinants of food security in the Arctic and how climate change will affect country food (or locally harvested food) systems (Council of Canadian Academies, 2014). (Study 1)
4. Analysis using the Arctic Supplement of the Aboriginal Peoples Survey has been limited in the past. (Study 2)
5. Research surrounding cultural continuity has often used a set of government measures –land claims, self-government, education services, police and fire services, health services, and cultural facilities – rather than culturally specific variables (Berkes, Berkes, & Fast, 2007; Castleden, Garvin, & Huu ay aht First Nation, 2008; Chandler & Lalonde, 1998). (Study 2)

6. There are few articles examining different cases implementing the LMMA approach to marine and coastal resource management. (Study 3)
7. Finally, there are limited efforts to represent social sciences research results using ontology engineering methods. (Study 4)

Overarching Research Question and Objectives

This dissertation aims to fill these research gaps through four original research studies, which are outlined below and described in more detail in Chapters 2, 3, 4, and 5. These studies seek to address the following overarching research question: "How can social, cultural, and ecological systems thinking be used to develop policy to strengthen community health and wellbeing and remove barriers in various contexts globally?" The key objectives used in the dissertation to address this research question include:

1. Examine the unique factors that influence health and wellbeing at a community and individual level (Study 1 and Study 2).
2. Explore the role that cultural continuity plays in community wellbeing for Inuit living in the Canadian Arctic (Study 1 and Study 2).
3. Develop a better understanding of what factors make LMMA implementation successful (Study 3).
4. Understand how representing research results in an ontology model can support interdisciplinary research and be used to inform policy (Study 4).

5. Generate evidence to inform policy that will support community wellbeing and adaptation to changes (Study 1, Study 2, Study 3, and Study 4).

Overarching Theoretical Framework of the Dissertation

The social, cultural, and ecological systems framework was used more broadly to drive the analysis for these four original studies. However, given the nature of Study 4, which attempts to understand how Studies 1, 2, and 3 are intertwined, an overarching theoretical framework for the dissertation was built. Within Study 1, the links between food security, cultural continuity, and community health and wellbeing were developed through a theoretical framework that helped shape the interview guide and informed the data analysis. It is this theoretical framework that was the foundation upon which Study 2 and 3 build, as shown in Figure 1. Figure 1 places the theoretical framework from Study 1 within the social, cultural, and ecological systems framework, which allows us to demonstrate how the various factors from Study 1, Study 2, and Study 3 influence community health and wellbeing.

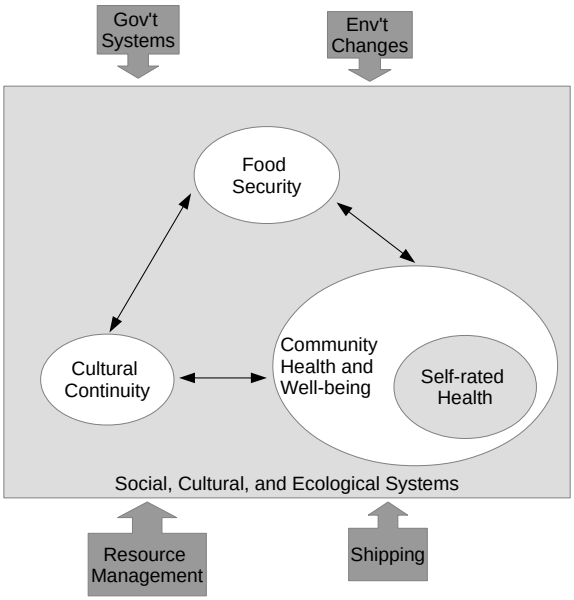

Figure 1: Theoretical framework for dissertation.

Overview of the Studies

Study 1 (Chapter 2): "Qaujimajatuqavut: The impacts of shipping and climate change on food security, cultural continuity, and community health and wellbeing for Chesterfield Inlet, Nunavut."*

The second chapter describes the results from a community-based research study conducted in collaboration with community members of Chesterfield Inlet, Nunavut to examine how shipping and climate change impact this community. This study first aims to understand how food security, cultural continuity, and community health and wellbeing are related using the theoretical framework developed prior to interviews (addressing research gap #1). This framework was used to understand how changes, such as increased shipping and climate change, impact these delicate relationships (addressing research gap #3). A community-based research approach was taken to ensure that the results were useful to the

community and the process was respectful of the community (addressing research gap #2).

In this study the importance of sharing country food to maintain cultural continuity and to support not just individual food security, but also community wellbeing, was a key finding. The insights gained about how shipping and climate change are impacting a hunter's ability to harvest country food were demonstrated through the sharing of marine mammals within the community. This chapter was only possible through the important contributions of the community of Chesterfield Inlet, David Kattegatsiak who recognized this as a potential opportunity for the community, and the organizations that helped put me in contact with them – Nunavut Association of Municipalities, Nunavut Food Security Coalition/Government of Nunavut, and Nunavut Research Institute.

Study 2 (Chapter 3): "Cultural continuity and Inuit health in Arctic Canada."

Building upon the insights of the previous study, Study 2 examines how cultural continuity can be linked to individual health. This study uses logistic regression methods to analyze the relationship between cultural continuity and self-rated health using the Aboriginal Peoples Survey. The models created in this study focus on Inuit Nunangaat (Inuit self-governed regions of Canada) and use the Arctic Supplement questions to explore different variables that can be used to measure cultural continuity that is specific to Inuit (addressing research gaps #4 & 5). Study 1 informed both this exploration of cultural continuity and the control variables specific to Inuit living in the Canadian Arctic. This study demonstrates that cultural

continuity has a statistically significant, positive relationship to self-rated health across two different ways of measuring cultural continuity.

Study 3 (Chapter 4): "Locally Managed Marine Areas (LMMAs) as the Future of Global Commons Resource Management."

The fourth chapter uses different cases to understand supports and barriers to LMMA implementation in different contexts. While the use of LMMAs to manage marine resources has increased in recent years, this study looks critically at not just the successes, but what policy and resource gaps exist which create barriers to successful implementation (addressing research gap #6). Both current literature and primary data are used to inform the different cases included in this study and understand the factors that might make LMMA implementation successful in Nunavut. The cases in this study demonstrate how LMMAs are successful at supporting biodiversity and conservation goals while limiting the negative impact on local fishing practices. However, cases also demonstrate the importance of different supports when implementing LMMAs such as legislation and funding.

Study 4 (Chapter 5): "An Ontological Model of the Social, Cultural, and Ecological Influences of Community Health and Wellbeing."

Study 4 performs the important function of linking the first three studies together in a novel way. This study uses computer engineering methods to represent the results of the first 3 studies, demonstrating the value of representing knowledge in an ontology model (addressing research gap #7). In this way, I demonstrate how an ontology model can be used to support interdisciplinary research through promotion of a systems approach to considering research results.

It is from Study 4 that the overarching theoretical framework was developed through the iterative process of defining the important concepts that need to be represented and the relationships between them. This study uses three scenarios to test the model which are based on the community perspective voiced in Study 1.

These four studies each take a different look at how social, cultural, and ecological systems impact community health and wellbeing. They aim to inform future policy so that it will support community adaptation to climate and other changes rather than hinder these efforts.

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Chapter 2

Qaujimajatuqavut [1]: The impacts of shipping and climate change on food security, cultural continuity, and community health and wellbeing for Chesterfield Inlet, Nunavut.

[1] Qaujimajatuqavut is the Inuktitut word for "our knowledge" as the research presented here represented the knowledge of community members from Chesterfield Inlet. This is not co-produced knowledge; rather, the knowledge community members were generous enough to share with the researchers about how climate change and shipping is impacting them. Different community members were involved in the conceptualization and design of the research project and many who chose not to participate stated that this was because they felt strongly that given those already involved, we had the knowledge needed to understand and answer our research questions.

Introduction

Food Security

Food security is a complex topic whose definition has changed over the years. The most comprehensive understanding of food security is having enough food, at an affordable cost, to meet nutritional and caloric needs, that is safe, healthy, and meets the preferences of the individual or household (Pinstrup-Andersen, 2009). This broad understanding is pertinent to this study as it includes important factors, such as cost and preference, which allow us to understand and address the complexity of food security in the Arctic.

Food insecurity is an important issue in the Arctic, with data from 2008 indicating that 70% of households in Nunavut experience moderate to severe food insecurity, the highest rate of any Indigenous population in a developed country (Cormier, 2016; Council of Canadian Academies, 2014). An important factor in Inuit food insecurity is the nutrition transition that has occurred recently as concerns over contaminants in traditional foods, increased availability of market foods, decreasing access to country food, and rising costs of gas and hunting equipment have led to eating more store-bought food (Chan et al., 2006; Council of Canadian Academies, 2014; Donaldson et al., 2010; Thompson, 2005). Country food, a term used by Inuit, describes food that is harvested locally on the land, such as caribou, seal, beluga, berries, etc.

There has been a growing body of literature about food security in the Canadian Arctic in the past 30 years (Ford & Beaumier, 2011). Focus has been on anthropological studies of food systems, biomedical studies of the impacts of

contaminant exposure, quantitative studies of nutrient intake and the prevalence of food insecurity, and more recently the implications of climate change on Inuit food systems (Council of Canadian Academies, 2014; Donaldson et al., 2010; Egeland, Williamson-Bathory, Johnson-Down, & Sobol, 2011; Ford & Beaumier, 2011). Previous research provides an important baseline upon which to demonstrate how changes are impacting community health and wellbeing of Inuit in the Canadian Arctic from their perspective. Food security is part of a larger, complex system, which needs to be understood at a community level in order to determine potential policies and strategies that build on the strengths of each community and create opportunities to adapt and thrive.

Cultural Continuity

When it comes to Indigenous health in Canada, there are many different ways in which colonial policies and cultural change have impacted health outcomes. The Indian Residential School system and the policies surrounding this system strove to eliminate Indigenous culture and assimilate Indigenous peoples into Canadian society (Kirmayer, Brass, & Tait, 2000; Truth and Reconciliation Commission of Canada, 2015b). There is growing awareness of the harmful health impacts of not only attending residential schools, but also of the intergenerational impacts of such trauma (Hackett, Feeny, & Tompa, 2016). Efforts to retain and build culture at the level of both individuals and communities have been seen to greatly impact the health of Indigenous peoples (Kirmayer et al., 2000). Cultural continuity in this context is defined as the continuation of traditional culture within modern society

(Oster, Grier, Lightning, Mayan, & Toth, 2014) or as "the degree of social and cultural cohesion within a community" (Reading & Wein, 2009).

Community Health and Wellbeing

The definition of community wellbeing has changed over time and varies across different disciplines (La Placa, McNaught, & Knight, 2013; Parlee & Furgal, 2012; Wiseman & Brasher, 2008). However, there is a growing recognition that individual health and wellbeing cannot be separated from the context within which we live, especially for Inuit communities (Kral & Idlout, 2012; La Placa et al., 2013; Wiseman & Brasher, 2008). In a very real way, community health and wellbeing is more than the sum of every individual's wellbeing: it includes their relation to the broader environment. For the purposes of this research, community health and wellbeing is understood to be "the combination of social, economic, environmental, cultural, and political conditions identified by individuals and their communities as essential for them to flourish and fulfil their potential" (Wiseman & Brasher, 2008, p. 358). Factors involved in measuring or understanding community wellbeing include: housing, intergenerational and interpersonal relationships within and without the family, access to economic and social resources, ecology and the environment, physical safety, and social cohesion (La Placa et al., 2013).

Community wellbeing is an important concept to consider for Inuit in the Canadian Arctic, as this is traditionally a family-based collectivist culture with important intergenerational relationships (Kral & Idlout, 2012). This way of life has been impacted in recent years due to government involvement in the north (Kral & Idlout, 2012). Within Inuit communities, an important factor of community

wellbeing is Inuit Qaujimajatuqangit, or Inuit Traditional Knowledge (Kral & Idlout, 2012), which represents an important link between cultural continuity and community health and wellbeing. Additionally, family connections (Kral & Idlout, 2012) and the health of the environment (Parlee & Furgal, 2012) are also tied to Inuit community wellbeing due to the history of life in the Arctic and the Inuit values and cultural practices which emerged. Health and wellbeing amongst Inuit communities in the Arctic will also be affected by the impacts of climate change in the coming years (Sharpe, Riedel, Miron, Berry, & Walker, 2001), making this an urgent area of understanding.

Connecting food, culture, and wellbeing

This research aims to understand the important ways in which food security, cultural continuity, and community health and wellbeing are intimately connected for Inuit in the Canadian Arctic. While many different combinations and connections between two of these three concepts are evident within existing literature, this paper aims to explicitly link all three concepts to provide a baseline for understanding how ecological, economic, and social changes are affecting communities. Figure 2 illustrates the theoretical framework that was drawn from the literature and developed further in the results and discussion sections.

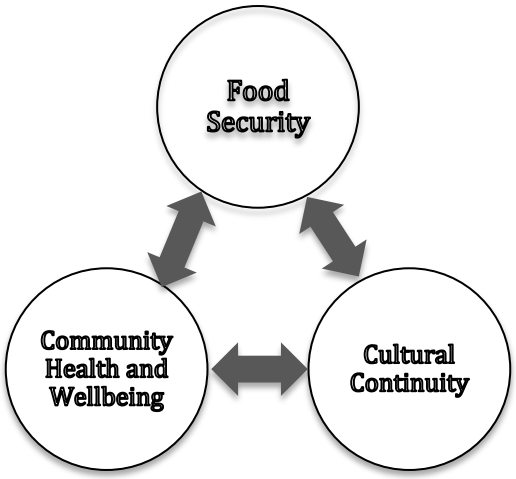

Figure 2: Theoretical model of the relationship between food security, cultural continuity, and community health and wellbeing in an Arctic community,

Methods

This research uses a community-based research approach and is informed by the direction found in Chapter 9 – Research Involving the First Nations, Inuit and Métis Peoples of Canada – of the Tri-Council Policy Statement on ethical conduct of research involving humans (Canadian Institutes of Health Research, Canada, Natural Sciences and Engineering Research Council of, Canada, & Social Sciences and Humanities Research Council of Canada, 2010). Table 1 outlines the steps employed in more detail.

Table 1: Research methods employed for this thesis research.

Steps	Dates	Location	Description
Finding a community	Mid-August to mid-September 2016	McMaster Campus	To avoid contributing to research fatigue, the Food Security Coalition, Government of Nunavut, and the Nunavut Association of Municipalities were contacted for a list of potentially interested communities. Following cold calls, Chesterfield Inlet's Senior

			Administrative Officer and Mayor agreed to collaborate on research.
Community consultation	1.5 weeks in October 2016	Chesterfield Inlet	Fall 2016, visit to the community involving a meeting in Chesterfield Inlet, individual meetings with elders and engaging community businesses and organizations to determine the focus and design of the research project; translation was available throughout.
Follow up and Research Design	Fall 2016 to Spring 2017	McMaster Campus	SN maintained communication with David Kattegatsiak through email and phone calls during this time. The research project was designed and ethics applications were applied for.
Data collection	End of May to End of June 2017	Chesterfield Inlet (short time in Iqaluit)	This project was approved by both the McMaster Research Ethics Board (Protocol Number 2016 158) and the Nunavut Research Institute (License Number 03 017 17N-M). The data collection was conducted over a 4-week period in spring 2017 to build trust; data was collected through individual interviews and a community meeting.
Data analysis	July to End of September 2017	McMaster Campus	SN transcribed the recorded interviews and community consultation, using written notes to check for understandings. In the cases where interviews were not audio recorded, the notes were coded as data.
Results consultation	1.5 weeks end of October/ beginning of November 2017	Chesterfield Inlet	These findings were taken back to the community in fall 2017 to allow participants and other interested community members an opportunity to validate the results. This involved another community consultation open to the public and efforts to contact participants who were not at this meeting. During this process, community members were invited to review the draft results and give feedback, ask questions, add to the results, or make changes that were necessary. The draft results document was translated into Inuktitut, and a translator was available for the community consultation and individual meetings. The feedback from this results consultation is included in the results and discussion below. At this point a summary report was made available to the community to allow them to advocate for change as soon as possible, which the community sent out to various regional organizations (Newell, S.L. Chesterfield Inlet Community Report – Impacts of Shipping. October 30, 2017).
Article writing and final poster creation	November 2017 to July 2018	McMaster Campus	Again maintaining contact with David and other community members while writing up the article and preparing posters to share with community members.
Return final results	2 weeks August 2018	Chesterfield Inlet	Final visit to Chesterfield Inlet for this research project. Posters in both languages were brought to the community and shared with participants and the broader community.

Ocean Canada Conference	1 week August 2018	Halifax	SN and David attended where they discussed the research that was conducted and explored future research and new connections for Chesterfield Inlet that David could bring back to the community.

Chesterfield Inlet, Nunavut is a community located on the west coast of Hudson Bay at the mouth of Chesterfield Inlet – the waterway that leads to nearby Baker Lake. According to 2016 census data, 415 people live in Chesterfield Inlet, 94% of which are Inuit (Statistics Canada, 2016). Traditional activities such as hunting, fishing, and passing on Inuit traditional knowledge about survival on the land are still practiced in Chesterfield Inlet.

Community members were consulted about the design of the interview guide, recruitment of participants, analysis and validation of results. There were 9 participants in the data collection community consultation and 27 interview participants (11 elders and 16 current hunters); interviews ranged from 10 minutes to 1.5 hours based on the participant's level of English and their interest in elaborating on different points.

A deductive coding approach was used to predefine the codes from the theoretical framework. Inductive coding was also used to generate daughter codes within the tree, which emerged from the data. Next the data was charted into the theoretical framework (Gale, Heath, Cameron, Rashid, & Redwood, 2013); this charting allowed for comparison of a single code across the different interviews and community consultation.

The results were then shared with community members and participants in fall 2017 as part of a validation process. This allowed participants and community

members to give feedback on the results, make additions or corrections to what was being said about their community before anything is published. At this time community members whose quotes were used were offered an opportunity to share their name as a way to claim that knowledge or remain anonymous if that was their preference. The feedback from this process is incorporated in the results below.

Results

Food Security

Amongst participants in Chesterfield Inlet, they reported that 50% or more of their meals consisted of country food; specifying that country food was often lunches and dinners, not breakfast food. Most participants said that they would eat country food as often as it was available, being limited only by access and health issues. However, participants did recognize that preferences might vary across the community, with the younger generation eating more store-bought food. Elders also said they were eating less country food than during their childhoods.

Many of the participants were still able to go out on the land to harvest country food and ate a lot of what they harvested themselves. Those hunters with extra would share with community members who didn't have access to country food, such as elders or single mothers. Some participants explained that the loss of a family member who used to take them out on the land or lack of equipment limited their ability to harvest their own country food. As a result they relied on others within the community to share through informal or formal mechanisms, such as the Hunter Food Distribution Program offered by the Department of Economic Development and Transportation.

While some participants expressed worry about the health of marine and land animals, participants overall felt that country food was healthier for them to eat. Walrus meat has been tested for disease since the 1950s and was a common concern when it comes to safety of country food. Participants noted that experienced hunters are able to tell if an animal is sick by looking at it and those with health issues were particularly careful about the quality of meat they eat.

> "S: No that's okay, yeah. Do you ever worry about the health of the animals that you're eating? P: Of course because my dad usually tells his grandsons or his sons are whomever he's teaching to keep an eye on the, what kind of meat they catch to see, cuz sometimes I've known caribou to have, I don't know what they call it but they have white." Lena Autut, a community member

Participants noticed that eating country food makes them feel warmer, relaxes the body, causes less stress, makes them feel more full, causes less bloating, and not having access to country food causes stress. The health of country food is supported in the literature and previous research regarding how they are an important source for many important vitamins and minerals, resulting in a unique focus on country food consumption in the Nunavut Food Guide (Government of Nunavut, n.d.; Kuhnlein & Kinloch, 1988; Rosol et al., 2014)

> "P3: Unhealthy food creates stress. S: Yeah? P3: Yes it does. S: And do you think not having enough country food creates stress as well? Like eating less country food? P1: Yeah. Mmhmm. Yeah. P2: The caribou are what keeps your body warm, keeps you warm during the winter. S: Mmhmm. So, you know, these traditional foods that you're eating, you're eating them for a reason because they help to keep you warm. P1: Yeah. P2: And you would relax your body. P1: Yeah. P2: Relax your body. Cause when you eat it, when you eat it, really good

> that's when your nice and full and it relaxes you want to sleep. [All laugh]" Community members in a community consultation

However, people are eating store bought food for a number of reasons: it has become easier to access, they use it when preparing harvested meat, younger people are brought up eating store bought food, and when there is less access to country food they rely on store bought food. Store bought food is seen as being junk food, more processed, makes people weaker, causes health impacts (such as diabetes), and is too expensive for people on income support.

> "D: There's two things, there's store bought, example hamburger and fries, or sandwiches. If she eats, after she eats either one of them she feels later or an hour later she'll get hungry. And for Inuit country food, like our traditional food, if we eat it there's more like, you're full, you have a full stomach and you're not as much as hungry as, compared to the store bought food. And you're more healthy, you feel more healthier and more not feeling tired. So what she was essentially saying is that Inuit traditional food or country food is a lot healthier diet." Eva Tanuyak, a community elder, spoken through a translator

In addition to being healthier, sharing of country food is also seen as being an important part of helping to support people financially. While equipment to hunt and fish is expensive, there are programs such as the Hunter Food Distribution Program to help offset the costs. Those hunters with equipment see it as the only way to afford to live in the Arctic given the high costs of store bought food.

> "P: …right now…especially when I'm budgeting money… I always make sure I have country food. S: Oh okay. So that helps you, your money to go further? P: Ya." A community member

Cultural Continuity

Inuit Traditional Knowledge (ITK) is an important part of life in the Arctic, especially for participants in Chesterfield Inlet, Nunavut. ITK is the large, unwritten laws about the environment that cannot be elucidated or codified, but it includes ideas about conservation, survival on the land, changes that have occurred over an elder's lifetime, and how to live your life in accordance with traditional values. Having access to elders and ITK is something participants felt was an important part of why they live in this community.

> "S: So it's important to have elders here? P: Oh ya, they have, it's very important they're our wisdom. They're our computer for the sea, out in the land, they're our computer." A community member

Learning and passing on ITK is often done on the land; people learn as they engage in traditional hunting and fishing activities. Families often go out on the land after work or for family vacations as a way to carry on some of the nomadic, traditional ways of life despite living within communities now. It is on these trips that people learn through watching their family, friends, elders, and other community members, often whoever is going out at the time.

> "P: Yeah my- all the hunting skills I learn are passed down from my dad, my father. … Practically every time he would go out boating I would tag along, I wouldn't be left behind [laughs]" Harry Aggark, a current hunter in the community

Community elders are not letting mobility issues limit their ability to teach the youth. They go on local radio, talk to family members, and answer any questions

youth come to them with. Elders felt very strongly that it is their duty while they are here to pass on this important knowledge.

> "That's one thing we have to give them an advice before we passed away ourselves… I like passing my knowledge, what I learned so they will remember me when I'm gone [laughs]." Casimir A.M. Kriterdluk, a community elder

Passing on ITK and continuing to harvest country food is an important part of survival, is part of Inuit identity, keeps people grounded, is good exercise, and something people love to do.

> "S: And you think it's important for young people to keep learning some of these traditional ways of life? P: Oh yeah, oh yeah. Cuz they can't just stick like stick in town, like it's, for us when we go out on the land it's a refresher for our mind, body and soul. It just refresh, get some fresh air away from town, just enjoy the scenery, enjoy the land." A current hunter

As this current hunter describes, time spent going out on the land, whether it be for harvesting activities or just to observe seasonal changes, has a important impact on individual health and wellbeing. Through my experience living in the community I observed this phenomenon of going out on the land daily in the spring to observe the daily changes in snow melt during days with long hours of sunlight. Many participants described how time spent on the land improved their mental health and supported their individual wellbeing, which was separate from whether country food was harvested during the process. Passing on ITK through travel on the land was key to maintaining individual health and wellbeing as well as at a community level.

However, there are some challenges when it comes to passing on ITK. Participants said that the younger generation don't always go out as much, they don't value traditional knowledge about survival on the land because they think they are invincible, they don't listen to their parents or grandparents, and are losing their language because technology today uses English.

> "P: They don't visit their parents anymore. They think they could survive themselves, no way! They have to help one another, that's the only answer in this world. You do have to think about the other people too eh. You can't live alone." Casimir A.M. Kriterdluk, a community elder

However, participants still felt it was important to pass on their knowledge to children and grandchildren despite these challenges.

> "S: Oh okay. Why do you think it's important for him [his son] to keep on hunting and fishing? P: He could pass it down to his kids too when he has kids." A current hunter referring to his 5 year old son

Community Health & Well-Being

While the health status of the whole community was difficult for participants to comment on, they did have some observations about changes that are impacting them and their families. Participants felt the community is less interactive, and that people are visiting each other less, which is negatively affecting community connections. Also, health impacts impede some people's ability to go out on the land, and some had eye and skin issues that were a concern. However, many participants thought the community was healthier because of the sharing of country food that occurs which helps others and that people rarely get sick.

Participants felt sharing country food was an important strength that kept the community better connected. This area has some of the best hunting grounds in the region and community members have an intimate knowledge of this land. The community is welcoming and their family connections and elders in the community are an important strength. Overall, there was a sense from participants that Chesterfield Inlet is a place they enjoy living.

Connections

Sharing of country food, especially freshly harvested large game (i.e. walrus or beluga), helps people to continue their traditional Inuit culture today, demonstrating the connection between these concepts. This sharing also improves the food security of community members who are unable to harvest country food themselves, such as elders. While sharing country food increases the food security of individual community members, it also improves the health and wellbeing of the community overall through building stronger relationships between people.

> "D: First of all say that when people are selling country food or harvested food, I mean he say when people are selling harvested or freshly caught meat it's not nice cuz they don't agree with it because it's not part of their livelihood growing up. Because if some people are selling country food or harvested food, some members in the community won't afford it because they don't have money or revenue on their table or to support their family members. So elders would not support that, selling harvested or freshly caught country food in the community." Eli Kimmaliardjuk, a community elder

Figure 3: The process in which changes impact community members in Chesterfield Inlet, Nunavut.

Changes And Their Impacts

Impacts of increased shipping

Since the opening of the Meadowbank mine outside of Baker Lake in 2010, shipping through the harbour and along the inlet has increased to about 30-40 ships every summer. As a result, participants have noticed fewer marine mammals in the harbour and around the community, such as seals and beluga whales. One participant explained why this is happening:

> "D: Back then there used to be lots marine mammals but today where are they? Like he's using also an example when they're hunting on the ice they will stand for many hours to hunt for seal, if the person standing right beside the hole to harpoon, like ready to harpoon a seal, standing there for quite some time, if one of his joints moves just few inches, or little move, or any muscle, seal can hear right away and a seal will move to another area. That's a sample he thinks that the marine mammals don't like the noise of ship, the sound of the ship, that's why there's hardly any marine mammals around our bay. Because of the traffic of the ships sound. He thinks that marine mammals don't like the sound of the ship engine. That's why they're not along our, not very many are along our waters now. He can use that for reference now today, that's his like a proof." Eli Kimmaliardjuk, a community elder spoken through a translator

As a result, people are harvesting fewer seals and beluga or they have to travel further, which increases the costs of hunting as you need more gas, time, and it causes more wear-and-tear on their equipment. When there is less country food being harvested, it also limits the amount that is available to share within the community; these shipping impacts are causing impacts on food security and community health and wellbeing.

> "S: Oh okay. And so are people harvesting less seal or is it just taking longer? D: Some of them do hunt seals but today there seems to be hunters catching less, even him. There seems to be…less quantity of seal or in most case, some cases now a days they're catching less seals or in some cases there's no seals at all. S: And they have to travel further? D: His response is people that go seal hunting they tend to go further distance due to less seal available near our waters or on the ice." Louie Autut, a community elder spoken through a translator

Impacts of Climate and Social Changes on Safety

Climate change and social changes are occurring side-by-side in the Arctic and in some instances social changes are supporting adaptations to climate change, while in other ways the social changes are making people more vulnerable to the impacts of climate change. In order to understand this complicated relationship, we will focus on the safety concerns voiced by participants.

Traveling on the land in the Arctic has always generated concerns about safety and much of traditional Inuit knowledge prepares people for these threats. For example, participants shared that learning to build snow shelters on the land, bringing extra supplies in case you get stuck, and navigating using snow drifts were important parts of ITK that are passed down to keep hunters safe on the land. However, they have also noticed that climate change is affecting the weather and snow conditions limiting the ability to use ITK.

As a result of social changes, people are no longer living on the land and instead taking evening trips after work, which has meant people are less likely to get stuck out on the land, need to build snow shelters, or use the snow drifts to navigate. Additionally, youth in the community use GPS more to navigate on the land, which addresses the problem of getting stuck in a blizzard and not being able to use a

snowdrift to navigate home. However, there is a danger to using a GPS for navigation: traditional knowledge teaches people how to recognize soft spots in the ice that are unsafe to cross while a GPS gives the most direct route home and may cause people to break through the ice if they aren't careful.

> "P: It's easier to get, if you get caught in a blizzard it's easier to get home cuz you got GPS and that now. Back then you didn't have those things. When compared to what it used to, more compared to get you home. S: Yeah it's the benefit of technology. P: But the GPS go straight and they don't tell you what to do, just pointing where you are going. S: So maybe not as helpful when it comes to an area that's soft? P: Yeah it's good for younger kids the younger likes to use it, us older guys who have lot more, taught back then they'll get home without those things." A community member

Stuck in the Middle

Being a community-based research project, it is important to come back to the heart of the issue from the community's perspective and what they hope this research project will achieve. Chesterfield Inlet is a community that sees itself as being at a tipping point of change, and our collective goal with this research is to empower them to be able to benefit from the changes that are impacting them. Many participants expressed this frustration of feeling like they are stuck in the middle of so many changes that are happening:

> "P: Like we're constantly struggling now to keep our, you know, heritage of traditional living and yet we're stuck in between modern day, traditional living, the food at the stores are like so expensive we can hardly afford them and then our animals are driven away because of all these industrial things going on in Nunavut. Like we're just stuck in the middle, we try to raise [the issue] but nothing's moving basically." A community member

While the changes that are occurring are not unique to Chesterfield Inlet, this is an important opportunity to give voice and validity to the concerns they raise and provide support for their efforts to make changes, which will convert these impacts into opportunities.

Discussion

While the importance of country food for Inuit communities is not a new concept within research, this study makes clear the ways in which these relationships are affected by changes that are occurring both within and surrounding the community.

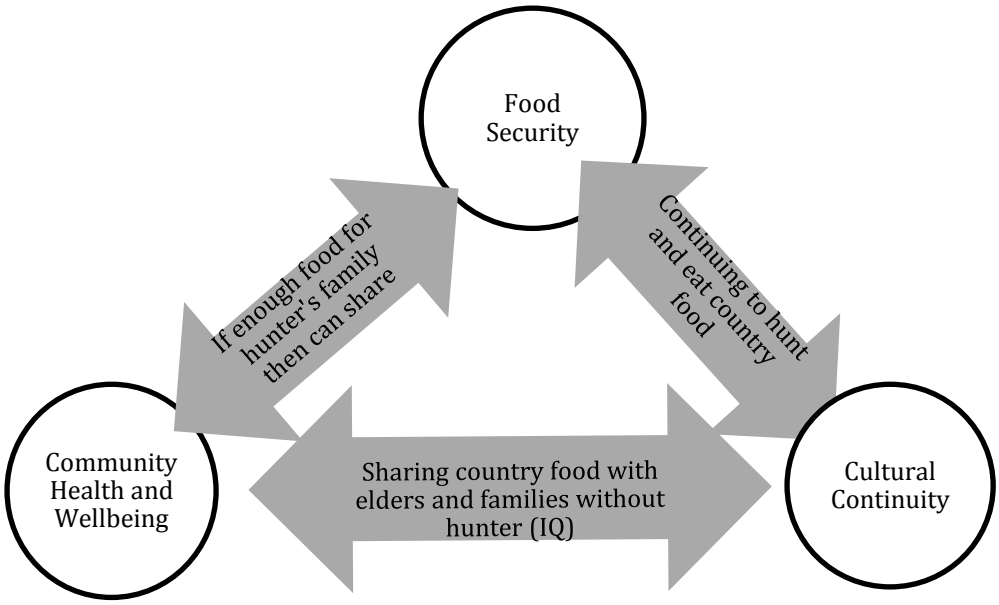

Figure 4: Community relationship between food security, cultural continuity, and community health and well-being in an Arctic community.

As Figure 4 describes, sharing of country food is an important mechanism used to understand the linkages between food, culture, and wellbeing in a way that demonstrates how changes influence these relationships. While continuing to

harvest and consume country food is an important way for Inuit to continue learning and passing on Inuit traditional knowledge, it is also a very important source of food security. If a hunter is able to harvest enough country food for their family to be food secure, then they are able to share with the community which improves the food security of elders or those without a hunter in the family, an important part of Inuit traditional knowledge. While sharing country food increases the food security of those individuals who receive it and maintains those traditional cultural practices passed down from ancestors, it also contributes to the broader community health and wellbeing. This is an interesting distinction that was made by community members, that sharing country food rather than selling it was not only good for food security, but also creates a better atmosphere within the community and keeps connections between community members strong and positive.

Using the framework to understand changes

Climate change and its impact on health have become a focus of much research in recent years (Donatuto, Grossman, Konovsky, Grossman, & Campbell, 2014; Ford et al., 2014; McClymont Peace & Myers, 2012). As participants described, Chesterfield Inlet is experiencing the impacts of climate change along with communities across the Arctic (Bolton et al., 2010; Ford et al., 2009, 2012, 2014). These changes include earlier sea ice melting, later freeze up, and generally conditions which make safety an increased concern.

While safety is not a new concern given the harsh environment of the Arctic (Kral & Idlout, 2012), there is more uncertainty which has created increased concern, especially about youth traveling on the land. One of the key impacts of

climate change is the decrease in the amount of country food harvested due to shorter seasons where it is safe to travel on the sea ice. Less harvested country food means that hunters themselves are less food secure, and they are not able to share with community members, which impacts their feeling of cultural continuity as well as community wellbeing.

Finally, the immediate concern for Chesterfield Inlet is the impact of increased shipping to the Meadowbank Mine outside of Baker Lake. Since the mine opened near Baker Lake in 2010, the number of ships past Chesterfield Inlet harbour, along the inlet and waterway has increased. Community members have noticed important impacts on marine mammals as a result. Each summer, once the ships begin travelling along the waterways, there are fewer marine mammals, such as seals and beluga whale. Community members posit that these animals are being scared away by the shipping noise. Observations of the impacts of anthropogenic noise on marine mammals is shared by other communities and is supported by existing research (Moore et al., 2012; Southall, 2005; Tyack, 2008; Wartzok, Popper, Gordon, & Merrill, 2003; Williams et al., 2015). This study adds to this evidence through observations of changes in marine mammal behaviour and making explicit the major impact on the community, as can be seen through the theoretical model. With the marine mammals being scared away by shipping noise, hunters have to travel further to harvest seals or beluga, if they are successful at all. Not only is a reduction in country food harvesting a problem, but the increased travel also exacerbates the impacts on the system as a whole. Hunters who must travel further to harvest seals for example spend more money on gas, cause more wear-and-tear

on their equipment, and require more time which is a valuable resource given the many other demands on people's time. Given these costs it is often difficult for people to purchase and maintain the equipment required such as transportation, guns, bullets, gas, warm clothing, food supplies and a tent in case they get stuck on the land. For those who have a job and therefore can afford hunting equipment, time available to spend on the land is limited.

Contributions and Opportunities for change

Community members voiced their frustration with this situation; the impact of ships on marine mammals is something community members have brought up on different occasions with regional organizations, the Nunavut Impact Review Board, and Agnico-Eagle Mines but feel their concerns are "falling on deaf ears". When added to the results of research in other communities, there is strong evidence that community members' concerns are valid and important to consider moving forward so that shipping along the inlet does not negatively impact them. While community members are concerned, they also recognize the importance of the Meadowbank Mine as a potential source of jobs and funding through regional organizations, which creates the opportunity of partnering with Agnico-Eagle Mines so they can share in the benefits of their local resources. These opportunities include: additional financial support for existing Community Harvesting Programs, building a deep sea port to limit ship traffic to only those necessary, begin ship traffic along the inlet late August to avoid impacting the char run, decrease ship speed, and have an Inuk guide on each boat to limit the impacts of those ships that are required to travel along the inlet and waterway. These recommendations from the community are not new,

they echo a long history of advocacy of Inuit organizations regarding how shipping is impacting wildlife and harvesting practices, as well as guidelines for changes that will be mutually beneficial (Arctic Council, 2009; Freeman, 1976).

When creating policy surrounding country food consumption there is important balance between the risks associated with an activity – such as safety concerns while traveling on the land and potential contaminants present in country food – and the benefit that it would have – such as through cultural continuity and as a rich source of vitamins and minerals. An important part of balancing those risks is ensuring that the right people are involved in the decision-making process – the community members – that their voices, values, and knowledge are not only present at the table, but respected and considered equal to other participants in the decision-making process.

Finally, the collaboration of community members throughout this research project created many important benefits to the overall dissertation. First, the community collaboration strengthened the results through a process of reviewing the results with community members, which became an iterative process of confirming those results. Additionally, engagement with community members through the original consultation during the design phase allowed the research to be tailored to fit the needs of the community. Originally the objective was to study how climate change was impacting the community, however, it became clear that shipping was an important concern to the community and broadening the scope would ensure they had the information needed to advocate for changes. The second study also benefitted from conversations with community members, not only about how to understand cultural continuity for Inuit, but also for what variables should be used as controls because they affect Inuit health, such as

house repairs. The third study examines what can be learned from LMMA implementation elsewhere and applied in the Arctic given the broader context of conversations with community members about the challenges in managing their marine resources in Chesterfield Inlet. Finally, the scenarios used to test the ontology model in study 4 are derived directly from the community collaboration in this study. In this was community collaboration in research improved not just this chapter, but also the overall approach to this dissertation.

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Chapter 3

Cultural continuity and Inuit health in Arctic Canada.

Introduction

Inuit and the Canadian Government

Seventy-five percent of Canada's total Inuit population reside in four areas comprising Inuit Nunangat (Inuit self-governed regions) (Statistics Canada, 2013). As of 2011, there were 1.4 million Aboriginal Peoples in Canada, a legal term which includes First Nations, Métis, and Inuit (Statistics Canada, 2013). The 59,445 Inuit in Canada make up 4.2% of the Aboriginal population (Statistics Canada, 2013). Aboriginal populations are younger and faster growing than non-Aboriginal populations in Canada. In 2011, 46.2% of Aboriginal people were under 24 years old compared to 29.5% of the non-Aboriginal population; First Nations and Inuit also have higher fertility rates, causing increases in their population (Statistics Canada, 2013).

Amongst Aboriginal Peoples, Inuit are unique in their geographic location, culture, language, and history, including their distinct relationship with the Canadian Government (Bonesteel, 2006; Statistics Canada, 2001). Prior to the 1950s, Inuit traditionally lived a semi-nomadic life organized into small kin groups which relied on harvested animals living naturally around them (Bonesteel, 2006). However, as European involvement in the Arctic increased, they became more reliant upon traded goods with the Hudson's Bay Company, despite still maintaining a subsistence lifestyle (Bonesteel, 2006). It was in the late 1940s and early 1950s that the Canadian Government began to actively interfere with the Inuit traditional way of life through education, wage labour, and the establishment of permanent housing and community settlements (Bonesteel, 2006). As a result of this more

recent history and relationship with the Canadian Government, it is important to look specifically at factors that affect Inuit health and wellbeing rather than generalizing research from other Indigenous people to the Arctic.

Cultural Continuity

Cultural change and colonial policies have impacted health outcomes among Indigenous Peoples in Canada. Residential school attendance and the policies surrounding this system aimed to end the culture of Indigenous peoples and assimilate them into Canadian society (Kirmayer et al., 2000; Truth and Reconciliation Commission of Canada, 2015b). There is growing awareness of the negative impact on health and mental health outcomes due to intergenerational trauma of residential school attendance, therefore not just survivors are affected, but also their children and grandchildren (Hackett et al., 2016).

In contrast, efforts to retain and build culture within both individuals and communities have been seen to greatly impact the health of Indigenous peoples (Kirmayer et al., 2000). Links between culture and health amongst Indigenous peoples have been given many various names including cultural continuity, enculturation, and cultural connectedness (Chandler & Lalonde, 1998; Denis, Wijesingha, & Jonathan, 2016). For the purposes of this thesis research, the concept cultural continuity will be used to understand the links between food, culture, and health in the Canadian Arctic. Cultural continuity is defined as the continuation of traditional culture within modern society (Oster et al., 2014) or as "the degree of social and cultural cohesion within a community" (Reading & Wein, 2009).

However, when it comes to measuring or operationalizing the concept of cultural continuity this becomes a problem, Chandler and Lalonde (1998) use measures of cultural continuity to explain the variation in youth suicide rates across First Nations reserves in British Columbia. This is the first attempt to create a set of indicators for cultural continuity to demonstrate a relationship to youth suicide. However, even in their inaugural work on measuring cultural continuity, they recognize that they are limited to the data which is currently available (as those using the APS to link culture and health are similarly limited; Chandler & Lalonde, 1998). In their research, cultural continuity is operationalized and measured using indicators that include "evidence that particular bands had taken steps to secure aboriginal title to their traditional lands", having self-governance, reserve run education, police, fire, and health services, as well as cultural facilities (Chandler & Lalonde, 1998, p. 209). Much of the research since has focused on the impacts of cultural continuity on mental health and suicide rates (Berkes et al., 2007; Castleden et al., 2008), however, there is limited research linking this concept to general health or food security or explorations of other ways to measure cultural continuity.

Some qualitative research seeks to understand ways in which cultural continuity can be conceptualized that resonates with Indigenous peoples and is valid. Filbert and Flynn (2010) used 3 yes/no questions to create an indexed score for cultural assets, such as opportunities to participate in community events, to understand resilience of First Nations youth, while others measure cultural connectedness through the extent to which individuals such as youth are integrated into culture (Denis et al., 2016; Snowshoe, Crooks, Tremblay, Craig, & Hinson, 2015).

Snowshoe et al (2015) interviewed Indigenous youth in two provinces using a 64 point cultural connectedness items to create 3 scales to measure identity, traditions, and spirituality; while Denis et al. (2016) use traditional activities, aboriginal language, traditional spirituality, and social support to understand cultural connectedness at an individual level for all ages.

Many of these analyses exclude Inuit, likely due to the small total numbers of people available for statistical analysis and the increased cost of travel to conduct qualitative research. However, there are important differences in how Canada's colonial policies affected Inuit in the Arctic compared to First Nations and Métis peoples. When the Indian Act first came into effect, Inuit were not considered the responsibility of the federal government (Bonesteel, 2006). It wasn't until 1924 that the role of the Canadian government in Inuit lives was considered at a policy level (Bonesteel, 2006). As a result they were able to maintain much of their culture and traditional activities despite the influence of the Hudson Bay Company, missionaries, and the RCMP (Bonesteel, 2006). Their experience with Residential Schools and similar policies has resulted in a more recent history; some people living today remember what life was like prior to the federal government's interference with the Inuit way of life through forced settlements and other such assimilation policies (Bonesteel, 2006).

These differences have resulted in different outcomes when it comes to cultural continuity of the Inuit as compared to Métis and First Nations peoples. For example, knowledge of Inuktitut in Inuit Nunangat is 84% as of 2006 as compared to 51% of First Nations with knowledge of their Indigenous knowledge amongst

those living on-reserve, 12% living off-reserve, and 2-12% Métis who have knowledge of their Aboriginal language (Reading & Wein, 2009). Additionally, the Truth and Reconciliation Commission recognized the unique cultures of the Inuit resulting in the creation of an Inuit Sub-Commission dedicated to their experiences (Truth and Reconciliation Commission of Canada, 2015b). The experiences of Inuit in Arctic Canada with residential schools and government involvement in communities has been more recent (Truth and Reconciliation Commission of Canada, 2015a), resulting in community elders living who have experienced semi-nomadic lifestyles prior to forcible settlement.

This research builds on Chandler and Lalonde (1998) by exploring how cultural continuity can be measured for individuals and communities in Inuit Nunangat and uses general health rather than youth suicide rates as an outcome measure. The 2001 and 2006 Aboriginal Peoples Survey asks about access to government services in an Aboriginal language including education, health, justice, and social services, etc. I am limited to these questions out of Chandler and Lalonde's list of indicators of cultural continuity for those Indigenous peoples living off-reserve, who are therefore not involved in First Nations land claims agreements, First Nations self-governance, etc. Due to the limitations of the available questions, I will focus on the Arctic Supplemental questions that focus on community wellness indicators and community involvement, such as satisfaction with police, education, health, and other such services that may be related to cultural continuity within Inuit communities.

Aboriginal Peoples Survey and the Arctic Supplement

The Aboriginal Peoples Survey (APS) is a national survey on social and economic conditions of Aboriginal people to inform policy and programming, and improve well-being (Statistics Canada, 2017b, 2017a). This survey includes First Nations people living off reserve, Métis, and Inuit who were 15 years of age or older (Statistics Canada, 2017a). During the 2001 and 2006 cycles of the APS there was an Arctic Supplement added – a set of questions asked in Inuit Nunangat related to harvesting activities, personal and community wellness, and social participation (Statistics Canada, 2001). Far less research has been conducted using the Arctic Supplement due to important limitations of the data, such as small sample size, particularly at the community level. However, this part of the survey represents an important part of an international collaboration called the Survey of Living Conditions in the Arctic (SLiCA) (Statistics Canada, 2001). SLiCA aims to measure and understand better the living conditions of people living in the Arctic to benefit those living not just in Canada, but also the United States, Greenland, Norway, Sweden, Finland, and Russia (SLiCA, n.d.). The Arctic Supplement is a part of SLiCA and the survey questions were developed through collaboration with the Inuvialuit Regional Corporation, Nunavut Tungavik Incorporated, Makivik Corporation, the Labrador Inuit Association, Inuit Tapiriit Kanatami, Laval University, and Statistics Canada (Statistics Canada, 2001). Given the importance of the Arctic Supplement internationally and to local stakeholders involved in its creation it is important to continue using this data to understand as much as possible the links between harvesting, wellness, social participation, and health.

Methods

As previous authors have acknowledged, cultural continuity is a difficult concept to measure and operationalize, especially given the use of secondary data in this case. As such, Chandler and Lalonde's categories were used to determine which variables from the APS and Arctic Supplement would be most appropriate. The 2001 and 2006 Arctic Supplements were appended to increase sample size. As a result respondents were people living in Inuvialuit, Nunavik, Nunavut, or Nunatsiavut, who self-identify as 'Aboriginal' and are 15 years of age or over. For the 2001 APS Arctic Supplement there were 8,943 respondents and a response rate of 83% (Calcutt, 2009), the 2006 version had 6,012 respondents and an 87% response rate (Statistics Canada, 2009).

Statistical analysis

Dependent variables

To explain the impact of cultural continuity on participants, self-rated health status was used as the dependent variable. Previous research has shown across a variety of populations the effectiveness of using self-rated health as a predictor of mortality or morbidity (Benjamins, Hummer, Eberstein, & Nam, 2004; Idler & Benyamini, 1997; Miilunpalo, Vuori, Oja, Pasanen, & Urponen, 1997). In the APS respondents were asked to rank their health as excellent, very good, good, fair, or poor. A dummy variable for health was created to represent a positive health status (excellent, very good, and good) and a negative health status (fair and poor). We modelled self-rated health as a dichotomous outcome given the skewed distribution of responses on a 5-point Likert-type scale. Respondents who answered excellent,

very good, and good were combined as 'good health' while responses of fair or poor were considered 'bad health'.

Independent variables

The Inuit social determinants of health and other documents published by Inuit Tapiriit Kanatami (organization representing Inuit in the Nunangat) were used to inform the selection of control variables for the models (Inuit Tapiriit Kanatami, 2014). Additionally, SN conducted qualitative interviews in a Nunavut community regarding links between food security, cultural continuity, and community health and wellbeing which informed the model creation as well as informal conversations with community members about what factors impact their health which should be included in these models. It became evident throughout the interviews that the importance of country food harvesting and consumption is not just for food security but also represents an essential form of cultural continuity, which is echoed in the results of the models. These control variables specific to Inuit health included whether the participant or a relative attended a residential school, degree of household crowding, level of house repairs needed, and which of the 4 areas of Inuit Nunangat the participant is from given the different histories of each region.

Two different approaches were used when considering the key explanatory variables for cultural continuity. First, a variable was derived from several questions asked about access to services in an Aboriginal language which mapped onto the indicators Chandler and Lalonde (1998) used to measure cultural continuity. Respondents who did not speak an Aboriginal language were not asked

whether they had access to health, justice, education, employment, social, financial, or other services in an Aboriginal language.

Secondly, a set of questions from the Arctic Supplement were used as an alternative measure of cultural continuity representing Inuit culture, community variables, and government variables. The category of Inuit cultural variables was composed of 3 questions relating to harvesting activities, access to country foods, and satisfaction with store bought food freshness in recognition of the importance of harvesting practices and the consumption of country foods documented in the literature and shared by participants in Study 1. Attendance of community events, sports participation, and attending public meetings represented community level variables that are theoretically part of cultural continuity in the Arctic. Finally, given that the Inuit Nunangat is comprised of self-governed regions in Canada, government satisfaction and municipal level voting were considered to be important indicators of culture through Inuit governance.

Statistical models

There are three models estimating a logistic regression using robust errors: one including only those who self-identified as Inuk, one including those who identify their ancestry as being Inuit, and one including all participants while using the two measures of Indigenous identity as independent variables. While the focus of this research is on how cultural continuity affects the health of Inuit people, given the integration of non-Inuit people within Arctic communities, the influence of cultural continuity on the health of these participants has implications for future policy based on these findings.

Missing data

Due to the small sample size, there was a concern that dropping participants would further limit the sample size making the analysis difficult. Additionally, given the nature of some of the questions included as independent variables, it was hypothesized that there might be a cultural reason for not responding to questions that represented a meaningful response and would not justify dropping these participants for the entire model. For example, questions regarding residential school attendance or attendance of a family member may be difficult for people to answer. Additionally, for questions about access to services in an Aboriginal language, those who have not sought such services may not be familiar with them. As such, these missing variables were coded as a dummy variable when the numbers were large enough to not be dropped.

Results

Descriptive statistics

Dependent and control variable proportions are shown in table 6 in Appendix B. The majority of participants' self-rated good or excellent health and fewer self-identified as Inuk than those who claim Inuit ancestry. The majority of participants live in Nunavut and did not graduate high school. The majority of participants did not attend a residential school, however, 44% had a relative that attended a residential school. Approximately 50% of respondents were employed and 62% had never moved from their community. The majority of participants lived in households with more than 3 people and required at least some repairs.

Approximately 70% of respondents are occasional or regular smokers, over 50% are occasional or regular drinkers, and 60% are not in common-law relationships.

Model outputs

There are 5 models with nested versions based on Indigenous identity shown in table 7 in Appendix B. Model 1 includes all variables, model 2 includes just the control variables, while the rest of the models add different measures of cultural continuity to the control variables; model 3 adds a variable for never having moved, model 4 includes a variable for access to services in an Aboriginal language, and model 5 includes a set of variables from the Arctic Supplement rather than access to services. There are 3 versions of each model, which vary based on different measures of Indigenous identity. IA includes respondents who stated that they had Inuit ancestry, either single or multiple ancestries, SI includes respondents that self-identified as Inuk, and All includes all respondents regardless of ancestry or self-identification (also includes a small number of non-Inuit and non-Indigenous peoples).

Access to services in an Aboriginal language

Results showed the odds of having good health are significantly and positively associated with having access to at least one service in an Aboriginal language ($p<0.01$). For both those who self-identify as Inuk and those with Inuit ancestry, the odds of good self-rated health based on having access to at least one service in an Aboriginal language are 33% and 32% respectively.

Arctic Supplement measures of culture

Additionally, good health was also positively associated with the set of Arctic Supplement variables with varying levels of significance. Household harvesting activities and satisfaction with access to country food were both significantly associated with the odds of better health by 17% and 49% respectively ($p<0.01$), which held true for both those with Inuit ancestry and those who self-identify as Inuk. Government satisfaction was also significantly associated with 28% increased odds of better health ($p<0.01$) and those missing responses had the same influence on health. Municipal voting is also positively associated with 5% increase in the odds of having better health but was not significantly associated; the missing variable however was statistically associated with a 34% increase in health. Finally, sporting events were statistically associated with 27% increase in the odds of having good health ($p<0.01$) with missing variables being significantly higher odds of increased health outcomes. Attendance at public meetings were associated with 10% increase in the odds of better health which was statistically significant ($p<0.10$ except for model 5), with participation in community events being positively but not significantly associated. The odds of health being positively and significantly associated with the measures of cultural continuity remained similar despite changes in measures of Inuit identity and inclusion of non-Inuit respondents.

Across all 5 models there is a better fit according to the Pseudo R^2 when including a measure of Indigenous identity. Additionally, the full model has the best fit followed closely by the model using the set of cultural, governance, and community questions. Based on the BIC and AIC values, we can see that model 5 using this set of variables has a significantly better fit than model 4 which uses

access to services previously used as measures of cultural continuity. This holds true across the different measures of Inuit identity.

Discussion

Cultural continuity: a determinant of Inuit health

The likelihood of having better self-reported health is increased if a person is more connected to their culture through harvesting, consumption of country foods, participation in community level activities, and Inuit self-governance. Previous literature on the connections between cultural continuity and Aboriginal youth suicide rates theorize the importance of addressing self-continuity at a cultural or community level to promote cultural alignment for personal identity (Chandler & Lalonde, 1998). Cultural alignment with personal identity at a community level has the potential to positively influence not just youth mental health, but general health at all ages in the Canadian Arctic.

While the questions regarding access to services in an Aboriginal language map well onto previous indicators used for cultural continuity (Berkes et al., 2007; Castleden et al., 2008; Chandler & Lalonde, 1998), this is a superficial measure at best. This is why focusing on the cultural variables contained within the Arctic Supplement was a way of triangulating the impact of cultural continuity on self-rated health. Aboriginal people in Canada are not a homogenous group with a single cultural tradition that is drawn upon; rather, this is a diverse group with varying histories that are reflected in rich cultures. The Arctic Supplement represented a unique opportunity to respect this diversity and access more meaningful measures of culture as the questions were designed in consultation with various Inuit

organizations. The results indicate that in the Inuit Nunangat, cultural continuity has a significantly positive impact on health even when controlling for background and health behaviours. The model outputs indicate that cultural continuity at a community level can serve as a protective factor when faced with negative influences on health such as structural-level variables and intergenerational effects of residential school attendance.

Limitations

There are important limitations to this research given the secondary nature of the data and sample sizes. The APS is a self-reported, cross-sectional survey, which limits the causal inferences that can be made and the variables which can be included in the analysis. Additionally, the Arctic Supplement questions were only asked of participants living in Inuit Nunangat so the sample size for each year was low, resulting in the need to append two years of the survey (2001 & 2006). Related to this, if missing responses were excluded the sample size was further limited, necessitating careful consideration about what refusal to respond to a question might mean. We hypothesized that there might be cultural reasons for not answering questions about government satisfaction or reasons related to the length of the survey as supported by previous research (Krosnick, 1991).

Practice and policy implications

Practice implications

The positive associations found between health and cultural continuity represent important practice implications. Despite the superficial nature of variables about access to services in an Aboriginal language and the fact that it measures perceived

access, the positive and significant association indicates that language of service is important for practitioners to consider. While services that are more aligned with cultural values and world views for Inuit would be the ultimate goal, the model outputs show that ensuring people have access in Inuktitut or Inuinnaqtun is important across the Canadian Arctic and likely in southern Canada for urban Inuit as well. Additionally, provision of culturally appropriate food sources, such as country food, in health care centres will be important going forward not just in the Arctic, but also in the south given that people from Nunavut especially are sent to Ottawa or Winnipeg for medical treatment.

Policy implications

This research shows that both at a superficial level and more culturally aligned, language and traditional practices have important associations with improved health. Future policy needs to support continuing harvesting activities and community members' access to country foods. Given the increases in hunting costs, the disruption of the intergenerational transfer of knowledge due to residential schools, and the broader policy legacies of colonization, the Canadian government has an opportunity to address health inequalities through supporting Inuit culture. One example is through increased funding of existing programs such as the Nunavut Harvester Support Program which provides funding for an individual hunter's equipment and for community hunts (Nunavut Tunngavik Inc., n.d.).

Additionally, this research demonstrates the importance of community voices not only in research, but also when creating policy that will directly impact those communities. This chapter, along with the previous chapter, benefitted

greatly from community involvement throughout to varying degrees. In policy, as in research, it is important to have full respect for Indigenous knowledge and an important first step is ensuring that Indigenous voices and values are always present when making decisions about future policy or research agendas.

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Chapter 4

Locally Managed Marine Areas (LMMAs) as the Future of Global Commons Resource Management

Introduction

Given the increased stress climate change and anthropogenic activities are putting on fragile marine ecosystems, the way in which marine and coastal resources are managed is essential to the survival of local communities. It is important to consider that there is a diversity of values people place on nature and that conflicts over these values are important considerations when managing common-pool resources. For example, local, Indigenous values may vary or be in direct conflict with tourism operators or larger harvesting companies all competing for limited resources. Locally Managed Marine Areas (LMMAs) are a way to manage resources that can be used to balance the different interests often involved in decision-making regarding coastal communities. 'Locally Managed Marine Area' is a term that encompasses the management styles being used to collaborate about how nearshore waters and coastal resource use can best be balanced considering different stakeholders' needs (Govan, Tawake, Tabunakawai, & Jenkins, 2009). These stakeholders include local community members, government, and others involved in coastal and marine resource use within the given area (Govan et al., 2009). Since being conceptualized in 2000, the use of LMMAs has increased globally, especially in the South Pacific (Govan et al., 2009). This management style allows the unique circumstances of each area to be taken into consideration in a bottom up rather than a top down approach (Govan et al., 2009).

Global commons are areas, such as high oceans, where no single nation has jurisdiction and common-pool resources are found (Schrijver, 2016). While not sovereign territory with national legislation regulating resource use, rules do exist

within global commons about the sharing of resources amongst multiple stakeholders (Berkes, 2005; Schrijver, 2016). However, there are important examples of where common-pool resources, such as the global whale population, are overexploited or the needs of many different stakeholders are ignored (Berkes, 2005; Schrijver, 2016). While the overexploitation of whales globally led to the decision in 1982 to create a moratorium on whale hunting through the banning of commercial whaling in 1986, as distinct from Aboriginal subsistence whaling, enacting this legislation in Canada was more complex. In the Canadian Arctic the use of beluga and other whales for human consumption and cultural practices of the Inuit was in conflict with the live capture of whales for aquaria, demonstrating this complexity in implementing the global ban and the importance of local stakeholder involvement in decision-making to protect Inuit harvesting rights (Berkes, 2005; Schrijver, 2016). Balancing local Indigenous subsistence needs and views on conservation, scientific understandings of conservation, and corporations' resource requirements allows marine resources to be shared in an equitable way.

Many different tools and management approaches exist for coastal or offshore marine resources, which can be categorized based on their management target or what level of governance and community engagement is involved in the process (Learn, 2016). Management styles which use ecosystem approaches – decision-making informed by the relationship between humans and the ecosystem – include integrated coastal zone management (ICZM), integrated coastal management (ICM), coastal resource management (CRM), and ecosystem approach to fisheries management (EAFM) (Farmer et al., 2012; Learn, 2016). Furthermore,

marine protected areas (MPAs) and marine spatial planning (MSP) are considered tools that can be used by these different approaches (Farmer et al., 2012; Learn, 2016). Such traditional marine management mostly applies a top-down approach that prioritizes national or conservation goals over local needs, through Marine Protected Areas and other national legislation within global commons.

Conventionally, the primary management approach employed by Marine Protected Areas (MPAs) is to identify "*a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*" (Day J., Dudley N., 2012, p. 12). The aim of MPAs was to support climate change adaptation, tourism, governance, health, enhance ecosystem resilience, protect ecosystem services, balance conservation and development goals, and the empowerment of women (Ford & Berrang-Ford, 2009; Mahajan & Daw, 2016; Rocliffe, Peabody, Samoilys, & Hawkins, 2014). However, in many instances MPAs failed to take into consideration the complex socio-ecological systems, lack of funding, contributions to local power asymmetries, conflict due to a lack of understanding of local social dynamics and international cooperation, and protection of natural wealth and resources beyond the limits of national jurisdiction (Mahajan & Daw, 2016; Rocliffe et al., 2014; Schrijver, 2016). Defacto expropriation of coastal resources by globalized economic forces also poses serious challenges to local communities (Bavinck et al., 2017). The recent literature reflects that for MPAs to be successful they need to incorporate traditional, local, and Indigenous knowledge into decision making processes through local institutions, a task that in

some quarters is increasingly being taken on by the community through LMMAs (Jupiter, Cohen, Weeks, Tawake, & Govan, 2014; Mahajan & Daw, 2016; Rocliffe et al., 2014).

MPAs represent one example of previous management styles for resource use and access rules in a defined space that use top-down, centralized approaches at a national level with limited input from local uses (Govan, Tawake, Tabunakawai, & Jenkins, 2009; Harris, 2011; Jupiter et al., 2014; Kawaka et al., 2015; Mahajan & Daw, 2016). The framework did not appropriately consider the needs and concerns of local subsistence resource users (Bolton et al., 2010; Cohen, Jupiter, Weeks, Tawake, & Govan, 2014; Govan et al., 2009; Mahajan & Daw, 2016), thus creating a need for approaches which include multiple stakeholder input into decision-making. Community-based models became promoted by NGOs and national governments to address these failures through the promotion of decentralized governance in marine management (Harris, 2011; Mahajan & Daw, 2016). These efforts involved significant input from northern Canada in the 1980s and spread globally to recognize "the power and rights of local fishing communities to manage their marine resources" (Kawaka et al., 2015, p. 4) and promote community-ownership to allow local stakeholders more responsibility over resource management. Indigenous peoples were an important part of these efforts through their local and Indigenous knowledge about conservation approaches and awareness of local stock numbers for example.

In contrast to these top-down management approaches, LMMAs represent an approach to managing resources that begins with the inclusion of communities in

decision-making as a way to address the gaps in previous approaches. An important benefit of LMMAs is the integration of scientific knowledge with traditional local and Indigenous knowledge, which is important for understanding ecological variability of each area (Govan, 2009; Jupiter et al., 2014; Mahajan & Daw, 2016). Community-based management approaches are seen as sustainable ways to respect Indigenous and local uses of marine areas through the effects of engaging with local actors, peer-to-peer and social learning (Stacey, Karam, Jackson, Kennett, & Wagey, 2015). LMMAs also offer a means of legal formalization to respect the traditional knowledge, practices, and values of local communities which already have established concepts of conservation and sustainable use as part of their traditional culture of resource use (Govan, 2009; Syakur, Wibowo, Firmansyah, Azam, & Linkie, 2012). Communities view LMMAs as enabling "recovery of natural resources, improved food security, improved governance, access to information and services, health benefits, improved security of tenure, cultural recovery, and community organisation, … exclusion of other stakeholders from fishing areas, working with outside agencies, [and] their increased control over local resources" (Govan, 2009, pp. 7–8).

LMMAs are not a new method for management of resources, rather, for some regions, it is a new approach to include local communities along with other important local stakeholders when making decisions about which existing management tools will be used (Govan et al., 2009). This is demonstrated in the multiple iterations based on national legislation and history of resource management in the area under study, demonstrated in the case studies below. For

example, some LMMAs are considered community-based Marine Protected Areas (MPAs) where the community, rather than the national government, regulates the area. Alternatively, in Fiji, LMMAs began as an area where a temporary harvesting ban was imposed to allow recovery of marine stocks, which then transitioned to using other current management tools once the ban was lifted (Teh, Teh, Starkhouse, & Sumaila, 2009). LMMAs allow for a more inclusive and participatory approach to management of marine resources, which embeds existing management tools that have been successful into the process. It is tailored to the unique needs of the area and stakeholders involved, and aligns with local, Indigenous harvesting practices and conservation knowledge.

It is important to consider what gaps may exist in implementing LMMAs which other jurisdictions can learn from, such as Arctic Canada. For example, LMMAs represent a different way of making decisions about resource use and in many cases require legislation to allow for these different stakeholders to be able to have a seat at the table. Additionally, in order for LMMAs to be successfully implemented there is important funding, education, and other supports that need to be met, as these case studies demonstrate.

Methodological Approach

Research questions

This chapter aims to understand the following research questions:

- What can be learned from the use of LMMAs in different cases that can be applied elsewhere?

- What gaps exist in the implementation of LMMAs that need to be addressed going forward?
- Is the use of LMMAs appropriate in the Canadian Arctic given the history of marine resource management?

This paper examines local cases to understand factors that make the implementation of LMMAs more successful and gaps that need to be addressed in the future. A desk review was conducted to target relatively unrepresented regions in Africa and the Asia-Pacific as cases for understanding the strengths and weakness of the implementation of LMMAs in different contexts. This study was conducted in part to satisfy the requirements of the UNU-INWEH Water Without Borders program; primary data collection was conducted in Mozambique on LMMA implementation and the purpose of this paper was to link this case with others globally and provide lessons learned for other jurisdictions, such as the Canadian Arctic. The desk review method applied in projects implemented by United Nations University and other development organizations was used to include multiple data sources and focus on specific countries for a targeted examination of key lessons regarding a specific policy or intervention of interest (Sandison, 2003; World Bank, n.d.).

Two cases from the Asian-Pacific (Fiji and Myanmar) were selected, as this region has led the field of LMMA implementation, and two cases from Africa (Kenya and Madagascar) were selected to contextualize the Mozambique case. Asian-Pacific and Small Island Developing States have led the implementation of LMMAs and the United Nations documentation regarding approaches to attaining the Sustainable

Development Goals states that other countries can learn from these cases, hence the cases selected to contextualize the Mozambique case (United Nations, n.d., 2015).

When conducting the literature search, Scholars Portal and Web of Science were searched using the term "locally managed marine areas" and the country name for all countries included as cases. Google Scholar was also searched and results relevant to the cases were added to the literature search results. Scholars Portal generated 52 results, Web of Science generated 12 results, and Google Scholar resulted in more than 10,000 results. Duplicates were then removed and abstracts were reviewed to determine if the articles described one or more of the country cases or the history of LMMAs, leaving 76 relevant articles. All articles were reviewed for content describing LMMAs and their history to inform the context, while articles in part or entirely about specific country cases were included in the comparative case study section.

Mozambique case

In addition to the desk review, Mozambique was included as an additional case informed by primary research, including focus group discussion, stakeholder consultations, and selected interviews. This case study was conducted in collaboration with UNU-INWEH and IUCN Africa, using qualitative research methods to analyze primary and secondary stakeholder data in order to answer a set of research questions and sub questions. This provides an interesting opportunity to compare current research regarding the implementation of LMMAs in Mozambique to existing LMMAs in the South Pacific and Africa. The results from this study

conducted by UNU-INWEH were the most up-to-date data regarding the Mozambique case.

Results: Comparative Analysis using a Case Study Approach

The Asia-Pacific Case Studies

Fiji: A mature leader in the LMMA implementation

Unique terrestrial and marine diversity has led to Fiji's coral reefs being an important resource for local food and income, tourist activities, and the protection of coastal areas from storms and floods (Hastings, Orbach, Karrer, & Kaufman, 2015; Teh et al., 2009). Coastal areas in Fiji are dominated by Indigenous peoples who use a community approach to management, property ownership, and their regulation style called 'qoliqoli' (Govan et al., 2009; Hastings et al., 2015). This existing system of resource management within Fiji's Indigenous communities has made it easier to adopt the community-based management system of LMMAs (Hastings et al., 2015). The qoliqoli management style in Fiji regulates where people can fish for legal and cultural reasons, restricts fishing methods, gear types, creates time limited fishing bans and tabu areas (Gaymer, Stadel, & Ban, 2014; Hastings et al., 2015; Mills, Jupiter, Pressey, & Ban, 2011). In 2000 the Fiji Locally Managed Marine Area Network (FLMMA) was created to scale up the success of LMMAs to a national level and allow for information sharing across the various sectors (Hastings et al., 2015; Mills, Jupiter, Pressey, et al., 2011; Veitayaki, Aalbersberg, Tawake, & Rupeni, 2003).

Fiji has experienced success in species recovery through LMMAs. For example, the first LMMA created in the early 1990s to address the issue of decreased clam stocks has resulted in recovery of Ucunivanua clam stocks in the Viti

Levu island and incomes for the village have increased as a result (Teh et al., 2009). LMMAs have also improved household welfare through stronger collective ownership rights, which has created increased food security due to increased consumption of fresh seafood harvested locally (Lawson-Remer, 2013). In Fiji, LMMAs, seen as community-based marine protected areas (MPAs), are the method the national government is using to achieve the 30% MPAs by 2030 goal set out by the International Union for the Conservation of Nature (IUCN) (Gaymer et al., 2014; Mills, Jupiter, Adams, Ban, & Pressey, 2011). However, researchers are suggesting that a combination of LMMAs and systematic, top-down approaches will be needed to achieve development goals and targets to ensure that legislation and funding is provided to local LMMAs and that the needs of different geographical regions can be balanced at a national level to meet the targets (Mills, Jupiter, Adams, et al., 2011). The FLMMA will likely play a large part in linking these two levels of governance as it is currently an integral part of Fiji's LMMA implementation success through the creation of partnerships across different qoliqoli, and among community members, scientists, and government agencies (Veitayaki et al., 2003).

Myanmar: Acceptance to innovative thinking for coastal resources management

Myanmar's coastline spreads nearly 3,000 km inhabited by a large diversity of coastal and marine resources, which contribute to the country's fourth largest source of foreign exchange after timber, minerals and rice (Zöckler, Delany, & Barber, 2013). Nearly 24 mangroves species are found in the country, with the most extensive mangroves spread in the Ayeyarwaddy Delta. The evidence of poorly managed coastal zone use can be seen in the rapid decline and degradation of

coastal vegetation of the Ayeyarwaddy Delta mangrove ecosystem from 250,000 hectares in the 1980's, to 110,000 ha in 2001, to 83,400 ha in 2012, and the decline is continuing (Webb et al., 2014; Zöckler et al., 2013). Additionally, the country is also frequently exposed to extreme climate events and lost nearly 60,000 ha of mangrove forest in the aftermath of Cyclone Nargis. The densely populated delta area is left in a crisis situation by the huge losses of life and livelihoods as a result of climate change and poor management. The gradient of unsustainable development is jeopardizing the fragile relationship between these crucial habitats and the livelihoods of rural people, thereby compromising most of the country's population. Low income in the area is a challenge, so coastal landscapes are falling prey to aquaculture and human settlements (Hung & Nagabhatla, 2017). Coastal resilience through community consultation and engagement has become an important focus of global sustainable development because environmental problems need to be addressed by more than just resource management, but also international agreements and funding.

International collaboration and transfer of best management practices may offer a sustainable solution for this growing economy as they may skip the cost-intensive phase of research and development while learning from others. Fauna & Flora International has collaborated with the Myanmar Government to create their first three LMMAs, which was announced on World Ocean Day, June 8, 2017 (Davis, 2017). The process began with a scientific survey conducted from 2012 to 2014 with the collaboration of the Ministry of Environment Conservation and Forestry, the Department of Fisheries, and the Navy to identify species of coral, fish,

echinoderms, crustaceans, molluscs, and sponges to understand the impacts of overfishing and destructive fishing techniques. This study was used to inform future resource management techniques and to advocate for the creation of the LMMAs in the Myeik Archipelago. The aim of creating these 3 LMMAs in 2017, or thereafter, was to improve the health and biodiversity of reefs in the region through local operation and care (Davis, 2017; Howard, 2017; Momberg, 2017).

Overall, Asian countries are hoping to build a strong case for scaling the LMMA approach across the region. Recently, Indonesia listed the revision of 'Banggai Island Zoning Plan' to ensure conservation is 'well presented' and the formation of locally-managed marine-protected areas to protect 'critical microhabitats,' (Techera, 2013). The Philippines is lobbying with the regional body, the Association of Southeast Asian Nations (ASEAN), to support the network of MPAs to safeguard migratory species and their habitats critical to species survival by employing a cooperative and collective action framework inspired by the LMMA guidelines (Techera, 2013). Both jurisdictions are part of the LMMA Network and are using the lessons learned from other countries to inform their marine resources management approaches ("LMMA Philippines – The LMMA Network," 2016).

The African Perspective on LMMA

Kenya: Leading way for the African region in LMMA implementation

Kenya's coastal and marine environment supports the livelihood of local communities through its rich but threatened biodiversity and numerous species (Odote et al., 2015). Their economy relies on this biodiversity to attract tourists, support the fishing industry, while also being impacted by pressures from other

sectors such as agriculture, forestry, mining, and shipping, causing degradation from over-exploitation of unregulated resource use, which threaten community livelihoods (Odote et al., 2015). MPAs were created in Kenya in the 1970s as a conservation tool in keeping with international conventions, however, their implementation was problematic due to lack of local involvement (Mahajan & Daw, 2016; Odote et al., 2015), making LMMAs a fitting and important management approach to balancing the needs of all of these important stakeholders.

In Kenya, new legislation supported the change from the top-down resource management to community management through the Forest Act in 2005 and the Beach Management Units (BMUs) Regulation in 2007 (Kawaka et al., 2015; Odote et al., 2015; Rocliffe et al., 2014). In this legislation, BMU responsibility includes "law enforcement, developing sanitation facilities and onshore infrastructure for the landing, buying, and selling of fish, collecting fisheries data, conflict resolution and welfare matters, and handling emergencies" (Mahajan & Daw, 2016, p. 110). In 2006, the first LMMA was created in Kuruwitu, central Kenya, and more have been created since, either called community-managed MPAs, Community Conservation Areas (CCAs), or LMMAs (Kawaka et al., 2015; Maina, Osuka, & Samoilys, 2011; Odote et al., 2015; Rocliffe et al., 2014). Kenya's LMMAs have been successful as demonstrated by the increase in live hard coral cover and fish numbers in the Kuruwitu LMMA (Kawaka et al., 2015; Rocliffe et al., 2014). The rapid increase in LMMAs demonstrate that local communities see benefits of this management style despite limitations, such as lack of education and awareness, marketing, financing, and monitoring strategies (Kawaka et al., 2015; Rocliffe et al., 2014). LMMAs in

Kenya are supported by the East African Wildlife Society (EAWLS), Flora and Fauna International (FFI), Wildlife Conservation Society (WCS), as well as local organizations such as the Kuruwitu Conservation and Welfare Association (KCWA) (Kawaka et al., 2015; Maina et al., 2011) and Coastal Oceans Research and Development - Indian Ocean (CORDIO).

In Kenya, local community members have voluntarily established LMMAs to give their communities an opportunity for structured engagement in the conservation of marine resources while deriving benefits from the same resources. The implementation process required collaboration between government - both the national and country level - and coastal communities. In order to establish LMMAs, tourism and artisanal fishery agents were analyzed to set up guidelines for the fishery and tourism sectors that can ensure sustainable use of ecosystems. The LMMA with a 'no fish-take' zone was established in 2006, necessitating the exploration of alternative livelihood activities through the use of corals and other marine life while the area was closed to fishing to recover from the effects of destructive practices and overfishing (Kawaka et al., 2015). As a result, fish stocks and coral reefs recovered and fish catch in surrounding areas increased. Also, the biodiversity as a result of ecosystem conservation has resulted in increased snorkelling revenue that benefits the local economy (Odote et al., 2015). At the same time, challenges remain concerning the manner in which LMMAs were established, as there is deficiency of a clear legal framework and guidelines for the establishment of community protected coastal areas (Odote et al., 2015).

Madagascar to inspire SIDS (Small Island Developing States)

In Madagascar, an arid region, fisheries are an important resource, especially the reef octopus fishery which represents one of the top three economic activities in the area (Benbow, 2014). The seas also have important cultural heritage for traditional fishing communities and are a source of food security and job creation (Harris, 2011; Mayol, 2013). In the early 2000s, traditional and subsistence octopus fishing areas became overexploited and unsustainably accessed by commercial fishers (Benbow, 2014). Community-based management through LMMAs are seen as a way to overcome the nation's political volatility, economical instability, decreasing social well-being, and capacity to manage in a top-down manner (Mayol, 2013). This community-based management approach fits within traditional values about social code called 'dina,' which are community laws predating independence (Rocliffe et al., 2014).

LMMAs have increased in order to meet the goal of tripling Madagascar's marine protected areas in five years set out in the Durban Vision (Durbin, 2006; Mayol, 2013; Rocliffe et al., 2014). Madagascar's LMMAs have witnessed success in increasing catch as demonstrated in the first LMMA in Andavadoaka, which focused on increasing their octopus stocks through a temporary closure supported by Wildlife Conservation Society and Blue Ventures (Benbow, 2014; Mayol, 2013; Rocliffe et al., 2014). In the seven years since its original success, LMMAs with temporary octopus closures have increased catches, enhanced catch compared to effort, and demonstrate that these benefits outweigh the costs of such management methods (Harris, 2011; Mayol, 2013). LMMAs in Madagascar have been supported

since 2006 by the Velondriake Association, which governs across multiple villages, as well as peer-to-peer learning and through the development of Andavadoaka as a training base, and Madagascar's first LMMA network called MIHARI (Mayol, 2013).

Mozambique: Towards a vision for Coastal Cities as Sustainable Economic Hubs

Mozambique is a nation recovering from years of civil war and struggle for liberation and is beginning to decentralize decision-making, such as through LMMAs for marine resources (Govan, Tawake, & Tabunakawai, 2006). Co-management of marine resources began in Mozambique with the Fishing Community Councils (CCPs) and Co-management Committees (CCGs) introduced through the 2003 Regulation on Marine Fisheries and legislation in 2007 (Rocliffe et al., 2014). The CCGs involve multiple stakeholders at more of a top level while the CCPs are community-based organizations that function as LMMAs (Rocliffe et al., 2014). While the number of LMMAs has increased dramatically, few are recognized by the Mozambique Ministry of Fisheries, which has created many struggles associated with this local/national discrepancy (Govan et al., 2006; Rocliffe et al., 2014). As a result the Vamizi Marine Sanctuary is the only functioning LMMA in Mozambique due to it's support from an eco-lodge on Vamizi Island and World Wildlife Fund (Rocliffe et al., 2014).

An empirical case study for the Province of Inhambane, Mozambique that was a collaborative effort of UNU INWEH with regional agencies viz., IUCN outlined a feasibility analysis towards an 'intervention strategy' that provides stakeholder-driven vision for integrated and sustainable development by employing the LMMA framework. With an objective to outline strategies for sustainable development of

coastal cities and enhance their resilience, the LMMA framework embeds tourism and fishery activities as drivers/influencers for coastal and marine habitats. LMMA guidelines were charted by integrating in three categories; socioeconomic, ecological, and policy attributes of the socio-ecological system for the province of Inhambane as a pilot province, with a scalable potential for four municipalities, namely Inhambane (city), Maxixe, Massinga and Vilankulo. These LMMA guidelines support integrated development that will in turn support sustainable economic growth and social improvement as well as nature conservation and coastal resilience, while also identifying options for an intervention strategy that is mutually engaging.

Drawing from existing best practices, this empirical case study further identified modalities for minimizing resource use conflicts while simultaneously keeping impacts on biodiversity as low as possible (Bloecker, 2016; Nagabhatla, Lee, Bloecker, & Deen, 2017). The study adopted a schematic methodology to collect data from representative stakeholders (fishers, tourism sector agents, government officials, local and international researchers, private and community actors) to set out guidelines for the establishment of LMMAs as a strategy for better coastal and marine protection. At the same time, this study assessed how and to what extent the local populations can be effectively involved in the management of the area and identified modalities for minimising resource driven conflicts, which may have serious impacts on biodiversity as well as the socio economy of the region. In addition, conscious effort was made to capture data, information, and knowledge from various stakeholders' groups. One key highlight from the socio-economic

survey analysis show that fishermen fully depend on fish and have low income (Bloecker, 2016). Tourism operators have high incomes and depend mainly on coral reefs and megafauna. A big socio-economic gap between these two sectors makes collaboration difficult and results in conflicts. Another outcome of the feasibility assessment was: "If the collaboration and communication between [fisheries cooperatives], tourism operators and the government is enhanced, the basis for a LMMA would be set" (Bloecker, 2016). A LMMA would benefit the region by coupling government support and funding with the fisheries cooperatives' and tourism operators' knowledge about local marine resources.

The comprehensive assessment helped stakeholders to understand the vision locals have for LMMAs to identify and define challenges to implementing this concept. Most responders agreed that compared to existing management frameworks for coastal and marine ecosystems, such as Marine Protected Area, ICZM are more of a top-down approach, where government takes charge of decision making. LMMA's approach is bottom-up wherein local stakeholders are in charge of decisions on resource systems with government as an advisor. LMMAs can benefit locals and the environment, taking note of demands and visions of the community and providing them the authority to be guardians.

LMMA guidelines for Kenya, which were modified to apply in Mozambique, outline for consideration by local and national authorities the key aspects that will be included in the proposed planning (Odote et al., 2015). These considerations include: variability, uncertainty and probable natural changes in the environment, capacity of the ecosystems to produce food, revenues, employment, and essential

ecosystem services and livelihood opportunities (Odote et al., 2015). Conservation of ecosystem structures, processes and interactions through sustainable management should be integrated to meet the objectives of the proposed LMMA approach. In doing so, the recommended guidelines strongly emphasize that new and innovative management approaches should include analysis of ecosystem services and developing strategies to conserve and/or restore their functions, along with equitable sharing of its benefits.

Table 2: Results of comparative case study.

Country	Year(s) Created	Key Focus & Impact	Goals to Meet	Strengths	Weaknesses
Fiji	Early 1990a	• Increase the clam stocks in Ucunivanua • Increased village incomes, improved household welfare • Increased food security	30% MPAs by 2030	• Aligns with existing Indigenous ways of managing resources • Scaled up through the FLMMA Network • Strengthened collective ownership rights	• Need to be combined with top-down support
Myanmar	2017	• Improve the health and biodiversity of coral reefs • Protect crab and fish nurseries • Increase fish stocks • Support local livelihoods	Sustainable Coastal Zone Management	• Began with a scientific survey to inform decision-making	• Hasn't been implemented long enough to know whether it is successful
Kenya	2006	• Increase live hard coral cover • Increase fish numbers in Kuruwitu	Reduce over-exploitation of coastal and marine resources	• Rapid increase in LMMAs across the country due to community buy-in	• Lack of education & awareness, marketing, funding, and monitoring strategies • Lack of clear legal framework and guidelines to support LMMA implementation

Madagascar	2004	• Temporary octopus closures to increase octopus stocks and catch in Andavadoaka, peer-to-peer learning	Durban Vision – triple MPAs in 5 years	• Aligns with traditional values around resource management • Peer-to-peer learning through training base • MIHARI as their first LMMA network	
Mozambique	2006	• Balancing needs of fishermen and tourism operators while conserving the environment	Sustainable Development Goals	• Local stakeholders prefer this approach to management	• Few LMMAs are recognized by the Mozambique Ministry of Fisheries • Lack funding

Discussion

How this study is related to and builds on existing literature

The case studies summarized in Table 2 highlight the factors that contribute to successful LMMA implementation and those which hinder or create gaps. Successful implementation is characterised in many cases by an alignment with local Indigenous ways of resource management (Fiji, Madagascar, and Mozambique), community buy-in (Kenya), strengthening local collective ownership rights (Fiji), learning from others through informal mechanisms or formal LMMA Networks (Fiji and Madagascar), and scientific studies informing the decisions being made at a local level (Myanmar). However, these LMMA implementations were hindered by a lack of top-down support such as legislation and national recognition (Fiji, Kenya, and Mozambique), lack of funding (Kenya and Mozambique), education and awareness, as well as marketing and monitoring strategies to determine success over time (Kenya). Other jurisdictions hoping to implement a LMMA approach to

marine resources management would benefit from national/territorial legislation and funding support to ensure that this is successful.

These cases demonstrate the growing appetite amongst communities to move from more traditional, top-down approaches to having local stakeholders involved in marine resource decisions. MPAs or other existing management regimes have been seen primarily as top-down management approaches where the government and higher agencies are in charge of management of resources. The exclusion of local communities is a serious existing problem. This was observed in Kenya, where the exclusion of local communities led to increased depletion of marine and coastal resources. In the Pacific region, LMMAs are taken as an alternative management strategy, especially where governments have comparatively little capacity to effectively manage dispersed, varied, and vital small-scale fisheries. To ensure that LMMAs are as beneficial as possible for local stakeholders, future research needs to focus on testing the effectiveness of LMMAs for improving the activities and sustainability of fisheries (i.e. designed to prevent the loss of benefits), rather than optimizing benefits (Cochrane, Andrew, & Parma, 2011). Research also needs to improve the understanding of how LMMAs might work in conjunction with centralised management and higher levels of planning to tackle small-scale fishery concerns (Cohen et al., 2014).

Over the years there have been many approaches used for environmental management of coastal resources, including integrated coastal zone management (ICZM) (Jupiter et al., 2014). ICZMs are management approaches that include the planning and coordination between various coastal area objectives such as

environmental, economic, social, cultural, and recreational with economic and ethical benefits, such as sustainable development and social equity (Cummins, V., Mahony, O, & Connolly, 2003; Jupiter et al., 2014). LMMAs complement the ICZM approach and create an important opportunity for community stakeholder involvement going forward.

Strengths

There is a widely recognized need to embed local and Indigenous knowledge into management approaches to recognize activities that guard and preserve coastal and marine biodiversity and ecosystems, while also ensuring food security, employment and income through local fisheries and tourism. The growth of LMMAs are complemented by the ICZM framework. ICZM approaches have now been mainstreamed as a central management principle in many states and across multiple sectors as a platform that offers tools for information collection, planning (in its broadest sense), decision making, management and monitoring. The ICZM framework also embeds settlement mechanisms for stakeholder's conflicts related to use of coastal ecosystems, while promulgating the concepts of common property and open access to resource use (Frost, Campbell, Medina, & Usongo, 2006). Both LMMA and ICZM frameworks include representation of local and Indigenous knowledge, which has developed international recognition as culturally appropriate approaches to management. The residents of areas requiring conservation planning, policy, and decision-making must hence be principally engaged in decision-making through the use of the LMMA approach. The case study analysis demonstrates that coastal and marine protection can be achieved through the establishment of LMMAs

to counter unsustainable resource use that often accompanies management options that neglect local stakeholder voices in decision-making. LMMA cases demonstrate how and to what extent the local population can most effectively be involved in the management of the coastal areas to balance ecological and human wellbeing.

Limitations

This study is a review of existing published and grey literature about specific cases of LMMA implementation. As a result, there are many cases that were not included in the review to make it more feasible. Additionally, there are no cases of unsuccessful LMMA implementation, rather a focus on what factors created barriers to existing LMMAs. Future research should examine those implementations that were unsuccessful to determine if there were different factors that were barriers compared to the cases described above.

Implications for policy

As discussed above, policy support for LMMAs nationally and locally is key to successful implementation and meeting both national and international goals surrounding biodiversity and marine health. The joint pledge of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), for example, calls for innovative thinking to implement strategic collaborations at all scales from local to global (IPBES, 2015). In addition, IPBES deliverable 1c: "*Procedures, approaches and participatory processes for working with indigenous and local knowledge systems"* highlights the need to define a clear stakeholder engagement policy that accounts for Indigenous and local knowledge systems while designing and planning future interventions that aim for biodiversity conservation

and ecosystem management (IPBES, n.d., 2015). To ensure that nature conservation and management strategies are effective, planners and policy makers should build their approach on existing experiences and embed various value and knowledge systems.

When considering the global context of marine conservation, LMMAs are a management approach that will help many nations meet their targets as set out by the UN Sustainable Development Goals. While this document set out 17 distinct goals, these are interconnected when it comes to practical ways to meet these goals. For example, Goal 14 is to "*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*"; this can be done through Goal 16 which aims to "*Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*" and Goal 11: "*Make cities and human settlements inclusive, safe, resilient and sustainable*" (United Nations, 2015). LMMAs as a management approach could assist in meeting these goals by focusing on conservation and sustainable use of marine resources while using a participatory governance approach. A participatory approach to governance also meets target 16.7 for Goal 16 which states that nations should "*Ensure responsive, inclusive, participatory and representative decision-making at all levels*", additionally, it helps meet target 11.3: "*By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries*" (United Nations, 2015). Unlike traditional management options, such as MPAs, LMMAs involve local communities as essential stakeholders in decisions about conservation

of marine resources which affects livelihoods and has the potential to impact the resilience and sustainability of coastal communities who rely on these resources to not only survive, but to thrive. Lessons learned from the inclusion of local stakeholder voices in marine management through LMMA implementation can provide important policy insights for other areas of development that aim to improve quality of life.

Implications for research

Experiences and efforts on LMMAs made by states such as Myanmar and Kenya show further research evaluating the long-term effectiveness of this approach as a community engaging management option will be important to support scalability. Using a SWOT analysis to examine the Strengths, Weaknesses, Opportunities, and Threats involved in each case will allow new jurisdictions to make evidence informed decisions about policy and implementation strategies. Existing experiences from countries that have adopted this approach reflect that LMMAs could serve as a mechanism to initiate tactical partnerships and engagement with stakeholders to deliver better and coordinated efforts to address priority needs. The need for in-depth investigation that leads to generation of evidence on large-scale merits of LMMA remains important to fill data and information gaps.

Conclusions

LMMAs represent an important approach to management of marine resources that respects Indigenous traditional knowledge and local ecological knowledge and values. An important strength of this approach is the inclusion of local stakeholders and know-how alongside scientific knowledge so that the diverse

ecological services and benefits of each marine area are embedded in the decision-making process. The emphasis on local stakeholders and local knowledge inclusion in the LMMA approach allows changes in values and changes in Indigenous and local ecological knowledge to be responded to more swiftly and reflected in ongoing decisions regarding resource allocation, use, and governance.

Innovations in management approaches in various social-ecological systems at the global scale that have been subjected to heavy anthropogenic influence are a positive sign for the sustainability agenda. LMMAs are a unique method of managing resources, which could be expanded to other geographies in the future to ensure that conservation of our oceans and planet is not occurring at the cost of local livelihoods. This management approach fits well with pre-existing methods of bottom-up management used by Indigenous peoples in Fiji and other coastal communities discussed in the cases. The approach recognizes the importance of Indigenous and local knowledge systems to the conservation and sustainable use of ecosystems and provides for a participatory mechanism to managing these systems. The lesson learned from the experiences of Arctic wildlife management and resource assessments is that results are much improved when local communities and local knowledge is included as a source of data to help modulate the findings of population science, and to inform management. Additionally, as sea ice melts due to climate change, increasing the opportunities for international interest in the resources contained within the global commons of the Arctic Ocean, the adoption of LMMA management approach will ensure that local interests are not neglected within this changing context.

Given immense dependence of humans on food derived from coastal and marine ecosystems, and more nations outlining strategies for expanding food reliance from these resource systems, sustainable practices and conservation methods are required to suitably use and harvest these resources. It is a firm assumption that fragile coastal and marine resource systems cannot sustain the growing demand using the "business as usual" approach. New approaches, such as LMMAs, need to be employed to successfully meet this growing demand without destroying conservation efforts. The success of this approach is demonstrated by the increase of LMMA coverage in Madagascar to over 14 percent of the 3,000-mile coastline in just 15 years and by the productivity of related aquaculture initiatives.

The creation of LMMAs not only allows nations to meet the UN Sustainable Development Goals (SDG 2, 13, 14, and 16) related to conservation of marine wildlife and collaborative governance, but also allows communities to thrive through inclusion of local actors in the decision-making process (United Nations, n.d.). Use of LMMAs could be comfortably scaled to jurisdictions in Canada. New approaches are needed in regions of the Canadian Arctic, such as in Nunavut, where vast reaches of ocean territory are supporting widely distributed wildlife populations whose numbers fluctuate and are difficult to estimate. There have been many instances in the past of scientists disregarding local knowledge of the abundance and distribution of marine and other mammals and many management interventions have lacked community involvement or participation. It is important going forward that in jurisdictions, such as Nunavut, where legal commitments to inclusion of local people and local knowledge in decision-making processes exist,

that additional means of actioning these requirements are developed. The further development of LMMAs would offer additional tools to honour the spirit of the Nunavut Land Claims Agreement, and to implement it more effectively in these areas of concern. LMMAs offer a potentially valuable management and decision-making tool to help to ensure the survival of local communities given the incredible threats they are facing with the impacts of climate change.

Indigenous participation in resource management and in LMMAs in earlier forms has been introduced to Canada's Arctic through land claims, such as the Inuvialuit Land Claim. Further development of this concept could be an effective way of meeting the changing needs of northern jurisdictions. LMMAs are distinct from Marine Protected Areas in that the purpose is not to ban resource extraction, rather, more like Biosphere Reserves, to create local rules and regulations about such resource extraction and use of the marine area (Govan et al., 2009). In this way LMMAs could support inclusion of local traditional knowledge of Inuit about how marine mammals should be harvested, conservation ideas, and knowledge of stock sizes. Additionally, the adoption of LMMAs as a management option allow the voices of community members to be included when making decisions about marine resources so that mining interests are not prioritized over subsistence needs by non-local decision-making.

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Chapter 5

An Ontological Model of the Social, Cultural, and Ecological Influences of Community Health and Wellbeing

Introduction

Community health and wellbeing, like individual health, are influenced by a number of factors that interact in complex ways. Therefore, health and wellbeing cannot be understood completely from a biomedical model approach; rather they include social, cultural, and ecological influences. The interconnections among food security, cultural continuity, and community health and wellbeing were explored in the second chapter of this dissertation with the aim of using these connections to understand how climate change and increased shipping impacts community health and wellbeing. The third chapter was more focused on examining the potential ways to measure cultural continuity and its influence on individual health. The fourth chapter used different case studies to understand the strengths and limitations of implementing a community focused resource management model - Locally Managed Marine Areas (LMMAs). This model also prioritizes community involvement and engagement in resource decision-making in an effort to support community wellbeing. Throughout this thesis, a social, cultural, and ecological systems lens has been used to better understand the factors that influence community health and wellbeing and, thus, inform future policy geared toward supporting this nexus.

Rationale and Purpose

The first three empirical studies of this thesis examined different aspects of the social, cultural, and ecological influences on community health and wellbeing. As disparate as these chapters may seem, ranging from focus on climate change in Nunavut to marine resource management in the Asian-Pacific, there are important

links that can be made among them. This chapter aims to explore these links through representing the findings of the previous chapters into a model, called an ontology, which was created using ontology engineering methods (explained further below). The overarching research objective for this study is to demonstrate how an ontology model representing diverse research results, such as the previous three studies, can serve as a tool that can efficiently make connections across studies and could be used to inform policy decisions regarding community health and wellbeing.

The formation of new research questions is often based upon a review of the current literature to discover what is known and where the gaps in knowledge may lie. When conducting a literature search, current practice involves using key terms to search certain databases that will return related articles. When trying to understand connections across different disciplines, it is often up to the researcher to make certain leaps in determining where connections can be made and the implications of these leaps. When investigating higher order relationships across disciplines in interdisciplinary research, important connections can potentially be missed. Therefore, having the knowledge about a particular subject, such as community health and wellbeing, represented in a structured way that maps the connections across the disciplines, such as an ontology model, could help tackle the complexity of this process and make it more efficient. In the same way, this model not only makes a literature search more efficient, but also the process of creating a policy brief regarding the current evidence surrounding an upcoming policy decision. By illustrating how these chapters could be linked despite using different methods and originating in different disciplines of research, this study's research

objective is to demonstrate the value of using such ontology engineering approaches to better inform research and policy about community health and wellbeing.

Method

Ontology engineering methods are used to create structured, organized models to represent knowledge in a given field, such as biomedicine and computer science (Fox, Barbuceanu, Gruninger, & Lin, 1998; Gruninger & Fox, 1995; Noy & McGuinness, 2001). An ontology (the name for the model created using ontology engineering methods that is distinct from, though related to, the field of philosophy) is made up of concepts and the relationships among these concepts. Given the structured nature of ontologies, concepts are defined within the model into a hierarchy of classes and subclasses (terms used for concepts) with instances or individuals, which are specific examples of each class. For example, when representing the Nunavut chapter, it is important to have a class for location with subclasses country, territory, and community, and the respective instances being Canada, Nunavut, and Chesterfield Inlet. Next, relationships between these hierarchies of classes or between the related instances are defined through axioms (or statements) using Descriptive Logic (DL). This allows for a structured representation of the knowledge and to allow inferences to be made across the different research results being represented. These relationships, called object or data properties in ontology engineering, allow a structured representation of the knowledge from different disciplines to be represented in a single model and the development of hypotheses about their connections, which could promote more interdisciplinary research.

Ontologies are designed with a specific purpose in mind – a domain and scope – as well as a set of questions it should be able to answer – competency questions. These competency questions are used to focus the building of the model and determine its completeness. The computer program Protégé was used to input the classes and properties into an ontology model, to create visual representations, and to perform queries to validate the competency questions.

Domain and Scope

The ontology domain in this paper covers social, cultural, and ecological influences on community health – in other words, the previous dissertation chapters. Researchers can use this ontology to link the results of diverse studies when creating policy briefs to inform decision-makers and determine gaps in the knowledge where new projects should focus. Additionally, community practitioners can use this model to gain a broader understanding of the current evidence without having to read multiple research articles when making decisions about how to support community health and wellbeing.

Competency Questions

Competency questions within the field of ontology engineering are a method used to shape the ontology being built and to determine when it is complete. Prior to building an ontology model, a list of competency questions, or questions the model should be able to answer if complete, are developed and agreed upon by the ontology engineers. Building an ontology is an iterative process which is guided by the competency questions to ensure that the necessary classes, instances, or properties required to validate them are included in the model.

The competency questions were designed to demonstrate how an ontology model could be used to make connections across three diverse research projects in order to inform policy using a diverse set of evidence including Indigenous knowledge and Western science. The competency questions are as follows:

1. How does doubling the number of ships travelling past Chesterfield Inlet harbour and along the inlet to Meadowbank Mine change/impact self-rated health?
2. How could using a Locally Managed Marine Area (LMMA) approach to resource decision-making in Chesterfield Inlet impact culture and sense of wellbeing for community members?
3. How could a LMMA approach impact the self-rated health of community members in the Arctic?

Existing Ontologies

As the purpose of creating this ontology was to demonstrate how connections across three research projects could be made, the reusing of existing ontologies did not seem to fit the purposes. However, existing ontologies were searched to determine if something similar existed and to determine if the current ontology was to be expanded, whether there was value in this linkage to pre-existing ontologies. Existing ontologies include for example, models of business processes to improve workflow or global city indicators that allow for comparison across jurisdictions and over time (Fox & Gruninger, 1998; Khazei & Fox, 2017; Wang & Fox, 2015). As the competency questions focus on connecting the three original research studies in this dissertation, existing ontologies that were linked

originally were then excluded from the final model as they complicated the model without adding concepts pertinent to validating the competency questions.

Class Taxonomy, Object/Data Properties, and Instances

The different terms from each research paper were then enumerated and the respective papers were used to create a taxonomy of terms and further create the object and data properties required for this ontology model. These terms and properties that can be seen in the ontology model are contained in tables 3, 4, and 5 and figure 6 in Appendix B below shows a visualization of them in Protégé. Classes, properties, and instances were then added to the model focusing on those required to validate the competency questions. For example, instances of Chesterfield Inlet current hunters were created to demonstrate the value of ontology engineering to represent the Nunavut chapter.

In order to answer the competency questions, the following concepts need to be added to the ontology model as classes or subclasses and instances specific to the scenarios: the number of ships along the inlet; the number of marine mammals in the area; the number of marine mammals that are harvested/harvesting activity; the amount of country food that is shared as a result; a level of cultural continuity that results from being able to share country food (or not being able to share); some level of self-rated health; access to country food; shipping speed; having an Inuk hunter on a ship; government satisfaction level; and municipal voting.

The object properties that were added were: affects, affected by, and impacts. Affected by and affects were transitional and inverse – any classes or instances that are connected by the object property affected by, were also inversely related by

affects. The ability to make these object properties transitional allows the model to infer a relationship between concepts through a series of if-then statements such as the connection between the number of ships along the inlet and self-rated health. Impacts was an object property that was transitional – as with affects and affected by – however, in this case, impacts was considered a symmetrical rather than inverse property, as the relationship is not simply one-way. For example, food security impacts cultural continuity and the reverse is also true, as my research in Nunavut demonstrated that hunters who were food secure were able to share country food (cultural value) with others and community members who received shared country food (cultural continuity) were more food secure. Whereas shipping causes decreased numbers of marine mammals, but community members did not describe marine mammals directly affecting the number of ships along the inlet (however this is possible in an indirect way though community intervention but this is not the scenario being represented, nor the interpretation of inverse or symmetrical relationships in an ontology). Finally, instances for each concept were created to allow the reasoner to perform the query to validate the competency questions related to the specific scenarios.

Validate using Competency Questions

When using Protégé to create the ontology model, there is a reasoner (computer program contained within) that is used to determine if the structured relationships represented using axioms (object or data properties) make sense together or if there are conflicts contained within the model. It is the use of this reasoner within Protégé that allows for queries to be made of the model's contents

to validate the competency questions and, therefore, determine the model's accuracy and whether it is complete. The responses to these competency questions represent the results of this thesis chapter. Scenarios were created based on the research studies that inform this chapter and were considered most likely for each of the competency questions.

Of many possible scenarios, three hypothetical scenarios were created for each competency question based on assumptions grounded in the research of the broader dissertation. The first competency question is in direct response to the concerns expressed by community members about the ships along the inlet to the mine doubling between the summer of 2017 (when I was in Chesterfield Inlet) and the summer of 2018. This is likely due to increases in the length of the season where the shipping route is available due to climate change and the projected opening of a new mine. As such, the three scenarios are based on their observations of current marine wildlife response to around 30-40 ships a summer, their memories prior to these increased ships to the mine, and projections based on the doubling of these ships.

The second competency question is designed to link the Nunavut and LMMA studies based on community member comments about the need to make changes to marine quotas and the difficulty of this process. Given the Inuit self-governed nature of Nunavut, the three scenarios here are based on the hypothesis that community member involvement in decision-making would result in the changes to shipping practices they are advocating for – having an Inuk hunter on a ship and slower shipping speeds to reduce the impact on marine mammals. One scenario

was a lot slower speeds and an Inuk hunter on board, the second was a little slower and no Inuk hunter on board (representing getting some of what they advocated for), and finally, the same speed and no Inuk hunter on board.

The third competency question was designed to fully integrate all three studies and builds on the scenarios from the second competency question. The hypothesis in this case is that when community members are included in decision-making (LMMAs) they will be more satisfied with the government and vote in municipal elections. By contrast when they are not involved they will be dissatisfied and not vote in municipal elections, leaving the final scenario being somewhat satisfied with the government but also not voting (therefore somewhere in the middle).

Results

Competency Question 1

The first competency question asks: ***How does doubling the number of ships travelling past Chesterfield Inlet harbour and along the inlet to Meadowbank Mine change/impact self-rated health?*** The query using DL was stated as such: *affectedBy value CI60Ships/CI30Ships/CINoShips,* with CI60Ships being the instance created to represent doubling the number of ships which currently number around 30 along the inlet (represented by the instance CI30Ships). The instance CINoShips was included to represent the situation when far less ships travelled along the inlet to Meadowbank Mine prior to its opening in 2010, as described by participants within the Nunavut chapter. The reasoner returned the following instances as a result of the DL query for CINoShips:

CIFamily+Lots, CIHighCC, CIManyMM, CIShareLot, and HighSRH, which means that it infers from the set of relationships contained within the model that having no ships traveling along the inlet will result in higher levels of self-rated health due to the higher number of marine mammals harvested and shared country food, resulting in higher levels of cultural continuity. This was done without an explicit relationship being contained within the model connecting the number of ships to self-rated health, but as a result of the transitional nature of the object properties affectedBy/affects. Due to the inverse nature of the affects/affectedBy object property we can also use the query: affects value HighSRH to generate the result: CIFamily+Lots, CIHighCC, CIManyMM, CIShareLot, and CINoShips. This means that high self-rated health is affected by having high levels of cultural continuity, which is affected by lots of country food sharing, which is affected by being able to harvest many marine mammals, which is affected by having a limited number of ships along the inlet.

Table 3: Concepts and instances for competency question #1.

Concept	No Ships Scenario	30 Ships Scenario	60 Ships Scenario
Number of ships along the inlet	No ships along the inlet (CINoShips)	30 ships along the inlet (Current situation - CI30Ships)	60 ships along the inlet (doubling the ships - CI60Ships)
Amount of marine mammals along the inlet	Many marine mammals along the inlet (CIManyMM)	Medium level of marine mammals along the inlet (CILessMM)	Low levels of marine mammals along the inlet (CIFewMM)
Amount of marine mammals harvested	Harvested enough for family and lots of sharing (CIFamily+Lots)	Harvested enough for family and limited sharing (CIFamily+Some)	Harvested only enough for family, no sharing (CIFamilyOnly)
Amount of marine mammals shared with community	Hunter shared a lot of country food (CIShareLot)	Hunter only shared a little country food (CIShareLittle)	Hunter can't share country food (CICan'tShare)
Level of cultural continuity	High level of cultural continuity (CIHighCC)	Medium level of cultural continuity	Low level of cultural continuity (CILowCC)

		(CIMediumCC)	
Level of self-rated health	High self-rated health (HighSRH)	Medium self-rated health (MediumSRH)	Low self-rated health (LowSRH)

Table 3 outlines the concepts and instances required to create the series of if-then statements to answer competency question #1 using three scenarios. In the first scenario where there are limited ships along the inlet, based on accounts of community members, there were higher levels of self-rated health. This is based on the following assumptions in the model which are informed by the previous research chapters: if there are limited ships along the inlet there will be many marine mammals; if there are many marine mammals the hunters will be able to harvest enough to feed their families and share within the community; if they have harvested enough to share freely with the community then hunters will share a lot of country food; if hunters are able to share a lot of country food then they will have high levels of cultural continuity because this is an important part of Inuit traditional knowledge; and if they have high levels of cultural continuity then they will have higher levels of self-rated health. If at any point when designing the ontology model one of these if-then statements was not added then the connection between the number of ships and self-rated health would not appear in the results of the query. This is why it is an iterative process, to determine when a link does not exist in the query results you must ask: was there a relationship that was missed? Is there a concept that needs to be added? Or is one of these relationships not elucidated in the research – allowing us to identify an area for future research. In the other two scenarios a similar series of if-then statements connects the level of shipping with the level of self-rated health, as listed in table 3.

The important result here when creating an ontology is that if any of these individual relationships are not made between the instances, then the reasoner will not make a connection between numbers of ships along the inlet and self-rated health. This means that the ontology query only makes logical conclusions based on what the researcher has added to the model; if one connection is missing then the researcher has to examine why that is. Did it get missed when creating the model as this is an iterative process? Or was there a leap that an individual is making that is not evident in the literature, hence it not being coded into the model. Additionally, if relationships are added to the model which conflict then this will generate an error, causing the researcher to consider whether it is a coding error or a nuance in the data not fully captured in the ontology to date. In this way the model assists researchers in connecting diverse bodies of research without making illogical leaps (provided they are representing only what is contained in the literature, something the structured nature of this method encourages).

Competency Question #2

The second competency question links the Nunavut paper to the LMMA paper by asking: ***How could using a Locally Managed Marine Area approach to resource decision-making in Chesterfield Inlet impact culture and sense of wellbeing for community members?*** Table 4 contains the concepts and instances that were included in the model in order to validate this question. In order to validate this competency question, the following DL query was employed: affectedBy value CICommunityEngaged. In this case, while impacts was used to connect the concepts food security, cultural continuity, and community health and

wellbeing, connecting the instances required an 'affects' object property. This allows us to more accurately represent these specific scenarios and resulted in the following output: CIFamily+Lots, CIHighCC, CIHighCHWB, CIManyMM, CIShareLot, CommunityMemberFS, HighSRH, HunterOnShip, and ShipsMuchSlower. Notice that this output includes the same instances as the first query with the addition of 'HunterOnShip', 'ShipsMuchSlower', 'CIHighCHWB', and 'CommunityMemberFS'. This is due to the relationships added which explicitly link food security, cultural continuity and community health and wellbeing. In the case of the hunter on the ship and the ships traveling slower, these were related simply to the number of marine mammals along the inlet from the first query, allowing the reasoner to infer the connection to the rest of the instances from the query which validated competency question #1.

Table 4: Concepts and instances added for competency question #2.

Concept	Community Engaged	Community Consulted	Community Not Engaged
Having an Inuk hunter on the ships	Having an Inuk hunter on the ship (HunterOnShip)		No Inuk hunter on the ship (NoHunterOnShip)
Ship speed along the inlet	Ships traveling much slower along the inlet (ShipMuchSlower)	Ships traveling only a little slower along the inlet (ShipLittleSlower)	Ships traveling the same speed as current (ShipSameSpeed)
Food security level for community members	Community members are food secure (CommunityMemberFS)	Community members experience moderate levels of food insecurity (CommunityMemberModerateFS)	Community members are food insecure (CommunityMemberFI)
Level of community health and wellbeing	High levels of community health and wellbeing (CIHighCHWB)	Medium levels of community health and wellbeing (CIMediumCHWB)	Low levels of community health and wellbeing (CILowCHWB)

Table 4 includes the concepts and instances required for the if-then statements that, when added to table 3, allow the ontology to validate competency question #2. The first scenario is using a LMMA marine resources management approach, which assumes community members are engaged in decision-making processes. In this scenario, instead of limited ships along the inlet leading to many marine mammals, it is ships of much slower speed and having an Inuk hunter on board which result in many marine mammals along the inlet. As table 3 demonstrates, many marine mammals along the inlet leads to the assumption that hunters are more food secure themselves and then they are able to share country food with community members, making community members more food secure as well. Table 5 picks up the series of concepts contained in the if-then statements at this point by summarizing that if you have high levels of food security then you will have high levels of community health and wellbeing.

Creating this series of if-then statements within the ontology was quick and easy because many of them already existed from table 5. This demonstrates the value of expanding an ontology to contain multiple research papers within a single model because making connections between multiple, diverse research studies is more efficient. If many diverse research papers are included in the model, this allows a researcher to add the specific relationships contained within their new study and allow the model to make logical connections to other papers in the model based on their relationships, potentially even papers the researcher has not read but someone else has added to the model. This demonstrates the potential benefit of having such an ontology model that would be available online and added to globally.

However, this is prefaced on the idea that the relationships contained within the model adequately represent those in the research study – an important consideration when conducting future research using this method. In some cases when ontology models are shared there is a single researcher/research group responsible for screening the additions to the model to limit errors.

Competency Question #3

Finally, the last competency question links all three by connecting the LMMA paper to the Aboriginal Peoples Survey paper through the use of the theoretical model from the Nunavut paper about the relationship between food security, cultural continuity, and community health and wellbeing: ***How could a LMMA approach impact the self-rated health of community members in the Arctic?*** The final query states either 'affectedBy value CICommunityEngaged' or 'affects value HighSRH'. With this case the output required the addition of connections between the existing model to CIGovtSatisfied and CIMunicipalVote because these were the concepts required to validate this competency question.

Table 5: Concepts and instances added for competency question #3.

Concept	Community Engaged	Community Consulted	Community Not Engaged
Government satisfaction level	Community satisfied with government (CIGovtSatisfied)	Community somewhat satisfied with government (CIGovtSomewhatSat)	Community not satisfied with government (CIGovtNotSat)
Municipal voting participation	Community members vote in municipal elections (CIMunicipalVote)		Community members don't vote in municipal elections (CIMunicpalNoVote)

Table 5 includes the final concepts from the if-then statements required to link all three research studies and validate competency question #3. In the first scenario, LMMAs are used to manage marine resources, again the assumption is that the community is engaged in the decision-making process and as a result they are satisfied with their government and vote in municipal elections to stay engaged. This adds to the concepts and relationships contained in table 4 which were used to validate competency question #2; now if there are LMMAs or community engaged decision-making then there are high levels of self-rated health. In this output the same concepts from the second query will be part of the list as well, making a strong link between all three research projects.

As demonstrated by these results, an ontology representing research knowledge about social, cultural, and ecological influences on community health and wellbeing is an advantage to researchers and decision-makers. As tables 3, 4, and 5 demonstrate in their dwindling number of rows, the benefit of representing knowledge in an ontology is that once a critical number of concepts and relationships are contained in the model, adding new research results is quick and easy. It also allows for queries to give a more focused answer to a potential literature search question. For example, rather than searching in Google Scholar which generates a list of articles that now need to be read, using the query function in Protégé would allow you to search the same question and generate the related concepts and relationships with a link to the article if you needed to read more. This could be used to not only inform research studies, but also inform decision-makers about some of the existing evidence when creating policy to support community

health and wellbeing. Different web-interfaces have also been created to allow practitioners to more easily use an ontology, an example of such is shown in figure 7 in Appendix B (ECOresearch, n.d.).

Discussion

This study used ontology engineering methods to represent the results of the first three research projects, which used knowledge from three different domains to study community health and wellbeing. The creation of this ontology and validation of the competency questions demonstrates the ability of this tool to enhance interdisciplinary research through inferring relationships between concepts across knowledge domains. This model not only allows these hypotheses about relationships among concepts to be made, but also gaps in the connections among knowledge domains to be identified. For example, when considering how LMMAs would impact Chesterfield Inlet it forced me to think about what a locally managed marine area would look like in this context and how that would impact the results of the study regarding how shipping and climate change impacted community health and wellbeing. While this was something that can be inferred by a researcher, it is in adding large numbers of research results to this model that the potential benefit of using this method to make links more efficiently across diverse projects can be understood. Also, gaps were identified when building this model, for example, the impact of climate change on LMMAs and community health and wellbeing in other countries included in study #3 were missing. Expanding the model to include the impacts of climate change on Fiji for example would address this gap or may be an area of future research to explore.

This study represented significant challenges in representing qualitative data, which contains important nuances and often contradictions (studies 1-3), using such a structured approach to communicating research results (the ontology). Using ontology engineering methods forces a researcher to think critically about the results they are representing within the model. For example, should two terms really be used interchangeably to describe the same concept or are there nuanced differences between the two terms which we are not always careful to acknowledge when we use them in plain English language. For example, health and wellbeing are sometimes used interchangeably, while others use them as distinct concepts, such as in this dissertation.

When we are creating a taxonomy of terms, which definition and whether a term is truly a subclass or a class on its own are important considerations which social scientists do not always consider in such a structured way when communicating using English language; or if they do this it is not always communicated as such within their publications. For example, many of the articles that form the background of the studies did not include definitions of concepts that were key to their arguments, such as culture and Inuit traditional knowledge. Additionally, the structured way of organizing the concepts within the ontology was not seen in these papers as I struggled reading papers about LMMA and other approaches to understand whether the researchers were arguing these were management approaches, or styles, or tools, or something else entirely.

Recommendations for Future Research

Current research practice involves a slow and difficult process of manually making connections across literature to determine new research questions and elucidate gaps in the knowledge. However, by representing knowledge in such a way, the gaps are more easily identified through a DL query and either, relationships not currently represented may be added, or research can be conducted to understand the nature of such gaps. For example, when building the model it is described as an iterative process because after adding classes, instances, and object properties, the queries that were performed often did not validate the competency question. This meant that either a concept needed to be added or an object property linking two instances was missing so the model was not generating the results we would expect. Often this was related to the specifications used when creating the object properties or the instances and classes.

While the process for creating the ontology for this study was done manually by the researcher, this is not always necessary. Code can be created to extract key information from existing literature to add knowledge to an ontology model, allowing for a more efficient process of building the model which could capture various strings of knowledge about the social, cultural, and ecological influences on community health and wellbeing. Future researchers expanding this model in such a way could also make the ontology available online so that other researchers may use it to not only inform their research, but also to build onto it with their results.

Additionally, as there is a growing movement towards representing social science knowledge and research in different models, such as an ontology, this study presents important considerations for this process. It is important to consider that

when representing knowledge about community health and wellbeing that models, such as this ontology, capture a picture of the average relationship or average impacts, they do not speak to an individual's experience. For example, a community involved in the decision-making process (using a LMMA approach) may still have community members who are dissatisfied with the governance. This process demonstrates the need to carefully and critically think about what 'big data' we are modeling, how that data is being used, and the practical and ethical implications of such use.

Implications for Practice & Policy

There has been an important push within health policy in the past to ensure that, as much as possible, decisions and policies within health care are evidence informed or evidence based (Lavis, Permanand, Oxman, Lewin, & Fretheim, 2009; Lomas & Brown, 2009). The same should be true of decisions made about these other various aspects that impact community health and wellbeing outside of the healthcare system. Having this model represent existing knowledge about these factors could allow decision-makers to be more informed about the various impacts any new policy may have on the health and wellbeing of communities affected by such decisions.

This study also demonstrates the need for caution when modeling data and creating policy based on these models. As stated above, if all the concepts or the relationships relevant to the research results are not contained within the model, then the results will be problematic and if someone using the model is not familiar with the research they might not be aware of this gap. Additionally, within social

sciences research we understand that the relationship between two concepts is not static and rarely the same across multiple circumstances, which few models are able to capture effectively. Therefore, it is important to consider what knowledge is being fed into the model and use caution when interpreting the results because they can be easily skewed by representing one area of research, or a set of circumstances, that do not necessarily represent the reality for all cases. For example, while sharing of country food was an important part of Inuit traditional knowledge and community health and wellbeing in Chesterfield Inlet, this is not the case for all communities – many community members told me of how they are one of the few communities that still share country food, many others have started selling country food within the community. If someone was not careful in using this model to make decisions about supporting community harvesting at the territory level then they may do more harm as it's impact outside of Chesterfield Inlet is not part of the existing ontology.

Limitations

Given the timeframe of a PhD thesis and the limited knowledge of the researcher about computer coding, the automated model described in the future research section was not built. However, the ontology built for this study meets the requirements set out in the competency questions from the outset and serves as a proof of concept for advocating the use of such knowledge representation techniques in the social sciences and interdisciplinary research.

Conclusions

Despite what may on the surface seem extreme differences between the scope and content of the first three research studies, this research exercise demonstrates how interconnected they are. This study demonstrates the potential of a knowledge representation method for social scientists to allow more explicit representations of the relationship between existing literature and the identification of gaps or areas of conflict which need to be resolved or which represent complexity not previously captured in a single article.

Glossary of Terms

Axiom: an ontology term, statement made using descriptive logic which is used to build the model, can either be used to define classes or connect properties to classes

Class: an ontology term, used to represent a concept within the model, there can exist a hierarchy of classes where a single class has several subclasses

Concept: an English language idea contained in the research which can often be described using different terms and can be represented in an ontology model as a 'class'; e.g., the continuation of cultural practices in present life which we call cultural continuity in this thesis

Descriptive Logic (DL): a formal knowledge representation language that is used to build ontology models because of it's structured nature, it is used in artificial intelligence to allow for reasoning capabilities (as in Protégé with the HermiT reasoner)

Instance/Individual: an ontology term, each class or subclass must have an associated instance or individual which is specific to the situation, this allows for queries to be made, for example, Chesterfield Inlet isn't a concept, it is an instance of the concept location or community

Property: an ontology term, is the relationships used to define classes in the model or relate two classes to one another, there are 2 types of properties:

Object property: these are the relationships between two individuals or two classes, the names for object properties can be found in other standardized

lists or created by the researcher, for example, an object property used to describe familial relationships could be 'hasSibling' or 'hasBirthMother'

Data property: data properties describe how individuals are related to data values, is considered a restriction, for example, a data property would assert that an individual has at least one 'hasSibling' relationship or max one 'hasBirthMother' relationship

Protégé: an ontology term, a computer program/interface, that is used to build an ontology model, it is easier to use and can visualize and query the model because it builds the DL model based on your inputs into the program (you do not need to write in DL to build the model using Protégé as it does this for you)

Reasoner: or semantic reasoner, an ontology term, is a computer program/software used by ontology modeling tools, such as Protégé, to infer responses to queries based on the logic of axioms represented in the model, i.e. having a list of statements represented in DL, the computer program can infer a solution to a question based on the logic of the model

Relationship: an English language term used to describe how two concepts are connected, called a property in the ontology model and represented using an axiom

Subclass: an ontology term, a concept that falls under another concept within the ontology model, within the hierarchy it is a kind of class and therefore will inherit the relationships of the class to which it belongs; i.e. resources are defined in the model as a class and marine resources would be a subclass of

resources so would have the same characteristics as resources with added ones to make them specific to marine resources

Term: an English language word or phrase used to label a concept, may vary across disciplines while actually describing the same concept.

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Chapter 6
Conclusion

The goal of this dissertation was to understand how social, cultural, and ecological systems affect community health and wellbeing in order to inform decision-makers so that policies created support rather than build barriers to improved community health and wellbeing. This goal was accomplished through the four original research studies that were designed and conducted to contribute new knowledge about community health and wellbeing to the field. In this chapter the main findings of the four research studies are highlighted, followed by the substantive, methodological, and theoretical contributions of these studies to the field. Finally, the chapter includes a description of the relationship among the studies and a summary of how they contribute to knowledge surrounding community health and wellbeing.

Main Findings

The findings of these four research studies are interwoven and united by the experience with community-based research in Study 1. This study benefited greatly from having community voices during the design and implementation of the research, it also informed the variable selection for Study 2 and the scenarios for Study 4. Study 3 was also informed by conversations with community members about their struggles with marine resource management under the current system.

Study 1 (Chapter 2) describes the community-based research conducted with Chesterfield Inlet, Nunavut to examine how shipping and climate change influence community health and wellbeing. This study involved community consultation throughout the design and implementation of the research project, which involved both semi-structured interviews and several community meetings. These

interviews aimed to understand how food security, cultural continuity, and community health and wellbeing are interconnected for community members in Chesterfield Inlet, which built upon the theoretical framework that was developed based on the literature. Using this theoretical framework, the impact of increased shipping and climate change on Chesterfield Inlet can be demonstrated at a community level. A key concept which emerged throughout was that the sharing of harvested country food is what strengthened this community as seen through the theoretical framework, but that climate and shipping changes challenge current hunters' ability to share with elders and community members who are not able to harvest on their own.

Study 2 (Chapter 3) presents a logistic regression model that examines the relationship between different measures of cultural continuity and self-rated health. The first measures of cultural continuity are based on the work of Chandler and Lalonde (1998), which look at government services as a proxy. The Aboriginal Peoples Survey asks about access to these services in an Aboriginal language, which the model shows increases the probability of having good self-rated health, however, the Arctic Supplement contained variables more specific to Inuit culture. From the Arctic Supplement, questions about harvesting activity, country food access, governance (which was Inuit governance given the participants all lived in Inuit Nunangat), and community involvement provided a model with a better fit.

Study 3 (Chapter 4) consists of different cases where Locally Managed Marine Areas (LMMAs) have been implemented to manage marine resources and uses existing literature and primary data to understand the successes and

challenges in each jurisdiction. LMMAs involve community members in the decision-making process, which is an important governance value in Inuit Nunangat. The lessons learned from Asian and African cases presented here are used to inform how LMMAs could be implemented in Nunavut in the future to support community adaptation to climate change and other stressors on marine resources.

Study 4 (Chapter 5) presents an ontology model which represents the results from the first three studies to demonstrate how such a method could support interdisciplinary research and be used to inform policy. Hypothetical scenarios were created which were informed by knowledge shared by community members of Chesterfield Inlet to demonstrate how the model can be used to develop research hypotheses about connections between studies conducted in different fields using a variety of methods and data sources, which can be tested with future research.

Contributions of the Dissertation

The four studies presented in this doctoral dissertation collectively represent important steps towards a better understanding of the supports and challenges to community health and wellbeing which advances the knowledge in this field. The substantive, methodological, and theoretical contributions are discussed within the context of each study to demonstrate how important gaps in the literature are filled with this dissertation.

Study 1. The first study of this dissertation is a community-based qualitative research project that examines how climate and shipping changes impact Chesterfield Inlet community members. This study contributed new knowledge by providing a greater understanding of how food, culture, and community health and

wellbeing are interconnected, which can be used to demonstrate how any changes will impact the community. The importance of sharing, rather than selling, country food with those within the community who cannot harvest themselves was key to understanding these connections and the impact of climate change and increased shipping. Having community member knowledge codified in this way allows them to advocate for changes to agreements made with the mining companies responsible for the increased shipping and create plans for adaptation to climate change.

From a methodological standpoint, a community-based approach was chosen to ensure the research was respectful of the community, the history with research in the Arctic, and was responsive to community need. Involving the community throughout the research process is important for accomplishing these goals and led to richer research results (Israel, Schulz, Parker, & Becker, 1998). This study is part of a broader movement within the field to build respectful, just relationships with community members (Canadian Institutes of Health Research et al., 2010; Truth and Reconciliation Commission of Canada, 2015b).

Collaboration for this research is important because it creates an opportunity to develop relationships with the community and build trust. It was the multiple in-person trips for at least a week that helped build trust, beginning with the consultation process. I was fortunate that David, the Economic Development Officer, recognized this as an important opportunity for the community and became an essential gatekeeper. Maintaining contact with him, the Hamlet Council, and Chesterfield Inlet's Hunters & Trappers Organization throughout was an important part of maintaining that trust and developing relationships. Submersing myself into

a community that is so culturally different from where I am from, for a longer period during data collection, allowed a better understanding of the context, way of life and helped develop a trust within the community which I could not have gained with a shorter visit. Additionally, that extended time in the community allowed the flexibility required in case something happened which meant I was not able to interview participants one week. Collaborating with the community throughout this research was not an easy task, requiring multiple trips to Nunavut, supportive funding grants for such travel, time to travel, and planning was often complicated. However, without such travel for face-to-face interaction with the community and collaboration throughout, such research could not have occurred.

This study contributes a theoretical model about the relationship between food security, cultural continuity, and community health and wellbeing which can be used to layer on changes which community members are experiencing. Existing studies have linked two of these concepts but not all three within a single model (Cormier, 2016; Council of Canadian Academies, 2014; Donaldson et al., 2010; Egeland et al., 2011; Ford & Beaumier, 2011). Other researchers in the future can use this model to demonstrate how changes in the environment or animal populations impact community health and wellbeing.

Study 2. The second study in this dissertation presents a logistic regression that models the relationship between cultural variables and self-rated health. This study explores different ways to conceptualize culture in a quantitative way using the Aboriginal Peoples Survey (APS). Limited research in the past has used Inuit as the population of focus, preferring to use First Nations which represents a larger

portion of the participants in the sample (Statistics Canada, 2017b, 2017a). Additionally, few researchers have used the Arctic Supplement, likely due to the limited number of participants and the limited years it was included in the broader APS. This study provides important understandings about how we can 'measure' cultural continuity and how it is associated with greater probability of having good self-rated health. The comparison made between Arctic Supplement variables and those regarding access to government services in an Aboriginal language, highlights that decision-makers need to consider in a meaningful way, how policy can promote cultural continuity beyond language of government services.

Methodologically, this study contributes to the current literature through the use of the Arctic Supplement variables regarding community engagement, governance, and culture to demonstrate other ways to operationalize the concept of cultural continuity for quantitative research. The small sample size when only using participants from Inuit Nunangat resulted in the need to append the two years of the APS that contain the Arctic Supplement set of questions. The Arctic Supplement questions were designed in collaboration with different Inuit groups making these more appropriate variables to use when trying to understand how culture and health are related for Inuit. This also demonstrates the importance of deep and meaningful consultation when creating surveys to ensure that the variables derived from its questions are effective indicators that could be used to inform future policy.

Finally, from a theoretical standpoint, this study contributes to the literature by providing support for the use of the questions contained within the Arctic Supplement to be used in the future to measure cultural continuity. Being informed

by Study 1, the importance of country food harvesting and access is highlighted as an important aspect of cultural continuity.

Study 3. The third study expands on the current literature surrounding the implementation of LMMAs by providing a comparison across different jurisdictions. The findings from this study help inform future decision-makers about what key supports need to be put in place for successful implementation of a LMMA and what barriers and challenges need to be removed.

From a methodological standpoint, this study uses a desk review of grey and published literature to inform the cases. In the case of Mozambique where such literature was limited, primary data was used to inform this case. The inclusion of grey literature provided important information for new cases of implementation, how the implementation met the needs of local community, and whether it has aligned with local, Indigenous ways of knowing.

From a theoretical standpoint, the findings from these cases highlight the importance of including existing management theories and local or Indigenous knowledge when making decisions about marine and coastal resource management. Many of the communities used existing frameworks to manage resources, but involved community in decision-making, which made this a distinct approach.

Study 4. This study presents an ontology model that demonstrates how this approach to communicating research results can be used to support interdisciplinary research in the future. In addition, the use of scenarios to validate the competency questions demonstrates how this method can be used to develop hypotheses and future research questions.

This study uses a computer science method to represent social sciences knowledge in a novel way. Methodologically this is unique as the focus of many ontology models to date has been for biomedical terminology, business processes, and global city indicators for example (Dahleh & Fox, 2016; Fox et al., 1998; Khazei & Fox, 2017). Using this method demonstrates the power of having knowledge from different disciplines and different data sources represented in a single model.

Finally, from a theoretical standpoint, this study provides a way to develop future theories that make connections across different disciplines. While this model is limited to the research results of the first three studies of this dissertation and creates hypotheses informed by them, it could be expanded to represent more existing literature in various fields and further develop theory surrounding what factors are key influencers of community health and wellbeing and how policy can support or hinder these factors.

Relationship Among the Studies

This thesis is comprised of four interrelated studies, as Chapter 5 demonstrates. The findings from Study 1 (the Nunavut chapter) inform the variable selection for Study 2. Additionally, Study 1 gives context to the review of different cases of LMMA implementation in Study 3. Finally, Study 4's main focus is making the connections between the first three studies more explicit through ontology engineering. Taken together, these four studies contribute to addressing the overarching research question: "***How can social, cultural, and ecological systems be used to develop policy to strengthen community health and wellbeing and remove barriers in various contexts globally?***"

Summary

Overall, the studies presented in this doctoral dissertation represent important steps forward for health systems and policy research. These studies contribute new knowledge about: 1) how shipping and climate change impact community health and wellbeing for a community in Nunavut; 2) an enhanced understanding of how we can measure cultural continuity and that it is associated with better health outcomes; 3) what factors support or limit the success of LMMA implementation in different jurisdictions; and 4) how interdisciplinary research can be aided through the use of ontology engineering methods. This work sets the foundation for future research into factors that affect community health and wellbeing. Additionally, this study provides timely evidence for Chesterfield Inlet community members about how they are being affected by climate change and increased shipping along the inlet, and informs future efforts to advocate for more support with the mining companies and various levels of government. The report provided to the community based on this research was sent to the mining company and regional organizations to inform them of this new research and continue their advocacy work.

Future Research

This dissertation contains four different research studies that employ four different methods. The diversity was to expand my knowledge and skills as a researcher, but also to address the limitations of the different research methods. When using community-based, qualitative research approaches, such as in Study 1, there are important limitations to the generalizability of the conclusions that can be

drawn and the policy implications. However, this approach allows the research to not only explore an issue more deeply, but also to ensure that the issue explored is timely and relevant to the community. While Study 2 does not explore any single community deeply, it does lead to conclusions and policy recommendations that can be applied more broadly. In this case the limitations include being restricted to questions which were included in the survey and the small number of years in which the Arctic Supplement was included within the broader Aboriginal Peoples Survey. While each method has important flaws, taken together we are able to minimize these limitations and maximize the insights.

Given my experience with these two methods in the Canadian Arctic, I would suggest that future research continues to use mixed methods to better understand phenomenon unique to this context. While literature can help gain a glimpse into another culture and a unique community, it pales in comparison to the experience of living in a community and participating in a culture different from your own. This was especially true for this dissertation. Prior to traveling to Chesterfield Inlet I read Chandler and Lalonde's (1998) work on cultural continuity which impacted me deeply and made me curious about the potential links to self-rated health. I had explored the APS and their previous measures of cultural continuity using First Nations, Métis, and Inuit participants, without considering the Arctic Supplement. It was only after visiting Chesterfield Inlet that the value of focusing on the Arctic and country food harvesting became the focus for this chapter. Additionally, I see important value in sharing the results of Study 2 with Chesterfield Inlet as another resource they can use for advocating change to benefit their community.

As a result of this experience I would advocate for future research to not only involve mixed methods, but also engage the community as much as possible in the process. There is a history of poor research practices involving Indigenous peoples in this country which requires all researchers to think very carefully about what they are researching, why they are doing it, and how they are conducting that research. Quantitative researchers using existing data may not always see the value of engaging communities in their research; however, I think this is a mistake. Research is most impactful when there is an end user considered before any step is even taken, which is true of quantitative research especially. Rather than asking what interesting academic questions we can answer with the data we have, we should be asking what kinds of questions communities want the answers to? Given the amount of government resources spent on collecting data for Statistics Canada and the time that the public spend participating in these surveys, we have a responsibility as researchers to use that data in a way that will benefit Canadians. Engaging with communities around what to do with this data will not only make the research more impactful in the sense that someone is more likely to read it and use it when making decisions, its also likely to evolve in ways researchers could not predict, as with this dissertation. Additionally, communities may be able to provide important insights about potential explanations of the results that are yielded.

While the use of community engagement in research can be time consuming and costly, the benefits far outweigh the costs. If done well, researchers will develop relationships with communities that will lead to a never-ending source of new research ideas as I have found with Chesterfield Inlet.

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Appendices

Appendix A: Thesis References

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Appendix B: Supplementary Tables and Data

Table 6: Proportion distribution for dependent and control variables.[2]

Variable		0	1
Health		.1291198	.8708802
Inuit Ancestry		.0961216	.9038784
Self-Identify Inuit		.1205137	.8794863
Female		.4965711	.5034289
Inuit Nunangat	Nunavut	.4597748	.5402252
	Nunavik	.7440733	.2559267
	Nunatsiavut	.8979273	.1020727
	Inuvialuit	.8987462	.1012538
Education	High School or Equivalent	.7751791	.2248210
	Currently in School	.8844678	.1155322
	Not In School	.3407026	.6592974
Residential School Attendance		.8524821	.1475179
Relative Attended Residential School		.5599795	.4400205
Employment Status	Employed	.4939099	.5060901
	Not In Labor Force	.6421699	.3578301
	Unemployed	.8828875	.1171125
Crowding*	1-2	.8704452	.1295548
	3-5	.5108751	.4891249
	6+	.6207929	.3792071
House Repair Status	Major Repairs	.7371546	.2628454
	Minor Repairs	.6800665	.3199335
	No Repairs	.5832783	.4167217
Smoker		.3048106	.6951894
Drinker		.4376151	.5623849
Common Law		.591172	.408828
Never Moved		.3768168	.6231832

***Number of people living in house**

[2] Proportions associated with the models created in Study 2.

Table 7: Results of model predicting self-rated health of Inuit peoples, conditional on cultural continuity.[3]

	Model 1 OR (Robust SE)			**Model 2 OR (Robust SE)**			**Model 3 OR (Robust SE)**			**Model 4 OR (Robust SE)**			**Model 5 OR (Robust SE)**		
	IA	**SI**	**All**	**IA**	**SI**	**All**	**IA**	**SI**	**All**	**IA**	**SI**	**All**	**IA**	**SI**	**All**
Inuit Ancestry	0.611***			0.631***			0.626***			0.656***			0.586***		
	(0.063)			(0.061)			(0.061)			(0.064)			(0.060)		
Self-identify		0.655***			0.678***			0.680***			0.703***			0.636***	
		(0.060)			(0.059)			(0.060)			(0.062)			(0.058)	
Female	0.933	0.938	0.935	0.877***	0.881***	0.879***	0.877***	0.882***	0.879***	0.875***	0.879***	0.876***	0.937	0.943	0.940
	(0.043)	(0.043)	(0.043)	(0.039)	(0.039)	(0.039)	(0.039)	(0.040)	(0.039)	(0.039)	(0.040)	(0.039)	(0.043)	(0.043)	(0.043)
Age	0.960***	0.960***	0.960***	0.961***	0.961***	0.961***	0.962***	0.962***	0.961***	0.961***	0.961***	0.961***	0.960***	0.960***	0.960***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Nunavik (reference)															
Nunavut	1.302***	1.295***	1.210***	1.284***	1.276***	1.198***	1.284***	1.274***	1.196***	1.315***	1.308***	1.240***	1.277***	1.267***	1.172***
	(0.078)	(0.077)	(0.070)	(0.069)	(0.069)	(0.063)	(0.070)	(0.069)	(0.063)	(0.071)	(0.070)	(0.065)	(0.077)	(0.076)	(0.067)
Nunatsiavut	1.968***	1.873***	1.919***	1.707***	1.636***	1.666***	1.735***	1.661***	1.694***	1.910***	1.840***	1.891***	1.816***	1.717***	1.741***
	(0.180)	(0.169)	(0.175)	(0.145)	(0.138)	(0.142)	(0.149)	(0.141)	(0.145)	(0.169)	(0.161)	(0.168)	(0.163)	(0.152)	(0.154)
Inuvialuit	1.399***	1.397***	1.407***	1.301***	1.297***	1.300***	1.322***	1.321***	1.324***	1.433***	1.436***	1.450***	1.309***	1.303***	1.301***
	(0.113)	(0.112)	(0.113)	(0.097)	(0.097)	(0.097)	(0.100)	(0.100)	(0.100)	(0.110)	(0.110)	(0.111)	(0.105)	(0.104)	(0.104)
Not Graduated High School (reference)															
HS or Equivalent	1.216***	1.211***	1.247***	1.205***	1.198***	1.235***	1.217***	1.214***	1.250***	1.222***	1.219***	1.253***	1.211***	1.206**	1.244***
	(0.088)	(0.088)	(0.090)	(0.084)	(0.084)	(0.086)	(0.086)	(0.086)	(0.088)	(0.086)	(0.086)	(0.089)	(0.088)	(0.088)	(0.090)
Currently	0.980	0.975	0.987	1.083	1.077	1.087	1.117	1.111	1.122	1.117	1.112	1.121	0.978	0.972	0.986

[3] Models created using the Arctic Supplement of the Aboriginal Peoples Survey appending years 2001 and 2006.

in School															
	(0.096)	(0.096)	(0.096)	(0.095)	(0.095)	(0.095)	(0.099)	(0.099)	(0.099)	(0.099)	(0.099)	(0.099)	(0.095)	(0.095)	(0.096)
RS Attendance	1.073	1.083	1.095	1.076	1.085	1.101	1.074	1.084	1.099	1.063	1.071	1.084	1.083	1.094	1.109
	(0.070)	(0.070)	(0.071)	(0.070)	(0.070)	(0.071)	(0.070)	(0.070)	(0.071)	(0.069)	(0.070)	(0.071)	(0.070)	(0.071)	(0.072)
Missing	1.237	1.241	1.245	1.247	1.252	1.258	1.283	1.287	1.293	1.302	1.306	1.312	1.227	1.231	1.236
	(0.214)	(0.216)	(0.217)	(0.201)	(0.203)	(0.204)	(0.215)	(0.216)	(0.218)	(0.217)	(0.218)	(0.220)	(0.213)	(0.215)	(0.216)
Relative Attended RS	0.824***	0.823***	0.842***	0.809***	0.808***	0.825***	0.815***	0.814***	0.832***	0.824***	0.824***	0.839***	0.815***	0.814***	0.835***
	(0.041)	(0.041)	(0.042)	(0.039)	(0.039)	(0.040)	(0.040)	(0.040)	(0.041)	(0.040)	(0.040)	(0.041)	(0.040)	(0.040)	(0.041)
Employed	1.206**	1.207**	1.228***	1.260***	1.262***	1.280***	1.247***	1.248***	1.267***	1.243***	1.244***	1.259***	1.208**	1.209**	1.233***
	(0.095)	(0.095)	(0.097)	(0.100)	(0.100)	(0.101)	(0.098)	(0.098)	(0.100)	(0.098)	(0.098)	(0.099)	(0.096)	(0.096)	(0.098)
Not In Labor Force	0.789***	0.789***	0.802***	0.769***	0.770***	0.783***	0.770***	0.771***	0.784***	0.772***	0.772***	0.784***	0.788***	0.789***	0.803***
	(0.062)	(0.062)	(0.064)	(0.060)	(0.060)	(0.062)	(0.060)	(0.061)	(0.062)	(0.060)	(0.060)	(0.061)	(0.063)	(0.063)	(0.064)
Missing	0.876	0.881	0.870	0.914	0.917	0.908	0.921	0.924	0.915	0.940	0.943	0.936	0.860	0.864	0.851
	(0.137)	(0.138)	(0.136)	(0.135)	(0.136)	(0.135)	(0.141)	(0.141)	(0.140)	(0.146)	(0.146)	(0.146)	(0.133)	(0.134)	(0.131)
Income+	1.002***	1.002***	1.003***	1.003***	1.003***	1.003***	1.003***	1.003***	1.003***	1.003***	1.003***	1.003***	1.002***	1.002***	1.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Crowding (number of people living in house)															
1-2	0.921	0.909	0.912	0.881*	0.870**	0.876*	0.869**	0.858**	0.864**	0.864**	0.852**	0.858**	0.929	0.916	0.920
	(0.065)	(0.064)	(0.065)	(0.062)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.061)	(0.060)	(0.061)	(0.066)	(0.065)	(0.065)
3-5	1.214***	1.214***	1.208***	1.187***	1.187***	1.181***	1.174***	1.174***	1.169***	1.173***	1.173***	1.168***	1.215***	1.215***	1.208***
	(0.060)	(0.060)	(0.060)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.060)	(0.060)	(0.060)
6+ (reference)															
Major Repairs	0.707***	0.709***	0.713***	0.705***	0.707***	0.709***	0.698***	0.700***	0.702***	0.698***	0.699***	0.701***	0.708***	0.710***	0.715***

	(0.038)	(0.038)	(0.038)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)	(0.038)	(0.038)
Minor Repairs	0.859***	0.858***	0.854***	0.862***	0.860***	0.854***	0.865***	0.863***	0.857***	0.870**	0.869***	0.864***	0.855***	0.853***	0.848***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.046)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.046)
No Repair (reference)															
Smoker	0.812***	0.812***	0.789***	0.773***	0.774***	0.752***	0.778***	0.778***	0.757***	0.780***	0.780***	0.762***	0.810***	0.810***	0.785***
	(0.043)	(0.043)	(0.042)	(0.040)	(0.040)	(0.039)	(0.041)	(0.041)	(0.040)	(0.041)	(0.041)	(0.040)	(0.043)	(0.043)	(0.041)
Missing	0.380***	0.374***	0.360***	0.398***	0.394***	0.381***	0.432***	0.426***	0.411***	0.438***	0.433***	0.420***	0.380***	0.373***	0.358***
	(0.079)	(0.079)	(0.075)	(0.072)	(0.073)	(0.069)	(0.086)	(0.086)	(0.082)	(0.089)	(0.089)	(0.085)	(0.078)	(0.078)	(0.073)
Drinker	0.990	0.990	0.975	0.998	0.996	0.981	1.003	1.002	0.986	1.000	0.999	0.986	0.993	0.993	0.976
	(0.050)	(0.050)	(0.049)	(0.049)	(0.049)	(0.048)	(0.050)	(0.050)	(0.049)	(0.049)	(0.049)	(0.049)	(0.050)	(0.050)	(0.049)
Missing	1.226*	1.229*	1.211*	1.164	1.166	1.147	1.229*	1.230*	1.211*	1.261**	1.264**	1.249**	1.205*	1.207*	1.185
	(0.136)	(0.138)	(0.136)	(0.120)	(0.121)	(0.119)	(0.130)	(0.131)	(0.130)	(0.134)	(0.135)	(0.134)	(0.134)	(0.135)	(0.132)
Common Law	0.762***	0.760***	0.741***	0.727***	0.725***	0.706***	0.735***	0.732***	0.714***	0.756***	0.755***	0.739***	0.744***	0.741***	0.719***
	(0.035)	(0.035)	(0.034)	(0.033)	(0.033)	(0.032)	(0.033)	(0.034)	(0.032)	(0.034)	(0.035)	(0.034)	(0.034)	(0.034)	(0.033)
Never Moved	1.077	1.087*	1.084*				1.090*	1.098**	1.095*	1.093*	1.101**	1.097**	1.073	1.084*	1.081*
	(0.051)	(0.051)	(0.051)				(0.051)	(0.052)	(0.051)	(0.051)	(0.052)	(0.052)	(0.051)	(0.051)	(0.051)
Ab. Lang. Services++	1.262***	1.271***	1.298***							1.316***	1.325***	1.347***			
	(0.062)	(0.062)	(0.064)							(0.064)	(0.064)	(0.066)			
HH harvesting	1.162**	1.161**	1.145**										1.176***	1.176***	1.160**
	(0.073)	(0.073)	(0.071)										(0.073)	(0.073)	(0.072)
Missing	1.128	1.119	1.149										1.126	1.117	1.149
	(0.156)	(0.156)	(0.161)										(0.155)	(0.155)	(0.160)
Satisfaction with Food Freshnes	1.061	1.053	1.074										1.059	1.050	1.072

s															
	(0.056)	(0.056)	(0.057)										(0.056)	(0.056)	(0.056)
Missing	0.996	0.990	1.008										0.997	0.991	1.010
	(0.108)	(0.107)	(0.107)										(0.109)	(0.108)	(0.108)
Satisfaction with Country Food Access	1.464***	1.467***	1.466***										1.486***	1.490***	1.489***
	(0.118)	(0.118)	(0.118)										(0.119)	(0.120)	(0.120)
Missing	1.151	1.153	1.146										1.177	1.180	1.173
	(0.166)	(0.167)	(0.164)										(0.171)	(0.172)	(0.169)
Gov't Satisfaction	1.274***	1.278***	1.244***										1.283***	1.287***	1.250***
	(0.070)	(0.070)	(0.068)										(0.070)	(0.071)	(0.068)
Missing	1.280***	1.286***	1.260***										1.283***	1.289***	1.260***
	(0.082)	(0.082)	(0.080)										(0.082)	(0.082)	(0.080)
Life Satisfaction	2.012***	2.013***	2.015***										2.027***	2.029***	2.033***
	(0.149)	(0.149)	(0.149)										(0.150)	(0.150)	(0.151)
Missing	1.824***	1.813***	1.783***										1.824***	1.813***	1.778***
	(0.220)	(0.219)	(0.214)										(0.221)	(0.220)	(0.215)
Community Events	1.057	1.058	1.048										1.052	1.053	1.042
	(0.058)	(0.058)	(0.057)										(0.058)	(0.058)	(0.057)
Missing	0.687**	0.691**	0.688**										0.696*	0.700*	0.699*
	(0.129)	(0.130)	(0.130)										(0.131)	(0.132)	(0.132)
Public Meetings	1.103*	1.102*	1.097*										1.101*	1.101*	1.095

	(0.062)	(0.062)	(0.062)										(0.062)	(0.062)	(0.062)
Missing	1.042	1.043	1.045										1.017	1.018	1.016
	(0.232)	(0.233)	(0.234)										(0.228)	(0.228)	(0.229)
Sports	1.350***	1.350***	1.358***										1.368***	1.368***	1.379***
	(0.074)	(0.074)	(0.074)										(0.075)	(0.075)	(0.075)
Missing	2.261***	2.265***	2.270***										2.256***	2.260***	2.268***
	(0.513)	(0.514)	(0.518)										(0.511)	(0.512)	(0.518)
Vote in Municipal	1.050	1.047	1.014										1.054	1.051	1.015
	(0.062)	(0.061)	(0.059)										(0.062)	(0.061)	(0.058)
Missing	1.342**	1.339**	1.309**										1.342**	1.339**	1.307**
	(0.166)	(0.166)	(0.163)										(0.167)	(0.167)	(0.163)
Too Young Municipal	1.179	1.175	1.147										1.183	1.177	1.147
	(0.141)	(0.141)	(0.138)										(0.142)	(0.142)	(0.137)
Constant	10.890***	10.140***	7.496***	57.235***	53.652***	39.911***	52.371***	48.319***	36.100***	43.681***	40.645***	30.847***	12.266***	11.344***	8.292***
	(2.163)	(1.977)	(1.418)	(8.693)	(7.887)	(5.305)	(8.485)	(7.544)	(5.146)	(7.128)	(6.395)	(4.426)	(2.437)	(2.211)	(1.571)
r2_p	0.114	0.114	0.112	0.096	0.096	0.094	0.095	0.095	0.093	0.097	0.097	0.096	0.113	0.113	0.111
N	29822.000	29822.000	29822.000	29968.000	29968.000	29968.000	29822.000	29822.000	29822.000	29822.000	29822.000	29822.000	29822.000	29822.000	29822.000
AIC										54119.52	54130.67	54204.29	53218.2	53233.83	53351.83
BIC										54343.7	54354.85	54420.17	53591.83	53607.47	53717.16

* p<0.10, ** p<0.05, *** p<0.01
+Census Family Income
++Access to services in an Aboriginal Language
HS – High School
RS – Residential School
IA – Inuit Ancestry
SI – Self-identify as Inuit

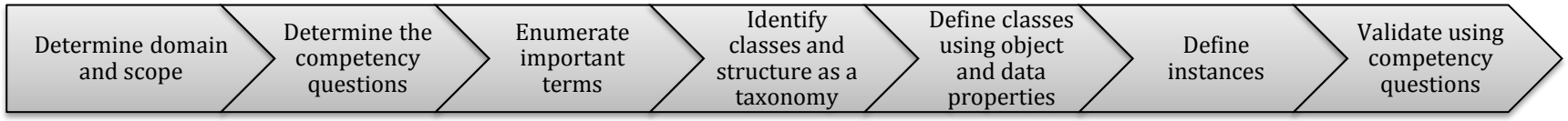


Figure 5: Steps used when creating an ontology (Fox, 2017)[4]

[4] Steps involved in creating an ontology model as described by Dr. Fox. These were the steps followed for Study 4 when creating the ontology model.

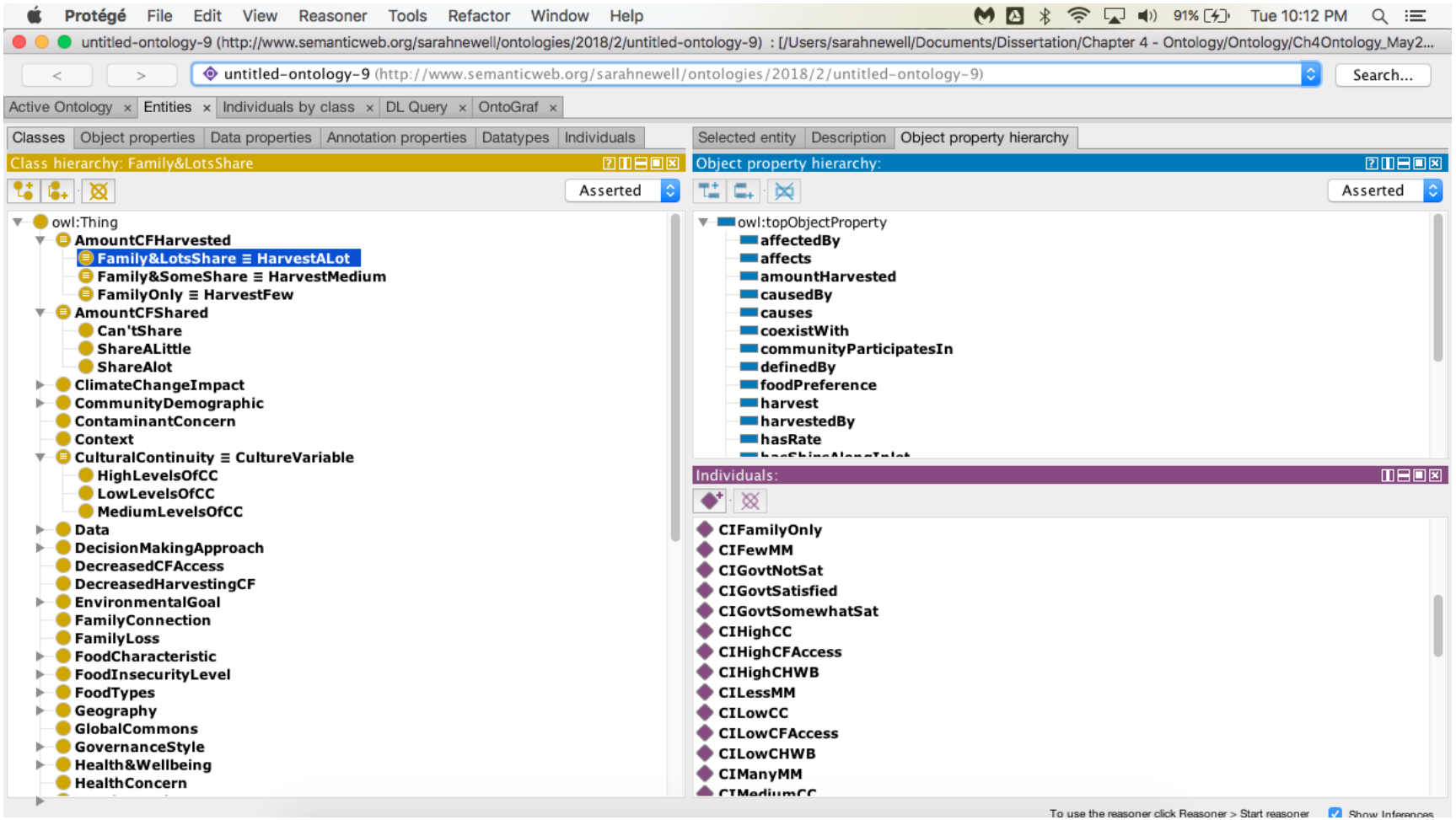


Figure 6: Classes, Individuals, and Object Properties contained within Protégé.[5]

[5] Screenshot of ontology created in Protégé software to validate the three scenarios for each competency question.

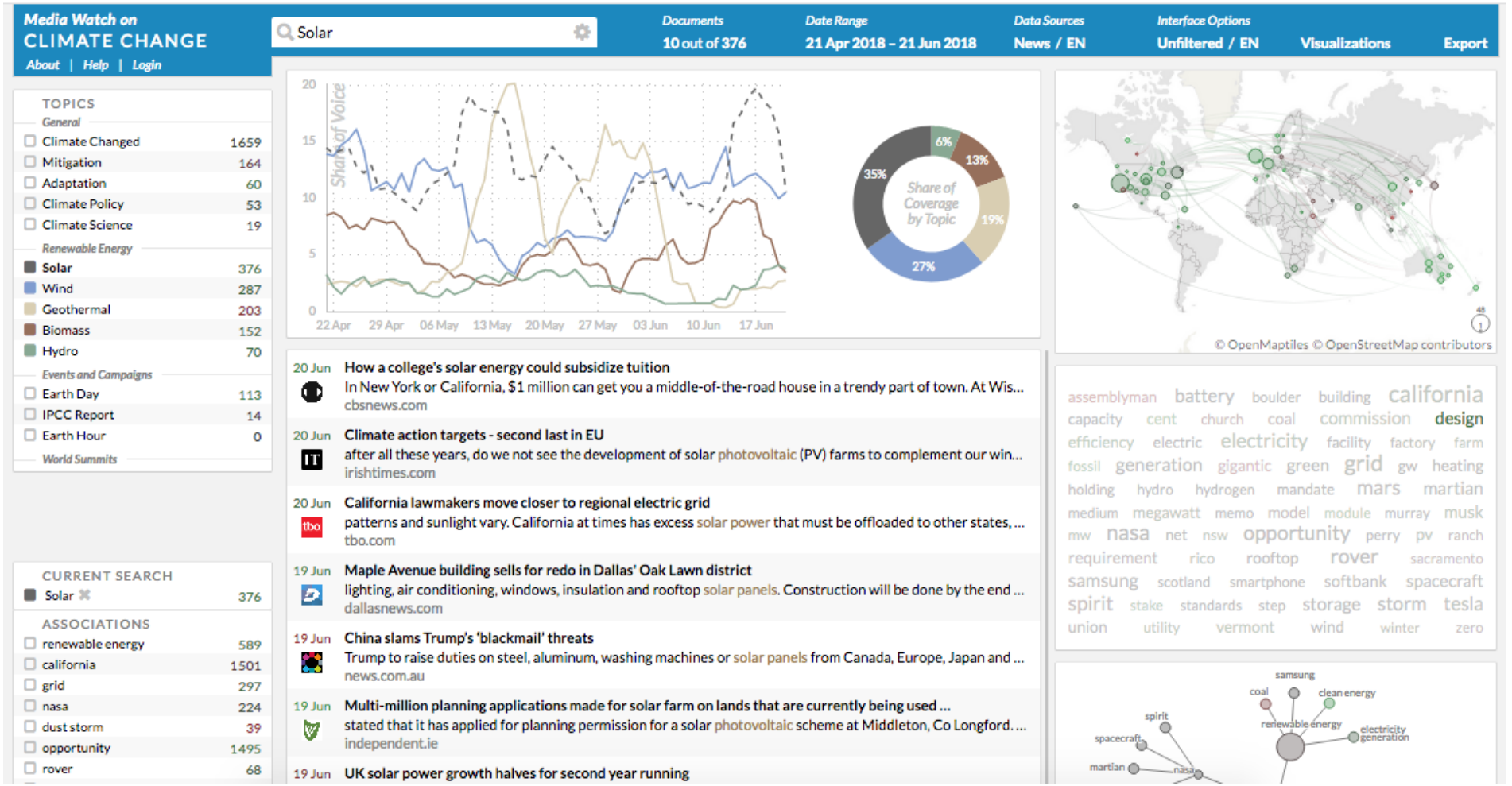


Figure 7: Sample ontology interface available online.[6]

[6] Screenshot of Media Watch on Climate Change website as an example of potential interfaces for ontologies: https://www.ecoresearch.net/climate/

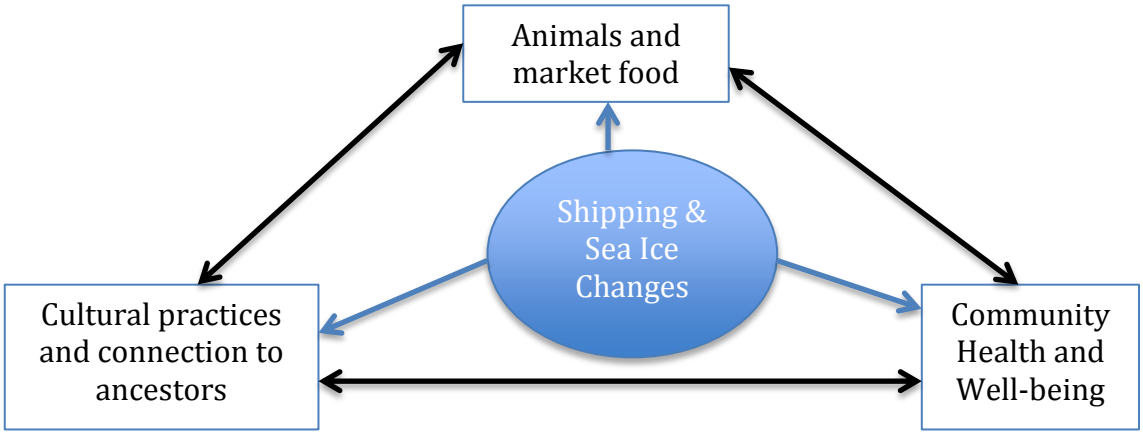
Appendix C – Accompanying documentation for Study 1

Appendix Ci
One-on-One Interview Guide for Chesterfield Inlet

Student Investigator: Sarah Newell, PhD Candidate
CHEPA, McMaster University, 1280 Main Street, Hamilton, Ontario, Canada, L8S 4L8
Email: newells@mcmaster.ca

Date:
Interviewee:

When I was here in October people shared their concerns about how changes are affecting the animals locally. These animals are important for food but also as a connection to your ancestors and culture. I see the connection between your food, culture, and community health as important to describe. This interview is a way for you to teach me about the connections between animals, food, culture, and your health. Then I will be able to better understand how changes like shipping and sea ice changes are affecting the animals and your community.



Food Security

1. Do you have enough food to eat?
   PROMPT: Do you ever worry about having enough food?
2. How much country food do you eat?
3. Do you worry about whether country foods are safe or healthy for you to eat?
   PROMPT: How does worrying about the safety of food make you feel?
4. How do hunters share food?
   PROMPT: Do they share food with the wider community or just family members?
   PROMPT: How do they decide how much to share?

Cultural Continuity

5. How did you learn about your culture?
   PROMPT: Did you learn from an elder?

6. How are you sharing and keeping your culture alive?
    PROMPT: Do you teach the youth?
    PROMPT: What is needed to keep your culture today?
7. How does your food connect to your cultural beliefs and practices?
    PROMPT: Do you consume more country foods to keep your culture?
    PROMPT: How do you feel if country food is not available?

Community Health and Well-being

8. Is your community healthy?
    PROMPT: What are Chesterfield Inlet's strengths?
    PROMPT: What makes it healthy?
9. Does being able to share and eat country foods make your community stronger?
10. How do your connections to your culture affect the health of the community?

Climate and other changes

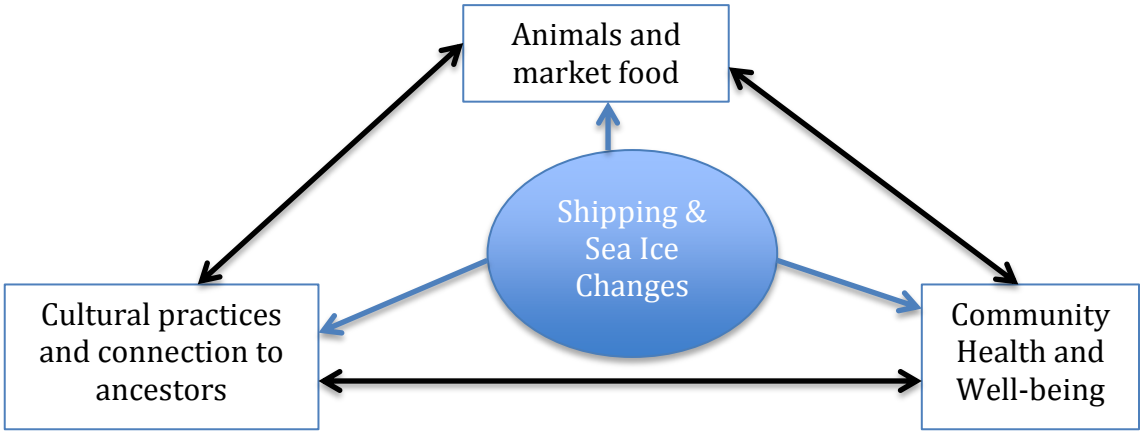
11. We believe that Inuit Knowledge (IQ) is important to understanding changes in the Arctic. Please can you tell us how the animals in your area are being affected by the mining in Baker Lake?
12. How are the animals being affected by changes in sea ice?
    PROMPT: I was told that the ice is freezing up later in the fall and breaking up earlier in the spring.

Appendix Cii
Community Consultation Guide for Chesterfield Inlet

Student Investigator: Sarah Newell, PhD Candidate
CHEPA, McMaster University, 1280 Main Street, Hamilton, Ontario, Canada, L8S 4L8
Email: newells@mcmaster.ca

Date:
Participants:

When I was here in October people shared their concerns about how changes are affecting the animals locally. These animals are important for food but also as a connection to your ancestors and culture. I see the connection between your food, culture, and community health as important to describe. This interview is a way for you to teach me about the connections between animals, food, culture, and your health. Then I will be able to better understand how changes like shipping and sea ice changes are affecting the animals and your community.



Food Security

1. Do you have enough food to eat?
   PROMPT: Do you ever worry about having enough food?
2. How much country food do you eat?
3. Do you worry about whether country foods are safe or healthy for you to eat?
   PROMPT: How does worrying about the safety of food make you feel?
4. How do hunters share food?
   PROMPT: Do they share food with the wider community or just family members?
   PROMPT: How do they decide how much to share?

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   PROMPT: Did you learn from an elder?
6. How are you sharing and keeping your culture alive?
   PROMPT: Do you teach the youth?
   PROMPT: What is needed to keep your culture today?

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    PROMPT: Do you consume more country foods to keep your culture?
    PROMPT: How do you feel if country food is not available?

Community Health and Well-being

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9. Does being able to share and eat country foods make your community stronger?
10. How do your connections to your culture affect the health of the community?

Climate and other changes

11. We believe that Inuit Knowledge (IQ) is important to understanding changes in the Arctic. Please can you tell us how the animals in your area are being affected by the mining in Baker Lake?
12. How are the animals being affected by changes in sea ice?
    PROMPT: I was told that the ice is freezing up later in the fall and breaking up earlier in the spring.

Appendix Ciii

LETTER OF INFORMATION / CONSENT - Interview

Student Investigator:
Sarah Newell
Department of Health Sciences
McMaster University
Hamilton, Ontario, Canada

E-mail: newells@mcmaster.ca

Supervisor:
Dr. Nancy Doubleday
Department of Philosophy
McMaster University
Hamilton, Ontario, Canada
(905) 525-9140 ext. 23464
E-mail: doublen@mcmaster.ca

Purpose of the Study:
This project comes from what was shared with me in October 2016 in a Chesterfield Inlet community meeting. I was also able to talk to elders in the community and others who work here, such as the Hunters and Trappers Organization. People talked about how climate and other changes are affecting the health and movement of animals, such as seals and caribou.

This interview is a way for you to teach me about the connections between animals, food, culture, and your health. Then I will be able to better understand how things like shipping and sea ice changes are affecting the animals and your community. I value your knowledge as members of the Chesterfield Inlet community because only you know how these changes are affecting your community. I hope that together we can develop a tool that will support the great work that you are already doing to build your community.

You are invited to take part in this study on how climate change is affecting Chesterfield Inlet.

What will happen during the study?
I'm inviting you to do a one-on-one interview that will take about 60-90 minutes. I will ask you questions about country foods, culture, and community health such as "how do hunters share food in your community?" I will take handwritten notes to record your answers as well as use an audio recorder to make sure I don't miss what you say. We can set up a time and place that works for us both.

Are there any risks to doing this study?
It is not likely that there will be any harms or discomforts from/associated with answering these questions in the interview.

You do not need to answer questions that you do not want to answer or that make you feel uncomfortable. I describe below the steps I am taking to protect your privacy.

Are there any benefits to doing this study?
It is unlikely that there will be direct benefits to you; however, by better understanding how climate change is affecting Chesterfield Inlet, researchers and others may be able to understand these changes.

Who will know what I said or did in the study?
I will keep the information you tell me during the interview confidential. Information I put in my report that could identify you will not be published or shared beyond the research team unless we have your permission. You will be given an opportunity to review the results before they are published and decide on any other products resulting from this research.

What if I change my mind about being in the study?
It is your choice to be part of the study or not. If you decide to be part of the study, you can stop the interview for whatever reason, even after signing the consent form or part-way through the study or up until approximately ***December 2017*.** If you decide to withdraw, there will be no consequences to you. In cases of withdrawal, any data you have provided will be destroyed unless you indicate otherwise. If you do not want to answer some of the questions you do not have to, but you can still be in the study.

How do I find out what was learned in this study?
I expect to have this study completed by approximately **October 2017**. I will return then to Chesterfield Inlet to share the results with you and other community members.

Questions about the Study:
If you have questions or need more information about the study itself, please contact me at:

newells@mcmaster.ca

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
C/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

CONSENT

- I have read the information presented in the information letter about a study being conducted by Sarah Newell, of McMaster University.
- I have had the opportunity to ask questions about my involvement in this study and to receive additional details I requested.
- I understand that if I agree to participate in this study, I may withdraw from the study at any time or up until approximately *December 2017.*
- I have been given a copy of this form.
- I agree to participate in the study.

Signature: _____ Date: _____

Name of Participant (Printed) _____

1. I agree that the interview can be audio recorded.
… Yes.
… No.

2. Yes, I would like to receive a summary of the study's results.
Please send them to me at this address _____
… No, I do not want to receive a summary of the study's results.