Assessing stakeholder participation in Northern scientific research

Nicolas D. Brunet

Department of Natural Resource Sciences

Faculty of Agricultural and Environmental Sciences

Macdonald Campus, McGill University, Montreal

August 15, 2014

A thesis submitted to McGill University in partial fulfilment of the requirements of the degree of Doctor of Philosophy

Abstract

Many researchers have claimed that Northern science has experienced a paradigm shift which includes an increased emphasis on local community engagement. However, very few studies have empirically examined this claim. This thesis seeks to better understand and explore stakeholder participation in Northern science to inform research policy and practice, primarily in Canada. The shift towards a greater emphasis on local community engagement in Northern science fits within a broader transition that has been observed in international research policy, described by Gibbons et al. (1994) as a shift from Mode 1 (traditional forms of scientific discovery) to Mode 2 (knowledge generated in the context of application) approaches to knowledge production. Using this framework to analyze research articles published between 1960 and 2010 in four prominent Arctic and polar-focused journals, we identify that shifts toward Mode 2 research approaches over time have been modest and gradual, and that Mode 1 forms of knowledge production continue to dominate Northern science. Local involvement in research appears to vary systematically among disciplines, organizations and regions, raising important questions for research and policy.

Recognizing that claims of a new Northern research paradigm have been coupled with growing levels of dissatisfaction with research activities within many Northern indigenous communities, there is a need to better understand the factors that enable and limit research partnership development as well as the associated outcomes. Using a single in-depth case study analysis of a successful research partnership of an International Polar Year program in a remote northern Yukon community, it was revealed that certain contextual and procedural aspects were associated with positive outcomes. The procedural aspects included early engagement in the research design or even proposal-writing process which was associated with decentralized control and power sharing. Important contextual elements included local research history and local decision making processes as well as local forms of reciprocity and trust, all identified as critical to building bridging social capital between researchers and communities. Building on these findings, a national survey of Northern research stakeholders revealed that contextual elements were generally considered more important than procedural considerations. More specifically, respondents indicated that research partnership success was more often depended on how and to what extent the social capital of stakeholders was bridged, often expressed as

trust. Acknowledging the importance of the research context and inspired by the literature on research for development, a capital assets approach to conceptualizing and assessing partnership outcomes is proposed. Based on survey data, the potential for such a capital assets approach to improve our understanding of the transformative effects of scientific research partnerships on communities and researchers is discussed.

Résumé

Plusieurs experts dans le domaine de la recherche nordique clament qu'un nouveau paradigme émerge, un paradigme caractérisé par une participation communautaire accrue en science. Cette affirmation d'un nouveau paradigme de recherche en science nordique a été exprimée dans de nombreux autres domaines, notamment dans le cadre théorique du mode 2. Comme il n'y avait pas de preuves empiriques d'un changement de paradigme, notre premier objectif était de tester cette affirmation. En utilisant le cadre mode 2, nous avons trouvé que les changements vers les approches de recherche mode 2 au fil du temps ont été modestes et progressifs et que le mode 1 continue de prédominer la science dans l'Arctique. La participation locale dans la recherche varie systématiquement entre les disciplines, les organisations et les régions. Nous avons également déterminé que la recherche sur les changements environnementaux contribue faiblement à l'émergence des approches mode 2. Ces revendications d'un nouveau paradigme de recherche ont été couplées avec une insatisfaction croissante par rapport aux activités de recherche, en particulier au sein des communautés autochtones de l'Arctique. Nous avons donc tenté de découvrir les facteurs qui permettent et limitent le développement de partenariats de recherche ainsi que les bénéfices associés. Une étude de cas approfondie d'un programme de recherche survenant dans une collectivité de l'Arctique a révélé que certains aspects contextuels et de la procédure de partenariats de recherche sont associés à des résultats bénéfiques. Ces aspects procéduraux inclus un engagement précoce des partenaires locaux dans le processus scientifique, de la conception de la recherche ou même, du processus de proposition de recherche. Ceci fut associé avec un sentiment de contrôle local et de partage du pouvoir. Les éléments contextuels inclus le capital social entre les chercheurs et les partenaires communautaires, associé à l'histoire de recherche locale, les processus décisionnels locaux ainsi que les formes locales de réciprocité et de développement de confiance. Notre sondage de parties prenantes en recherche nordique a en outre confirmé ces résultats. Cependant, nous avons trouvé que des éléments contextuels étaient plus importants que les considérations de procédure. Nous avons constaté que, finalement, le succès des partenariats est associé au niveau de capital social des partenaires, souvent exprimé en termes de confiance. Sur la base de ces résultats et inspiré par la littérature sur la recherche pour le développement, nous avons décidé d'utiliser les cinq capitaux (humain, social, naturel, physique, financier) afin de conceptualiser et d'évaluer les partenariats. Le succès

serait évalué relatif aux changements de ces cinq capitaux. Nous avons utilisé un sondage auprès d'intervenants de recherche nordique pour tester le potentiel de cette approche afin de conceptualiser et devenir un outil pour l'évaluation de la réussite d'un partenariat de recherche. Nous avons constaté qu'en effet, la nature contextuelle des partenariats a permis à cette approche de fournir un indicateur important du changement des niveaux de capitaux, et donc, pourrait devenir un indicateur de réussite.

Contributions to knowledge

Chapter 2

- Connects national and international claims of a new Northern research paradigm to an analogous but broader research policy discourse on Mode 1 versus Mode 2 approaches to knowledge production.
- Provides the first comprehensive quantification of the extent of a paradigm shift in Northern research, through a content analysis of published Northern research articles, and shows that there has been no paradigm shift.
- Identifies the disciplines, circumpolar regions, organizations, and topics that most often use Mode 2 research approaches, showing that Mode 2 approaches were most common within social sciences research focused on contemporary people or life sciences research focused on harvested wildlife, particularly if the research was led by local or territorial governments
- Finds that the research focus on environmental change contributes little if anything to the emergence of Mode 2 approaches.

Chapter 3

- Provides a rare comparison of researcher and indigenous community perspectives on research partnerships in Northern Canada.
- Provides important contributions to empirical research on the context and process-related factors that are important to research partnerships, showing that funding and performance assessment processes, leadership and capacity at the community level, the proposal development and research design strategies, and the timing and perceived transparency in results dissemination are critical to partnership success.
- Identifies that informal interactions, that are often not part of the research process in the natural sciences, are strongly valued by research stakeholders in Northern science although often neglected in recommendations for effective engagement.
- Finds that research partnership strategies provide more than tangible benefits such as financial gain and training for local stakeholders. Less tangible benefits include

legitimizing knowledge systems and aiding in their integration and mutual understanding and an overall development of social capital.

Chapter 4

- Provides quantitative evidence that researchers are generally perceived to benefit more from Northern research partnerships than local stakeholders in Canada.
- Confirms and quantifies some findings of previous research and Chapter 3, showing that local engagement at the proposal and research design phases, the hiring of community researchers and engagement of local stakeholders at the results dissemination phase are perceived as the most important factors affecting partnership success by Northern research stakeholders.
- Finds that an underlying lack of social capital (trust and reciprocity) between researchers and communities is the principle significant factor negatively impacting Northern science partnerships.

Chapter 5

- Provides quantitative evidence, using the capital assets approach, that researchers generally benefit more from Northern research partnerships than their community counterparts.
- Provides quantitative evidence that research stakeholders gain most in human and social capital as a result of engaging in research partnerships.
- Provides a novel framework for conceptualising and assessing research partnerships as well as new insight for policy using the capital assets approach.

Contributions of co-authors and remarks on style

This thesis follows a manuscript-based format. As a result, there is some repetition in the text.

I am the primary author of all the chapters of the thesis. Chapter 2, 3, 4, and 5 are coauthored with Dr. Gordon Hickey and Dr. Murray Humphries. Chapter 2 has been published in the journal Ecology and Society (2014). Chapter 3 was published in the Journal of Rural Studies (2014). Chapter 4 was accepted for publication in the journal Arctic. Chapter 5 is in preparation for submission to an international peer reviewed journal.

Both Dr. Gordon Hickey and Dr. Murray Humphries provided academic supervision, intellectual input, methodological and theoretical development, funding and writing support for all chapters. Dr. Humphries aided with the collection and analysis of the data for Chapter 2. I also received statistical aid for Chapter 2 from Dr. Quinn Fletcher, a PhD student of Dr. Humphries in 2011.

Acknowledgements

This work is dedicated to Thérèse Wylie, my grandmother.

First and foremost, I would like to thank Dr. Gordon Hickey, supervisor extraordinaire and wise beyond his years. Gordon has been there for me through some very serious ups and downs over the course of my doctoral studies. He has shown what true professionalism looks like and has been essential to the completion of my degree. Second, I also thank Dr. Murray Humphries. Murray provided invaluable guidance for this research as an experienced Northern researcher and overall mentor. His enthusiasm and curiosity for community participation has been a driving force behind my work. I would also like to thank Dr. Colin Scott, committee member, for providing guidance throughout the project.

I would also like to thank the Community of Old Crow, Yukon, and in particular, Mary Jane Moses, Megan Williams, Nick Grey and Stephen Frost, the heart and soul of my work, who I regrettably could not keep close ties with, providing another example of how research partnership are not truly supported in the current context.

I would like to acknowledge the help of Jeremy Brammer, who inadvertently provided easy access to the community of Old Crow. Jeremy's openness and kindness were essential to his and my research success.

Thank you to my lab and work mates over the last few years, Dr. Archi Rastogi, Dr. Owen Temby, Dr. Nicole Klenk, Gengrui Wang, Colleen Eidt, Natalia Canova, Stephanie Sabbagh, Stephanie Shumsky, Arlette Saint Ville, June Po, H.M. Tuihedur Rahman, and many more, who participated in numerous lab meetings and informal therapy sessions which pushed me through the harder times and Dr. Guillaume Larocque, for aid with R and statistical analyses as well as Manuelle Landry-Cuerrier for her aid throughout the project.

I would also like to acknowledge the important contribution of my funders, le Fond Québécois de Recherche sur la Société et la Culture, the NSERC Northern Research Chairs Program, McGill University and the Northern Scientific Training Program.

Finally, none of this would have been possible without the love and support of Rowan and Willow, my two lovely girls, Hillary, my partner, Audrey, my mother, Phil, my brother and my many friends, who for some reason decided to stick around.

To all of you, thank you.

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AAAR: Arctic, Antarctic and Alpine Research

ABCD: Asset-Based approach to Community Development

BASC: Barrow Arctic Science Consortium

IJCH: International Journal of Circumpolar Health

INAC: Indigenous and Northern Affairs Canada

IPCC: International Panel on Climate Change

IPY: International Polar Year

ITK: Inuit Tapiriit Kanatami

NRI: Nunavut Research Institute

NSERC: National Science and Engineering Research Council

OCF: Old Crow Flats

OPP: Office of Polar Programs

VGFN Vuntut Gwitchin First Nation

VGG: Vuntut Gwitchin Government

YNNK: Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa

1 General Introduction

1.1 Literature review

Arctic science has played an important part in furthering human understanding of the natural world and improving overall human well-being (Pearce et al., 2009). In particular, findings from the natural sciences in the Arctic have resulted in a number of "practical applications that have improved the quality of life" in remote communities throughout the world (Gearheard and Shirley, 2007, p.64). For example, advances in navigation and telecommunications have improved weather and ice condition forecasting. Global positioning systems and satellite phone technology have made travel and hunting by land and water more safe and effective. Some communities also call upon scientific experts to assess the safety of their food, water, and infrastructure (Gearheard and Shirley, 2007) or to conduct studies relating to resources and environmental management. Ongoing research on global climate change and its impacts on local people is perhaps best characterized as a juxtaposition of international science (observation, modeling, and discovery) and local knowledge and experience (Ford and Pearce, 2010; Furgal and Seguin, 2006). Science is also perceived as a source of employment and technical training for youth and elders in the Arctic (Pearce et al., 2009).

Conversely, science has been found to conjure negative feelings for some arctic communities (especially marginalized groups), which stems, in part, from a history of non–communication, miscommunication and misunderstanding (Gagnon and Berteaux, 2009; Korsmo and Graham, 2002). As in other indigenous lands throughout world, the negative impacts of science have included the fragmentation and loss of culture and language and the theft and abuse of indigenous knowledge through classification and interpretation of histories, artifacts, etc. (Smith 1999). There still remains evidence of broken cultural protocols (Mosby, 2013), neglected values and ignorance of local forms of authority by scientists (Gibbs, 2001). This has led, in some instances, to the development of ill-informed policies legitimated by science (Gibbs, 2001; Smith, 1999) and a level of cynicism regarding scientific research and its benefits for communities (Davidson-Hunt and O'Flaherty, 2007; Inuit Tapiriit Kanatami (ITK) and Nunavut Research Institute (NRI), 2007; Norgaard, 1994; Scott, 1998). It is clear that researchers stand to benefit from research by taking the information they collect from communities and publishing it,

lecturing about it or otherwise applying it in ways that advance their own careers (Inuit Tapiriit Kanatami (ITK), 2002). However, scientific research results have often been found to be irrelevant to communities and of little use for the problems they face (Mercer et al., 2008). Researchers often do not understand the culture or the context of their work and importantly, do not acknowledge their biases in conducting research in these settings (ITK, 2002). In ITK`s guide for communities engaging in research, Arctic residents have expressed strong dissatisfaction with their level of engagement in science:

"People in the communities have told us that they aren't always sure about what researchers do, why they do it and how their research benefits the community. Many Inuit feel they have not been involved enough in the research process." (ITK, 2002, p.20).

Recent research also suggests that publications resulting from natural science in the Arctic rarely acknowledge an involvement of non-academic stakeholders in scientific activities further compounding the dissatisfaction and disillusionment of arctic residents (Bravo and Sorlin, 2002). This general lack of acknowledgement and engagement appears to have persisted while Northern communities continue to express a strong desire to participate in research, be it through the co-development of research needs on their lands, contributing to the overall research design or even conducting independent studies (Shirley, 2005). Inuit communities in Canada "have called for greater access to project funding, as well as dedicated infrastructure and capacity to initiate, conduct and manage research that addresses Inuit concerns and priorities (Gearheard and Shirley, 2007, p.64).

A number of authors have indicated that certain barriers are driving this situation, including: chronic instability in the leadership of community governments and organizations, cultural and linguistic differences, poor historical research and community-researcher relations and financial and time constraints (Gearheard and Shirley, 2007; ITK and NRI, 2007; Pearce et al., 2009; Wolfe et al., 2007). Internal political tensions and agendas have been observed as sometimes leading to biased, often inequitable participation by local actors who may not represent overall community perspectives (Smith, 1999). Beyond the researcher-community relationship, a number of other factors are thought to inhibit the institutional use and successful adoption of participatory research approaches, including government and university funding structures (given

the relatively high cost of Arctic research), time constraints in academic programs and the need for training (Pearce et al., 2009). Garnett et al. (2009) add that funding bodies may not make provisions for employment and training of community members as researchers.

1.1.1 Participation: from understanding to assessment

In response to these challenges, much attention has been given to participatory methodologies and the underlying tenants of engagement, its benefits and challenges (Davidson-Hunt and O'Flaherty, 2007; Gearheard and Shirley, 2007; Gibbs, 2001; Kruse et al., 2004; Pearce et al., 2009; Smith, 1999; Wolfe et al., 2007).

Many believe that participatory research approaches have emerged from studies of industrial democracy (Lewin, 1948) and planning (Forester, 1989; Friedman, 1973) and were influenced by the works of John Dewey (Dewey, 1944) and Paulo Freire (Freire, 2000). These approaches were developed in the 1960's and 1970's as a critique of the dominant positivist approach to scientific research. Early works attempted to better conceptualize stakeholder engagement as a gradation from a situation of extreme power imbalance in favour of authorities to some form of partnership and ultimately stakeholder control. Such studies include seminal works such as Arnstein's (1969) 'Ladder of citizen control', which attempted to better understand the different degrees to which stakeholders could be engaged as well as the associated benefits of such strategies. Today, significant advances have been made in understanding the theoretical underpinnings of engagement and developing participatory research methodologies in numerous disciplines, often under the guise of different nomenclatures, including participatory action research in development studies (Whyte, 1991), community-based participatory research in health research (Minkler and Wallerstein, 2008), participatory appraisal emerging from science and technology studies (Chilvers, 2008), civic science (Backstrand, 2003; Schmandt, 1998), public ecology (Robertson and Hull, 2003) and many more (see Reed and McIlveen, 2006). Underlying these approaches is a discussion regarding models for knowledge exchange in citizen science including democratizing science (Liberatore and Funtowicz, 2003), transdiciplinarity (Nicolescu, 2002, Tress et al., 2005) and open innovation (Von Hippel, 2005). An important literature also argues that there has been a global and transdisciplinary shift in the way we produce knowledge. According to this view, traditional forms of scientific discovery (Mode 1) are being expanded upon or even superseded by a new paradigm of knowledge production (Mode 2), focused on

application-focused forms of science including enhanced stakeholder engagement (Gibbons et al., 1994; Nowotny et al., 2003).

An important and recurring aspect of this cross disciplinary transition towards engagement has been the question of utility. According to Phillipson et al. (2012), academics are increasingly pressured to demonstrate and justify the impact of their research. They are also required to identify the beneficiaries and strategies for knowledge transfer in their work (Shove and Rip, 2000). This is built upon an emerging realization that effective research uptake in policy and practice may be built upon a foundation of active knowledge exchange and stakeholder engagement during the process of knowledge production itself (Phillipson, et al., 2012).

However, research funders are often criticized for facilitating academic push rather than user pull, while research communities are often viewed as unmotivated and ill-equipped to generate impacts beyond research, with some scientists expressing that stakeholder engagement in knowledge generation can undermine scientific integrity (Phillipson, et al., 2012). Fundamentally, it is difficult to balance scientific rigor with relevance to community needs (Wulfhorst et al., 2008). One perspective is that the generation and application of knowledge are best maintained as separate processes that require different approaches to assess their success or usefulness. An alternative view is that the generation, diffusion and use of scientific knowledge should be an integrated and iterative process that draws expertise from multiple sources (Phillipson et al., 2012; Raymond, 2010).

Exposure to a wider range of public knowledge, values, and meanings has been argued to generate scientific knowledge that is more socially intelligent and robust (Chilvers, 2008; Leach et al., 2005). With this argument comes intense debate over the nature, desired extent, and legitimacy of citizen-engaged science (Collins and Evans, 2002; Wynne, 2003) adding impetus to the need to better understand and assess the quality of such processes (e.g. Fiorino, 1990; Laird, 1993; Renn et al., 1995; Rowe and Frewer 2000, 2004). Given the widespread discussion regarding the benefits of 'appropriate forms of engagement' in different contexts, many scientific researchers choose to engage stakeholders in their work. However, the benefits of this work have yet to be examined empirically (Abreu et al., 2009)

Participatory research projects are inherently complex, requiring processes to decide who is involved, what questions will be asked, and what issues should findings address (Cooke and Kothari, 2001). They also offer no guarantee of producing more meaningful community participation in science, capacity-building and democratization (Wilmsen, 2008). In some instances, even the most well-intentioned researchers will contract people into projects that are entirely managed by scientists (Wilmsen, 2008). Such tokenism fails to respect the underlying principles of engagement and partnership development and have been found, in some cases, to do more harm than good through maintaining inequities in access to resources and political power in communities (Cooke and Kothari, 2001; Wilmsen, 2008). As a result, extensive community engagement is not necessarily a positive outcome of research.

1.1.2 Participation in the natural sciences and natural resource management

Within natural resource management, participation is recognized as an important method in "building the adaptive capacity and social learning required for the development and maintenance of resilient and sustainable socio-ecological systems" (Barreteau et al., 2010, p.2). It is recognized as an approach to producing knowledge that is "sufficiently grounded in local needs and realities to support community-based natural resource management" and often seen as "crucial to the sustainable management of forests and other natural resources" (Wilmsen 2008, p.12). Adaptive management literature also recognizes the importance of stakeholder involvement, although consensus on the effectiveness of different methods is yet to be reached (Rowe and Frewer, 2000; Stringer et al., 2006).

The application of participatory processes in natural resource science and management is often confronted with a number of issues that stem primarily from the commonly agreed perception that human subjects are not the intended focus of natural science research (Gearheard and Shirley, 2007). However, natural science research is designed by human subjects, done by human subjects, and at least, according to governments, funding agencies and grant applications, intended to benefit human subjects. This apparent dichotomy becomes especially complex when research is undertaken far away from human settlements and considered outside the realm of traditional or local knowledge, or of immediate relevance to locals, such as atmospheric chemistry or geomorphology. A number of these studies also require specialized knowledge and

instruments, which are difficult and costly to obtain in isolated communities. Accordingly, Gorham and Spalding (1989) found that community involvement in the physical science (10%) was much less than the biological sciences (40%). In particular, biological research focused on wildlife populations frequently solicits the help of local hunters, trappers, elders and other traditional knowledge holders in the Arctic (Berkes, 2008; Huntington, 2000; Mulrennan and Scott, 2005). According to Scott and Humphries (In preperation) the underlying models or paradigms in applied ecology may be able to engage traditional knowledge holders in profound and meaningful ways. This may be achieved through the development of long-term relationships with traditional knowledge holders that can result in the co-production of research agendas and designs.

It is, however, important to recognize that certain scientific disciplines/topics will inevitably be of more interest to community stakeholders, and that events occurring at temporal and spatial scales similar to those of human life may inevitably be of most interest. This was reflected by Shirley (2005) who surveyed a Northern community's research needs related to climate change and found that "the majority expressed a need for investigation, monitoring and assessment of specific local problems or phenomena" (p.6) such as understanding the causes of physical abnormalities in local wildlife populations. This is not to say that the interests of communities are narrow, but rather that certain questions may never emerge from community research objectives.

1.2 Motivations for research

Before starting my PhD research, I worked on planning infrastructure development and disaster response projects with First Nations clients in Arctic and sub-Arctic Quebec. Much of this time was spent attempting to promote local engagement in the planning process. I believed, at the time, that these processes were more often than not failures, seeming tokenistic in nature. I was therefore often left feeling like I had failed local citizens. Inevitably, however, projects moved ahead, often relying on the input of a handful of locally powerful individuals. Through this experience, I wanted to not only improve my knowledge of effective participation but also contribute to our understanding of participatory development processes in Northern contexts.

My emerging research interest coincided with a push by International Polar Year, an international bi-centennial funding mechanism that had recently been awarded to Northern researchers, to engage Northerners and local stakeholders in research through various means (Rapley et al., 2004). This large-scale international initiative provided an ideal opportunity to better understand the factors that affect success of participatory processes as well as their outcomes. As I began my field research in the Community of Old Crow, Yukon Territory I found that my questions were very much in line with those of the researchers and locals who have spent years working in the North. Importantly, researchers generally wanted to know if their efforts to engage local stakeholders in science were having an impact. Many sought potential strategies that could better support effective participatory research strategies in the natural sciences. Were the benefits limited to simply providing employment to local residents or were they more far researching? Many suspected that natural science research can play an important role in the sustainable and equitable development of Northern communities. Further, amidst numerous claims of a new research paradigm focused on the application of knowledge and engagement, many researchers believed that the implications of stakeholder participation in science needed to be better understood. This dissertation therefore aims to empirically explore and inform these questions and discussions.

1.3 Research objectives

Given the clear emphasis on the need for stakeholder participation in Northern science and the general lack of empirical evidence available on the challenges, opportunities and outcomes of participatory approaches to science in the north, my research had four objectives:

1. To assess and characterize the evolution of local participation in Northern science (Chap. 2)
2. To critically examine the factors that influence stakeholder participation in natural science research in Northern Canada. (Chap. 3-4)
3. To identify the outcomes of stakeholder participation in natural science research in Northern Canada. (Chap. 3-4)
4. To conceptualize an approach to assessing the effectiveness of scientific research partnerships and participatory strategies (Chap. 5)

1.4 Theoretical foundations

This study is founded upon a rich history of public participation and participatory democracy literature spanning most of the last century (Arnstein 1969; Pateman 1970; Webler and Renn 1995). It draws upon a number of theories which provide support for the integration of multiple stakeholders in decision-making processes, providing opportunities for those most affected by decisions to be included in shaping their future (e.g. Gordon, 2009; Minkler and Wallerstein, 2008; Shalowitz et al., 2009).

The theoretical underpinnings of participatory research are therefore complex (Wallerstein and Duran, 2008). Two principal theories are of particular interest in the context of this study. They are the following:

1. Participatory democratic theory

Participatory democratic theory contends that democracy is the outcome of an agreement among people who establish a sovereignty based upon popular and mutual consent (Pateman, 1970; Webler and Renn, 1995). According to participatory democratic theorists, the ability of democracy to function is measured by the soundness of the decisions reached in light of the needs of the community and by the scope of public participation in reaching them (Bachrach, 1967). Rousseau states that "only through interaction can the general will emerge from the plurality of particular wills" (Rousseau 1968, p.1762). In other words, it requires public involvement in determining legitimate objectives for society both locally and at larger scales.

2. Theory of communicative action

The theory of communicative action draws upon critical social theory which views knowledge as historically and socially constructed (Habermas, 1971). It contends that all validity is rooted in what we experience as individuals, what we construct as society and what knowledge we have stored in culture (Habermas, 1984). In the process of redeeming validity claims, people reflect upon, discuss, and renew this consensus. Habermas also contends that claims to validity can be redeemed by those who have had a hand in building and preserving that body of meaning (i.e. the public, stakeholders, etc.). The consequence of putting this premise into practice is the realization of "popular sovereignty" (Habermas, 1984, p.70). Therefore, by involving

stakeholders in the decision making process, in this case the scientific process, there is a stronger chance that they will not only use this information more effectively but allow it to grow and evolve into a tool for self-empowerment.

1.5 Methodological approach

This complex research topic required the integration of multiple methods in the research design (Figure 1.1) to ensure the validity of findings through triangulation of scales of observation and data sources (qualitative and quantitative primary data, literature review, report review, observation). As such, this study was developed using a mixed method approach within the pragmatic paradigm, which focuses on "'what works' as the truth regarding the research questions under investigation" (Tashakkori and Teddlie, 2003, p. 713). The central approach was the representative case study combined with grounded theory (Glaser and Strauss, 1967) which was both exploratory (to a larger extent) and explanatory in nature (Yin, 2009) and focused on community and local level perspectives (Chapter 3). This core component of the thesis prioritized the phenomena under study. The methods, data and analysis that emerged from this chapter were a reflection of shared experiences and relationships developed with participants (Charmaz, 2006). The secondary approach was the survey which was used to question observed patterns and processes of the case study (Chapter 4, 5) (Folz, 1996). This component of the thesis explored national and regional level stakeholder perspectives using both quantitative and qualitative analysis tools. The tertiary approach was the quantitative meta-analysis to study large scale trends and characteristics in community participation in Arctic science (Chapter 2). This last component of the study provided an important characterisation of stakeholder engagement in Northern science, answering important question upon which Chapters 3 to 5 were designed and developed.

1.6 Organization of thesis

This research was carried out through a series of connected research steps, designed to progressively inform the research questions (refer to Figure 1.1 and Table 1.1). The thesis follows a manuscript-based format and is written as a series of papers, most of which are at various stages of submission and publication in international peer-reviewed journals (Table 1.1).

In Chapter 2, I assess the evolution of community engagement in Northern science, often referred to as being central to the 'new Northern research paradigm'. Through a meta-analysis of scientific articles published in the journal *Arctic* between 1965 and 2010, I show that the involvement of local people has increased only slightly over the last half century and continues to vary systematically among disciplines, organizations, and regions. Given the strong emphasis on community engagement in Arctic science, I then discuss the potential reasons for these findings.

In Chapter 3, I explore the mechanisms that promote or inhibit successful research partnerships and the outcomes of such strategies using a single in-depth case study of a successful scientific research partnership in Northern Canada. Drawing on interviews with community members and scientific researchers, I identify important contextual as well as procedural aspects of scientific research partnerships that can inform Northern research policy and practice. In particular, both researchers and local stakeholders strongly valued their informal interactions, seen as facilitating the development of local networks and friendships which play an important role in building their social capital.

Building upon the findings of the case study, I then present the results of a national survey of Northern research stakeholders to better understand the factors and outcomes that drive and inhibit research partnerships across Canada. Chapter 4 reveals that, overall, researchers are perceived as benefitting far more from research partnerships than their community counterparts, limiting the effectiveness of partnership development. Results also suggest that research partnerships in science need to be better supported by policies and frameworks that focus on building social capital and equity between partners in the research process. Recognizing the importance of social and human capital to successful research partnerships, Chapter 5 tests the potential of the capital assets approach to assist with conceptualizing, and ultimately, assessing the success of scientific research partnerships in the North. The results suggest that this approach is capable of capturing the contextual nature of partnerships in Northern science, providing useful insight to the impacts of participatory research projects.

Methodologically, these chapters draw upon both qualitative and quantitative data analyses to provide diverse insight into stakeholder participation issues in Northern scientific research at a

range of scales, including circumpolar, national, and community levels, in order to inform Northern research policy and practice.

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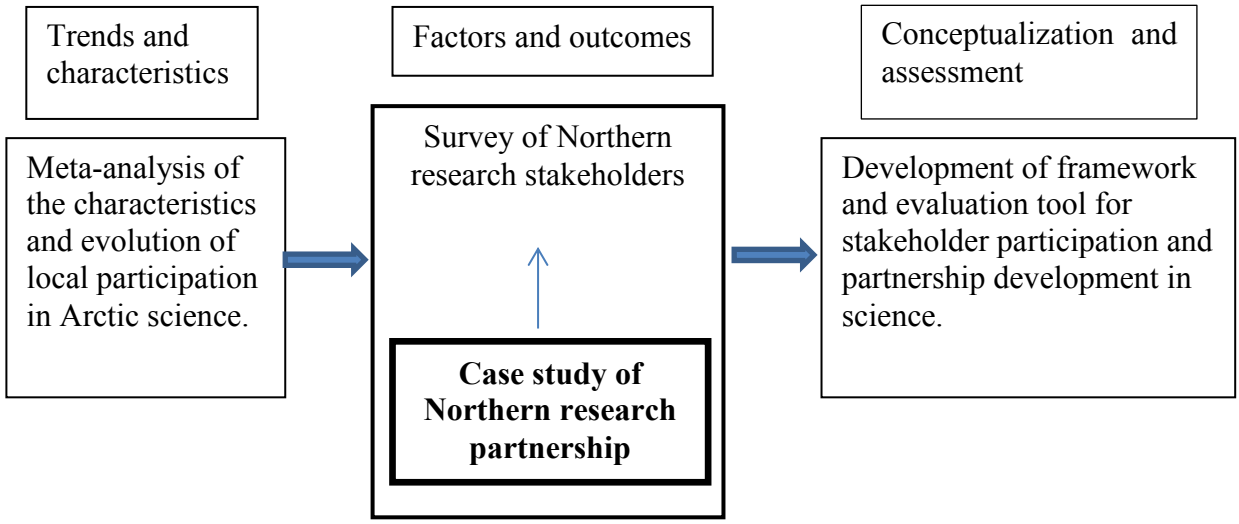

Figure 1.1 Conceptual organization of thesis

Table 1.1 Organization of thesis

Chapter	Scope of analysis	Analytic method	Quant./ Qual.	Targeted journal
2	Circumpolar	Meta-analysis	Quant.	Ecology and Society*
3	Community/Program	Case study and grounded theory	Qual.	Journal of Rural Studies*
4	National (Canada)	Online Survey	Quant./ Qual.	Arctic+
5	National (Canada)	Capital assets analysis and online survey	Quant./ Qual.	World Development±

*Published
+ Revised and resubmitted
± Under review

2 The evolution of local participation and the mode of knowledge production in Arctic research

Abstract

Arctic science is often claimed to have been transformed by the increased involvement of local people, but these claims of a new research paradigm have not been empirically evaluated. We argue that the "new" participatory research paradigm emerging in Arctic science embodies many of the principles of the Mode 2 knowledge production framework. Using the Mode 2 thesis as an assessment framework, we examined research articles appearing between 1965 and 2010 in the journal *Arctic* to assess the extent to which there has been a paradigm shift toward more participatory approaches. Results suggest that the involvement of local people has increased only slightly over the last half century and continues to vary systematically among disciplines, organizations, and regions. Analysis of three additional journals focused on Arctic and circumpolar science establishes the generality of these slight increases in local involvement. There is clearly room for more community involvement in Arctic science, but achieving this will require either increasing the proportional representation of the organizations, disciplines, and regions with a track record of successful Mode 2 research, or encouraging Mode 2 research innovation within the organizations, disciplines, and regions currently predominated by Mode 1 approaches.

2.1 Introduction

Stakeholder participation in research is increasingly acknowledged as critical to ensuring the legitimacy and applicability of research findings (Barreteau et al., 2010; Chilvers, 2008; Kainer et al., 2009; Phillipson et al., 2012; Tsouvalis and Waterton, 2012). Although the challenges associated with participation are numerous, the integration of local insights into the research process and the subsequent generation of knowledge and policy have resulted in many benefits (Gearheard and Shirley 2007, Pearce et al., 2009). For instance, it is widely recognized that stakeholder engagement is an approach to producing knowledge that is “sufficiently grounded in local needs and realities to support community-based natural resource management” and is often seen as “crucial to the sustainable management of forests and other natural resources” (Wilmsen 2008, p.121). Participation is also recognized as an important method in “building the adaptive

capacity and social learning required for the development and maintenance of resilient and sustainable socio-ecological systems" (Barreteau et al., 2010, p.2). Further, studies suggest that the active participation of stakeholders in research that informs management policy leads to broader understanding and acceptance of management decisions derived from the research (Jones et al., 2008; Wilson et al., 2006).

Community engagement in Arctic science has received considerable attention, in part because local people have long been employed as guides and interpreters in Northern science (Bocking, 2007). Furthermore, modern treaty and land claim agreements frequently specify that research conducted within traditional territories should address local priorities and incorporate local knowledge (Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007). Finally, Arctic communities and their leaders have expressed a strong desire for their traditional knowledge to feature more prominently in the international discourse about the nature and impact of environmental change in the Arctic (Gearheard and Shirley, 2007; Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007). Today, research conducted in the Arctic is intended to be both globally relevant and locally important, achieved through both international coordination and local community participation. The opportunities and challenges associated with Arctic research have led to international cooperation and coordination emerging as a defining feature of Arctic science, exemplified by International Polar Year efforts, which were first initiated in 1882 (International Council for Science, 2004).

2.1.1 Modes of knowledge production

An important and expanding literature argues that there has been an international and multidisciplinary shift in the mode of scientific knowledge production, with traditional forms of scientific discovery, Mode 1, being expanded upon or even replaced by more participatory and application-focused forms of science, Mode 2 (Gibbons et al., 1994; Nowotny et al., 2003). Table 2.1 presents the essential characteristics of these modes of knowledge production and contrasts them with two related concepts in Arctic science: participatory research (Minkler and Wallerstein, 2008; Wilmsen, 2008) and the new Arctic research paradigm (Graham and Fortier, 2005; National Science Foundation and Barrow Arctic Science Consortium, 2004; Southcott 2011; Wolfe et al., 2011).

The transition toward more participatory research approaches in Arctic science can be viewed as both a contributor to, and an outcome of, a more generalized Mode 1 to Mode 2 transition (Minkler and Wallerstein, 2008; Wilmsen 2008). Therefore, we believe the Mode 1/Mode 2 dichotomy offers a useful and applicable framework for assessing whether Arctic science is moving toward the interests and involvement of Arctic people, while also linking this assessment to contemporary international research policy discourse. Using this framework, we can view the transition from Mode 1 to Mode 2 approaches to Arctic science as being characterized by fundamental changes in how scientists conduct their research. Such changes can include explicit recognition of the context within which scientific research questions are asked and efforts to assess and maximize the applicability of the knowledge generated. This transition also allows for the inclusion of diverse stakeholders in the research process, including novel forms of quality control that could include expanded peer-review processes involving the knowledge users (Klenk and Hickey, 2013).

2.1.2 Research objective and justification

Using the Mode 2 thesis (Gibbons et al., 1994; Nowotny et al., 2003) as an assessment framework, our objective was to assess evidence for a new research paradigm in Arctic science and to uncover major factors contributing to this progression. Similar to the global relevance of the physical and biological change processes occurring near the poles, we believe that changes in the research approaches used in Arctic science are globally important, both as immediate contributors to international policy and as a regional case study of participatory research trends that are likely to play out in other parts of the world in the coming years.

2.1.3 Case study: Arctic science

We assessed the emergence of participatory approaches and shifts in the mode of knowledge production based on research articles published within the journal *Arctic* (http://www.arctic.ucalgary.ca) between 1965 and 2010. We selected *Arctic* because it publishes Northern science exclusively; is an authoritative, international source of Northern scholarship; and is an eclectic, multidisciplinary journal that publishes papers applying diverse approaches to widely ranging areas of inquiry, spanning physical, life, and social sciences. The format and content of research articles have also remained relatively homogenous since the creation of the

journal, making it easier to develop specific and replicable criteria to study articles over the whole study period. We also analyzed three other journals focused on polar science, using the same criteria to assess the generality of trends apparent in the journal *Arctic*.

An important limitation of using published papers to assess the mode of knowledge production is that we only assessed the published presentation of Arctic science, which may not reflect how and why the knowledge was produced. We selected criteria that we hope helped us get behind the presentation and toward the mode of knowledge production, acknowledging that our assessment was influenced by differences in how the science was presented in addition to how the science was done.

2.2 Research design

We contextualized the Mode 2 framework for Arctic science by identifying specific criteria for each general characteristic outlined by Nowotny et al. (2003). Importantly, these criteria needed to be reasonably easy to assess as objectively as possible from reading the published article (see Table 2.2).

Recognizing that Mode 1 and Mode 2 approaches are best interpreted as two end points on a continuum (van Aken, 2005), our criteria included thresholds identifying Mode 1 and Mode 2 end points, as well as three incremental thresholds. For convenience we labeled these increments as 1.25, 1.5, and 1.75 between end points 1 and 2, but intended them to be interpreted qualitatively; that is, 1.25 represented an approach slightly in the direction of Mode 2 but not much different than Mode 1 and 1.5 represented an approach roughly midway between the Mode 1 and 2 end points.

2.2.1 Study of the journal *Arctic*

We randomly selected 25 articles from the journal *Arctic* for each given year, obtained the electronic version of the full text, and then assessed their eligibility for inclusion. We selected articles published between 1965 and 2010 to capture the 1970-1980 period when adherence to Mode 1 science was most likely to be most dominant (Edqvist, 2003; Levere, 1993) as well as the post-1980s period when several fundamental shifts occurred in Northern science policy (e.g., Bielawski, 1984). Much of this shift was driven by the policy called Northward Looking: A Strategy and Science Policy for Northern Development, which was released by the Science

Council of Canada in 1977 and led to new research grant programs such as The Human Context of Science and Technology in 1981, which formally recognized the importance of local partners in science.

We limited our analysis to research articles that described their specific methodology and generated new knowledge. These included most research notes, but excluded review papers, editorials, opinion pieces, historical accounts, and other regular *Arctic* editorial sections such as InfoNorth, obituaries, and profiles. Any excluded papers were replaced with new random selections from articles published in that year until we obtained 25 research papers or ran out of alternatives. Fewer than 25 research papers could be located in 1966-1967, 1971, 1976, and 1977, but in all other years we assessed 25. The minimum number of articles was 16 in 1966. In total, we assessed 1113 articles over 46 years. Two of us, M. M. Humphries and N. D. Brunet, analyzed half of the papers each, one doing odd years and the other even, with the observer recorded and included in the analysis as an explanatory variable.

Once papers were deemed eligible, we completed a content analysis (Babbie, 2002) of the text. We paid particular attention to the introduction and conclusion for context; the abstract and main method description for transdisciplinarity; the authors' addresses and funding sources for heterogeneity; the introduction and discussion for reflexivity; and the methods and acknowledgements for non-traditional quality control (Table 2.2). We then quantified several additional attributes from each paper as potential explanatory variables, including the discipline, the location, the organizational origin of the research, and the extent of focus on environmental change.

The disciplinary focus of each paper was classified broadly as physical science, life science, social science, or multidisciplinary. Papers classified as physical sciences included climate research, atmospheric research, physical geography, geology, and cryosphere research. Papers classified as life sciences included all biological sciences, paleontological studies focused on faunal descriptions, and biomedical research focused on human physiology. Social science papers included research focused on human subjects, including anthropology, human geography, community health research, resource policy, and archaeology. Papers were classified as multidisciplinary if they focused on two or three of these disciplinary categories. Because

research on harvested wildlife is often identified as a priority by Northern communities (Council of Yukon First Nations, Yukon Northern Climate ExChange, and Yukon Climate Change Secretariat, 2011; Shirley, 2005; Yukon climate change needs assessment, unpublished manuscript), we further subdivided life sciences papers according to whether or not they focused on traditional food and fur-bearing species, based on cross-referencing species emphasized in the title and abstract (Kuhnlein and Turner, 1996; Kuhnlein and Humphries, unpublished manuscript Novak et al., 1987). Social science papers were also further subcategorized according to whether they focused primarily on living people, i.e., contemporary; remains and artifacts, i.e., archeological; or written history, i.e., historical. We labeled these subcategories as disciplines, recognizing that our seven categories in fact represent only three widely recognized disciplines, two of which were subdivided into topic-area categories.

We classified the organizational origin of the research according to whether the first author's institution was a local government, territory or state government, federal government, university, or other, which were primarily consulting firms. The research region was classified according to whether the primary region of focus was Alaska, Canada, Greenland, Scandinavia, Russia, or circumpolar.

Finally, the extent to which the paper focused on environmental change was assessed by doing a full-text search, excluding French-translated abstracts and literature cited, for "warm$" and "chang$." The search was intended to capture phrases such as climate change, environmental change, changing climate, climatic warming, global warming, and so forth. We then read the text surrounding each search return to ensure the usage was related to long-term, large-scale, directional environmental change. Papers were then assigned to one of four categories of emphasis: no if 0 mentions, minor if 1-4 mentions, moderate if 5-19 mentions, or major if 20 or more mentions.

2.2.1.1 Analyses

We first determined temporal patterns in Mode 1 and Mode 2 Arctic science between 1965 and 2010 for all five criteria, i.e., context, transdisciplinarity, heterogeneity, reflexivity, and non-traditional quality control. These patterns are presented using bubble plots, which usefully

present proportional prevalence in situations in which variables are semi-discrete. As a result, there are many overlapping data points.

Second, we conducted a statistical analysis to identify which variables best predicted the mode of knowledge production in Arctic science. In this general linear model, the response variable was mode: 1, 1.25, 1.5, 1.75, or 2. The explanatory variables were year, year², location, discipline, organization, and environmental change focus. In this analysis, the response variable was not normally distributed because it was an interval with a small number of discrete values, was bounded between a minimum and maximum, and was skewed with more low than high values. Although the non-normality of the resulting model residuals did not affect the estimation of coefficients, it did compromise estimation of their error and significance. Accordingly, confidence intervals, t statistics (β'/standard error), and P values for coefficients were generated using sequential subsets of data via a jackknifing procedure. All statistical analyses were conducted with R (R Development Core Team, 2011).

In a final analysis of papers published in the journal *Arctic*, we evaluated temporal, regional, and disciplinary trends in the research focus on global environmental change. In this general linear model, the response variable was global environmental change focus, i.e., no, minor, moderate, or major, and the explanatory variables were year, location, discipline, and organization. To account for potential nonlinear temporal trends, we also included a quadratic effect of year (year²).

2.2.2 Multi-journal generality

To assess the generality of findings from the journal *Arctic*, we also conducted an abridged review of scientific articles in three other journals focusing on polar science in different disciplines: *Arctic, Antarctic and Alpine Research*, focusing mostly on physical sciences; *Polar Biology*, focusing mostly on life sciences; and the *International Journal of Circumpolar Health* (IJCH), an interdisciplinary journal with articles bridging contemporary health, life, and social sciences. These journals were also selected because of their importance and because they have been published at least since 1985, although two of the journals changed their titles during this interval (in 1985 IJCH was *Arctic Medical Research and Arctic*, *Antarctic and Alpine Research* was *Arctic and Alpine Research*).

We randomly selected 10 articles from each of these three journals for the years 1985 and 2010, a period that would be long enough to demonstrate a Mode 1 to Mode 2 transition. After obtaining the electronic version of the full texts, we assessed their eligibility for inclusion.

Similar to our analysis of *Arctic*, we limited our analysis to research articles that described their specific methodology and generated new knowledge. These included most research articles and notes, but excluded review papers, editorials, opinion pieces, historical accounts, and other regular editorial sections. Any excluded papers were replaced with new random selections from articles published in that year until we obtained 10 research papers for each journal for both years. In total, 60 articles were reviewed. Once papers were deemed eligible, we completed a content analysis (Babbie, 2002) of the text, paying particular attention to the introduction and conclusion for context, the abstract and main method description for transdisciplinarity, authors' addresses and funding sources for heterogeneity, introduction and discussion for reflexivity, and methods and acknowledgement for non-traditional quality control (Table 2.2).

2.3 Results

2.3.1 Study of the journal *Arctic*

Mode 1 approaches dominated papers published in *Arctic* from 1965 to 2010 (Fig. 2.1). There was, however, a modest increase over time in the prevalence of Mode 2 and intermediate mode approaches for all five characteristics, particularly between the mid-1980s and 2010. Nevertheless, even in the most recent years of analysis, only a small proportion of papers included Mode 2 approaches. We also found that Mode 2 approaches are not new in *Arctic* science; a number of strongly Mode 2 studies, particularly in context and transdisciplinarity, were published between the mid-1960s and mid-1970s. Examples are provided in the Discussion section. Recognizing the potential importance of editorial preferences for journal content over time, we reviewed *Arctic*'s Aims and Scope over our study period and found no evidence to indicate a significant change of focus. The format of the journal also remained essentially the same throughout our study period. Nevertheless, we recognize that editorial preference and changes at the journal could have affected the research accepted for publication.

General linear model analysis of the contributors to variation in the mode of knowledge production indicated significant effects of lead author institution, discipline, region where the

research was performed, and year (Fig. 2.1, Appendix 2.1). Lead author institution had the most pronounced effect on the mode of knowledge production, with local governments and to a lesser extent territorial and state governments associated with more Mode 2 research than other organizations. The mode of knowledge production also varied by discipline, with social sciences research and, to a lesser extent, life sciences research being more Mode 2 than physical sciences research. Life sciences articles focused on wildlife species that are used for fur or as traditional food were more Mode 2 than life science articles focused on other species. Similarly, social sciences articles focused on contemporary people were more Mode 2 than archeological or historical research. Regional differences in the mode of knowledge production were not as pronounced as institutional and disciplinary differences, but research conducted in Canada and to a lesser extent Alaska tended to be more Mode 2 than research focused on the European and circumpolar Arctic. Observer differences were small, but were significant for context and reflexivity (Fig. 2.2), which may indicate that the criteria used to assess these two characteristics were less explicit and more ambiguous than those used for the other characteristics. Papers with a major focus on environment change were not significantly more Mode 2 than papers less focused on environmental change (Fig. 2.2). After accounting for all other covariates, there remained a significant nonlinear time trend, with context, transdisciplinarity, heterogeneity, and reflexivity all weakly accelerating as a quadratic function of time. However, context started somewhat more Mode 2 and declined toward a Mode 1 minimum, i.e., scores were closest to 1, in the early 1980s, with Mode 2 articles then increasing to the end of the time series.

From 1965 to 2010, the number of papers published in *Arctic* with a first author from a local government increased, but remained very low (Fig. 2.3). During the same period, there was a strong decline in the proportion of *Arctic* papers focused on the physical sciences (Fig. 2.4). The proportion of social sciences papers remained relatively constant, whereas the prevalence of life sciences and multidisciplinary research increased substantially. The number of *Arctic* papers with a minor, moderate, or major focus on environmental change increased dramatically over time, particularly since 1995 (Fig. 2.5).

2.3.2 Study of the three other polar journals

Across three additional polar science journals, the transition from Mode 1 to Mode 2 from 1985 to 2010 was limited or nonexistent for most criteria (Fig. 2.6). IJCH was more Mode 2 in context

than the other journals we analyzed, but this Mode 2 attribute declined from 1985 to 2010 in the transition from *Arctic Medical Research* to IJCH. There was a slight shift in *Polar Biology* from 1985 to 2010 toward more Mode 2 heterogeneity, consistent with trends observed in life sciences papers within the journal *Arctic*. Finally, IJCH became more Mode 2 from 1985 to 2010 in heterogeneity, reflexivity, and to a lesser extent, non-traditional quality control.

2.4 Discussion

2.4.1 Prevalence of Mode 1 and Mode 2 research in Arctic science

Arctic communities, leaders, and research policy have clearly expressed the importance of engaging local people in Arctic research, including the incorporation of traditional knowledge into research findings and the co-development of research agendas (Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007; Shirley, 2005). However, our Mode 1 versus Mode 2 classification of 1173 papers published in four polar science journals suggests that community engagement in Arctic research continues to be very limited and heterogeneous. Across all years and disciplines, 74% of papers published in *Arctic* had a strictly Mode 1 context, 78% made no mention of local knowledge, 80% lacked heterogeneity of authorship and funding, 83% showed no evidence of reflexivity in relation to local people, and 77% showed no evidence of non-traditional quality control. There was a modest shift in the journal *Arctic* toward more Mode 2 approaches between 1965 and 2010, occurring largely after the mid-1980s. However, Mode 2 research also occurred in the 1960s and 1970s, and remained rare in the most recent years of analysis. Our analysis of three additional journals supports our findings from the journal *Arctic*, albeit with more evidence of Mode 2 approaches in contemporary health research than other disciplines. If there has been a paradigm shift in Arctic science toward more community engagement, this shift is far from complete. Mode 1 science predominates contemporary Arctic research and, if current trends persist, will predominate future Arctic science.

Early examples of Mode 2 Arctic science identified by our analysis include the study by Irving et al. (1967) of Willow Ptarmigan (*Lagopus lagopus*) migration in Alaska. This study focused on an Inuit community's use, knowledge, and personification of the birds, co-presented local and scientific knowledge about their migration, and included a community member as a coauthor. Although many Northern scientists have long relied on the land skills and land knowledge of local guides to do their research, wildlife research has a long history of also using local harvest

records and harvester knowledge to better understand wildlife behavior and abundance. However, reliance on local knowledge and expertise in wildlife research declined in the postwar era when researchers began to emphasize the importance of trained observers, systematic observation, and scientific instrumentation (Banfield, 1954; Bocking, 2007; Kelsall and Calaprice, 1972; Levere 1993). Another early example of Mode 2 research identified in our analysis presented a compelling account of why participatory approaches were needed in the Arctic and how to accomplish them (Francis, 1973). Northern peoples' rejection of imposed roles as subjects of investigation and curiosity was described in 1973 much as it continues to be described now (Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007).

Examples of early and recent Mode 1 Arctic science are too numerous to describe in detail, but collectively these studies emphasize that a considerable portion of Arctic science, now and in the past, appears to be rather distant from community concerns and involvement. Much Arctic research is conducted in locations that are physically distant from communities and places that community members frequently visit (e.g., Abnizova and Young, 2010), involves geological time periods that are temporally distant from the experience and oral histories of contemporary people (e.g., Swanson, 2006), involves physical and biological phenomena that are distant from the primary interests and knowledge of local people (e.g., Gradinger and Bluhm, 2010), and involves methodologies that are distant from the expertise and interests of non-scientists (e.g., Laidler et al., 2008).

2.4.2 Factors contributing to the heterogeneity of research approaches in Arctic science

The mode of knowledge production varied by researcher organization, discipline, and region, but not according to the extent of research focus on global environmental change. These contributing factors are presented in order of their explanatory power from most influential to least influential.

2.4.2.1 Researcher organization

Studies with lead authors from local and territorial governments were positioned closer to Mode 2 than studies with lead authors from federal governments, universities, and other organizations including the private sector. In fact, lead author organization was the strongest mode predictor in our statistical analysis. The average mode score across all five criteria was 1.6 for articles with a

first author from a local government, 1.3 with a first author from a territorial government, and 1.1 with a first author from a university or federal government. The number of studies with lead authors from local and territorial governments has increased over time, but these studies remain a small proportion of the papers published in *Arctic*, representing fewer than 7% of papers published between 2008 and 2010. Within our sample, examples include education research from the late 1990s (Norton and Kassam 1997; Stenton and Rigby, 1995) and wildlife management studies from the last decade (O'Hara et al., 2003, Person et al., 2007), which actively engaged communities in every aspect of the research process. It is not surprising that papers with lead authors from local and territorial governments tend toward Mode 2 in heterogeneity, especially because they often involved authors and funding from other levels of government and/or universities. However, these papers also tended to be more oriented toward questions of relevance at the local level, focused on participatory approaches, and inclusive of traditional knowledge and community forms of quality control (Agrawal, 1995; Wolfe et al., 2007).

The integration of traditional knowledge in scientific studies has been found to play an important role in empowering local communities to engage in research and publish work themselves (Berkes, 2008) and provides important insights for research (see Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007). Some studies have indicated that the rise of traditional knowledge has helped initiate a paradigm shift in the natural sciences (Agrawal, 1995; Berkes, 2008; Bohensky and Maru, 2011; Chaplin et al., 2013; Gearheard and Shirley, 2007; Norton, 2008) characterized by respect for other knowledge systems and the acknowledgment that all knowledge is situated within specific historic and social contexts (Scott, 1996). Although this shift goes beyond the scope of Arctic science, it does indicate that the phenomena under study are part of a larger process occurring globally. Further case studies in different contexts would be valuable.

2.4.2.2 Discipline

Disciplinary differences were the second most important contributor to the mode of knowledge production. Social sciences were more Mode 2 than other disciplines across all criteria other than heterogeneity. Life sciences were found to be slightly more Mode 2 than physical sciences for most criteria. An earlier study by Gorham and Spalding (1989) also found that there was 40%

local involvement in the biological sciences compared with only 10% local involvement in the physical sciences. However, we found considerable mode diversity within the life sciences, with papers focused on traditional food and fur-bearing species more oriented toward Mode 2 approaches than life science papers focused on other species or phenomena, which were overall similar in mode to physical sciences papers.

Other literature has noted that life sciences research oriented around harvested wildlife species is more likely to involve local hunters, trappers, elders, and other traditional knowledge holders (Berkes, 2008; Gearheard and Shirley, 2007; Huntington, 2000; Mulrennan and Scott, 2005). Thus, certain fields within the life sciences have historically been, and continue to be, more amenable to the engagement of local partners and perspectives. For example, C. Scott and M. M. Humphries (unpublished manuscript) suggest that the underlying models or paradigms in wildlife and ecosystem ecology could engage traditional knowledge holders in profound and meaningful ways. Scott (1996) also suggested that events or phenomena occurring at temporal and spatial scales similar to those of human life may inevitably be of more interest to local partners. Further supporting this claim, respondents in a Canadian Climate Impacts and Adaptation Research Network–North report on community research needs in Nunavut, Canada, found that community members were most interested in climate impacts related to the environment and wildlife, particularly in the context of subsistence harvesting and management (Shirley 2005). There are, however, important exceptions to these disciplinary generalizations, including examples of Mode 2–oriented research on oceanography (Carmack and Macdonald, 2008), geomorphology (Eisner et al., 2009), and climate science (Barber et al., 2008).

Overall, between 1965 and 2010 in the journal *Arctic*, there was an increase in the number of life sciences papers, particularly wildlife studies related to traditional food and furbearers, a decline in the number of physical science papers, and no clear change in the number of social science papers. These shifts in disciplinary presence in *Arctic* are likely to be marginal contributors toward the slightly increased prevalence of Mode 2 approaches.

2.4.2.3 Region of study

The region of study was a significant, but weak, predictor of research mode in our sample. In particular, studies conducted in Canada and Alaska tended to be more Mode 2 across most

criteria than those conducted in Scandinavia, Greenland, and Russia. Detailed exploration of the causes and consequences of these regional differences is outside the scope of the present study, but we will briefly discuss U.S. and Canadian research contexts and their influence on community engagement in science.

In Canada, there have been significant changes in the institutional, legal, and political context of Arctic governance since 1990 (Association of Canadian Universities for Northern Studies, 2003; Gearheard and Shirley, 2007; Graham and Fortier, 2005; Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007), resulting in new research policies and procedures that better reflect the needs of Arctic residents. In Nunavut, published guides for negotiating research relationships between Inuit and academic and government researchers present step-by-step information on community involvement, local perceptions of science, licensing, access, communication, and so forth (Inuit Tapiriit Kanatami, 2002, Inuit Tapiriit Kanatami and Nunavut Research Institute, 2007). In certain jurisdictions, special regulations are also in place relating to the collection, dissemination, and ownership of traditional knowledge. For example, in the Yukon Territory, the Umbrella Final Agreement signed in l993 by the Council for Yukon Indians, now the Council of Yukon First Nations, the Government of Canada, and the Government of Yukon stipulates that any researcher who wants to work on Yukon First Nation Settlement Land must first obtain the permission of that First Nation. The agreement also requires mandatory reporting to affected communities (Cultural Services Branch, 2008). Court decisions in Canada have also served to empower Arctic peoples and provide tools and experience to better engage researchers.

In the United States, a 2004 report from the National Science Foundation and the Barrow Arctic Science Consortium indicated “a continuing commitment to research in the Arctic and working with residents to shape research so that it is not in conflict with the subsistence lifestyles of many Arctic residents and whenever possible addresses questions relevant to their lives” (2004, p.4). It also offers checklists and principles of conduct to promote mutual respect and communication between scientists and Arctic residents. In Alaska, the presence of the University of Alaska likely supports better partnerships with local communities and agencies. The presence of receptive and engaged agencies and local governments such as North Slope Borough and the community of Point Barrow may further support these relationships. Another interesting factor that warrants further investigation is the history of industrial development and oil production in the region and

their impact on establishing research partnerships. Industry funds substantial amounts of research in Alaska, and a better understanding of corporate policies regarding community engagement would provide important insights into the forces that might help shape participatory processes.

2.4.2.4 Environmental change

Although environmental change has emerged as a major focus of Arctic science, it is only marginally predictive of research mode. In other words, the prevalence of Mode 1 and Mode 2 approaches did not differ between papers that focused on global environmental change versus those that focused on other topics. Papers published in *Arctic* with some mention of environmental change accounted for 76% of research in 2010 compared with 20% in 1965, with most of this increase occurring in the past 15 years. This increase coincides with a period of intense international activity related to climate change and environmental change research (IPCC 1990, 1996, 2001, 2007). Many papers focused on environmental change used participatory approaches to integrate local concerns and knowledge into the research process and to identify mitigation and adaptation strategies (Ford and Pearce, 2010; Nickels et al., 2002; Pearce et al., 2009; Wolfe et al., 2011). However, many other forms of environmental change research continue to be oriented around Mode 1 approaches, including forest ecology (e.g., Juntunen et al., 2002), wildlife ecology (Towns et al., 2010), and atmospheric sciences (Timlin and Walsh, 2007).

2.5 Conclusion

Arctic science is being transformed by both an intensified focus on environmental change and increased involvement of local people (see, e.g., Graham and Fortier, 2005; Pearce et al., 2009). In this study, we empirically assessed claims of a new research paradigm in Arctic science that is oriented around local engagement and participation. We approached this assessment through a Mode 1 versus Mode 2 classification of articles published in the journal *Arctic* as well as three other leading polar science journals. We found that shifts toward Mode 2 research approaches over time have been small and scattered, with Mode 1 approaches continuing to dominate Arctic science. The emergence of Mode 2 approaches was unrelated to a pronounced increase in the prevalence of environmental change research. Instead, it was correlated with the increased involvement of Northern organizations and the increased prevalence of life sciences research focused on harvested wildlife and social sciences research focused on contemporary people.

Thus, local people are becoming more involved in Arctic science, but the nature and level of this involvement remain limited and vary systematically among disciplines, organizations, and regions.

In this paper, we describe how Arctic research is done, not how Arctic science should be done. Whether the modes of knowledge production and the extent and form of community engagement that they reflect can or should be different is a broader question of research policy. There is clearly room for more community involvement in Arctic science. Our analysis indicates that the emerging focus on environmental change research will not by itself lead to substantially more community involvement because environmental change research spans the same range of Mode 1 and Mode 2 approaches as other Arctic research does. More community involvement could be achieved by increasing the proportional representation of the organizations, disciplines, and regions with a track record of successful Mode 2 research or by encouraging Mode 2 research innovations within the organizations, disciplines, and regions currently predominated by Mode 1 approaches. On the other hand, many forms of Arctic science appear to be well served by Mode 1 approaches, and their continued existence and value need to be acknowledged in Arctic science policy.

Efforts to increase community engagement in Arctic science need to recognize the diversity of research interests and approaches in polar science, and to be skeptical of one-size-fits-all solutions. Clearly, community collaboration and partnerships should be encouraged and facilitated when appropriate. However, there are likely to remain many situations in which circumpolar research priorities and approaches do not align well with local community priorities and engagement. This is, perhaps, the elephant in the room or, given our Arctic science context, the woolly mammoth in the permafrost. The Arctic is a vast, interesting, and important place that is home to more than 4 million people. Contemporary Arctic research aspires to engage and benefit local communities and to advance international science and discovery. Some research can do both, and some is likely to do one much better than the other. Finding the appropriate balance in research aspirations, approaches, and expectations will be one of the grand challenges of Arctic science in the coming decades.

Acknowledgements

We would like to acknowledge Dr. Quinn Fletcher for improving the statistical analyses and Drs Marianne Marcoux and Guillaume Larocque for assisting with access to the papers. We would also like to thank Dr. Elena Bennett and the Humphries Lab for insightful comments on previous versions of this work. This work was funded by the Fond Québécois de Recherche sur la Science et la Culture, the Natural Sciences and Engineering Research Council of Canada's Northern Research Chair Program, and McGill University.

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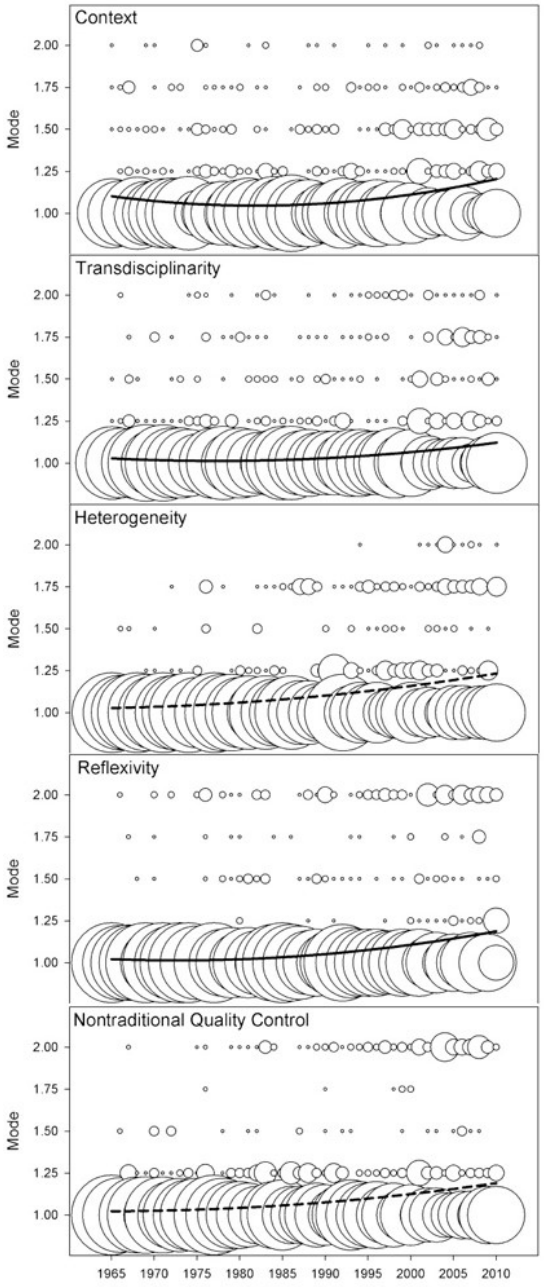

Figure 2.1 Patterns in the Mode of knowledge production in Arctic science and Mode 2 approaches over time, above and beyond differences accounted for by the influence of discipline, organization, and region in our analysis of research papers published in *Arctic* 1965-2010. Circles are bubbles, with size reflective of the proportion of studies in that category. Lines are 5 yr running means. Characteristics and evaluation criteria are described in Table 2.2.

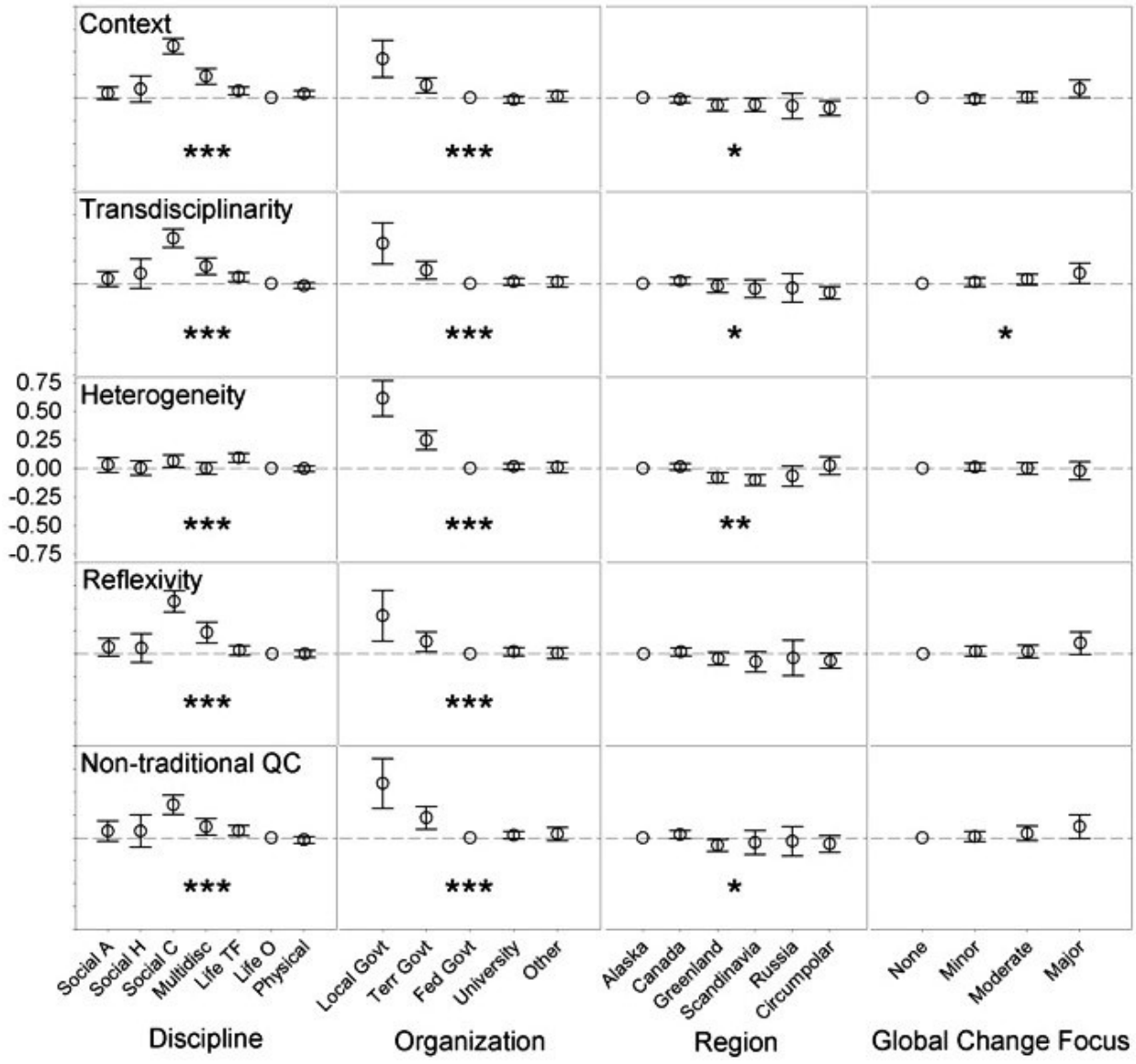

Figure 2.2 Regression coefficients from an initial multiple regression analysis of Mode score predicted by the five explanatory variables included. Coefficients are expressed relative to one arbitrarily chosen level of each explanatory variable, which has a value constrained to 0. Therefore, it is arbitrary whether most points are above, below, or grouped around the line, but the general direction of the trend is meaningful. Points higher on the Y-axis, with error bars that do not overlap with other points, are more Mode 2 than the points of comparison that are lower on the Y-axis and more Mode 1. Therefore, for example, social sciences, local governments, and Alaska are all more Mode 2 than their counterparts.

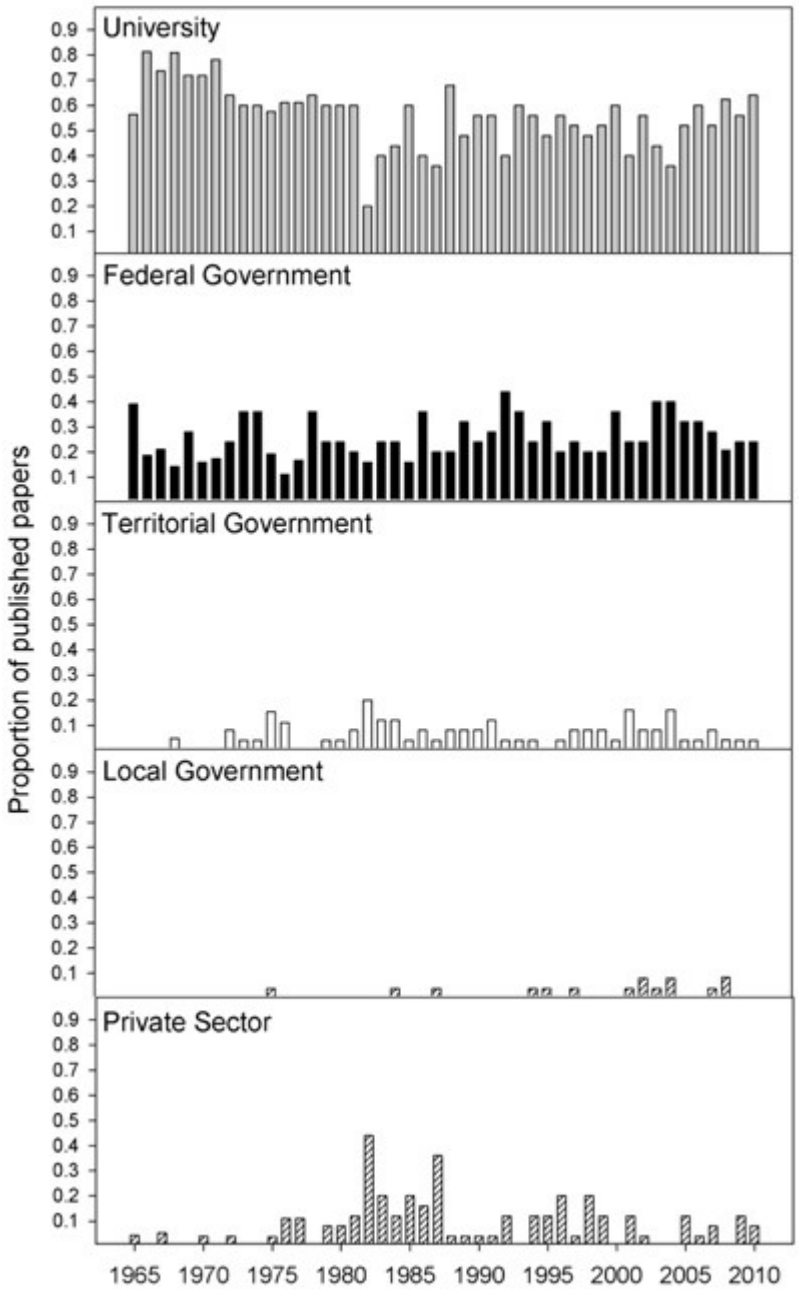

Figure 2.3 The organizational composition of research included in our analysis of research papers published in *Arctic* 1965-2010. Papers were classified based on lead author of the paper. This sample is not necessarily reflective of the organizational composition of all articles published in *Arctic*, because it includes only research articles that describe specific methodology and results, while excluding review papers presenting no new data, as well as editorials, opinion pieces, historical accounts, and other regular editorial sections.

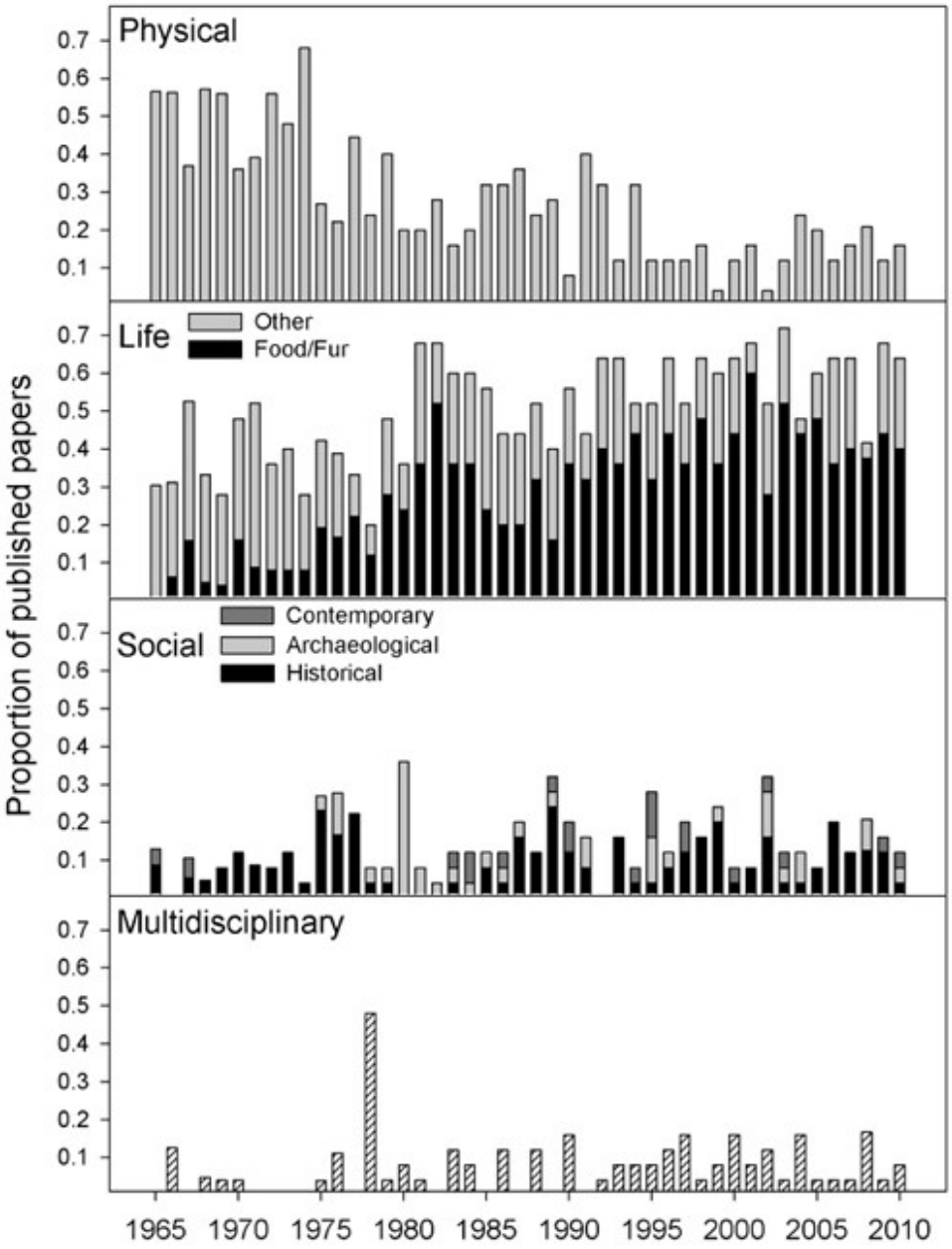

Figure 2.4 The disciplinary and subcategory composition of research included in our analysis of research papers published in *Arctic* 1965-2010. This sample is not necessarily reflective of the disciplinary composition of all articles published in *Arctic*, because it includes only research articles that describe specific methodology and results, while excluding review papers presenting no new data, as well as editorials, opinion pieces, historical accounts, and other regular editorial sections.

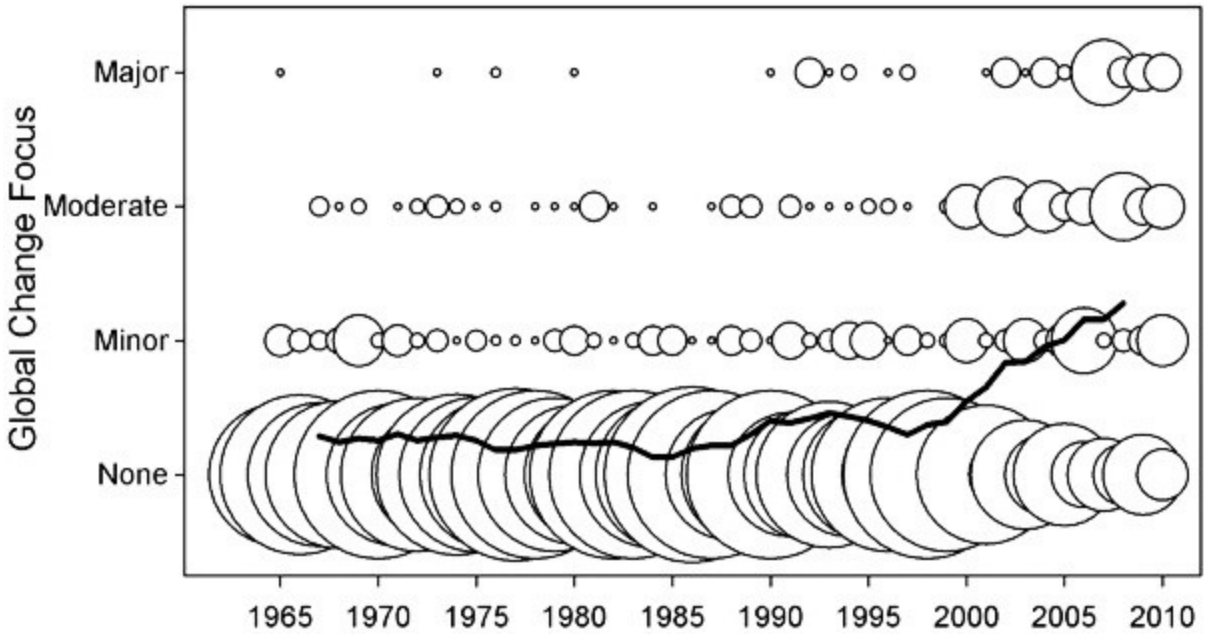

Figure 2.5 The prevalence of global environmental change as a topic in our analysis of research papers published in *Arctic* 1965-2010. This sample is not necessarily reflective of the organizational composition of all articles published in *Arctic*, because it includes only research articles that describe specific methodology and results, while excluding review papers presenting no new data, as well as editorials, opinion pieces, historical accounts, and other regular editorial sections.

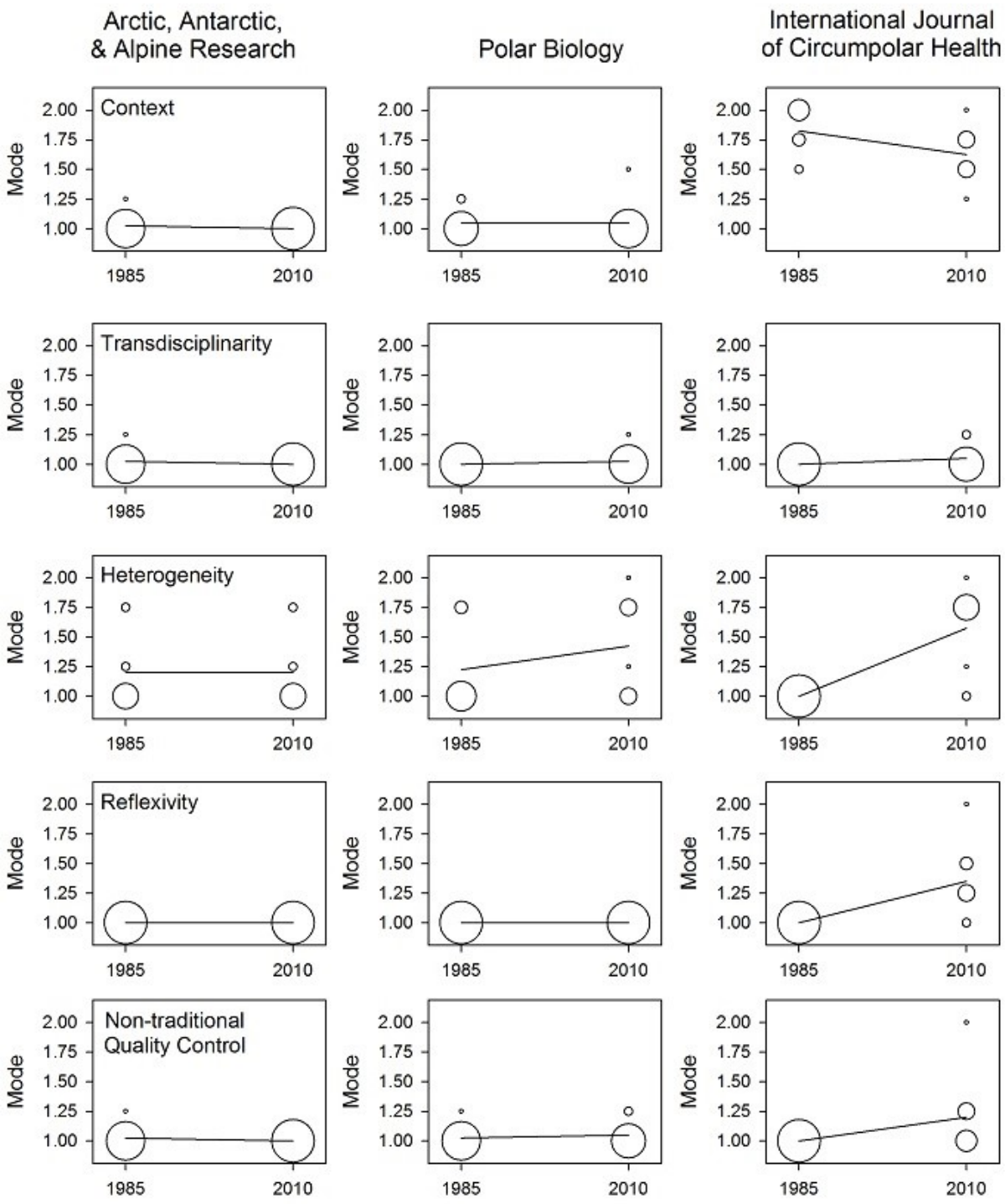

Figure 2.6 Patterns in the Mode of knowledge production in Arctic science and Mode 2 approaches in 1985 and 2010 in our analysis of research papers published in the journals AAAR, IJCH, and *Polar Biology*. Circles are bubbles, with size reflective of the proportion of studies in that category.

Table 2.1 Comparative review of Mode 1, Mode 2, participatory research, and the new Northern research paradigm. Italics are direct quotes from Nowotny et al. 2003:186-188.

Mode 1 (Berkes, 2008; Nowotny et al., 2003)	Mode 2 (Nowotny et al., 2003)	Participatory Research (Minkler and Wallerstein, 2008; Wilmsen, 2008)	"New" Arctic research paradigm (Graham and Fortier, 2005; Southcott, 2011)
Knowledge is generated independently of context.	*Knowledge is generated within a context of application.*	Knowledge is cultural. There is no objective truth about the world. Knowledge is situated within certain historical and social context.	Partnership. Knowledge is developed through meaningful relationships between researchers and communities.
Hegemony of theoretical and experimental science.	*This is different from the process of application by which 'pure' science, generated in theoretical/experimental environments, is 'applied'; technology is 'transferred'; knowledge is subsequently 'managed'.*	Success is defined by the utility and action of outcomes.	Research must be beneficial to all participants and affected parties.
Autonomy of scientists and host institutions.	*The mobilization of a range of theoretical perspectives and practical methodologies to solve problems.*	Research process results from a negotiated settlement between all parties involved.	Based on mutual understanding and cooperation.
Internally driven taxonomy of disciplines.	*Knowledge is embodied in the expertise of individual researchers and research teams as much as, or possibly more than, it is encoded in conventional research products such as journal articles or patents.*	Researchers as facilitators of the research process.	We must strive to build the capacity of Northern communities so they can conduct their own research.
Most knowledge is generated in centralized locations such as	*Much greater diversity of the sites at which knowledge is produced, and in the types of*	Knowledge produced by science is negotiated.	Research process built of effective communication

universities.	*knowledge produced.*		strategies.
Focused on western/scientific forms of knowledge.	*Has allowed many new kinds of 'knowledge' organizations to join the research game.*	Integrates and recognizes the validity of local knowledge. Participation of nonscientists in research processes. Conscious engagement with relationships of power.	Researchers must actively engage local knowledge holders and experts.
Knowledge production characterized as objective.	*Knowledge that is highly reflexive. The research process can no longer be characterized as an 'objective' investigation of the natural (or social) world.*	Trustworthiness over validity. Self reflexive.	Active engagement of community members in all aspects of research.
Consequences of new knowledge are considered outside the research process.	*The consequences (predictable and unintended) of new knowledge cannot be regarded as being 'outside' the research process.*	Participation of stakeholders and affected parties affected by situation under study. Concerned with social change/ supports action.	Research processes must be empowering for Northern communities.
Traditional means of quality control, based on peer review process.	*Novel forms of quality control.*	Participation of stakeholders in every aspect of research process. Community control.	Local collection, validation, and ownership of data.

Table 2.2 Criteria used to evaluate the Mode of knowledge production in Arctic research.

Mode	**Context of introductory and concluding text**
1	Entirely academic or applied research, with no mention of applicability to contemporary local people
1.25	Mostly academic or applied research, with some mention of applicability to contemporary local people
1.5	Even mix of academic/applied relevance and local applicability
1.75	Mostly focused on applicability to local people, with some mention of academic/applied relevance
2	Entirely focused on local people, with no mention of academic/applied research relevance
	Transdisciplinarity of abstract or research focus
1	Academic approaches or sources only
1.25	Primarily academic approaches or sources with limited mention of local knowledge
1.5	Primarily academic approaches or sources but including explicit use, application, or testing of local knowledge
1.75	Attempted copresentation, integration, and/or synthesis of local and academic knowledge
2	Predominant focus on local knowledge
	Heterogeneity of author institutions and funding/in kind support (university/federal vs. territory/state vs. local)
1	Authors, funding, and substantial in kind support all from one level
1.25	Authors from one level, funding, or substantial in kind support from two levels
1.5	Authors from one level, funding, or substantial in kind support from three levels
1.75	Authors from two levels
2	Authors from three levels

	Evidence of reflexivity/social accountability
1	No evidence of reflexivity/social accountability in relation to local people
1.25	Statement of licensing or research ethics compliance
1.5	Evidence that a specific methodology/interpretation was modified in recognition of impacts on local people
1.75	Evidence that general methodology/interpretation was modified in recognition of impacts on local people
2	Evidence that general methodology/interpretation derived from recognition of impacts on local people
	Evidence of non-traditional quality control in methods and acknowledgements
1	No evidence of local quality control
1.25	Evidence that local people were involved in data collection (e.g., field assistants, carcass samples, translation, interviews)
1.5	Evidence of local quality control at the results interpretation or manuscript review stage
1.75	Evidence of local quality control at research design stage
2	Evidence of local control at multiple stages of the research process

Preface to Chapter 3

In Chapter 2, we completed a thorough analysis of a random sample to 1113 papers in the journal *Arctic* from 1965 -2010 as well as a smaller sample of papers from three leading polar journals from 1985 and 2010. We established that the transition towards a new research paradigm is far from complete and that local people are becoming more involved in Arctic science, but the nature and level of this involvement remains limited and varies systematically among disciplines, organizations, and regions. In Chapter 3, we attempt to understand the factors that promote and inhibit such activities as well as the methodological considerations that support effective partnerships in Northern science. We focus on a single case of a successful research partnership known as the YNNK which occurred from 2007-2010 in Old Crow, Yukon Territory, Canada between the Vuntut Gwitchin and a group of academic and government researchers as part the International Polar Year 2007-2008 funding program.

3 Understanding community-researcher partnerships in the natural sciences: A case study from the Arctic

Abstract

Rural community participation in scientific knowledge production processes has become a central component of research and development policy and practice internationally. However, relatively little is known about the factors that influence the development of successful research partnerships in the applied natural sciences, as well as their associated outcomes. This paper presents an in-depth case study of a successful community-researcher natural resource science partnership in the Canadian Arctic. The results suggest both context and process-related factors were important to the research partnership, including funding and performance assessment processes, leadership and capacity at the community level, the proposal development and research design strategies, and the timing and perceived transparency in results dissemination. Researchers and local stakeholders also strongly valued the informal interactions that are often not part of the research process in the natural sciences. This "idle time" spent in the community facilitated the development of local networks and friendships and played an important role in building the human and social capital of all stakeholders. The outcomes of the partnership strategies used by those involved were numerous and went beyond the more tangible financial benefits, including outcomes such as legitimizing the knowledge systems of both parties and aiding in their integration and mutual understanding.

3.1 Introduction

Inter-dependencies between the state of the environment and human well-being are a focal point in applied environmental sciences (Balmford and Bond, 2005; Frumkin, 2001; Raudsepp-Hearne, et al., 2010). Many environmental scientists are interested in studying people-environment interactions away from the urban environment, where human-modifications of the landscape are less extreme and environmental influences on livelihood and subsistence are most obvious. Research conducted in these rural environments, particularly applied research that is intended to benefit the people living in the places where the research is conducted, invokes questions of identity, cultural context, and knowledge systems that transcend the rural research process, whether or not they are considered within the intended scope of the research (Abele

2009; Furgal and Parlee, 2012; Furgal and Seguin, 2006; Haalboom and Natcher, 2012; Lyons, 2010).

Environmental research involving Indigenous Peoples in remote Northern regions is an extreme, but illustrative, example of rural studies involving fundamental differences in the objectives, life experience, and worldview of researchers and community members. Embedded within these differences are important issues related to colonialism, aboriginal identity, and power, all of which comprise the backdrop upon which research partnerships are developed in this context (Grimwood et al., 2012). These partnerships are considered by some to be an extension of colonial power over those communities and peoples who would subscribe to different worldviews and methods for understanding the natural world around them (Smith, 1999). Research with Indigenous communities that are located far from urban centers also challenges conventional assumptions about the disadvantages of remoteness and rurality; Indigenous homelands may seem, to some, to be situated at the periphery of access and opportunity, but to Indigenous Peoples they are "situated more in the core, than on the periphery of it." (Sherval, 2009, p.433). Further, an important distinction between indigenous community participation in environmental science versus most citizen science projects is the recognition that local participants, guides, and research assistants are often perceived as experts in the phenomena under study or, at the very least, necessary to accessing study sites (Grimwood et al., 2012). Still, much environmental research is conducted independently of the people that live where the research occurs (Brunet et al., 2014). The lack of community-research engagement has been attributed to many factors including instability in the leadership of community governments and organizations, cultural and linguistic differences, poor historical research and community-researcher relations and financial and time constraints (Gearheard and Shirley, 2007; ITK and NRI, 2007; Pearce et al., 2009; Wolfe et al., 2007). Internal political tensions and agendas have also been suggested to lead to biased, often inequitable participation by local actors who may not represent overall community perspectives (Smith, 1999). Beyond the researcher-community relationship, government and university funding structures (given the relatively high cost of Arctic research), time constraints in academic programs, and a lack of training can also serve as barriers to effective community researcher partnerships (Pearce et al., 2009). Garnett et al.

(2009) adds that funding bodies may not make provisions for employment and training of community members as researchers.

Community participation in research has received increased attention in recent decades, both within and beyond an indigenous context (Phillipson et al., 2012; Tsouvalis and Waterton, 2012; Wallerstein and Duran, 2008; Wilmsen, 2008). Numerous researchers have called for greater public participation in the development of knowledge as part of a movement to democratize science (Esrahi, 1990; Gibbons et al., 1994; Pateman, 1970; Tsouvalis and Waterton, 2012). Ezrahi (1990), for instance, challenges us to see participation as a movement towards redefining expertise and in that sense, as part of a larger socio-cultural and very much political movement. In this context, participation is seen to support democratic ideals and address the limitations of top down approaches that have failed to build the capacity of local partners to utilize the results of science (Tsouvalis and Waterton, 2012; Wilmsen, 2008). Wynne (2006) also demonstrates that the public does not need to be technically qualified to effectively be engaged in the scientific process. The value of public engagement resides in the benefits of integrating public issues with technical expertise in the scientific process (Felt et al., 2009).

In this context, community participation is seen to provide opportunities for leveling underlying power differentials and accessing experiential or local knowledge related to studied phenomena (Mulder, 1971; Wilmsen, 2008). There is also increased focus on the integration of traditional and local knowledge in science (Agrawal, 1995; Raffles, 2002) with polarized opinion regarding the success and usefulness of this knowledge integration (Agrawal, 2002; Nadasdy, 1999). Nevertheless, knowledge generated through participatory processes has numerous benefits, including generating more trusted and likely-to-be-applied results because stakeholders are involved in its development (Wilmsen, 2008). Active participation of stakeholders in research that can inform management policy has been found to encourage stakeholders to more widely understand and accept management decisions based on the information resulting from that research (Jones et al., 2008; Wilson et al., 2006). An important and recurring aspect of this transition towards engagement has therefore been the question of utility. According to Phillipson et al. (2012), academics are increasingly pressured to demonstrate and justify the impact of their research. They are also required to identify the beneficiaries and strategies for knowledge transfer in their work (Shove and Rip, 2000). This is built upon an emerging realization that

effective research uptake in policy and practice may be built upon a foundation of active knowledge exchange and stakeholder engagement during the process of knowledge production itself (Phillipson, et al., 2012). Further still, Tsouvalis and Waterton (2012) found that such dialogue between local and academic stakeholders is increasingly being seen as a pre-requisite to establishing the legitimacy of scientific claims.

Much attention has been given to understanding the process of participation and community engagement in disciplines that often engage local people in the research process, such as social and health sciences (Chilvers, 2008; Minkler and Wallerstein, 2008; Pain et al., 2011). Some have noted that in such fields, many researchers have expressed disillusionment regarding the integration of stakeholder perspectives in science (Tsouvalis and Waterton, 2012). Others are more optimistic about participatory activities and the inclusion of non-expert publics in expert policy domains such as environmental assessment and management (Grimwood et al., 2012). For example, Tsouvalis and Waterton (2012) suggested that participation of non-experts in traditionally expert-dominated fields of environmental decision making is becoming increasingly common. However, despite the increasing adoption of participatory approaches in many scientific knowledge production processes, comparatively little research has been done on the role and process of community participation in the natural sciences (Gearheard and Shirley, 2007; Pearce et al., 2009; Wolfe et al., 2007), where local participation is not a necessary a pre-condition for successful data collection (Kainer et al., 2009).

This paper presents a detailed case study of community-researcher partnership in the Canadian Arctic to better understand the factors influencing the development of research partnerships in the natural sciences, as well as their associated outcomes. More specifically, our aim was to identify the key elements that underpin successful community-researcher partnership development in the natural sciences with a view to informing research policy and practice in remote rural contexts.

3.2 Methods

3.2.1 Approach

We followed a grounded theory approach (Glaser and Strauss, 1967) for this exploratory study, founded on the premise that theoretical prediction or preconceived theory should be avoided

before data collection (Strauss and Corbin, 1998). This allowed us to develop insights that were grounded in data (Strauss and Corbin, 1998). Suddaby (2006) described grounded theory as an organic process by which the emergence of theory is based on how well data fit conceptual categories identified by the researcher and by how relevant the categories are to explaining the phenomena being observed. The grounded theory approach was combined with case study research to achieve our research objective (Eisenhardt and Graebner, 2007; Yin, 2009), a strategy which has been acknowledged as significant and relevant in developing new insights about organisations and processes in development and management literature (Fendt and Sachs, 2008; Kruegera et al., 2013; Suddaby, 2006; Sutton, 1987; Turner, 1983; Vannoy and Salam, 2009).

Case study research provided a suitable framework to deal with the full variety of evidence (documents, artifacts, interviews and observations) and to examine contemporary events within their 'real life' context, where the investigator had little or no control (Stake, 2005; Yin, 2009). This research approach is based on the assumption that the phenomena under study are intrinsically tied to the context in which they emerge (Yin, 2009) and is particularly appropriate for studying community participation in science (see Mulrennan and Scott, 2005; Jones et al., 2008; Pearce et al., 2009).

Our analysis is divided into three mains sections inspired by the evaluation framework proposed in Mercer et al. (2008) (See Fig. 3.1). The context analysis, process analysis and outcomes analysis were completed sequentially, although a number of iterations were expected as new information and results emerged.

3.2.2 Case study: YNNK project, Old Crow, Yukon Territory

Old Crow is a community of approximately 300 people located at the confluence of the Crow and the Porcupine Rivers in Northern Yukon, Canada. It is considered the Northernmost settlement of the territory and is the territory's only settlement located north of the Arctic Circle.

It is highly isolated and does not have road access. As described in more detail by Wolfe et al. (2012), VGFN has a rich history of active involvement in scientific research conducted within their traditional territory. A long series of paleontological and archeological research in the region has involved several generations of Old Crow residents as guides and field assistants (Zazula and Froese, 2013) and has left a lasting impression that scientific research offers both

local employment and international recognition. A preliminary review of the literature indicates that published health and anthropology studies in Old Crow date back to the 1960's (Lewis et al., 1960). There were also a number of wildlife surveys conducted in the area in the early 1900's as a result of collaborations between the Hudson's Bay Company, local trappers and scientists (Chitty and Elton, 1937). Research has continued in Old Crow (Cumbaa et al., 1981; Fafard and Leblanc, 1999; Irving and Cinqmars, 1974). Additional examples of Old Crow involvement in research and monitoring include participation in the development of the Arctic Borderlands community-based ecological monitoring program (Kofinas, et al., 2002) as well as the Porcupine Caribou Management Board (Kofinas, 2005)

The Vuntut Gwitchin have also been actively engaged in negotiation with the federal government in Canada. The most important example of this being their land settlement agreement signed in 1993 (Aboriginal Affairs and Northern Development Canada, 1993). Many of their leaders were involved in this process and still exert considerable power over local decision making to this day. These same leaders were actively involved in determining research objectives and negotiating local engagement strategies with scientists.

Working with the community of Old Crow, we selected the Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa collaborative project (YNNK) as our case study. The YNNK was initiated in 2006 when the Vuntut Gwitchin Government (VGG) Natural Resource Department, Government of Yukon Department of Environment and a team of predominantly natural science researchers from seven different universities began a multidisciplinary study in the Old Crow Flats (OCF). Wolfe et al. (2011) provide a detailed description of the work undertaken in their collaborative project including some preliminary local reactions and reflections by community members. This project was initiated when the VGG invited researchers to Old Crow to develop research questions for an International Polar Year[1] (IPY) Project (Grimwood et al., 2012). Research objectives were established jointly by the Vuntut Gwitchin First Nation, VGG Natural Resource Department, and the researchers and included:

[1] The International Polar Year is a large scientific program focused on the Arctic and the Antarctic from March 2007 to March 2009.

1) Documenting the history of environmental change from the last interglacial to the present in the OCF;

2) Assessing the distribution and abundance of vegetation and wildlife within a changing physical environment;

3) Evaluating the impact of changes in the physical and biological environment on traditional food sources of the VGFN;

4) Developing a long-term, environmental monitoring program for the OCF to be conducted by the VGFN. (YNNK, 2009)

The natural science studies were conducted under the supervision of a local principal investigator and three academic co-investigators. All three academic researchers were holders of a Natural Science and Engineering Research Council of Canada[2] (NSERC) Northern Research Chair, which financially supported a large portion of their research.

In this case, initial contact was in 2006 and the official IPY funding for the YNNK ended in 2010, although some projects did continue after this period. Most of the collaborative research occurred within the period of 2007-2010. This case study was selected because initial discussions with community and academic stakeholders revealed that the YNNK was distinct in its degree of success as a collaborative scientific project. For the most part, researchers agreed that this project was successful for the simple fact that it was initiated by community members who invited their academic counterparts to develop a proposal collaboratively. As such, it was perceived by researchers and community members as a unique and positive experience, offering an opportunity to learn and potentially be repeated in other contexts.

3.2.3 Data collection and analysis

Interviews were the main source of data for this study. A total of 40 semi-structured interviews were conducted between April 2010 and September 2011, focusing primarily but not exclusively on stakeholders that were directly engaged in developing the partnership and the research

[2] The NSERC Northern Research Chairs Program had four core objectives, two of which required local involvement and the development of partnerships with communities.

process. They also included local residents that were aware of the project but not directly involved. As Old Crow is a small isolated village, most villagers and or their families were impacted by the project in some way. Informants were categorized as either researchers (or academic stakeholders) (n=18), local stakeholders (or community stakeholders) (n=19) or funding agency representatives (n=3). No further interviews were conducted when each category of analysis was 'theoretically saturated', i.e. when no additional data could have facilitated further elaboration of qualities of perspectives and relevant social meanings (Glaser and Strauss, 1967).

We interviewed 22 males and 18 females. The interviewees were identified from personal involvement in the International Polar Year annual general meetings, from reports and personal communications (theoretical sampling). This process was facilitated by Mary-Jane Moses, an employee of the Vuntut Gwitchin Heritage Department and a member of the Vuntut Gwitchin First Nation. Details regarding interviewees are listed in Table 3.1. Interviews with local or community stakeholders were all conducted in person in the village of Old Crow, Yukon. Interviews with researchers and funding agency representatives were mostly conducted via telephone. Each interview lasted between 45 minutes and 2 hours.

Interview questions were open-ended to allow the interviewee to speak authentically and in a relaxed manner. The specific questionnaire for the various stakeholders varied somewhat between stakeholders although the objectives remained the same. A typical interview flow is presented in Figure 3.2.

Interviews were recorded and transcribed in full. The information collected during the three phases of the case study was then analyzed using the constant comparison method (Glaser and Strauss, 1967). MaxQDA was used to manually code the texts (both transcriptions and other textual materials) into initial categories which were progressively refined through an iterative and hierarchical process until definitive patterns emerged (Babbie, 2001; Charmaz, 2006). The process of coding involves assigning categories to interview passages to identify and generate empirical evidence supporting relevant themes for further analysis. Initially, coding is performed as creatively as possible, not caring for any direct theoretical relevance, but emphasizing proximity to the subject (inductive elements). The process of developing codes through an

`oscillation' between, on the one hand, inductively generating them from the raw data (inspiration) and, on the other hand, deriving them from theoretical considerations (orientation by the original question) proved to be valuable (see Geissel, 1999).

3.2.4 Management of assumptions and limitations and community engagement

When working with a combined grounded theory-mixed methods research design, it is important to recognize and reflexively manage the potential for bias. We reduced the impacts of sampling bias by interviewing people within the community of Old Crow that held different positions or relations to the government and researchers, within different social communities and with various perspectives on science. We also minimized response bias by conducting a series of pre-tests of our questionnaire in May of 2010 with 5 respondents to test questions for objectivity, clarity and neutrality. This pre-testing process also aided in reducing interviewer bias, which was further reviewed via the complete and thorough transcription of the recorded interviews. By using MaxQDA to systematically manage and analyze textual data, we were able to minimize the potential for confirmation bias by allowing for the meticulous and auditable tracking and identification of each code, category and theme that emerged.

In order to maximize the reliability and trustworthiness of our findings, we relied on data triangulation to maximize construct validity and test the repeatability of our observed patterns (Stake, 2005). More specifically, triangulation was used to clarify meaning by identifying the different ways the same case was perceived (Billgren and Holmen, 2008; Denzin and Lincoln, 2005). To do this, we conducted an extended content analysis (Charmaz, 2006) of yearly reports that were submitted by the various university investigators to the community. These were used to reinforce and cross-check the evidence collected through interviews. The lead author also spent time with different researchers in the field and attended the community's IPY Annual General Meeting in 2011. The field study was developed with the assistance of local government employees who facilitated the research process. Multiple presentations and feedback sessions were held to enhance the reliability of the findings. In particular, the researchers returned to the community to present the preliminary results and obtain community feedback in 2011 (Mercer et al., 2008). This event drew a good crowd and was valuable in obtaining early feedback on our results. The authors also were involved in community events and daily activities and developed personal ties with local people involved in the partnership as well as researchers.

The internal validity of our research was maximized by thoroughly analyzing the level of similarity within and across our dataset, based on diverse perspectives from different respondent groups (Boeije, 2002), while external validity was maximised by using a theoretical sampling strategy which focused on informants that were engaged in all aspects of the research process (Eisenhardt, 1989). External validity was also enhanced by ensuring that our data trail is fully auditable so that readers can better track where findings originated, understand the context in which phenomena occurred, and be better equipped to decide in which context the findings may be applicable (Eisenhardt, 1989; Thorne, 2000).

3.3 Results and discussion: Understanding participation

In this section we explore the prevalent themes that emerged from our case study. The complete list of emergent themes can be found in Appendix 3.1.

3.3.1 Contextual factors

A number of studies have indicated that the contexts in which participatory activities occur are a fundamental precursor to the success or failure of the process (Bardati, 2002; Renn et al., 1995; Smith, 1983; Webler and Tuler, 2006). The goal of our context analysis was to develop our understanding of community characteristics, institutional and political factors as well as historical factors (including a review of previous research experiences) which may have influenced the success or failure of the partnership. This process revealed four factors, with associated sub-factors, as being of critical importance to our case study: 1) Research history; 2) Funding and performance assessment; 3) Leadership and capacity; and 4) Geography/ connection to the land.

3.3.1.1 Research history

An important contextual factor mentioned by both researchers and local stakeholders was the long history of collaborative research in the community which was also indicated in Zazula and Froese (2013). Numerous respondents, especially older local respondents easily recalled and reflected upon work that they had conducted up to 50 years ago. In general, comments and memories of these experiences left positive impressions:

"I was involved in some archeologist camps you know. I was there to show them things. We found arrow heads. Where they get that I don't know. I used to get duck eggs for them, for

doctor [] back in the 50's., I just paddled around on the lakes and shot whatever they asked me to shoot. I was shooting duck for them. I was collecting the skin. They wanted ducks so I get it for them." Local Stakeholder

Positive memories regarding research were associated with a perception that mutual respect was attained and friendship and trust were developed through the research process. Very few local informants mentioned anything about the actual research or the local implications of the results for the community. There was also limited mention of the educational value associated with participating in these projects. In fact, the most positive feedback on previous research related to practices which are or were common at that time, such as trapping, hunting or guiding research on the land.

"A couple of the participants that we had, their parents had worked as field assistants in the 70's with Dr. [] and referred to Dr. [] and they still refer to him positively today." Academic Stakeholder

"Well you can still hear people talk about Dr. [] in the community because so many people in the community worked on those ecological projects throughout the 70's. I think the ability to carry out the IPY in the way that it was, I think, in my own sense, an extension from those efforts that those guys made. And I don't think, I doubt, any of the IPY researchers would even be aware of who those people are." Local Stakeholder

Much of the positivity surrounding research was associated with the possibility of engaging in traditional activities while making money. Being employed by researchers in the field provided opportunities to be on the land, which is now perceived as expensive and time consuming but also fundamental to identity and culture. Garnett et al. (2009) found that employing community members as co-researchers allows the research process to respect local knowledge, achieve a better balance of power and transform thinking beyond the research process, especially with regard to management strategies emerging from scientific studies. It can also lead to mutual understanding of alternative realities because it allows for partners to search for and selectively process information confirming their beliefs (Evan, 1989). Although we did not find that specific elements of prior research were retained, we agree with Garnett et al. (2009) that participation in

numerous studies over time were transformative (Arnstein, 1968; White, 1996) and led to some important outcomes that extended beyond the life of individual research projects.

Others did show some level of disappointment at the outcomes of all the research that had occurred in the past. For example, another local elder mentioned his disappointment with the lack of communication between researchers and local residents, especially with regard to results and their utility to the community. "The problem is that the ones that came and studied archeology but never gave no results to us" Local Stakeholder. Research saturation and skepticism associated with communication and transparency issues are relatively common in communities such as Old Crow. This important topic is explored extensively in the literature (ITK and NRI, 2007; Pearce et al., 2009).

This rare look into the long term impacts of engagement in research provides us with an opportunity to understand what local stakeholders 'get out' of their participation. It forces us to reflect upon the association between different levels of engagement and actual benefits, those that withstand the test of time. Clearly, Old Crow has hosted numerous researchers over time who have all to varying degree engaged the community. Overall, the legacy of this long term engagement was not clear.

3.3.1.2 Funding and performance assessment

Academic respondents generally agreed that funding and the assessment of professional merit was a key component of successful collaboration and partnership development with local stakeholders.

"Generally we are evaluated at the university level on teaching or administrative roles in research. Research is generally the merit and defined by grants and publications and all the training of graduate students would fall under that as well. I guess one easy thing with publications and grants is that you can count them. It is something that is relatively measurable but how do you measure the quality of a partnership?" Academic Stakeholder

This is supported by other studies where it has been found that faculty and unit-level incentives and rewards need to better encourage and support public engagement in scholarship (Bruns et al., 2011; Votruba, 2011). Many scientists have also indicated that engaging local communities in

research is not typically rewarded and is therefore perceived as an impediment to professional advancement because it lowers productivity (Shanley and Lopez, 2009). Kainer et al. (2009) found that researchers rarely receive significant institutional credit for research products such as manuals or locally oriented education materials that are not peer reviewed.

Concurrently, there is a growing debate in Europe regarding their Research Assessment Exercises and the criteria that are used to evaluate the impacts of academic research (Pain et al., 2011). A principle criticism of this framework is its focus on significant and transformative impacts which has become synonymous with large scale, even global-level, projects. Pain et al. (2011) argue that this may lead to associating local with modest impacts, thereby discouraging research that involves local dialogue, contexts, outcomes and engagement. None the less, recent large scale work in the United Kingdom has attempted to dissect participation in science and develop criteria upon which community engagement strategies may be evaluated (See Phillipson et al., 2012; Tsouvalis and Walterton, 2012).

In Canada, no formal national research assessment process exists. However, numerous scientists working in the YNNK partnership project were obliged to obtain letters of support from non-academic partners in order to secure research funding. They also needed to submit reports to community and other local partners to obtain funding. Although some believed this was enough to promote collaboration, many scientists believed that the incentives still do not outweigh the costs of partnering with a community and that motivation to engage local stakeholders is more a function of individual ethics and values. Importantly, some researchers believed that mechanisms for assessing local impacts and the level of community engagement were tokenistic in nature and are still considered by many as "one more thing that needs to get done to satisfy funding agencies" Academic Stakeholder. Importantly, no researchers in our study were aware of university policies regarding community engagement nor were they aware of any professional incentive to engage in this sort of work. Requirements for community participation are also heterogeneous across Canada, depending on the location of the study. Different villages and territorial government have different priorities regarding participation making the navigation of these requirements difficult.

Interestingly however, in the case of International Polar Year, and more specifically this case study, the presence of an engaged territorial and local coordinator whose principal function was to facilitate contact between local stakeholders and scientists was considered highly beneficial. This was especially true for researchers who initiated discussions with communities to build early ties with local partners. "As an IPY coordinator you really have a bit of an undefined role as mediator between researchers and communities." Funding Agency Representative. These ties with certain members of the community were transmitted to future researchers that worked in the and around the community allowing for some level of continuity between projects which was identified as a key challenge within this case study and has been reflected upon in other works (Minkler and Wallerstein, 2008).

Another important element of this case study was that all the principal academic partners had access to significant and stable funding through Canada`s federal funding mechanism for natural science, the Natural Sciences and Engineering Research Council of Canada (NSERC, 2009). These researchers had the resources to answer a local call for a collaborative research design process which was to become known as the YNNK. Many large scale programs in Canada aim to achieve collaboration and partnerships with non-academic stakeholders (Office of Community-Based Research, 2009). In this same report, it was concluded that "an impressive array of impactful knowledge and mobilization through community university research partnerships" is being generated in almost every sphere of public activity (Office of Community-Based Research, 2009, p. 5). However, inter-disciplinary collaboration and partnership development was also recognized as a key challenge and vital to address complex issues at national and international scales. Recently, Canada's federal government has acted upon this through the development of large scale funding programs (See NSERC, 2009). Consequently, researchers within our case study described fearing that this model will make community partners more dissatisfied with the process as numerous locally relevant applications will inevitably be rejected due to their scale of impact. These changes in the Canadian context have been coupled with the elimination of smaller programs such as the Northern internship program which have been found to be highly beneficial for both students and communities (Wolfe et al., 2011). These contradictions must be explored further and, based on the results of our study,

demonstrate a lack of understanding of the process of community researcher partnership development in the natural sciences and associated outcomes.

3.3.1.3 Leadership capacity and gatekeepers

Most academic (and a minority of community) stakeholders described the role of local capacity as critical throughout the research process. Many respondents attributed this capacity to the local history of political activism which has taken many local leaders out of the community and into international discourse.

"What sets this community apart is that certain important community leaders have been highly vocal about indigenous rights throughout the world and are used to negotiating and developing partnerships with outsiders or large government organizations" Academic Stakeholder

These leaders have long sought to reverse the impacts of colonialism and have, over the last few decades, obtained numerous rights for their people such as self-government and a successful and ground-breaking land claims process which gave the Vuntut Gwitchin surface and sub-surface rights to a large part of their traditional lands (VGFN and INAC, 1993).

Further, the researchers noted the high relative number of local leaders and/or engaged citizens in Old Crow given its isolation and relative lack of formal education. This high number of engaged citizens made the research move forward while remaining in line with community requirements and aspirations. There were also numerous gatekeepers or local people well-suited to providing informal linkages with community stakeholders and local resources necessary to allow for the research to progress. Community researchers with prior experience did contribute more to the research and partnership development process. Garnett et al. (2009) found that engaged locals with prior formal training were able to contribute substantially to the research findings through transmission of tacit knowledge. Experienced local partners allowed for easier integration of findings and in some cases, they found that this involvement may even play an important role in changing attitudes or behaviours related to environmental management issues (Garnett et al., 2009).

Researchers also noted that the benefits accrued from local capacity were mostly attainable through negotiation and compromise in research design. These elements of the research process

were seen as critical in integrating local knowledge into scientific approaches to knowledge acquisition:

"… we really depended on them. It made us feel like children. They know the land; they know what they are doing. Logistically, they made most of the decisions even though sometimes we would have liked to. We were dependent on them. They have their trap lines and their territories. We would go where they traditionally go trapping with their family and at the lakes that they trap and use the methods that they are used too." Academic Stakeholder

3.3.1.4 Geography, isolation and connection to the land

The importance of 'gatekeepers' was compounded by the fact that Old Crow is highly isolated. If not for community involvement, the costs and logistics of research on the traditional lands of the Vuntut Gwitchin would be prohibitive. Numerous respondents recognized that this isolation in many ways *forced* or at least provided an incentive for outsiders to rely on local knowledge and capacity to undertake research.

"My impression is that because we are an isolated community they could not come here and do research on their own and be completely self-sufficient. It just was not going to be possible. They had to work with community if they wanted to come here so it leveled out the power balance." Local Stakeholder

Furthermore, the relatively small size of the community allowed for researchers to better grasp community objectives, which were not homogenous and could be very difficult to navigate at times.

"The size and isolation of Old Crow made it easier for some students to better navigate the needs and objectives of community members, even when the issues at hand were political in nature." Local Stakeholder

Understanding this heterogeneity, even within the context of a single community has been found to be beneficial in developing community researcher partnerships (ITK and NRI, 2007; Office of Community-Based Research, 2009). Both academic and local respondents also recognized that the treatment of outsiders in Old Crow was important in the development of the YNNK. This was also perceived by some as a function of isolation. "A community where there are not lots of

visitors also helps. People are just not as jaded as they are in some other communities. They want to help and they are interested in the researcher and curious about them and they want to help." Local Stakeholder

It was also evident that members of the VGFN had a strong desire to preserve their ancestral culture and some respondents still practiced traditional activities. Chomitz et al. (2007) found that close proximity and use of resources, phenomena and species under study means that local people frequently exercise final, on the ground decisions about the fate of that resource. The presence of these local experts has been found to lead to more effective working partnerships (Shackleton et al., 2009). For many respondents, youth training and the transmission of local knowledge from elders to younger generations was also very important. Numerous community respondents believed that science was an interesting way to get youth *out on the land*. It provided a different context or perspective on the natural world that some elders believed could aid in promoting environmental awareness.

"This science makes it fun and different for the kids who do not like to hunt, like when researchers help with science camp" Local Stakeholder

This identification of science as a potential vehicle for the transmission of cultural knowledge was rooted in serious and deeply held concerns about the rapid pace of environmental change in and around Old Crow, which was also noted by Wolfe et al. (2011). This concern was therefore fundamental in understanding why some members of the community chose to be engaged in science.

Finally, it was recognized by most stakeholders that the Old Crow Flats offered unique natural features and interesting opportunities for scientists in numerous fields of research. "I think that research will always be going on here because it's such a unique place." Local Stakeholder. This is not always the case and may be a limiting factor in replicating the success of this large collaborative effort in other contexts. Numerous researchers noted the importance of this factor for receiving support from formal funding and university support frameworks. Based on our results, we suggest that the combination of unique contextual factors created ideal conditions for the successful development of a community-researcher partnership in natural science.

3.3.2 Process Factors

There has been considerable attention given to the factors that contribute to successful collaboration, partnerships and local participation in science (Davidson-Hunt and O'Flaherty, 2007; Mercer et al., 2008; Pearce et al., 2009; Garnett et al., 2009; Kainer et al., 2009; Phillipson et al., 2012; Grimwood et al., 2012). Without neglecting these advancements in our understanding of partnership development, in this study, we chose to focus on the specific elements which make the process of community-researcher partnership development in the natural sciences more successful (as perceived by stakeholders).

Results from our case study indicate that local stakeholders valued, above all else in the relationship, the respect of their culture, especially as it related to decision-making, valuing and understanding research objectives and early and ongoing culturally appropriate forms of communication and results dissemination. These findings are consistent with other studies in the Arctic and elsewhere (Garnett et al., 2009; ITK and NRI, 2007; Phillipson et al., 2012). Besides obtaining appropriate data for publication, researchers, on the other hand, found that negotiation at the proposal development stage and during field investigations, as well as high local capacity and the respect and understanding of cultural protocols were the most important factors affecting success during the research process. Based on these findings, we identified three process factors affecting the success of community/researcher scientific collaboration: 1) the process of proposal development and research design; 2) the nature of the communication strategies and results dissemination; and 3) the understanding and respect of cultural protocols. We also discuss data analysis in community engagement and its importance in our project related to the literature.

3.3.2.1 Proposal development and research design

Through our interviews it was recognized that the collaborative proposal development process which initiated this partnership was important for all those involved and for many informants, it was a relatively new approach. This finding has also been identified by previous studies (Barnard et al., 2006; Garnett et al., 2009; Gearheard and Shirley, 2007; ITK and NRI, 2007; Kainer et al., 2009; Phillipson et al., 2012). In our case, collaboration at the proposal development stage was associated with an immediate sense of power sharing, and a critical development of trust and respect which permeated the process from then on. These pre-research interactions also involved

informal communication and friendship development, elements of the research process which are often neglected but vital in partnership development.

“All the researchers came up using their own funds and on their own time. This shows dedication. They took a risk.” Local Stakeholder

“We told people they did a meeting here in February and people told them what they want them to do. They have to hire people locally and try to buy all their food from Old Crow. Just little things like that. They got directions from Old Crow and I guess that is why it went good.” Local Stakeholder

“The whole meaning of the work changes when you know what it’s about.” Local Stakeholder

Researchers also reported how the community was able to adapt their needs to those of their academic counterparts and vice versa. Compromise in the development of research objectives and design were seen as allowing all stakeholders involved to better understand and value research objectives. In some instances, this process was also helpful in understanding the role and potential integration of traditional knowledge. Local knowledge of the land sometimes oriented researchers in unexpected directions and proved to be fruitful not only in responding to community needs but in enhancing scientific understanding of unusual phenomena. In this case, the Zelma lake draining event provides an example of the benefits associated with adaptability in research design and the integration of local knowledge (See Wolfe and Turner, 2008). Demonstrated adaptability and compromise, especially by the researchers, were perceived very positively among respondents and were associated with feelings of acceptance and trust. Similarly, Barnard et al. (2006) found that this initial stage of research design and development of research questions was a critical moment for engaging stakeholders in research processes as it builds greater research relevance and trust among partners. Importantly, local feedback at this stage helps redirect or redefine research to better meet local needs (Kainer et al., 2009). Consequently, the involvement of local stakeholders in research design becomes an important step in transforming local partners into co-researchers which provides the foundation for mutual understanding of alternative realities and leveling power differences (Garnett et al., 2009; Phillipson et al., 2012).

The following quotes exemplify this complex phenomenon:

"The researchers were very open minded and seemed to be willing to change and adapt their research objectives to fit into community needs for research. This was extraordinary. These researchers, all Northern Research Chair holders came and went out of their way to listen to the community leaders." Local Stakeholder

"It was truly collaborative at the very outset because we arrived with our expertise and some sense of what we could do but it was the concerns that were expressed by the community. And again over the course of those couples of days, we learned a lot about the kind of work that had been done from the people from the resource department and other organizations in Old Crow. Also, we got a fairly clear idea where the knowledge gaps existed and where we as researchers could play a role. There was a lot that happened in that weekend that really established a foundation for the project." Academic Stakeholder

"[He] comes with a plan and we changed those plans through the RRC and trappers. He went out with the trappers and he sees the changes that were needed. He was there first hand and he saw why the hunters want to change the way they do stuff. That is why he made the change to start in March not in April. 1st of March is when people start trapping. We asked that he stakes the traps before going out and he went along with that. The muskrat is always changing." Local Stakeholder

3.3.2.2 Ongoing communication and results dissemination

Numerous authors have identified that communication is an essential ingredient in promoting healthy and effective partnerships between researchers and local stakeholders (Jones et al., 2008; Kainer et al., 2009; Pearce et al., 2009; Phillipson et al., 2012; Shanley and Laird, 2002). Communication can take various forms during and after the research process including interactive workshops, extension pamphlets, manuals, school curricula, radio, field visits and more (Shanley and Laird, 2002).

Results from our case study indicate that the timing and context for disseminating results are very important in promoting a healthy partnership. Trust, once again, was identified as being heavily associated with the perception of transparency. Independent of the venue, level of detail

or circumstances, the perception that research results were being made available in any form was highly valued by community members. Similarly, Kainer et al. (2009) suggested that the dissemination phase is most likely to attract stakeholders and in some cases, integrate them into the research process and that transparency was critical to developing local acceptance. Phillipson et al. (2012) found that positive impacts on stakeholder knowledge and practice were associated with the dissemination of results and opportunities to provide feedback. In our study, this presented a challenges to academic stakeholders who typically did not want to present results before they had been extensively verified, a process that often takes too long to maintain constant dialog with local stakeholders. This challenge has also been identified as a key concern by community stakeholders in other studies: "One of the longstanding and frequent criticisms of research (…) is that scientists do not do enough to return results from their studies (…) in a timely manner and/or appropriate format" (ITK and NRI, 2007, p.4). ITK and NRI (2007) further noted that this issue is compounded in the natural sciences where, in some instances, local stakeholders have been so excluded from research processes that they were not even aware that a project has ended.

In our case study, an important aspect of the results dissemination identified by local stakeholders was demonstrating the interconnectedness of the various projects that were taking place as part of the YNNK. Providing simplified, yet holistic, representations of the collaboration was reported as being very helpful for local people to understand the importance of the different elements of the research that were less directly relevant to their lives and culture, such as permafrost research or certain water chemistry projects that took place. A similar conclusion was reported by Wolfe et al. (2011) who found that the development of the framework presented in Figure 3.3 was an important team building exercise for the researchers, as they themselves were not entirely clear how their projects interrelated. This figure shows how all the projects in the YNNK were connected and the flow of information between different sections. It was subsequently well received by the community and perceived as an effort by the researchers to be transparent and respectful of local cultural processes. The local principle investigator indicated that "when the results were presented [in Fig. 3.3] it really showed how things were interconnected in a cause and effect relationship between these environmental factors that were studied through our project. It illustrated exactly how things are interconnected so that was great.

There was an awareness of that before but I would say now there is some people that have become more educated on those relationships as a result of these efforts." Local Stakeholder

3.3.2.3 Understanding and respect of informal cultural protocols

Our results indicated that researchers and community members recognized the value of informal interactions during or between field work and outside formal community meetings. Although many of our informants felt that budget and other constraints, such as university program requirements, were limiting in terms of spending time in the community, there was a sense that these interactions were very important in developing and maintaining relationships of trust and respect with local stakeholders.

"I think researchers need to know that and get to know the people. Go to lunches and help around. Let people know why you are here. I think that is the key. Hang around and talk to people." Local Stakeholder

This "down time" also gave researchers an opportunity to discuss their research on a one-on-one basis with local people, identified as the most effective way to disseminate results by our local informants. These were also seen as providing opportunities for obtaining valuable feedback and new insights on the processes under study in an informal and culturally appropriate manner, something identified as a key challenge in the literature (Davidson-Hunt and O'Flaherty, 2007; ITK and NRI, 2007; Mercer et al., 2008). As the following story highlights, time spent in the community, even idle time, proved to be highly beneficial for researchers and community members.

"[She] came for three to four months and that was really positive because she was able to help out with the science camp and other things so that is more what you want to see from researchers is more programs with schools and working with the teachers and just doing more of the levels of their research here so instead of taking the samples and going down south, get the community involved in data analysis. Ideally you would want to see that. We don't always have the facilities here and people miss their families and stuff like that but the more levels of research that are being done here people will benefit from. They will see how research is done and instead of just collecting data they will see what all this was working towards." Local Stakeholder

It is clear that the quality of these interactions are dependent on the amount of time the researcher spends in the community, which for many natural scientists is a costly activity that is perceived to cut into the time available for being in the field collecting data. However, our results indicate that participation and the organization of community events such as dinners, raffles, festivals, etc. will eventually lead to tangible benefits for the researcher while also benefiting the community.

3.3.2.4 Data analysis

Although respondents were asked about their involvement in all aspect of the research process, community members very rarely mentioned data analysis and few knew what it entailed. We suspect that local residents had very little experience with this highly technical and project specific component of science. Reflecting upon this would be very difficult. However, much of the literature seems to agree that engagement of stakeholders at this stage is critical in the development of conservation and management plans (Basset et al., 2004; Sheil and Lawrence, 2004) although concerns over data quality remain. Parrado- Rosseli (2007) found that interactions in data analysis may provide opportunities for debating over observations, findings and the interpretation of results. Similarly, Kainer et al. (2009) found that important rewards of these strategies can include in depth knowledge exchanges and opportunities to obtain diverse interpretations of findings which can strengthen understanding of the subject under study and build stronger strategies for conservation and management. This limited community participation in data analysis may also indicate that the process under study would not rank very high in evaluation schemes such Arnstein's ladder of citizen participation (Arnstein, 1969). However, we believe that the important elements of participation were prioritized in this case, which included important local decision making powers, a joint funding application and project initiation, compromise and collaboration in research design, transparency and local participation in results dissemination, active participation of many residents of all ages in field work and data collection, active participation of researchers in community events, reciprocal respect and humility. Overall, for these reasons, our assessment of the YNNK would rank the process as a *partnership* according to Arnstein (1969).

3.3.3 Understanding participation: Tangible and intangible outcomes

Understanding of the benefits of participation and partnership development is a critical step in effectively promoting these strategies when and where they are most needed. Pain et al. (2011) argued that most participatory research assessment strategies are based on linear models of impact that ignore the benefits of the process of collaboration, the impacts that arise from projects well before their end. They found that "effective knowledge co-production is a diverse and porous series of smaller transformative actions that arise through changed understanding among all those involved" (Pain et al., p.187). Acknowledging this important premise, we have assessed predominantly short-term and process-related outcomes. However, it should also be noted that the benefits of participatory research may result in larger and longer term impacts that would warrant further study. In our case study, the outcomes identified by local stakeholders were numerous (see Appendix 3.1). In what follows, we focus on the principal ones.

Based on our results, communities have much to gain in engaging in research when the conditions and processes for meaningful partnership development are respected and the institutional mechanisms are in place.

First and foremost, our results indicate that the benefits of participating in scientific activities go beyond financial incentives and employment or training, which we found to be relatively short term and impacted the lives of relatively few people. There is, however, a strong emphasis on these benefits in the participatory research and community engagement literature, particularly in the context of Arctic science (Gearheard and Shirley, 2007; Korsmo and Graham, 2002; Pearce et al., 2009; Wolfe et al., 2007).

Our interview research revealed that having 'outsider' perspectives (through their sustained presence in the community) served to strengthen or build the perceived value associated with the intangible characteristics of Old Crow and its people, such as the beauty and ecological importance of the land and important community processes that have been somewhat lost in numerous southern contexts (such as informal decision-making mechanisms and the respect of elders). Outsider perspectives were therefore seen as strengthening community cohesion, pride and connection to the land. We suggest that these impacts of participatory research are important elements contributing to the development of human and social capital in the community, yet are

often overlooked in the literature (Bennett et al., 2012; Scoones, 1998). This is supported by Garnett et al. (2009) that associated a host of positive outcomes for local social and human capital including a much deeper understanding of the research process and active engagement which lead to co-authorship, increased status for engaged individuals, improved oral transfer of knowledge and changes in community organization practices. Underlying this was the ability of local stakeholders to participate in previously inaccessible discussions and evaluate the options being promoted. Engaged stakeholders were also early adopters of technologies and management strategies (Garnett et al., 2009).

Local informants also recalled fond memories of working and engaging with the researchers. There was a sense that friendships were built and that long term relationships resulted from this collaboration, another important yet often overlooked component of social capital development during research (Scoones, 1998). Most local respondents believed that the presence of highly educated and trained researchers would eventually motivate younger people to become scientists themselves, or at least seek post-secondary education. It was also perceived that the researchers, in this case, went above and beyond local requirements for engagement. Younger informants mentioned the importance of outside role models but were very aware of the limitations they face in entering university, such as leaving their traditional land, prohibitive costs which often outweighed the perceived benefits of formal schooling.

In terms of the specific outcomes for academic stakeholders, respondents reported long- and short-term financial benefits associated with engaging in the research partnership, including professional advancement, scholarships, grants, lower research costs and/or logistical support provided by local stakeholders. This is supported by numerous other studies in the field (Ford and Pearce, 2010; Wolfe et al., 2011). Some of our respondents even said that research would not have been possible without local involvement. For example, on occasion the logistical and knowledge barriers were too great for students to obtain data without local help. This was recognized by the researchers. More importantly, however, researchers also alluded to less tangible benefits related to informal interactions with community members which led to friendships and unusual life experiences such as engaging in local traditional activities and simply being involved in local life and events. These experiences provided numerous

opportunities for the researchers to better appreciate local connections to the land, and obtain a potentially deeper understanding of conservation and local environmental change.

"Those tidbits of information can be few and far between at times, but I find they come up more and more the longer you spend there which makes sense. I won't say that those later understandings really developed or helped us develop the direction of our project but they helped give us a good foundation of understanding the flats as a whole and so we can maybe be a little more effective in our synthesis of our information." Academic Stakeholder

This more holistic view of nature, which is supported by traditional knowledge systems, aided researchers who were interested in local knowledge as part of their studies to more accurately and ethically integrate it (Scott and Humphries, In preperation). In doing so, there was a sense that engagement did lead to more balanced power relationships as indicated in other studies (Garnett et al., 2009; Pain et al., 2011; Phillipson et al., 2012; Wilmsen, 2008).

Moreover, the researchers within this study legitimized local decision-making and consensus building processes through the use of locally-relevant modes of knowledge transmission. Conversely, these processes also served to legitimize scientific findings for local stakeholders. Associated with this process, many researchers remarked how participation in community meetings was "abnormally" high and engaged compared to other community-based experiences. Similarly, Yamamoto (2010) found that the credibility of scientists and associated outcomes such as stakeholder participation are, among other factors, linked to the characteristics of the research process, including the openness of the researchers to outside input such as was the case in our study.

Community engagement was also perceived as a way for researchers to translate findings into tools for the management of the land. There was a sense that without community engagement the knowledge produced through research would have less impact or less 'real world' application and be limited to academic debate which was perceived by many as insular or exclusive. This practical dimension of science was important for this group of researchers and was valued in their responses.

"Science is about generating data to come up with conclusions that are useful to society. In the north, while that society means certainly what we've traditionally viewed it as, like government departments we have to make responsible for stewarding natural resources and generating policy and all that sort of thing but a central part of that audience, our user group is the First Nation to rely on that landscape for their wellbeing, economic and social and cultural wellbeing. When our scientific studies produce results that are meaningful to them in ways that they can use that knowledge, then we've really had an impact and we've really been useful." Academic Stakeholder

Researchers also found that being identified within a larger multidisciplinary group was beneficial in that certain local relationships were already developed and that key local stakeholders were identified by others. Some also mentioned cost reduction through resource sharing for both research and for results dissemination activities. Based on our results, the collaboration between researchers, which was not the focus of this study, was indirectly perceived as beneficial in that it allowed the researcher to address larger scale issues. It offered local stakeholders a "holistic" perspective on locally relevant and pressing issues such as climate change. Certain researchers recognized that this would not have been possible had they not been part of a larger group of researchers, even though most teams conducted their studies independently of others. In Bruns et al. (2011), it is also noted that underlying community engagement is an understanding that most societal issues are inherently complex and multidisciplinary. Specialized academic knowledge is often inadequate to address these issues. However, the linkages between interdisciplinarity and community engagement are not clearly explored in the literature, although these approaches to research have been associated in the past (Brunet et al., 2014; Kainer et al., 2009; Nowotny et al., 2003).

3.3.4 Challenges of partnership development

It has been recognized that partnership development in science is faced with numerous challenges because, by nature, this process tends to occur between groups that do not always share common languages, cultures, goal orientations, values (Garnett et al., 2009; Kainer et al. 2009; Gearheard and Shirley, 2007; Googins and Rochlin, 2000; Smith, 1999). Consequently, partnership development with isolated cultures poses specific issues that have been identified in the literature and were reflected in our findings, such as the lack of local facilities and logistical

support, the extra time and funding requirements, etc. (Barnard et al., 2006; Kainer et al., 2009) Barnard et al. (2006) also found that these circumstances take scientists outside their comfort zone, create situations where communication is difficult because of linguistic differences and where gender, ethnic and class differences may render interaction awkward. Importantly, this leads to situations where results dissemination activities may become risky, and can lead to conflict, misinterpretation or use to pursue unintended agendas. While some informants did mention these issues, they were not considered important in this case. Overall, most perceived the YNNK community-researcher partnership as successful, although some aspects could be improved. In fact**,** local informants were wary to share criticisms of the research or the people that conducted work. The biggest points of contention were raised when scientist's findings were not supported by local knowledge or when methodologies conflicted with local practices. Many local informants demonstrated some level of frustration with the methodological choices of their academic counterparts. This was especially true when local informants were perceived to not fully understand the linkages between research objectives and sampling methods, which were often a compromise between academic and local needs. Most researchers agreed that more effort needed to be made to explain sampling strategies and the importance of such things as the random selection of research sites in scientific research.

"There are lots of other places they can study too. Sometimes they study the same area year after year. They should study different areas." Local Stakeholder

Respondents also reported internal community-level politics being at play. The small and isolated nature of the community of Old Crow meant that community members were acutely aware of any real or perceived favoritism in the hiring practices of researchers. Some informants mentioned cautiously that they felt that other local people had abused their positions as research guides.

"I think in the past people were not honest with the researchers. They were using them to get all that gas and then store it for themselves. I am glad to be interviewed about it because I shared a lot with people I was working with and I told them that they were wasting their money. If you keep doing that we're not going to get anywhere." Local Stakeholder

Most researchers and local stakeholders in our study did acknowledge that this "was a small town thing" and was perceived as bearable and unavoidable. Such behaviour was not seen as significant enough to affect the partnership or research process. The lack of formal youth involvement and a lack of recognition for the efforts of local stakeholders were also mentioned as issues by a few local informants.

Overall, our results suggest that community dissatisfaction was generally associated to some form of underlying research saturation. Most local informants demonstrated a high level of respect for the researchers and their work but still questioned the relevance of *all this research*. "It's another study and we accommodate that but I think it does not take nor does it add anything to what is happening here." Local Stakeholder. These kinds of reactions are common in Arctic research (Gearheard and Shirley, 2007; ITK and NRI, 2007) and it is difficult for us to dissociate the outcomes of this particular case study with previously held biases in the community, demonstrating, once again, the importance of previous experiences with researchers.

For the academic stakeholders in our case study, some important limitations were identified. Many researchers believed that community members had false expectations of the project which, in their eyes, would inevitably lead to cynicism. Some mentioned that the role of science and the larger implications of the generation of new scientific knowledge were poorly understood at the local level. There was also a lack of long-term vision regarding the use of the knowledge generated through the YNNK. Without a clear idea of why these projects were useful locally, research leaders had difficulty conveying the importance of local contributions to the scientific studies and the larger ramification of environmental change research.

"Sometimes it's hard to explain why your project is important without sounding very technical or confusing. As a student sometimes I didn't really know what others were doing and how it was globally relevant to the people in Old Crow" Academic Stakeholder

Finally, there was also mention of some cultural or social conflicts, mainly at the level of the individual, which were likely the result of personality conflicts which are common and difficult to eliminate in any circumstance (Yamamoto, 2010). Although generally viewed favourably, local field assistants and guides were sometimes perceived as being unreliable or needing some form of training. For many academic informants, this was associated with a lack of ownership

regarding the research process. Most acknowledged that they could have provided more support for this but felt that many community members were not interested in the details of their work. However, although this was not expressed in our study, researchers have been found to generally lack the skills necessary to manage partnerships, local employees and the dissemination of findings, which could explain why interest was so low (Shanley and Laird, 2002). Few training opportunities are available for graduate students to learn appropriate forms of communication, group facilitation and negotiation with partners (Kainer et al., 2009).

Overall, these findings suggest that both researchers and community members were blaming the other for the failings of the YNNK. This was not entirely false and has been previously noted in arctic science literature on research partnership development (ITK, 2002; ITK and NRI, 2007). However, many researchers did also indicate that the research funding apparatus in Canada does not support long term partnership development and the translation of research results into local management plans. This systemic funding problem puts researchers and community members in the mutually-frustrating situation of not being able to achieve meaningful, reciprocating, and impactful research partnerships in many circumstances.

3.4 Conclusion

Our case study of the YNNK project has revealed that certain key factors must be considered in the development of effective and meaningful community researcher partnerships in natural science research. Important factors were both context and process-related and included funding and performance assessment processes, leadership and capacity at the community level, the proposal development and research design strategies, the timing and perceived transparency in results dissemination. Clearly, the context in which this research proceeded did have important implications for the success attributed to this process. However, it was clear that if policy makers, researchers or communities are to reproduce this level of engagement, especially from the community perspective, in other circumstances, that there needs to be resources made available to allow for local stakeholders to remain aware of opportunities in funding and have the incentives to communicate their research agendas to potential academic collaborators. We found it to be critical that communities be the initiators of projects related to questions of relevance to them. Innovative mechanisms for such processes must be explored further.

We also found that researchers and local stakeholders strongly valued the informal interactions that are often not part of the research process in natural science. This "idle time" spent in the community was seen as highly valuable in the development of local networks and friendships and, we believe, played an important role in building the human and social capital of all stakeholders. As such, funding mechanisms and academic programs should allow for longer stays in communities and incentives or rewards should be further developed to promote such activities. Of course, these strategies do not come without their fair share of difficulties including a lack of reliable and agreed upon assessment tools for engagement, an overall climate of austerity and a global academic system which favors productivity over outreach.

The outcomes of the partnership strategies used by those involved were numerous for both academic and community stakeholders and went beyond the more tangible financial benefits, including employment and training, which have often been the focus of previous studies (Kruse et al., 2004; Pearce et al., 2009). Our results suggest that the benefits of engaging in research partnership activities were more far-reaching, including outcomes such as legitimizing the knowledge systems of both parties and aiding in their integration and mutual understanding. Overall, there was a sense that the YNNK would not have been possible without the dedicated involvement of both community and researcher groups and that, in the end, the knowledge produced was more applicable locally because of the nature of this partnership. This was possible even though the YNNK sought to address large-scale issues related to environmental change. The partnership, in this case, offered the potential for science to become a vehicle for enhancing the social capital of all stakeholders. These intangible benefits of community researcher partnerships in science need to be further explored in future research.

Acknowledgements

We would like to thank the community of Old Crow, Yukon, Canada for their continued support. In particular, we would like to extend our gratitude to Mary-Jane Moses, Megan Williams, Nick Grey, Renee Charlie, Stephen Frost Sr. and Jeremy Brammer who provided an incredible amount of support both logistically and morally. We would also like to thank the Fond Québécois de Recherche sur la Société et la Culture for their financial support.

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Context Analysis	Process Analysis	Outcomes Analysis
Community characteristics Institutional and political context Historical context	Understanding important factors in all major steps of research process from proposal stage to results dissemination and follow-up	Understanding tangible and intangible benefits of research as well as key challenges.
Methods used		
• Review of scientific literature • Review of reports, historical documents • Key informant interviews	• Interviews • Review of reports and publications • Participant observation	This section will explore perceived outcomes and relate these to the process characteristics and context. This will be achieved using : • Interviews • Review of reports and publications • Participant observation

Figure 3.1 Methodological framework

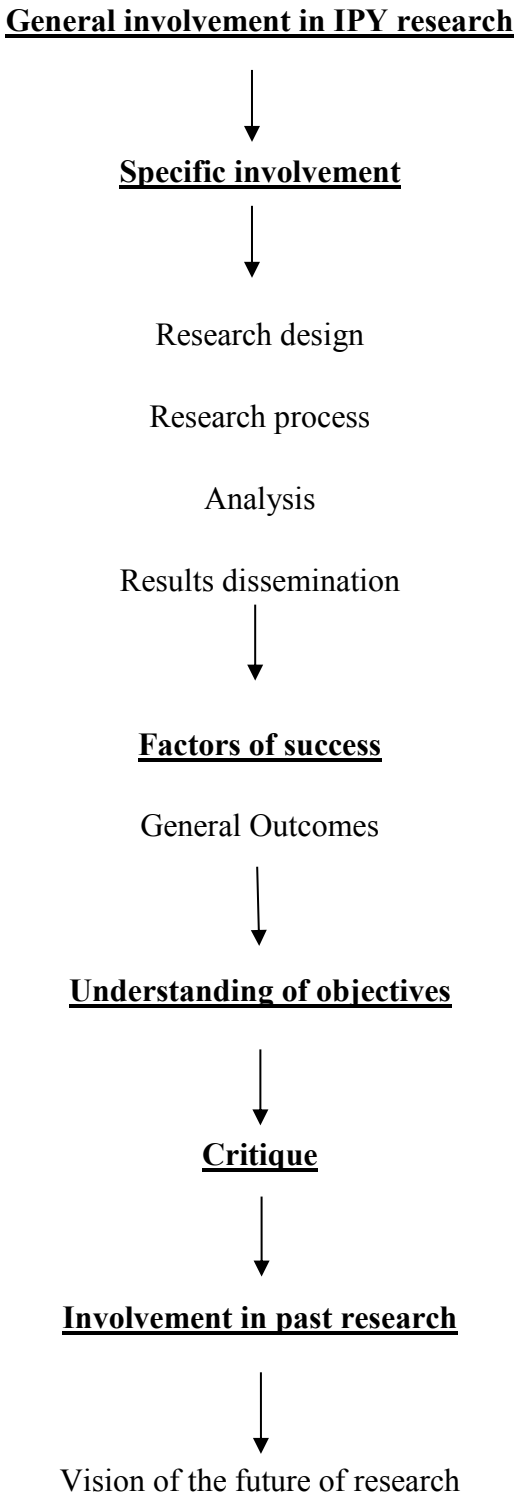

Figure 3.2 Interview flow

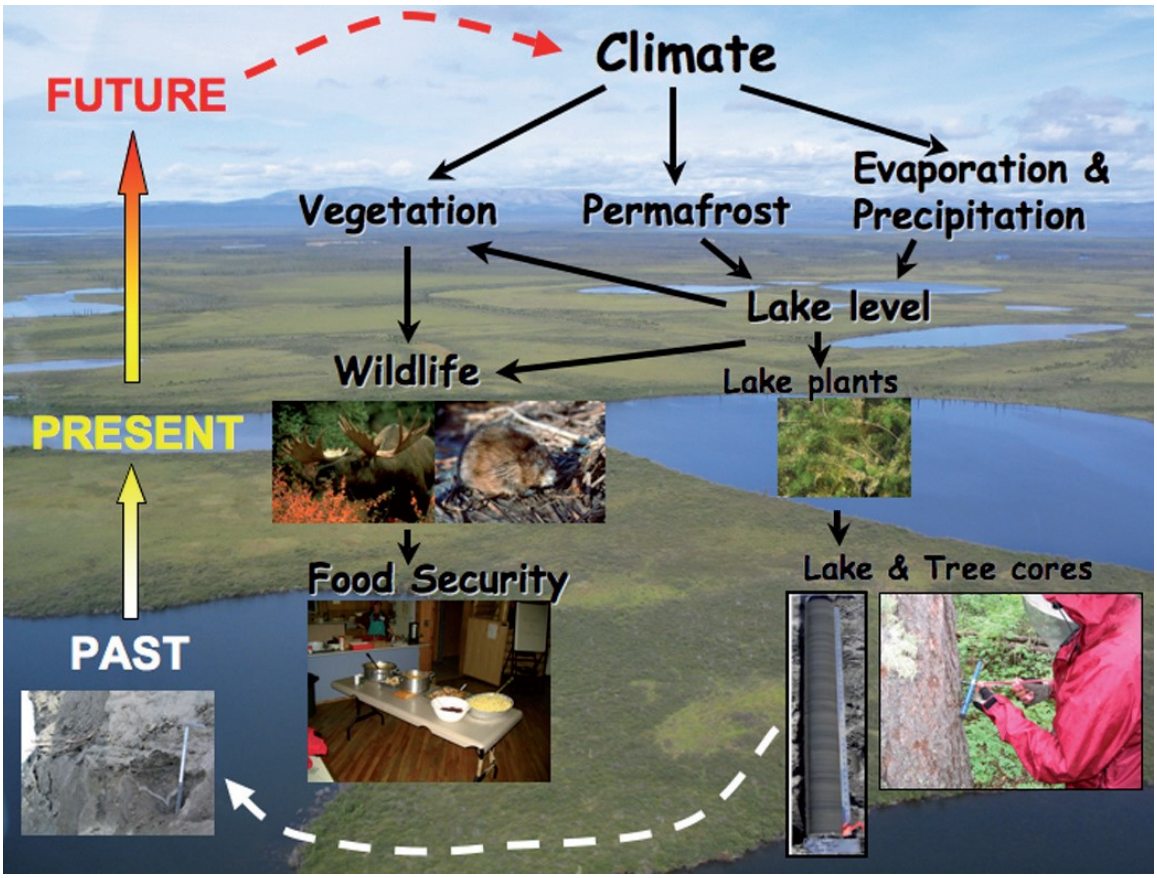

Figure 3.3 Graphic used to explain research elements and interactions within the YNNK IPY project "Environmental Change and Traditional Use of the Old Crow Flats in Northern Canada" to the community of Old Crow. (Wolfe et al., 2011).

Table 3.1 Informant categories (informants could be in multiple categories)

Informant categories	**n**
University/ academic	18
Vuntut Gwitchin First Nation	13
Vuntut Gwitchin Government	6
North Yukon Renewable Resource Council	4
Parks Canada	3
International Polar Year	3
Environment Yukon	1
Non-government Organization	1

Preface to Chapter 4

In Chapter 3, we determined that certain key factors were critical in the establishment of long lasting and effective Northern research partnerships that benefit all stakeholders, including researchers and community members. In Chapter 4, we test the findings of this chapter and further refine our understanding of community-researcher partnership development using an online survey of a broad sample of Northern research stakeholders across Canada.

4 Stakeholder perspectives on community participation and partnership development in Northern science: Challenges and opportunities

Abstract

An important component of Northern research in Canada has been a strong emphasis on local participation. However, the policy and permit landscape for community participation in Northern research is heterogeneous and presents specific challenges in promoting effective partnerships between researchers and local stakeholders. We conducted a survey of Northern science stakeholders across Canada in order to better understand the benefits and challenges associated with Northern research partnerships with a view to informing future Northern research policy and practice. We found that local engagement at the proposal and research design phases, the hiring of community researchers and engagement of local stakeholders at the results dissemination phase were important factors affecting success. Respondents also indicated a lack of social capital (trust and reciprocity) between researchers and communities as negatively impacting science partnerships. Community researchers were described as emerging from a system that provides stable, predictable employment and training to overcome a lack of availability and interest of local partners. Partnerships in Northern research will likely require further decentralization of power to achieve the policy objectives of local community participation in Northern science. This could be achieved, in part, by allowing non-academic principal investigators to receive funding for science, or by involving communities in research priority-setting, proposal review and funding allocation processes.

4.1 Introduction

The Arctic is a dynamic space that has been critical for the advancement of scientific research focused on understanding both natural and social systems (Graham and Fortier, 2005). More recently, it has become a particularly important landscape for better understanding the mechanisms and impacts of global environmental change (Chylek et al., 2014; Hinzman et al. 2005; Rayner et al., 2003; Shindell et al., 1998). The Arctic is also home to Northern indigenous

peoples, who have been living upon, and developing a profound understanding of, their environment for generations (Berkes, 2008; Krupnik and Jolly, 2002).

4.1.1 Stakeholder engagement in Northern science

Local participation has a long history within Northern research in Canada, for reasons including access, logistics, and guidance (Bocking, 2007; Chitty and Elton, 1937). However, for modern indigenous peoples in the North, much of the right to self-determination and consequent engagement in science has emerged from long struggles to regain control over their traditional territories, knowledge and artifacts. Many indigenous groups have negotiated land claims agreements providing, in some cases, surface and subsurface control of large areas of land (e.g. Aboriginal Affairs and Northern Development Canada, 1993). As the potential end users of much Northern science, indigenous communities have voiced the need for knowledge generated through research to be useful and locally relevant, a need that has become increasingly recognized in Canada's Northern research policies (Davidson –Hunt and O'Flaherty, 2007). This recognition has often been described as part of a new Northern research paradigm, associated with ensuring partnership, mutual benefits for research stakeholders and the empowerment of local researchers (Office of Polar Programs (OPP) and Barrow Arctic Science Consortium (BASC) 2004; Graham and Fortier, 2005; Southcott, 2011; Wolfe et al., 2011). This 'paradigm shift' in Northern science fits within a broader transition that has been observed in international research policy, described by Gibbons et al. (1994) as a shift from Mode 1 (traditional forms of scientific discovery) to Mode 2 (knowledge generated in the context of application) approaches to knowledge production (Brunet et al., 2014a). An expanding literature also refers to the increasing policy desire for *socially robust* research, where knowledge production involves the end-users, bringing together diverse forms of knowledge, experience and expertise to produce new knowledge that is then strengthened and modified through use and testing in the social world (Klenk and Hickey, 2013; Nowotny, 2003). The extent to which Canadian Northern science is socially robust is not clear, although numerous studies, reports, and reviews, focused primarily on researcher perspectives and reflections, have indicated that engagement has become a priority and that it has had numerous benefits for local stakeholders and researchers, albeit with some challenges (such as balancing local and scientific priorities and research saturation in some Arctic communities) (Ford et al., 2010; ITK and NRI 2007; Korsmo and Graham, 2002; Kruse et

al., 2004; Nickels et al., 2002; Parlee and Furgal, 2012; Pearce et al., 2009; Wolfe et al., 2011. Wolfe et al., 2007).

Recognizing the lack of empirical evidence of the extent of local participation in Northern science, Brunet et al. (2014a) examined research articles appearing between 1965 and 2010 in the journal Arctic, as well as three other polar science journals, to assess the extent to which a paradigm shift has occurred towards more participatory approaches. The results indicate that the involvement of local people increased only slightly over the least 50 years and varies systematically among disciplines, organizations and regions (Brunet et al. 2014a). Other studies support this finding, pointing to a number of important challenges associated with local engagement strategies that persist despite the emphasis on local participation in Canada's Arctic research policies (Gearherd and Shirley, 2007; Pearce et al., 2009). These include chronic instability in the leadership of community governments and organizations, cultural and linguistic differences, poor historical research and community-researcher relations and financial and time constraints (Gearheard and Shirley, 2007; ITK and NRI, 2007; Pearce et al., 2009; Wolfe et al., 2007).

Recognizing the significance of these challenges, there remains a need to improve our understanding of the factors affecting Northern research partnerships with a view to informing local, regional and federal research policies that seek to promote local participation in, and local relevance of, scientific research (Brunet et al, 2014b, Garnett et al., 2009; Pearce et al., 2009; Phillipson et al., 2012).

4.1.2 The policy landscape for Northern science

The policy landscape for stakeholder participation and partnership development in Northern science is heterogeneous yet consistently oriented around community involvement and relevance. There are requirements for community support and participation in international and federal science funding mechanisms (e.g., International Polar Year (IPY) and National Science and Engineering Research Council of Canada (NSERC)) as well as within provincial, territorial, regional permitting processes and when applying for local access to traditional territories, knowledge and artifacts (Inuit Tuttarvingat, 2014). For instance, the IPY 2007-2008 framework stated that "key objectives are to attract and develop the next generation of polar researchers and

engineers, and to engage the interest and involvement of polar residents, and of schoolchildren, the general public, and decision-makers, worldwide" (Rapley et al., 2004, p.9), the results of which provide important lessons regarding best practices of community collaboration and engagement in both research and decision-making (Cuerrier et al., 2012; Grimwood, 2012; Parlee and Furgal, 2012). At the federal level, the NSERC Northern Research Chairs program (2000-2010) clearly stated in its objectives that developing meaningful Northern partnerships was a priority: "The aim here is to ensure that new knowledge generated in the Chair's research program is relevant to Northern needs. Possible partners in Northern research are diverse and may include Northern and Aboriginal communities and organizations, territorial and provincial governments, federal departments, industry, and non-government organizations. All of these groups need research results for their policies, resource management and decision making" (NSERC, 2010, p.1) (For further details on the core objective see Appendix 2). Each territory and some provinces have clear policies for research conducted in the North, mostly under scientific research legislation which requires permits and some level of community consultation. For instance, in the Northwest Territories, research "needs to be defined clearly, conducted ethically, and used constructively in order to promote cooperation and mutual respect between researchers and the people of the North" (Aurora College, 1999, p.1). Some communities also have individual permit processes and policies. For instance, the community of Old Crow in Yukon Territory requires researchers to obtain a local research permit via a formal application process. Applications are then assessed for their potential impacts and benefits by a local review committee (find general info at Cultural Services Branch, Department of Tourism and Culture, Government of Yukon, 2008).

The heterogeneity within this policy system reflects the needs and priorities of the various governments and community-based organizations involved. However, for researchers, this policy and permit landscape can be quite daunting. A review of research policies across Canada revealed a high degree of variability across provinces in the degree to which permits are required for research in their Northern regions, while certain communities have strict requirements and processes and others have none. This makes the process of developing, monitoring and maintaining Northern community-researcher partnerships complex. Recognizing that there remains a lack of empirical evidence to inform Northern science research policies promoting

community-researcher partnerships at various scales, we conducted a survey of Northern science stakeholder experiences and perceptions across Canada to better understand the opportunities and challenges associated with Northern research partnerships.

4.2 Methods

4.2.1 Data Collection

Data were collected through an online survey of Northern research stakeholders in Canada. We used a broad definition of research including all fields of scientific study (social, life, physical) conducted in the North. Surveys are widely used in the evaluation of research policy and planning (Garrett-Jones et al., 2005; Klenk and Hickey, 2013; Klenk and Hickey, 2011; Turpin and Garrett-Jones, 2009). As the population and composition of Northern research stakeholders is unknown, we used a broad selection method in order to obtain perspectives from all stakeholder groups identified in the literature in order to reduce coverage bias (Sue and Ritter, 2012). Participants were subsequently identified using online searches, phone calls to key research organizations, governments and other agencies, and through science-policy networks such as ArcticNet and International Polar Year. This resulted in a list of 178 potential survey participants from across Canada and included southern based university researchers and students, researchers at northern colleges and organisations, community researchers, community research liaisons, territorial and local government researchers.

In order to reduce the potential for survey bias, we developed and pre-tested the questionnaire with five participants, resulting in adjustments to improve clarity based on their feedback (Folz, 1996; Sue and Ritter, 2012). The online survey was then distributed via personalized email to all 178 potential participants between October and December 2013. We subsequently received 49 survey responses, 39 of which were complete, representing a satisfactory completed response rate of 21.9%[3].

The survey began with respondent profile questions, followed by questions regarding the context of Northern research (history, policy, etc.), questions regarding the research process (proposal

[3] We acknowledge that although we obtained a broad sample of respondents, that low response rates for certain groups, such as community researchers, inhibits us from comparing and contrasting responses between groups (see Fig. 4.1 for details)

development, field work, results dissemination, etc.) and assessing the importance of partnerships during the different phases of research, and finally, the outcomes of research partnerships (Table 4.1).

Most questions were closed-ended, where participants were asked to rank responses or were given multiple choices. Questions that explored more theoretical concepts had definitions and explanations to guide the respondent (see questionnaire in Appendix 4.1) and reduce response bias (Rooney et al., 2004). Options for ranked and multiple choice questions were based on detailed literature review and the findings of case study research conducted in Old Crow, Yukon (see Brunet et al., 2014b). We also provided open-ended questions in each section to allow participants to elaborate on their responses further, provide context through qualitative responses, or raise concerns with the questions being asked to reduce response order effects (Choi and Pak, 2005). Response bias was also reduced by providing context for questions being asked (Schwarz et al., 1991).

Because our sample (n) was not equal throughout the study, we tested for non-response bias in order to assess respondent characteristic changes throughout the study (Sue and Ritter, 2012). Non-response bias was tested by comparing average results for all socio-geographical indicators (Section 3.1) from those who responded at n=49 and those who responded at n=39. Based on the results of a Welsh two sample t-test in the program R, we found that groups did not differ significantly ($p=0.996$). We also report the n values for each of the results being presented.

4.2.2 Analysis

Given the heterogeneous nature of our questionnaire, we used a multi-method approach for our analysis (Table 4.1). For section 1 of our survey, we conducted simple descriptive statistics to characterize our respondent profile (mostly % of total respondents). For section 2, given the nature of the question (rank 7 of 7 options), we were able to complete a series of different analyses using the pmr package for ranked data in the software R (Lee and Yu, 2013). Tests included mean rank, pairs matrix, marginals matrix and boxplot. The pairs matrix provides the number of observations for which the first item (row) is more preferred than the second item (column). The marginal matrix provides the number of observations which the item factor (row) is ranked 1-7 (column). For section 3, we scored the top five ranked outcomes from 5 points

(ranked 1) to 1 point (ranked 5), then calculated the mean score for each outcome. For section 4 of the questionnaire, we conducted a boxplot analysis and determined significance using a Welsh 2 sample t-test. This allowed us to test if partnerships were perceived as more beneficial for community partners or researchers using significance tests.

The final section was an open-ended question exploring policy directions that would allow for the positive outcomes of research to be maintained or enhanced as a result of Northern research partnerships. We used qualitative data coding and content analysis to uncover trends in stakeholder responses, which involved assigning codes to specific response categories and counting the number of times respondents mentioned each category to determine the top three strategies favored by respondents (Charmaz, 2006; Folz, 1996; Glaser and Strauss, 1967). We also present illustrative quotes to help contextualize our quantitative findings where relevant.

4.3 Results

4.3.1 Respondent profile (n=49)

Our sample was 53% female and 47% male and was well distributed in terms of age groups and years of involvement in Northern research (Figure 4.1a and 4.1b). 45% of our respondents had more than 16 years of experience working in Northern science.

Figure 4.1c presents the role of our respondents in Northern research programs, showing a large percentage of university researchers (48%). However, 25% of our respondents also identified as Northern residents or community members, with over 10% indicating that they were members of a First Nation or Inuit community. Overall, we received responses from all role categories offering an important diversity of perspectives on Northern research partnerships in Canada.

Respondents were also well distributed in terms of the geographic locations of their research activities, representing all Northern regions of Canada (Figure 4.1d). The largest proportion of respondents were involved with research projects in the Territory of Nunavut (60%) followed by Northwest Territories (48%) and Yukon (38%). Many respondents also identified working in multiple Northern regions.

4.3.2 Success factors for community-researcher partnerships (n=48)

Participants were asked to rank a series of factors that are considered important in successful research partnerships (Figure 4.2). The results indicate that 'community participation in research processes', 'researcher participation in local processes' and 'early and ongoing communication' were the top three factors affecting successful research partnerships, the definitions of which are in the questionnaire (Appendix 4.1).

Figure 4.2 presents a boxplot of respondent rankings of the success factors as well as mean scores. The results indicate that *Community participation in research processes* has the highest mode score (2) with a range from 1 to 4. *Researcher participation in local processes* and *Community culture: awareness, perceptions, history* have the same range from 2 to 4, although *Researcher participation in local processes* does have a lower mode score (3). Although *Early and ongoing communication* (3) has a mode score that is higher than *Community culture: awareness, perceptions, history* (3.5), it does have a wider range from 2 to 6, meaning that there is less consensus regarding its importance. *Characteristics of academic research and researchers*, once again, is the least favored factor (mode score of 7). All factors (except *Local-community capacity*) have the maximum variance (1 to 7).

The pairs matrix test (Table 4.2) shows that *Community participation in research processes* was consistently chosen prior to the other factors (Values between 29 and 40 out of a maximum of 47). The marginal matrix test (Table 4.3) confirms this finding, indicating that this factor was ranked first the most times (17) followed by *Early and ongoing communication* (11). The marginal matrix test also indicates that although *Early and ongoing communication* came third in mean rank, it was considered the first rank for more respondents than *Researcher participation in local processes* (2^{nd} in mean rank). Conversely, we can also see that *Characteristics of academic research and researchers*, which has a mean rank well below any other (5.56), is identified as more important by respondents before *Community participation in research processes* and *Researcher participation in local processes* to the same extent as *Geographic factors, characteristics of the natural environment* . It is also ranked first and second the same number of times as factor *Local- community capacity.*

4.3.3 Outcomes of community-researcher partnerships (n=41)

Recognizing that a number of positive outcomes are associated with successful collaboration between researchers and partner communities, we asked respondents to rank their top five positive outcomes from a list. Results from the weighed scoring (Table 4.4) suggests that the most important positive outcome of research partnerships was *training, new skills and professional growth for students and engaged locals*, followed closely by *motivation, inspiration, and empowerment for local partners* and a *reduction of cultural conflict between researchers and local stakeholders*. We also reviewed the number of times each outcome was ranked first, finding that the *reduction of cultural conflict between researchers and local stakeholders* had the highest score (8), followed by *increase local appropriation of research occurring in community* (5) and *motivation, inspiration, and empowerment for local partners* (5).

Recognizing that certain conflicts can arise during the development of Northern research partnerships as well as limitations which can have negative impacts on the research process, we asked respondents to rank their top five negative outcomes and sources of conflict from a list. We found that *research saturation* was overwhelmingly ranked the highest with a mean score of almost 3 (Table 4.5). It was also selected as the first negative outcome 15 times followed by *misuse, misunderstanding or ignorance of local knowledge* (5). *Miscommunication of research objectives and associated methods* was also considered important by our respondents, with a mean score of 1.9.

4.3.4 Overall benefit of community-researcher partnerships

We also explored the extent to which our participants believed that research partnerships between communities and researchers were beneficial to both researcher and local partners. We found that more than 70% of our sample believed that research partnerships are at least very beneficial for researchers compared to around 25% who believed they were very beneficial for community partners. We then assigned a score to each response category. Figure 4.3 shows that researchers had a median benefit score (3) and score range (2-4) that was higher than results for community counterparts (2 and 1-3). Overall, researchers were perceived by our respondents to benefit significantly more than community partners as a result of research partnerships ($p = 0.002$; 95% confidence interval). The mean community benefit score was also lower at 2.27

versus a researcher score of 2.98. The following quotes from Northern community residents provide perspectives on this disparity in terms of benefits:

“Often the benefits are more one-sided - the researcher receives money, in the form of grants, fellowships, scholarships, etc. The researcher advances their career, obtains notoriety, becomes a 'Northern expert" (often after only one field season in the North...!) and then moves on with their career, feeling enriched by their "Northern adventure", while local folks are left wondering "what ever happened to that young person to came to speak to us...what was the outcome of their research? Where did those stories go? Why did we trust that person?" I believe the real benefit is that Northern communities have become wise to the ways of academia and they are now able to talk the talk of the academic world, obtain research funds themselves and conduct their own, truly community-based, projects, in an authentic and beneficial manner. Local experts are finally being recognized and communities are realizing they can do their own research...or not!” College/university student, Northern resident, First Nation, NWT, Yukon

“Academic researchers get all the glory. Many people have made their careers by speaking about the North, even though they may not have sincere, mutual, lasting relationships with Northern people.” Northern resident, Yukon, NWT.

“A colleague of mine once said, "The north is sexy." In terms of public perception and scientific/knowledge capital, researchers benefit hugely from Northern research partnerships.” Territorial government representative, university researcher, Northern resident, NWT, Nunavut.

The results of the coding and content analysis based on 30 qualitative responses provides interesting insights regarding the ways that federal research policy in Canada could better ensure that the benefits of partnered approaches to Northern science are maintained and enhanced over time. Responses revealed that three principal strategies could be prioritized including the development of funding programs for early and long-term engagement, the development of programs that support and enhance local autonomy and capacity and further opportunities for the training and education of researchers, students and funders in areas such as effective partnership strategies and the respect of Northern values and cultural protocols. Detailed responses also provided a number of specific suggestions (Table 4.6). Another important finding was that many stakeholders expressed some level of frustration regarding the maintenance or enhancement of

benefits once programs were completed, often noting that partnerships generally have a very limited legacy in partner communities.

4.4 Discussion

As very few quantitative empirical studies have assessed participation (Abreu et al., 2009; Phillipson et al., 2012), the perspectives of our diverse sample of research stakeholders across Northern Canada provide important insights for policy and practice. They also allow us to ground key aspects of the Northern research discourse ongoing in Canada that is dominated by qualitative case studies (Brunet et al., 2014b; Gearheard and Shirley, 2007; Pearce et al., 2009) and reviews and reports on research at the community or individual research project scale (Ford et al., 2010; ITK and NRI, 2007; Korsmo and Graham, 2002; Kruse et al., 2004; Nickels et al., 2002; Parlee and Furgal, 2012; Pearce et al., 2009; Wolfe et al., 2011; Wolfe et al., 2007). In order to help us draw out the main findings from our survey, we have compared and contrasted our results with a selection of recent empirical research projects examining community-research partnerships in environmental research (Table 4.7).

4.4.1 Factors affecting community-researcher partnerships in Arctic science

Our results support the need for the early engagement of local partners at the research design and objective setting phases to ensure a successful partnership development process. For example, a community researcher and Northern resident in the Yukon and NWT commented: "if they (researchers) speak to the community and develop their research questions with the community's concerns in mind and maintain the partnership throughout then the community does see that there is benefit". According to Brunet et al. (2014b), local participation at this phase is often associated with dimensions of trust and power distribution, key elements of partnership development that have also been identified in numerous other contexts (Christopher, 2005; Christopher et al., 2008; Fisher and Ball, 2003; Weaver, 1997).

Our results support other studies indicating that maintaining the benefits of collaborative research design and objective setting throughout the research process is generally maximized through two important factors: employment of community researchers, guides, field assistants and the participation of researchers in local activities beyond research. Garnett et al. (2009) stressed the importance of employing local stakeholders as co-researchers, noting that the

interaction of researchers with local communities would have been minimal or impossible had the community researcher not been engaged. Results dissemination was identified as another key priority for building successful partnership development in our survey, a finding supported by Brunet et al (2014b) and Phillipson et al. (2012) who identified that engagement of local participants in results dissemination through various means from actual participation in disseminating results to providing feedback or being informed in a timely and transparent manner were important.

Open ended survey responses suggested that community research partnerships "increased local institutional capacity to plan, initiate, and manage research partnerships"; are important vehicles for the "empowerment of the community as a whole to be able to use scientific data to inform land management decisions and promote local stewardship" (College/university student, field assistant, Yukon Territory) and may inspire some participants to pursue careers in science: "I had one youth say to me 'Sometimes, you make me want to be a scientist'" (University student, Yukon Territory). Further, stakeholder participation was reported to improve not only the research but also university researcher capacity. Reported partnership outcomes for university researchers included: "Increased cultural sensitivity of researchers, and development of their skills to communicate across cultural and linguistic barriers" and "these relationships often enrich the individual researcher" (Territorial government representative, Nunavut). Based on the results from other studies (Table 4.7), there appears to be a degree of consensus that research partnerships are associated with improved local capacity to understand and use scientific information for management and planning purposes.

Our survey respondents attributed negative outcomes and limitations of community-researcher partnerships to a lack of long term commitment to partnership development, a poor process of results dissemination and integration of research into action and policy and a lack of coordination between scientific projects that leads to overuse of certain resources and people. Also mentioned were difficulties integrating or balancing inputs from local versus scientific knowledge and the availability of reliable and skilled local help. There appears to be a need for more reflection on these issues in Northern research policy from the national to the local level. Some of our respondents also mentioned having "difficulty 'staying on the radar' of busy partners" and "partners are very busy with many other commitments and are already over committed within

work environments" (Academic researcher, Nunavut). Overall, our results indicate that research is sometimes perceived as a disruption of local livelihood and traditional activities, another factor that warrants explicit consideration in policies seeking to increase the level of interaction between researchers and local communities.

Another important finding that emerged from our study was a general underlying lack of social capital (trust and reciprocity) between academic and local stakeholders. For example, a First Nation resident and community researcher in our sample suggested that on one hand there was a "lack of confidence in local researchers, elders, heritage workers, local experts, etc." as well as a "lack of belief in community ability to conduct research in a professional manner." On the other hand, another respondent believed there was "too much academic control over research - people coming into a community thinking they will help, when really they're just fulfilling their own objectives and/or academic requirements" as well as "a lack of sincerity in research partnerships on the part of outside academics" (College student, NWT and Yukon). Overall, issues related to bridging social capital (i.e. social ties that cut across differences such as race, class or ethnicity) (Sandler & Lowry 2006) are known to be crucial to the success of research partnership strategies in indigenous contexts (Brunet et al. 2014b) where many communities have been analysed, stereotyped and exploited by outside groups (Christopher, 2005; Christopher et al., 2008; Fisher and Ball, 2003; Smith, 1999; Weaver, 1997). Interestingly, the development of bridging social capital between communities and researchers may ultimately be the most important benefit of, and limitation to, successful scientific research partnerships (Klenk and Hickey, 2013; Turpin and Garrett-Jones, 2009), and this is an area that requires further critical discussion and reflection in the context of Canada's Northern research policy frameworks.

4.4.2 Strategies for strengthening community-researcher partnerships in Northern science

Recognizing the link between bridging social capital and partnership success (Bennett et al., 2012; Christopher et al., 2008; Taylor, 2000), our results from a diverse cross-section of stakeholders working in Northern science suggest that research policy in Canada (federal, provincial and local) could do more to support equity in partnership development by focusing more on the relational (i.e. quality) dimensions of research partnerships rather than on the structural (i.e. configuration). Partnerships in research require a decentralization of power in order to strengthen trust between partners (Pain et al., 2011). However, many existing funding

structures tend towards prioritizing questions of relevance to the government and the academic community (see for example, NSERC, 2014). Researchers also play a prominent role in setting research agendas within government which results in a lack of transparency over to whom certain priority research questions are actually important.

These questions relate to a broader discourse occurring in research and science policy internationally concerning the desirability (or not) of a move towards more socially robust science, where issues of power sharing, trust and reciprocity are central, issues recognized by many as a priority in Arctic research (Ford et al., 2010; ITK and NRI, 2007; Korsmo and Graham, 2002; Kruse et al., 2004; Nickels et al., 2002; Parlee and Furgal, 2012; Pearce et al., 2009; Wolfe et al., 2011. Wolfe et al., 2007). Such an approach requires a high degree of reflexivity in the policy and research frameworks that support research partnerships to enable continuous learning, adaptation and innovation in the nature of knowledge production and the roles of partners and collaborators (Hendriks and Grin, 2007; Klenk and Hickey, 2013; Klenk and Hickey, 2011).

Another factor identified in our study is the need for better targeted and longer-term funding and mechanisms that can support researchers and local stakeholders to develop social capital in support of successful research partnerships. This finding is supported by Christopher et al. (2008), who identified a lack of funding for the initial stages of project development to be an important barrier to building trust in research partnerships (see also Minkler et al., 2003). Such mechanisms could include the funding of regular social networking events between researchers and interested communities, informal community-researcher festivals and community events.

There are, however, in our opinion, some important barriers at the community level that have yet to be thoroughly explored. For instance, our experience in Northern research has revealed tensions between some territorial and local governments in terms of controlling access to sites and issuing research permits. Many indigenous communities in Canada, through land claims processes, have obtained the right to govern ancestral lands. Territorial governments have often not shared or relinquished control over the permit process for research. Therefore, indigenous communities sometimes and rightfully take a position of opposition to research, declaring a potential for exploitation and their right to reject research. This situation clearly does nothing to

generate benefits for communities or improve research outcomes. We believe that Northern research needs to move away from situations of confrontation over control to one of stewardship, where communities have the opportunities to direct and lead research focus and approaches in their territory as foundations for effective partnerships.

Beyond the Northern context, Klenk and Hickey (2013) suggested that research policy may benefit from seeking a balance between funding research focused on questions of relevance to academics, economic or social development goals and providing civil society actors, government and industry partners with opportunities to obtain funding as Principal Investigators of projects. Our results suggest that such opportunities are generally missing in Northern science, yet could go some way towards enhancing the benefits accrued through research partnerships by fostering varied forms of participation from different societal sectors in knowledge production and agenda setting processes (Lepori, 2011). Providing local and/or community stakeholders access to funds and processes to assess and review the extent to which research funding allocations address their needs and interests would also work to improve the democratic legitimacy of Northern science (Klenk and Hickey, 2013; Real and Hickey, 2013). This is an area that would benefit from further research and critical reflection in Canada's diverse array of Northern research policy.

4.5 Conclusion

In this study we sought to better understand the contemporary factors affecting successful community-researcher partnerships in Northern science with a view to informing research policy at various scales. Our broad survey of Northern science stakeholders in Canada provides empirical support for many case study-based findings that have been reported in the literature. Overall, researchers were perceived to benefit more from research partnerships than their community counterparts. This asymmetry is an overarching and critical limitation to effective partnership development. Our results suggest that research partnerships in science need to be better supported by policies and frameworks that focus on building social capital and equity between partners in the research process. This may be achieved through the early engagement of stakeholders in research design and objective setting phases, the long term employment of community researchers within and between research projects, and engagement in and transparency of results dissemination strategies.

Successful community-researcher partnerships in Northern science will ultimately require greater decentralization of power to strengthen social capital. This could be achieved by allowing non-academic principal investigators to receive funding for science, or by involving communities in research priority-setting, proposal review and funding allocation processes through councils or advisory groups. This is no simple task, challenging many of our most entrenched cultural, organizational and institutional norms and these issues are further compounded by an apparent lack of availability of interested local stakeholders. Real and Hickey (2013) found that promoting communication between local advisory groups or councils and academic interest groups and public funders is critical to ensuring the legitimacy and relevance of participatory mechanisms but very difficult to achieve. Representation within these groups is also difficult to establish given the heterogeneity in goals, needs and aspirations of local stakeholders. These processes are also confronted with issues regarding the selection of actors and their role in decision-making (Hall et al., 2003). Ultimately, according to Bogner et al. (2012), the decentralization of power and control over research processes within a centralized context of funding and setting research priorities has been found to undermine the legitimacy of the participatory processes. Participants tend to adopt the dominant scientific and ethical paradigms at the expense of their own in order to participate in a process of decision making that does not respect their culture and traditions (Bogner et al., 2012). Applying participatory principles to developing research programs for Northern research will require much thought and reflection with our community and local partners to find appropriate solutions that respond to the needs of all stakeholders.

Acknowledgements

We would like to thank the participants of this study who took the time to respond to our survey. Nicolas Brunet's research is supported by the Fond Québécois de Recherche sur la Société, la Culture and the NSERC Northern Research Chairs program and the Quebec Centre for Biodiversity Science.

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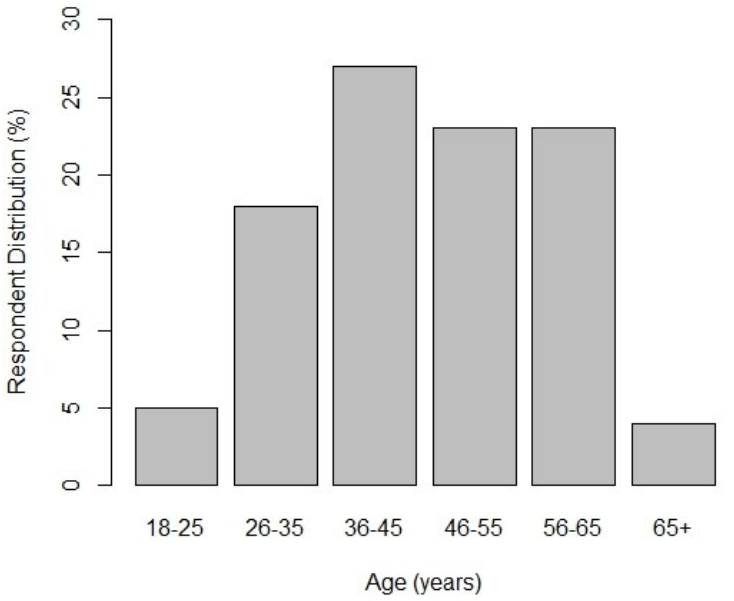
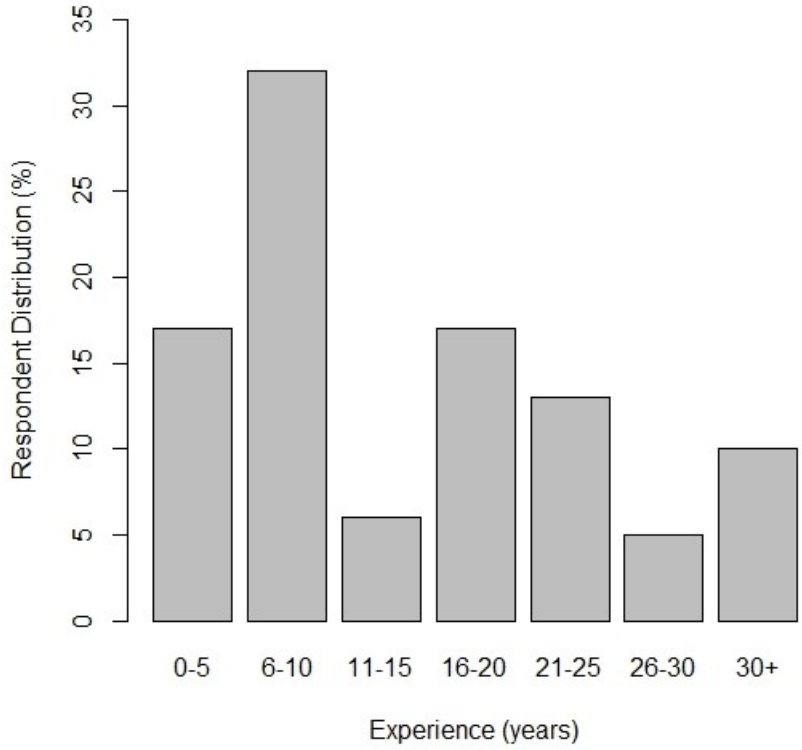

Respondent Distribution (%)
0
5
10
15
20
25
30
18-25
26-35
36-45
46-55
56-65
65+
Age (years)

a)


Respondent Distribution (%)
0
5
10
15
20
25
30
35
0-5
6-10
11-15
16-20
21-25
26-30
30+
Experience (years)

b)

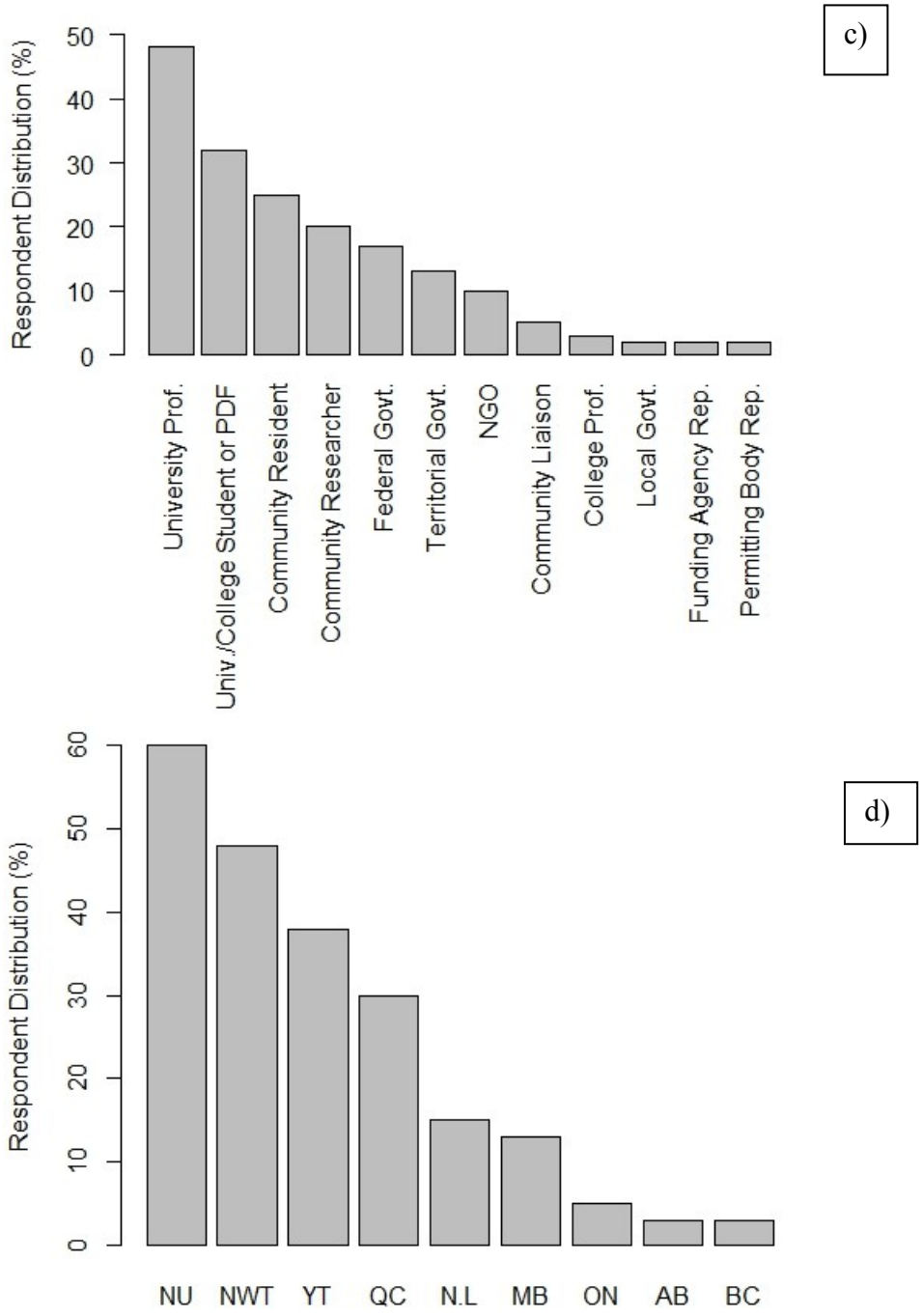


Figure 4.1 a-d. Respondent profile. Panels a and b are discreet categories where respondents could only select one option. Panel a represents the age distribution of respondents. Panel b represents their number of years of experience in Northern research. In Panels c and d, respondents could select multiple options. Panel c represents the distribution in terms of respondent roles in Northern research. Panel d represents the location of respondent involvement

in Northern research (NU= Nunavut, NWT= North West Territory, YT= Yukon Territory, QC= Quebec, N.L= Newfoundland and Labrador, MB= Manitoba, ON= Ontario, AB= Alberta, BC= British Columbia).

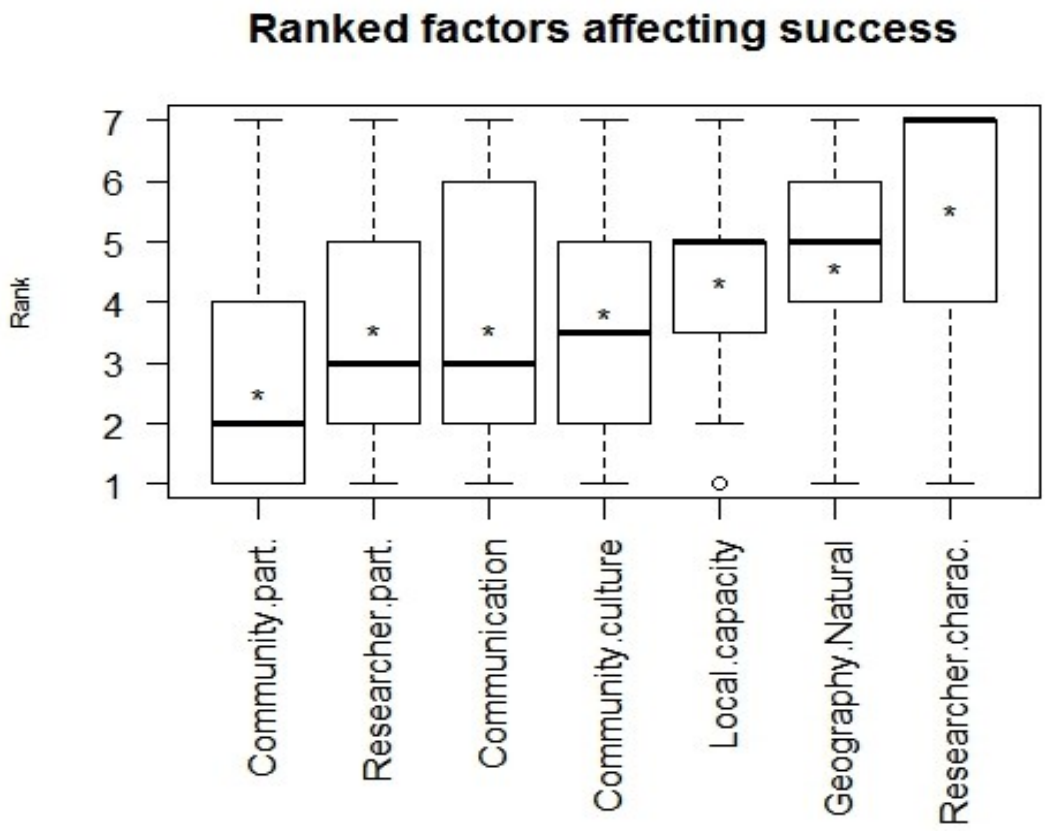


Figure 4.2 Boxplot of success factor rankings. * are mean ranks.

Benefit values and scores	
Extremely beneficial	4
Very beneficial	3
Moderately beneficial	2
Slightly beneficial	1
Not beneficial	0

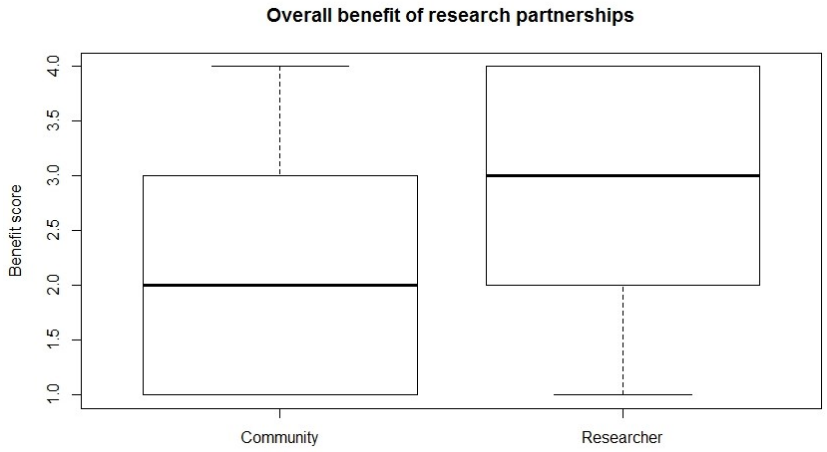


Figure 4.3 Boxplot of overall benefit of research partnership for researchers versus community partners.

Table 4.1 Question sections and analysis strategies

Question sections	**Analysis strategy**
1. Respondents profile	Basic descriptive statistics (mean, %, etc.)
2. Success factors for research partnerships	Mean rank, pairs matrix, marginals matrix, boxplot
3. Outcomes of research partnerships (+ and -)	Weighted scoring
4. Overall benefit of partnerships	% of total responses, boxplot and Welsh 2 sample t-test
5. Research policy	Coding and content analysis

Table 4.2 Pairs matrix of success factors. Represents the numbers of times a factor was ranked before another factor.

Factors	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Community participation in research processes (A)	0	33	36	38	40	39	29
Researcher participation in local processes (B)	15	0	26	32	34	34	24
Community culture: awareness, perceptions, history (C)	12	22	0	27	30	38	23
Local- community capacity (D)	10	16	21	0	26	35	19
Geographic factors, characteristics of the natural environment (E)	8	14	18	22	0	34	20
Characteristics of academic research and researchers (F)	9	14	10	13	14	0	9
Early and ongoing communication (G)	19	24	25	29	28	39	0

Table 4.3 Marginals matrix of success factors. Represents the number of times a factors was ranked from 1 to 7.

Factors/Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Community participation in research processes (A)	17	12	6	7	3	2	1
Researcher participation in local processes (B)	7	10	8	7	7	6	3
Community culture: awareness, perceptions, history (C)	5	9	10	3	10	8	3
Local- community capacity (D)	3	4	5	11	14	8	3
Geographic factors, characteristics of the natural environment (E)	2	4	5	12	9	10	6
Characteristics of academic research and researchers (F)	3	4	4	3	1	4	29
Early and ongoing communication (G)	11	5	10	5	4	10	3

Table 4.4 Ranked positive outcomes (5 is the highest mean score, 0 when not selected in top 5)

Positive outcomes	**Mean Score**	**# of times ranked 1**
Training, new skills and professional growth for students and engaged locals	1.69	4
Motivation, inspiration, and empowerment for local partners	1.62	5
Reduce cultural conflicts between researchers and local stakeholders	1.55	8
Opportunities for researchers to better understand local experiential or traditional knowledge	1.24	2
Increase local appropriation of research occurring in community	1.21	5
Opportunities for the conscientious integration of traditional and local knowledge and science	1.02	1
Motivation for pursuit of formal schooling for local youth	0.95	2
Opportunities for improving local understanding of science	0.88	4
More useful knowledge locally (long term monitoring and sustainability, for instance)	0.86	0
Resource sharing, logistical support and cost reduction	0.83	0
Collaboration between researchers in different fields	0.79	3
More accurate results	0.79	1
Financial rewards for engaged community members	0.52	1
Opportunities for new (for youth) or renewed connection to the land for some local partners	0.50	1
Exposure to outside cultures/ people for local partners	0.26	0
Power imbalances between researchers and community members	0.21	0
Improve community cohesion	0.00	0

Table 4.5 Ranked negative outcomes (5 is the highest mean score)

Negative outcomes and sources of conflict	**Mean Score**	**# of times ranked 1**
Research saturation (too much research, no visible local outcomes)	2.95	15
Miscommunication of research objectives and associated methods	1.90	4
Divergent research objectives	1.78	2
Misuse, misunderstanding or ignorance of local knowledge	1.75	5
Lack of recognition of local contributions	1.43	4
Lack of local trained help	1.00	1
Loss of academic freedom because of overriding community objectives (bias in method selection, analysis and results)	0.80	2
Local dependence on outsiders for financial viability	0.78	2
Inter-personal conflicts	0.78	2
Low reliability of assistants and guides	0.78	1
Lack of formal youth involvement	0.38	0
Misuses of funding	0.15	0

Table 4.6 Coding and content analysis of stakeholder opinions on policy strategies for research partnerships.

General approach	Proposed strategies
Development of funding programs for early and long term engagement	Develop training funding to bring in aboriginal students and take southern students to the North. Modify NSTP program to allow students to showcase the outcomes of their research in communities (make sure the community receives the research outcomes) Funding agencies should provide adequate resources to visit, meet and discuss with communities in order to develop research objectives. NSERC Northern Internship program should be reinstated and give additional funding to students to spend additional time in the North to build relationships. Universities should adapt their policies to ensure and mandate that any researcher conducting work in the North commits to a long-term partnership (minimum 10 years) with Northern communities and local organizations.
Development of programs and strategies that support and enhance local autonomy and capacity	Improved communications with decision makers. Much of the money directed to streams of academic research could be directed to local, community programming. Enhance mandate of colleges and encourage independent research institutes in the north. De-bureaucratize the permitting process and promote local control. Increase Northern capacity to set research agenda. Research partnerships should arise from questions raised by Northerners. Increase opportunities for local training, including sending Northern youth to southern universities. Base rewards for research partners on performance. Resources need to be made available for science education in Northern schools.
Provide opportunities for the training and education of	Develop a Northern or aboriginal paradigm of scientific research. Ensure that ethical protocols are followed by researchers and research results are returned to the communities in ways that are culturally and

researchers, students and funders in effective partnership development	linguistically accessible. Provide training opportunities for early career researchers on how to make successful partnerships with communities (pre-contact) and ways in which these connections can be maintained and enhanced throughout the research process. Systematic evaluations of research engagement and partnership

Table 4.7 Comparative review of recent empirical research on community-researcher partnerships in environmental research.

Current study	**Brunet et al. (2014a)**	**Garnett et al. (2009)**	**Pearce et al. (2009)**	**Phillipson et al. (2012)**
Northern research in Canada	Arctic environmental research in Canada	Tropical natural resource management research in Zimbabwe and Australia	Climate change studies in the Canadian Arctic	Rural land use research in the UK
Quantitative survey	Qualitative case study	Qualitative case studies	Qualitative case studies	Quantitative survey
50 stakeholders	1 case, 40 stakeholder interviews	6 cases	3 cases	1048 stakeholders
Summary of success factors				
Community participation in research processes Researcher participation in local processes Early and ongoing communication Local culture: awareness, perceptions, history	Proposal development and research design The nature of the communication strategies and results dissemination Understanding and respect of cultural protocols	Employment of community researchers Incorporated local priorities for knowledge building Recognizing and rewarding prior tacit knowledge of the systems being studied, building on it to enhance two-way knowledge transfer	Early and ongoing communication including informal and formal interactions Community involvement in research design and development Providing employment as local researchers and Interpreters	Stakeholder engagement in objective setting, project design, knowledge production and provide access to facilities Gaining feedback on findings and involving stakeholders in dissemination of results
Summary of positive outcomes				
Training, new skills and professional growth for students and engaged locals Motivation, inspiration, and empowerment for local partners Reduce cultural conflicts between researchers and local stakeholders Opportunities for researchers to better understand local experiential or	Improved stakeholder social capital : strengthening community cohesion, pride and connection to the land, friendships, relationships of trust Motivate youth to seek higher education More accurate and ethical integration of TEK and local	Participation of community researchers in discussions and evaluation of project options through tacit knowledge Transfer of scientific knowledge to local researcher and community changes in behaviors and attitudes, early adoption of new technologies	Linking of research with other existing research projects Developing community–researcher relationships and communication channels. Community support for research projects Ensure the accuracy of results. Training and	Improve research quality and relevance Improved research relevance to stakeholder needs Improved knowledge transfer and practices

traditional knowledge	knowledge. Legitimization of local decision-making and consensus	Facilitation of knowledge transfer through local end user networks Local researchers gained status	employment of community researchers	
Summary of principle limitations/negative outcomes				
Research saturation (too much research, no visible local outcomes) Miscommunication of research objectives and associated methods Misuse, misunderstanding or ignorance of local knowledge	Researcher findings not supported by local knowledge Methodologies conflicted with local practices Internal community-level politics Local research saturation	Intellectual and technical skills beyond what can be developed at community level Funding bodies may not always make provision for employment of community members and training Not all researchers are effective teachers Culturally inappropriate to employ certain community members as researchers (selection difficult and sensitive)	Research saturation, researchers unaware of other projects-some ask the same questions Expertise and interest of university researchers contrast with community needs and aspirations Finding and employing local researchers (compensation, availability, reliability) Cost of research	No definitive association with power sharing Effective engagement strategies locally specific Integration of different knowledge systems in research design phase

Preface to Chapter 5

In Chapter 4, we identified that while Northern research partnerships are highly contextual in nature, certain key elements of the research process are critical to partnership success. We also confirmed the case study findings of Chapter 3 that the main outcome of these strategies can often be summarized as the development of social capital. In Chapter 5, I explore the extent to which Northern research partnerships might benefit from being conceptualized as a development activity. Using the same survey of Northern research stakeholders presented in Chapter 4, I describe a capital assets-based approach to assessing community-researcher partnerships in Northern science and discuss some of the potential implications for research policy and practice.

5 Research for development: A capital assets-based approach to assessing community-researcher partnerships in Northern science

Abstract

Partner communities are often dissatisfied with scientific research decades after researchers and development practitioners started emphasizing the importance of local participation. This could be attributed to the contextual nature of partnerships in science, as opposed to a focus on procedural considerations. In order to better conceptualize the research partnership process and evaluate the potential of improving our understanding of science partnership development, we assess research partnership development using a capital assets approach to better understand transformative impacts. We assess the utility of this framework using a survey of stakeholders involved in developing and maintaining research partnerships in the Canadian North. Our results suggest that researchers generally benefit more from research partnerships than their community counterparts, but that both groups gain the most in terms of human and social capital. Building on these results, we offer an approach to assessing community-researcher partnerships in science based upon three criteria: complementarity of initial assets, change in assets as a result of research and strategies for post research maintenance and enhancement of assets.

5.1 Introduction

Research and innovation are important factors contributing to sustainable global development (Swiss Programme for Research on Global Issues for Development, 2014). When strategically linked, science, technology, and innovation have been found to drive economic growth, help solve social and environmental problems, and reduce poverty (International Development Research Centre, 2014). Importantly, such 'research for development' initiatives emphasize the need to develop the capacity to produce, adapt and use science and technology in order to better address diverse societal needs. Not surprisingly, much of the literature on research for development has emerged from developing area contexts where the capacity to utilize scientific findings is often severely challenged and the need for innovation tends to be great. More specifically, a research for development paradigm is increasingly apparent in the interactions

between development organizations partnering with researchers in fields such as agriculture and food security (International Development Research Centre, 2014a; Rusike et al., 2014), health (Abrahams et al., 2004; Loewenson et al., 2014), natural resource management (German et al., 2013) and climate change (Conway, 2011). However, this paradigm has been less explicitly apparent in the developing area contexts of Northern Canada where public investments in science have not generally been formally linked to Northern development outcomes. Recognizing that most Northern research policy frameworks operating in Canada overtly require some degree of community-researcher partnership, we believe that a more explicit and nuanced understanding of how broader research for development thinking might inform Northern research policy and practice is needed.

Importantly, research for development emphasizes that, through partnership with key actors, their knowledge, skills, experience and networks, researchers may contribute to solving global problems (International Development Research Centre, 2014). Ashbi (2003) stated that research for development "emphasizes the iterative, adaptive nature of innovation in complex ecosystems, which is achieved through systematic enquiry combined with learning based in action" (p.1). An important aspect of research for development is therefore the recognition that researchers are one of many stakeholder groups involved in the development of knowledge, with each group often having different worldviews, knowledge systems and competing ideas about the purpose of inquiry (Klenk and Hickey, 2013). Research for development fits well within larger theoretical frameworks that support the inclusion of non-expert and expert publics in scientific research, such as Mode 2 (Nowotny et al., 2003), triple helix (Etzkowitz and Leydesdorff, 2000), community based participatory research (Minkler and Wallerstein, 2008) and socially robust science (Nowotny et al., 2013). Irrespective of the terms used, such frameworks generally support the need to focus less on classical, reductionist notions of control and objectivity in applied research design and implementation (Ashbi, 2003) and more on issues of credibility, salience and legitimacy (McNie 2007; Lalor and Hickey 2014). According to Ashbi, (2003), research for development ultimately relies upon jointly-managed processes of investigation and learning which promote democracy in the search for solutions and innovations in science and technology. In many cases, these participatory processes strive for increased adoption rates and reduced adoption times for such technologies or scientific knowledge by improving relevance

and access to end users (Jones et al., 2014). The quality and success of research for development is therefore dependent on the quality of the participation of stakeholders in knowledge production (see Bell et al., 2012; Davis and Whittington, 1998).

More generally, developing tools and measuring the success of development activities is a central theme in the literature and one that has relied heavily upon the sustainable livelihoods framework (SLF) (Carney, 1998; Chambers, 1997; Scoones, 1998), although other evaluative approaches have been proposed (e.g. Engel et al., 2007). More recently, the SLF has been used in studies exploring assets-based approaches to community and resource development (Bennett, et al., 2012; Green and Haines, 2002; Rahman, et al., 2012). The SLF generally supports the importance of five (sometimes seven) capital assets in local development efforts (social, human, physical, financial and natural) (Table 5.1).

These assets provide important indicators of capacity and focus on what partners, such as small isolated communities, have to offer the research and development process, rather than what they may be lacking (Moser, 1998). This approach considers not only tangible assets such as finances or infrastructure but also the complex and important intangible assets such as culture, social relations, local decision-making and communication processes which previous studies have found are critical, although often overlooked, in community-researcher partnership development processes (Brunet et al., 2014a; Engel et al., 2007; Garnett et al., 2012; Parlee and Furgal, 2012; Phillipson et al., 2012). Such assets have been found to give stakeholders the capability to act and engage with and change the world (Bebbington, 1999; Sen, 1997). Engel et al. (2007) demonstrated that a balanced approach to assessing capacity must acknowledge and integrate such "soft" sides of capacity as legitimate and essential to achieving development goals. Although difficult to assess, better understanding the contextual factors affecting capacity have the potential to inform research and development policies to improve outcomes for both communities and scientists engaging in research for development partnerships (see Keijzer et al., 2011).

This emphasis on better understanding the impacts of stakeholder participation and engagement on local development is of particular importance in the development field (Gaventa and Barrett, 2012). Shattan et al. (2008) found that participation may contribute to more just and viable

policies with a significant impact on poverty, inequality and development. In studies of ecosystems services management, Buytaert et al. (2014) found the co-generation of knowledge is key to achieving local development goals. Menocal and Sharma (2008) linked public engagement to more responsive and accountable public institutions linked with broad development outcomes. Numerous studies also associate local participation to a host of democratic governance outcomes (e.g., Coelho & Favareto, 2008; Fung, 2003; Manor, 2004; Robinson, 2004). Despite this strong evidence, there is a clear gap "between normative positions promoting citizen engagement and the empirical evidence and understanding of what difference citizen engagement makes (or not) to achieving the stated goals" (p. 2399, Gaventa and Barrett, 2012; see also Brinkerhoff and Azfar, 2006; Mansbridge, 1999). There are also few studies that have used quantitative means to assessing research for development outcomes at local and regional levels (Brunet et al., in press; Phillipson et al, 2014; Rusike et al., 2014).

In our study, we propose an adaptable and quantitative approach to assessing the impacts of research on stakeholder development. Focusing on the broad case of Arctic[4] science, we aimed to identify the kinds of change that generally result from research partnerships in developing area contexts using a capital assets approach. Our aim was to better understand the process of local engagement in Arctic research and the perceived impacts on stakeholders. More specifically, we assessed whether the capital assets approach has the potential to both capture the subtlety of social and cultural interactions and provide a more generalizable framework for better understanding change through research partnership, building upon previous work on evaluating stakeholder participation in research (Arnstein, 1969; Rowe and Frewer, 2000).

5.1.1 Case Study: Arctic research in Canada

The Canadian Arctic occupies approximately 50% of the country's landmass and accounts for two thirds of its coastline, but is home to only one percent of the population. It is home to Northern Aboriginal peoples, who comprise approximately half the population in this region (Graham and Fortier, 2005). It is a unique and sensitive environment, facing unprecedented

[4] We use Arctic and Northern interchangeably in this paper recognizing that Northern may also refer to sub-Arctic regions of Canada.

social, physical, and environmental challenges (Furgal and Seguin 2006; Pearce et al., 2009). Many studies have found that communities within this region fall behind in terms of development as they are challenged with issues regarding health among young and vulnerable groups, socio-economic inequities, struggling local economies and land and resource use conflicts (Abele, 2009; Andersen and Poppel, 2002; Christensen, 2011; Furgal and Seguin, 2006; Lyons, 2010; Oosten and Laugrand, 2002; Suluk and Blakney, 2009; Young and Mollins, 1996). Government statistics also reveal that many individuals and communities struggle with high levels of unemployment, lack of safe drinking water, limited housing infrastructure, and physical health problems conventionally associated with developing areas (Bjerregaard et al., 2004; Christensen, 2011; Parlee and Furgal, 2012; Wootton and Metcalfe, 2010; Young and Mollins, 1996). Many of these, often traditionally based, communities are faced with issues of chronic poverty that are rooted in Canadian histories of colonialism and socio-political marginalization (Parlee and Furgal, 2012).

Northern communities have long considered the lands and resources around them as key to their well-being (Parlee and Furgal, 2012). Scientists, in this context, are being increasingly asked to reconcile the outcomes of research with the socioeconomic reality of the Arctic. Parlee and Furgal (2012) argued that this could allow research to contribute to local capacity building and the well-being of residents and research partners. In this context, Arctic science is being recognized as a vehicle for socio-economic development in this region (Bielawski, 1984; ITK, 2002; Graham and Fortier, 2005; ITK and NRI, 2007; Wolfe et al., 2011). The engagement of community stakeholders has been a defining feature of Arctic research (Bocking, 2007; Chitty and Elton, 1937). However, many challenges related to the quality of participatory strategies, the lack of shared benefits being accrued and the lack of recognition of the important work done by local partners persist (Brunet et al., 2014a; Gearheard and Shirley, 2007; ITK, 2002; ITK and NRI, 2007; Pearce et al., 2009).

There are differing views regarding the benefits of participatory strategies within the scientific community. Phillipson et al. (2012) found that some scientists believe that stakeholder engagement in knowledge generation can be a distraction or undermine scientific integrity. Some believe that balancing scientific rigor with relevance to community needs presents many difficulties (Wulfhorst et al., 2008). It has also been argued that the generation and application of

knowledge and development are best maintained as separate processes that require different approaches to assess their success or usefulness (Phillipson et al., 2012). An alternative view is that the generation, diffusion and use of scientific knowledge should be an integrated and iterative process that draws expertise from multiple sources (Phillipson et al., 2012, Raymond et al., 2010).

Independent of these challenges, research in the Canadian North presents particular circumstances, (including weak local economies, colonial histories and high levels of reliance on local natural resources for subsistence) that warrant a reflection on the role science plays in local development. Recognizing this, we used a capital assets approach to examine the contextual nature of the research process, largely overlooked by research policy and research stakeholders, moving the focus away from process to outcomes.

5.2 Methods

5.2.1 Data Collection

Data were collected through an online survey of Northern research stakeholders in Canada. This study used the same survey tool described in Chapter 4 (see Appendix 4.1 for the rest of the questionnaire). We invited 178 potential respondents and received 49 partial and 39 full responses for a satisfactory response rate of 22%. Participants were identified using online searches, phone calls to key research organizations, governments and other agencies, and through networks such as ArcticNet and International Polar Year. Coverage bias (Sue and Ritter, 2012) was limited by selecting for a broad representation from all groups identified in our research and the literature. We did not, however, obtain equal representation in all groups. Certain groups were therefore over represented within the sample (see section 5.4.1 for details). We acknowledge this in drawing our conclusions.

The first section included biographical information which we analyzed using descriptive statistics. The other section of the survey, the capital assets assessment, included two Likert type scales (Likert, 1932). Likert scales were used because they have been found to be effective in measuring questions related to attitudes, beliefs and/ or behaviours (Folz, 1996; Gerring, 2004). In the first part of our capital assets assessment, participants were asked to give a pre-research score from 0 to 5 (5 being a very high level of asset, 0 being no asset) for all five assets for both

community and academic stakeholders (Fig. 5.1). In the second section respondents were asked to give a score from -5 to +5 (-5 being a very high loss of that asset, +5 being a very high gain in that asset), for the five asset categories for both researchers and community stakeholders (Fig. 5.2). This tool allowed us to quantify perceived changes in asset categories as a result of research partnerships based on the experiences and understandings of our respondents. These numerical scales were combined with prompts from each asset category (see Figs 5.1 and 5.2) in order to reduce response bias (Rooney et al., 2004). Response bias was also reduced by providing context for the questions being asked although eliminating all forms of bias in rating scales that contain numbers has been found to be challenging (Schwarz et al., 1991). Schwarz et al. (1991) found that in rating scales containing numbers, numeric values can change the meanings of the scale descriptors. We tested these issues via pre-testing of the questionnaire.

Because our n was not equal throughout the study, we also tested for non-response bias in order to assess respondent characteristic changes throughout the study (Sue and Ritter, 2012). Non response bias was tested by comparing average results for all socio-geographical indicators from those who responded to first set of questions on initial assets levels (n=49) and those who responded to assets change level questions (n=39). Based on the results of a Welsh two sample t-test in the program R, we found that differences between groups were not statistically significant with a p-value of 0,995 with a confidence level of 95%.

5.3 Results

5.3.1 Respondent profile (n=49)

Our respondent profile is described in detail in Chapter 4. In summary, our respondents were 53% female, 47 % male, 45% had more than 16 years of experience in Northern research. Most of the respondents identified as university researchers (48%) with 25% residents of Northern communities, 20% identifying as community researchers and over 30% as university students. There was also representation from NGO's and local organizations (10%). Respondents were engaged in research activities throughout the Canadian North with a large portion in Nunavut, Northwest Territory and Yukon Territory but there was also representation from the other provinces with Arctic or sub-Arctic regions (Ontario, Manitoba, Quebec, Newfoundland and Labrador, Alberta).

5.3.2 The development of capital assets through research partnerships

We asked respondents to identify the pre-partnership asset levels for each of the five capital asset categories for both researcher and community stakeholders on a scale from 0 to 5. Overall, researchers were rated as having a higher initial asset level (2.98) than their local counterparts (2.78) although these values were not significantly different (p-value=0,332) (Table 5.2). Community assets were scored as follows (high to low): human, natural, social, physical and financial. Researcher assets were scored as follows (high to low): financial, human, physical, social and natural.

We then asked respondents to quantify the changes in capital asset levels based on their experience as part of research projects and/or their career in Northern research (Table 5.2, Fig. 5.3 and Table 5.3). Overall, our results indicate very low to moderate perceived positive changes in all categories for both stakeholder groups. Figure 5.3 shows six boxplots comparing the perceived change for all asset types for both communities and researchers, as well as an overall analysis. Respondents indicated that the highest changes in assets were in human and social capital for both groups. The human capital category was the only asset where researchers gained statistically more than community partners (p-value=0.00735, see Table 5.3) although researchers were perceived to gain more social capital as well. Communities were perceived as gaining more in terms of financial capital than researchers.

By obtaining an initial and change asset score, we were able to calculate a post–research partnership score (Table 5.2). Community partners received a lower overall score (4.03) than academic partners (4.56) although the difference between these values was not significant (p-value=0.09). Post-research partnership community assets were scored as follows (high to low): human, social, physical, natural and financial. Post-partnership researcher assets were scored as follow (high to low): human, social, financial, physical and natural.

Overall, our results suggest that research partnerships likely change the hierarchy of assets for partners (Table 5.4) and that these can be evaluated by stakeholders. Social capital was the only asset category to increase relative to other asset types for both groups. For communities, physical assets moved to a higher rank while natural capital went down by two positions. Human and financial capital remained in the same position. For researchers, human capital became the top

asset while financial dropped from the top position to the third. Physical assets dropped from third to fourth position. Natural capital stayed in the bottom position.

5.4 Discussion

In this study, we sought to better understand the transformative effects of scientific research partnerships on communities and researchers. Inspired by the research for development framework, our findings indicate that indeed, research partnerships are perceived as contributing to stakeholder development and that the capital assets approach can provide an interesting approach to characterizing and assessing this change. Using this approach and the results of the present study, we propose a conceptual framework for assessing community researcher partnerships (Figure 5.4).

The framework (Figure 5.4) is divided into three main sections: context, process and outcomes. The context represents the pre-research program level of assets. Context capital assets are the foundation upon which partnerships are built (Greenfield and Home, 2006). The process component represents the research partnership process from initial talks to project end, and is represented by the intersection of initial assets. The joining of assets in research (process phase) represents an exchange or a contribution of key strengths by both groups to the partnership. The asset levels in the outcomes phase are the addition of initial assets and the change in assets (see results Table 5.3). Initial assets are represented by the dashed line. Full lines are the final asset levels. Between the outcomes asset radar charts is the change in assets for both partners. In this example, we can see that researchers gain more in most categories than community partners. The framework also provides a visual representation of the post research phase. Given that development is an iterative process, we represent this phase by a hypothetical feedback loop.

5.4.1 The capital assets framework as an assessment tool

Rowe and Frewer (2000) identified the need for a more comprehensive set of criteria for determining whether a public participation mechanism is successful. Often the main problem in the evaluation of participation methods has been the absence of optimal benchmarks against which they might be compared and measured, arising in part, because of confusion over what is meant by ‘effectiveness’ or ‘success’ (Abelson et al., 2003; Rowe and Frewer, 2000).

Taking a capital assets approach avoids many of the issues that can arise when focusing on the quality of the process or outcomes, instead providing adaptable project or program 'spheres' of influence that can be quantified using agreed indicators (see Bennett et al., 2012). Success, for instance, may be defined as the perceived increase of certain asset categories to pre-agreed levels by researchers and community partners. As such, we build upon the works of Bebbington (1999) and Sen (1997) as well as earlier works by Habermas (1971) that claim that assets are not simply ways of making a living or resources, but foundations upon which people give meaning to the world around them.

Going beyond much of the research for development literature, we argue that research for development projects need to be conceptualized beyond the application of technologies or resolving a specific local issue (see Rusike, 2014) to include all applied research activities occurring in developing area contexts (see Brunet et al., 2014a). For instance, global climate change research, which plays a prominent role in the Arctic, can offer important insights for local adaptation, development and planning (Brunet et al., 2014a; Pearce et al., 2009). While previous studies do point to the potential for research to act as a vehicle for reducing poverty, improving nutrition and the sustainable management of natural resources (Renkow and Byerlee, 2010; Rusike, 2014), there remains many questions about the quality and credibility of research impact (Barrett et al., 2009).

5.4.1.1 Criteria for assessing research for development partnerships

Our proposed evaluative framework is based upon three main criteria: complementarity of initial assets (context), change in assets as a result of research (outcomes) and strategies for post research maintenance and enhancement of assets (post research pathways). As previously mentioned, our approach does not focus on procedural considerations and instead focuses on research for development outcomes (Rowe and Frewer, 2000). Acknowledging that no two partnerships share the same characteristics, these criteria are adaptable and move beyond early empirical evaluations of engagement and participatory methods which generally involved documenting how a particular method was used, what results were obtained or whether methods incorporated certain characteristics, with implications for effectiveness (e.g., Abelson et al., 2003; Crosby et al., 1986; Fiorino, 1990; Lynn and Busenberg, 1995; Smith et al., 1997; Webler, 1995). Such an approach fits within the Asset-Based approach to Community Development

(ABCD), which emerged from community development work in the US as an alternative to the previous needs-based focus of community development practice which was critiqued as being overly negative, deficiency-oriented, and degenerative (e.g., Kretzmann and McKnight, 1993, Green and Haines, 2002).

Criterion 1: Complementarity of initial assets

This first criterion requires the establishment of baseline assets, considered an important step in development literature (Greenfield and Home, 2006). Rowe and Frewer (2000) found that contextual factors interact with characteristics of research methods in determining the effectiveness of research partnerships. Such factors have been discussed in the literature, such as informal decision making processes, relationships of trust, local networks, local infrastructure, local governance, mechanisms for participation, academic incentives and funding programmes (Brunet et al., 2014a; Nelkin and Pollak, 1979). According to Rowe and Frewer (2000), identifying and characterizing the context of research is also important in directing the choice of participatory methods used in research partnerships.

The complementarity criterion assumes that, when engaging in partnerships, scientists and communities should be able to achieve objectives that neither could achieve alone (Googins and Rochlin, 2012). Googins and Rochlin (2012) suggest that effective partnerships emerge from projects that are designed to both understand the strengths and weaknesses of participating groups and find ways in which the strengths of one can be brought into the partnership to overcome the weaknesses of the other. Recognizing and creating mutual gain through the complementarity of assets and liabilities has the potential to sustain partnerships in a way more meaningful to both parties.

We propose that agencies that fund research, or institutions that regulate research and access to local stakeholders, may benefit from taking a capital assets approach to assessing the potential complementarity of research partnerships using, for example, surveys, interviews and focus groups. This could be of particular interest to such agencies that seek to improve the efficiency of partnership development by pre-emptively assessing potential for success. These initial values might also provide a type of baseline from which to assess perceived capital asset development over time, which could be done periodically.

Based on our purposive survey of Arctic research stakeholders, there appears to be a generally strong complementarity in terms of perceived financial and natural capital assets (Fig. 4) between communities and researchers. This is not surprising given that much of the research in the Arctic is related to certain ecosystems, landscapes or species. Researchers search for specific areas to conduct their research relying on critical local natural capital. Communities, in turn, use financial capital obtained through research (employment, for instance) for local development. Somewhat surprisingly, our generalized study did not reveal much perceived complementarity in other asset categories. Applying the framework to a specific research partnership would likely reveal more subtle differences in asset categories and this is an area that requires further research.

Criterion 2: Change in assets as a result of research

The second criterion of the framework involves conducting the same assessment test after a specific project is completed to obtain perspectives and assess changes in asset levels. Like in Rowe and Frewer (2000), there is a focus here on assessing outcomes with asset changes as indicators. Positive changes in asset categories become an indicator of the level of success or effectiveness of the partnership. Explicitly developing and agreeing on the desired targets in terms of asset change will be an important objective of future research. Further, a lack of professional incentives has been identified as an important limitation to researchers investing in long term and effective partnership strategies (Bruns et al., 2011; Votruba, 2011). Using a capital assets approach to evaluating research partnership outcomes may provide such an incentive and allow successes to be better identified and celebrated.

In the present study, general gains in human and social capital as a result of research partnerships were perceived to be the highest. Our results indicate that human and social capital assets were seen as benefiting the most from research partnerships for both researchers and community stakeholders. There has been a strong emphasis on the relationship between social capital development and the success of partnerships and collaboration in the literature, sometimes classified as the intangible outcomes of partnerships (Bebbington et al., 1999; Bennett et al., 2012; Brunet et al., 2014a; Christopher et al., 2008; Klenk and Hickey, 2013; Sandler and Lowny, 2006; Taylor, 2000; Turpin and Garrett-Jones, 2009). Further collaborative work would

be required to contextualize the specific measures of social and human capital assets for each particular partnership project.

Criterion 3: Strategies for post research maintenance and enhancement of assets

In our study, as well as in the broader literature on research partnerships, it has been identified that partners often diverge and communication declines or terminates once a research program has ended (ITK and NRI, 2007; Phillipson et al., 2012). This can be considered a weakness of competitive research funding mechanisms, often based on 3 to 5 year funding cycles which tend to result in a loss of benefits when funding ceases, primarily for local community partners (Brunet et al., 2014a; Phillipson, et al., 2012). Previous research has suggested that it is very difficult for community partners to build upon such research experiences to enhance their assets over time (Davies et al., 2005; Molas-Gallart et al., 2000). Although important, the iterative nature of the research partnership process therefore cannot be easily ensured. As a result, we include a feedback loop in Figure 4, recognizing that this is not typically supported by existing research funding structures.

Brunet et al. (2014a) have suggested that an important contributor to research saturation, research fatigue and cynicism, identified as the principle limitations to partnership success in an Arctic research context, may be a lack of tangible long lasting benefits to the community. The challenge therefore lies in the development of strategies for the maintenance of these benefits over time as well as methods to evaluate their effectiveness. Phillipson et al. (2012) found that it is very difficult to assess how enduring the impacts of research partnerships are for stakeholders. In fact, a number of studies have found that longer-term impact analysis faces potentially insurmountable difficulties, perhaps none more so than the challenge of attributing effects back to specific research programs or methods (Davies et al., 2005; Molas-Gallart et al., 2000). Phillipson et al. (2012) therefore suggest that an assessment of early effects may be best suited to understanding causality before clear links are lost. Regrettably, this runs counter to the prevailing consensus among researchers and funding organizations in many countries, such as the United Kingdom, which suggests that impact analysis should be left until many years after a research project has ended (Phillipson et al., 2012). It is also counter to research impact analysis in Canada, which in many cases is limited to publication output conducted numerous years after the

end of a program (e.g. Policy and International Relations Division, Natural Sciences and Engineering Research Council of Canada, 2007).

This raises an important question for those agencies promoting research partnerships for development; if the maintenance of researcher-community relationships is essential for the effective use of science as a vehicle for development and environmental management at the community level, then is there a way for funding mechanisms to enable longer-term security, essential for partnership development, without undermining scientific principles of competition and excellence? Providing specific funds for community-researcher partnership development may not be the solution. In a review paper by Israel et al. (1998) in the public health field, they found that in instances where funders altered their normal priorities and funded community-based research efforts, the expectations and parameters associated with a more traditional research paradigm often still applied. Funding sources had deadlines for grant submissions that did not allow the time needed to develop trusting working relationships and collaborative applications, and time frames for conducting effective community-based research were not well-supported. This was further compounded by short-term expectations at the university level. Further, although some long-term research programs have been successful, Lindenmeyer and Likens (2009) found that many are poorly planned and unfocused. Importantly, long-term funding programs can limit opportunities for new scholars or communities with new questions to access funds and may lead to "rich get richer" scenarios in the research community and among local partners. On the other hand, short term cycles may allow for more partnerships to develop but with important implications for impact, effectiveness and success. There is clearly no easy solution to this issue. Further research into research policy for effective community-researcher partnership within the 'research for development' paradigm is needed.

5.5 Conclusion

Researchers and practitioners have been emphasizing the importance of community engagement in research and planning for decades. This has provided important insights into participatory methods and tools for effective partnerships in research. Building upon this rich history, research for development emphasizes that scientific activity can act as an engine for development. Here, we sought to better understand the transformative effects of scientific research partnerships on communities and researchers using a novel capital assets framework. The usefulness of this

approach to assessing partnership effectiveness and success highlights the contextual nature of partnerships in science. We believe that the evaluation of partnership success would benefit from focusing on outcomes, not specific methodologies, which could then be adapted to the local context or program level requirements. Overall, we found that the capital assets framework has the potential both to capture the subtlety of social and cultural interactions and to provide a more generalizable framework within which to better understand change through the research partnership. Our results also suggest that researchers generally benefit more from research partnerships than their community counterparts, but that both groups gain the most in terms of human and social capital. Our approach to assessing community-researcher partnerships in science is based upon three criteria: complementarity of initial assets, change in assets as a result of research and strategies for post research maintenance and enhancement of assets. These criteria highlight the contextual nature of partnerships by focusing on the assessment of baseline assets for stakeholders and measuring perceived change as a result of the research and partnership process. They also highlight the importance of maintaining benefits over time through the provision of continuity between research programs, found to be a major contributor to the prevention of research saturation in local community partners.

Acknowledgements

We would like to thank the participants for completing the survey and providing us with valuable information to test our framework. Nicolas D. Brunet`s research is funded by the Fond Québécois de Recherche sur la Science et la Culture and the NSERC Northern Research Chairs Program (M.M. Humphries).

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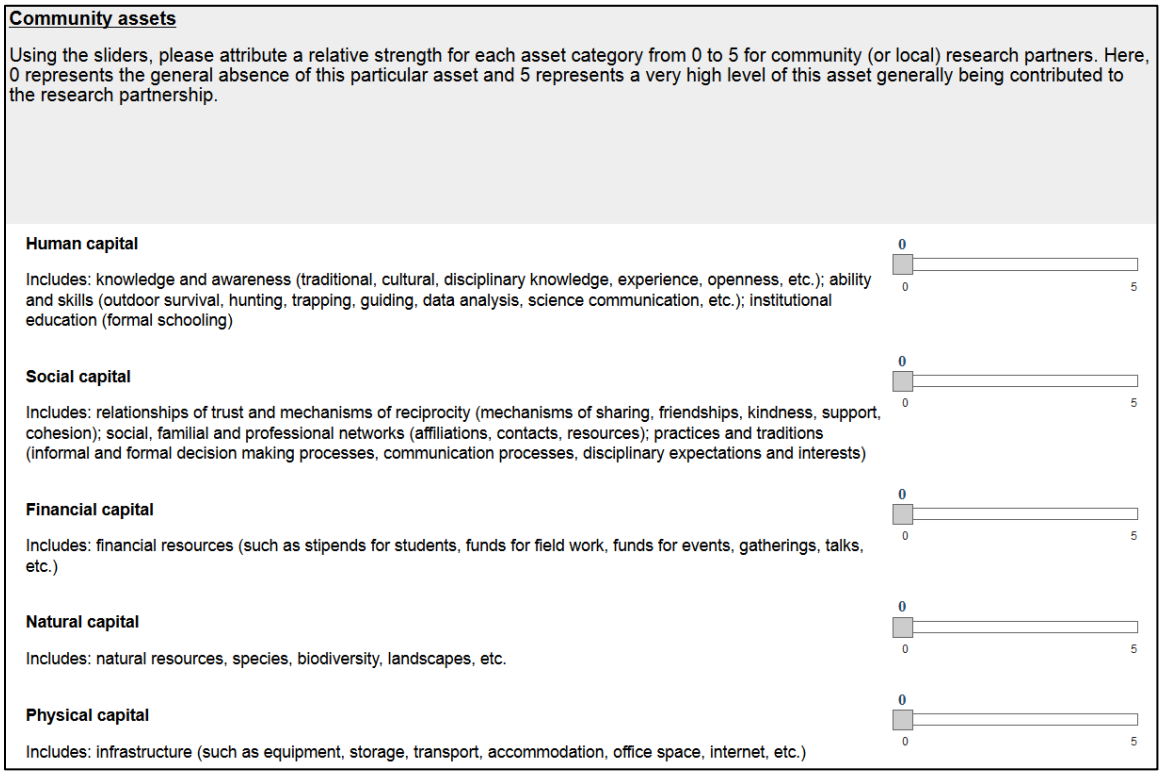

Figure 5.1 Initial asset level question from the survey with slider from 0 to 5 (Community)

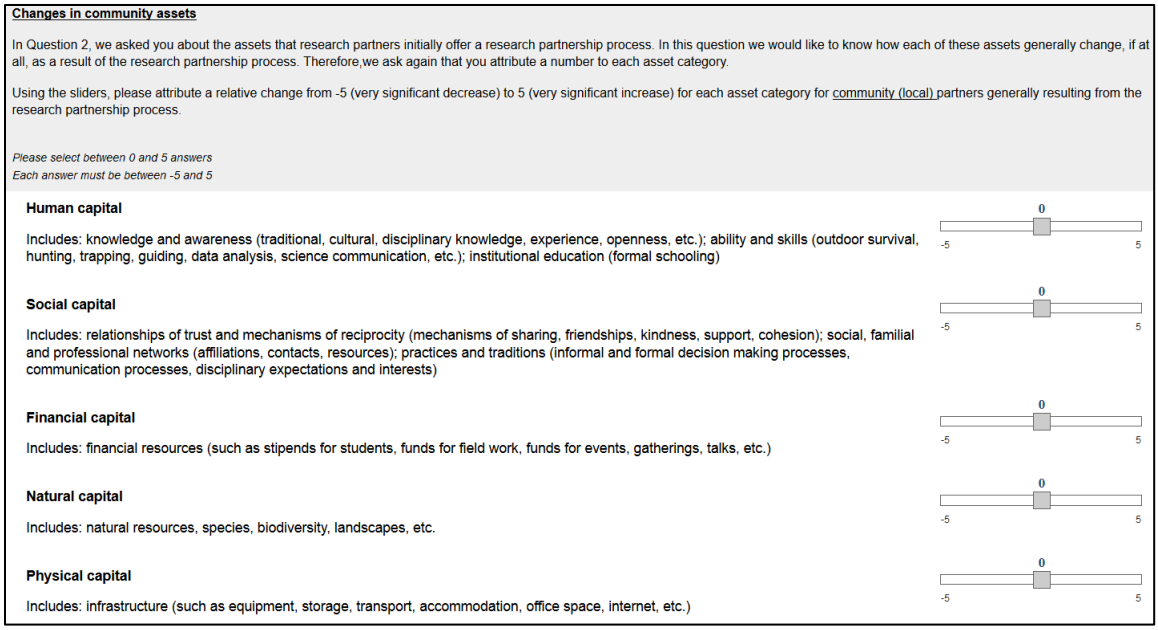

Figure 5.2 Asset change question from the survey with scale from -5 to 5 (Community)

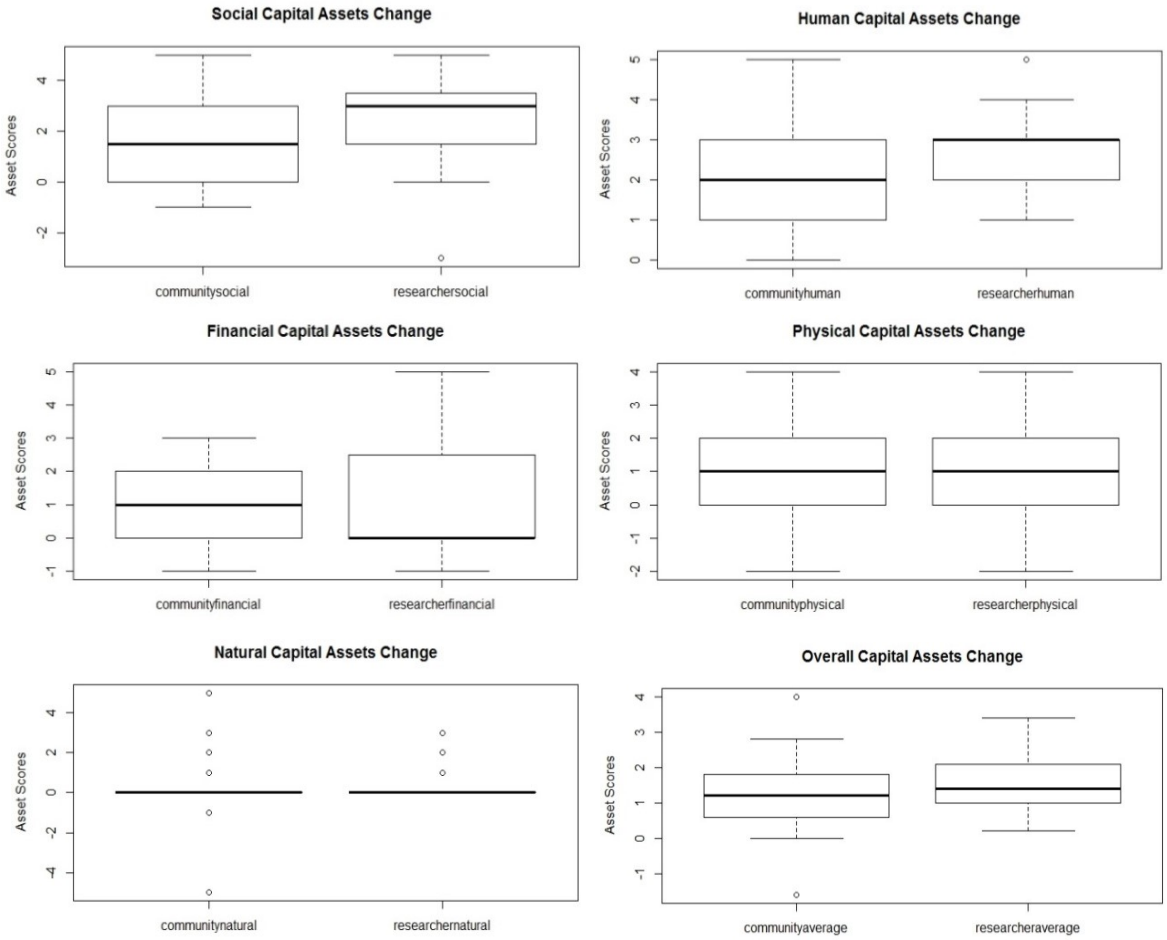

Figure 5.3 Boxplots comparing asset level changes for community and researcher partners for all asset categories

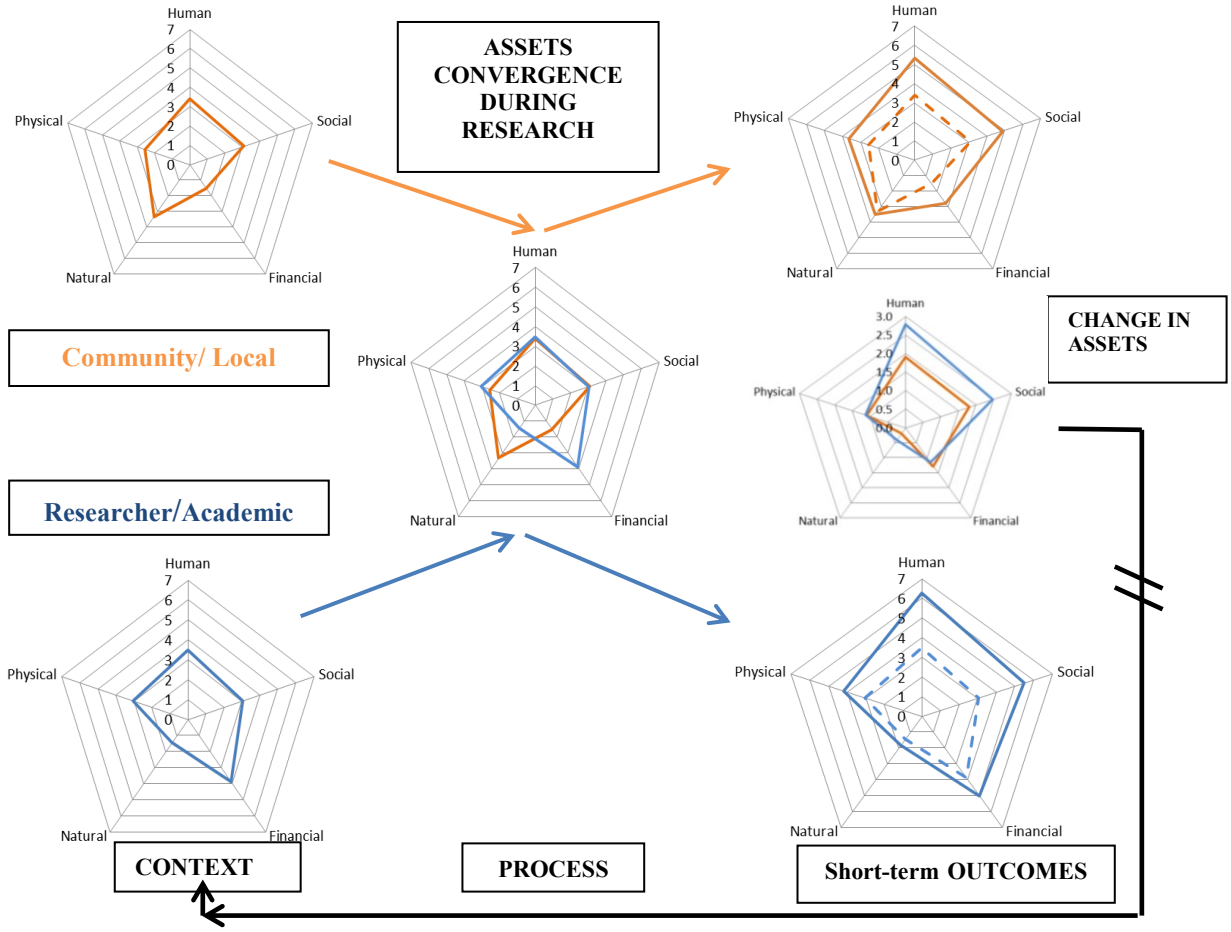

Figure 5.4 An assets-based framework for community researcher partnerships.

Table 5.1 Important definitions used in the survey for asset types.

Asset categories	**Definitions and examples from the survey**
Human capital	Knowledge and awareness (traditional, cultural, disciplinary knowledge, experience, openness, etc.); ability and skills (outdoor survival, hunting, trapping, guiding, data analysis, science communication, etc.); institutional education (formal schooling)
Social capital	Relationships of trust and mechanisms of reciprocity (mechanisms of sharing, friendships, kindness, support, cohesion); social, familial and professional networks (affiliations, contacts, resources); practices and traditions (informal and formal decision making processes, communication processes, disciplinary expectations and interests)
Financial capital	Financial resources (such as stipends for students, funds for field work, funds for events, gatherings, talks, etc.)
Natural capital	Natural resources, species, biodiversity, landscapes, etc.
Physical capital	Infrastructure (such as equipment, storage, transport, accommodation, office space, internet, etc.)

Table 5.2 Mean scores of the capital assets analysis

Assets	community before n=49	community change n=39	community after	researcher before n=49	researcher change n=39	researcher after
Human	3.41	1.91	5.31	3.47	2.78	6.25
Social	3.08	1.81	4.89	3.04	2.47	5.51
Financial	1.51	1.28	2.79	3.88	1.16	5.03
Natural	3.33	0.19	3.51	1.43	0.41	1.83
Physical	2.55	1.09	3.64	3.06	1.13	4.19
Mean	2.78	1.26	4.03	2.98	1.59	4.56

Table 5.3 Mean asset change and p-values

Assets	**Mean community change**	**Mean researcher change**	**p-value**
Human	1.91	2.78	0.00735*
Social	1.81	2.47	0.115
Financial	1.28	1.16	0.724
Natural	0.19	0.41	0.468
Physical	1.09	1.13	0.927
Overall	**1.26**	**1.59**	**0.172**

*significant difference with 95% confidence level (n=39)

Table 5.4 Hierarchy of assets

Community		**Researcher**	
Pre research	**Post research**	**Pre research**	**Post research**
1 human	**1 human**	1 financial	**1 human**
2 natural	**2 social**	2 human	**2 social**
3social	3 physical	3 physical	3 financial,
4 physical	4 natural	4 social	4 physical,
5 financial	5 financial	5 natural	5 natural

6 General Conclusion

Scientific research fundamentally seeks to advance our knowledge of systems, phenomena, organisms, peoples, cultures and traditions through careful and systematic observation and experimentation (Chalmers, 1976). Evolving yet stringent methodological traditions in physical and social sciences have aided researchers to move beyond speculation and opinion in generating novel ideas and theories about the world around us (Chalmers, 1976). In recent decades, it has been suggested that this traditional mission of science emphasizing knowledge production is increasing being shifted towards research regarding the application of this knowledge and understanding its impact on stakeholders (Etzkowitz and Leydesdorff, 2000; Gibbons et al., 1994). In the context of Northern science in Canada, territorial governments and communities have formalized many processes for engagement with local stakeholders, finding that important issues related to power, ownership, control and access have often been overlooked by mostly well-meaning researchers (ITK, 2002). Much of the community push for greater engagement is likely not directly the result of science per say, but rather the abuses of colonialism, which continue to permeate researcher-community relationships in Northern Canada today.

The push for further local engagement in science has been coupled with increasing claims of a new research paradigm in Northern science, based primarily on important researcher reflections and experience and government reports (e.g. Graham and Fortier, 2005; Pearce et al., 2009). We sought to go beyond these studies to empirically assess claims of a new research paradigm in Northern science through a 'Mode 1' versus 'Mode 2' classification of scientific articles published in the journal *Arctic* as well as three other leading polar science journals over time. We found that the shift toward Mode 2 Northern research has been small and scattered, with Mode 1 approaches continuing to dominate. Where Mode 2 approaches were found to have emerged, it was correlated with the increased involvement of Northern organizations and the increased prevalence of life sciences research focused on harvested wildlife and social sciences research focused on contemporary people. Therefore, our study supported the view that local people are becoming more involved in science, but also suggested that the nature and level of this involvement remains limited and varies systematically among disciplines, organizations, and regions. However, our characterisation of this change indicates that Northern stakeholders have

reason to be concerned about their level engagement and the recognition they receive as co-researchers and participation in scientific research.

How then, may a new research paradigm focused on pragmatism and democracy in knowledge production be achieved in the North? Our case study of the YNNK project revealed that certain key factors need to be considered in the development of effective and meaningful community-researcher partnerships in natural science research. Important factors were both context and process-related and included funding and performance assessment processes, leadership and capacity at the community level, the proposal development and research design strategies, and the timing and perceived transparency in results dissemination. This was consistent with other empirical studies within and beyond Northern Canada (Garnett et al., 2009, Phillipson et al., 2012; Tsouvalis and Waterton, 2012). While we recognize that the context in which the YNNK research proceeded had important implications for the success attributed to this process, it was also clear that if policy makers, researchers or communities are to reproduce this level of engagement, that there is a need for resources to allow for local stakeholders to remain aware of funding opportunities and communicate their research agendas to potential academic collaborators. We found it to be critical that communities be empowered to initiate projects related to questions of relevance to them. Innovative mechanisms for such processes need to be explored further. This study also revealed that researchers and local stakeholders strongly valued the informal interactions that are often not part of the research process in natural science. This time spent in the community was seen as highly valuable in the development of local networks and friendships and played an important role in building the human and social capital of stakeholders. This component is often overlooked in empirical work on participatory research but has been mentioned in informal guides in Northern Canada (e.g. ITK, 2002; ITK and NRI, 2007). We believe that funding mechanisms and academic programs would benefit from allowing for longer stays in communities and incentives or rewards could be further developed to promote such activities. However, such strategies do not come without complications, including a lack of reliable and agreed upon assessment tools for engagement, an overall financial climate of austerity and a global academic system which still favours high levels of productivity, often in the form of publication output, over outreach and stakeholder engagement.

This thesis has also revealed that the outcomes of the partnership strategies used by those involved were numerous for both academic and community stakeholders and went beyond the more tangible financial benefits, including employment and training, which have often been the focus of previous studies in the North (ITK and NRI, 2007; Kruse et al., 2004; Pearce et al., 2009). Our results suggested that the benefits of engaging in research partnership activities were more far-reaching than previously reported, including outcomes such as legitimizing knowledge systems and aiding in the integration and mutual understanding of science and local or traditional forms of knowledge. Overall, there was a sense that the YNNK research program could not have been achieved without the dedicated involvement of both community and researcher groups and that, in the end, the knowledge produced was more applicable and relevant locally because of the nature of the partnership. This relevance to local issues was possible even though the YNNK sought to address large-scale issues related to environmental change. We also found that this partnership offered the potential for science to become a vehicle for enhancing the social capital of participating stakeholders. We believe that these intangible benefits of community researcher partnerships in science need to be further explored in future research.

As a means to move beyond a single case study and provide opportunities to develop broader theories and inform policy regarding community participation and partnership development in Arctic science, we tested many of our emerging findings using a national survey of research stakeholders in Northern Canada. Overall, we found that researchers were perceived to benefit more from research partnerships than their community counterparts, suggesting that research partnerships in science need to be better supported by policies and frameworks that focus on building social capital and equity between partners in the research process. This is supported by the growing dissatisfaction in Northern communities regarding the outcomes of research (ITK, 2002). Research in other fields also suggests that social capital is a critical precursor to and outcome of partnership development (Christopher, 2005; Christopher et al., 2008; Fisher and Ball, 2003; Smith, 1999; Weaver, 1997). Our results suggest that this dissatisfaction may be overcome through the early engagement of stakeholders in research design and objective setting phases, the employment of community researchers, and engagement in and transparency of results dissemination strategies, which was also corroborated by the findings of Chapter 3 and to varying degrees in empirical studies in other contexts (Garnett et al., 2009; Phillipson et al.,

2012). Overall, we found that successful community-researcher partnerships in Northern science will ultimately require greater decentralization of power to strengthen social capital. This could be achieved by allowing non-academic principal investigators to receive funding for science, or by involving communities in research priority-setting, proposal review and funding allocation processes through councils or advisory groups.

Fundamentally, this dissertation reveals that research and research partnerships can play an important role in the socio-economic development of remote Northern communities. Using the research for development framework (Ashbi, 2003) combined with a capital assets approach (Carney, 1998, Chambers, 1997, Scoones, 1998), we conceptualized a way in which the impacts of Northern research on stakeholders can be assessed. Again, our results suggested that researchers generally benefited more from research partnerships than their community counterparts. However, we found that both groups gained the most in terms of their human and social capital. We also offered an approach to assessing community-researcher partnerships in science based upon three criteria: complementarity of initial assets, change in assets as a result of research and strategies for post research maintenance and enhancement of assets. These criteria, unlike many previous studies (Abelson et al., 2003; Crosby, et al., 1986; Fiorino, 1990; Lynn and Busenberg, 1995; Smith et al., 1997; Webler, 1995) highlighted the contextual nature of partnerships by focusing on the assessment of baseline assets for stakeholders and measuring perceived change as a result of the research and partnership process. This focus on context over process in the assessment of participatory research is corroborated in important work by Rowe and Frewer (2000). It also highlighted the importance of maintaining benefits over time through the provision of continuity between research programs, found to be a major contributor to the prevention of research saturation in local partners in Chapter 3.

Overall, efforts in governments, universities and other organisations to increase community participation and promote effective partnerships in Arctic science need to better recognize the diversity of research interests and approaches of local and academic researchers, and therefore, avoid one-size-fits-all solutions. There will likely always remain circumstances in which research priorities and approaches do no align well with local community priorities. Our experience of the last five years in studying this topic and multiple discussions with experts and stakeholders in the field of Arctic research, suggest that in some situations engagement may not

be useful or appropriate for the advancement of our understanding of phenomena even though contemporary Northern research aspires to provide benefits to local communities. Some researchers and research domains can effectively do both, others cannot. Given the importance of the North as an early indicator of the impacts of global environmental changes on people and their environment, we believe that finding this balance in research aspirations, approaches, and expectations will be one of the challenges, but also the major contribution, of Arctic science to western research and its evolution over the coming decades.

6.1 General summary

This thesis was directed at understanding and exploring stakeholder participation in Northern science, primarily in Canada. A detailed literature review revealed that many researchers both in government and academia claim that Arctic science has experienced a paradigm shift which included an increased emphasis on local engagement. However, few studies have empirically tested this claim.

To test this claim, we performed a meta-analysis of the articles published in the journal Arctic from 1965 to 2010 in order to characterize and assess the extent to which local stakeholders are participating in scientific research (Chapter 2). This study used the Mode 1- Mode 2 framework to structure the analysis. We found that shifts toward Mode 2 research approaches over time have been modest and gradual and that Mode 1 continues to predominate Arctic science. Local involvement in research varied systematically among disciplines, organizations and regions.

We then conducted an in-depth case study of a Northern research partnership in order to better understand the mechanisms that promote or inhibit partnership processes in Arctic science (Chapter 3). Our results identify important contextual as well as procedural aspects that could be prioritized in Arctic research policy and practice attempting to develop successful partnerships. Given that this was a single case study, it was critical that we further explore these findings with the broader Arctic research community in Canada.

We subsequently conducted a national survey of arctic research stakeholders across Canada to examine the factors and outcomes that affect research partnerships (Chapter 4). Ultimately, partnerships success was associated with trust, emphasizing the need for policy to better focus on social capital development within the research partnership process. Inspired by the literature on research for development and the capital assets approach, we also conceptualised and assessed Northern research partnerships and outcomes using the national survey (Chapter 5). We found that the capital assets approach offered insight on the contextual nature of research partnerships, moved away from process related issues and enabled change in asset levels to be assessed.

6.2 Future Directions

Based on this study of stakeholder participation and partnership development in Northern science, we identified three main areas that would benefit from further study.

First and foremost, we identified that the required decentralisation of power within the highly centralized support system for academic research poses complex issues for research policy that support local engagement. There is, therefore, a need for further research into the mechanisms by which policy institutions can reduce the situation of resistance and opposition by local stakeholders to researchers and research, in general. This situation, as described in Chapters 3, 4 and 5 inhibits the development of bridging and bonding social capital, found to be critical in research partnership development. Instead, local, regional and federal policy needs to better foster a spirit of stewardship and collaboration. For instance, studies of the potential for First Nation and Inuit advisory committees for the review of research proposals at the federal level could be conducted. Researchers could explore if these committees actually serve the purpose of influencing research priorities at the national level or if they are merely tokenistic in nature. The ways to achieve more effective stakeholder partnerships through improved policy are not clear and may reveal that such policies are not the appropriate avenue for attaining this goal.

Second, an important structural element of the research process that inhibits research partnership is the lack of recognition of the importance of this work conducted by researchers and community stakeholders. For researchers, a capital assets based tool would benefit from further testing and refinement. In particular, better, more specific criteria need to be explored and tested to better identify the subtle impacts of research and partnership success. Such an assessment tool could also be used to study the long term outcomes and impacts of research on partner communities that have various research histories. For funding agencies, similar studies could be conducted to better understand the potential of a capital assets approach for pre and post assessments of partnerships or for better matching researchers with potential host communities and assessing partnership success.

Overall, our research has revealed that more work needs to be done to understand the importance of and linkages between the different elements that comprise bonding (within stakeholder groups) and bridging social (between stakeholder groups) capital and research partnership development. In particular, the development of trust and reciprocity in situations of chronically uneven power relations and important historical considerations, such as research in the Canadian North, need special consideration. Strategies for overcoming these important barriers will need further consideration.

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Appendices

Appendix 2.1 Detailed results of multiple regression analysis of the Mode score predicted by the five explanatory variables included in our study of the journal Arctic *(1965-2010).*

Response Variable: Context

Adj R^2 = 0.330, $F_{21,1091}$ = 27.02, p < 0.0001

Predictor	Sum Sq	Df	F	P
Intercept	0.822	1	19.313	< 0.0001
Year	0.824	1	19.350	< 0.0001
Year^2	0.828	1	19.441	< 0.0001
Observer	0.560	1	13.154	< 0.001
Region	0.540	5	2.539	0.027
Discipline	16.348	6	64.010	< 0.0001
Organization	2.539	4	14.914	< 0.0001
GlobalChange	0.298	3	2.333	0.073
Residuals	46.440	1091		

Response Variable: Transdisciplinarity

Adj R^2 = 0.266, $F_{21,1091}$ = 20.22, p < 0.0001

Predictor	Sum Sq	Df	F	P
Intercept	0.191	1	3.851	0.050
Year	0.191	1	3.863	0.050
Year^2	0.193	1	3.898	0.049
Observer	0.014	1	0.282	0.596
Region	0.638	5	2.578	0.025
Discipline	14.022	6	47.238	< 0.0001
Organization	2.295	4	11.597	< 0.0001
GlobalChange	0.395	3	2.663	0.047
Residuals	53.975	1091		

Response Variable: Heterogeneity

Adj R^2 = 0.271, $F_{21,1091}$ = 20.65, p < 0.0001

Predictor	Sum Sq	Df	F	P
Intercept	0.161	1	3.917	0.048
Year	0.164	1	3.987	0.046
Year^2	0.168	1	4.083	0.044
Observer	0.026	1	0.622	0.431
Region	0.904	5	4.392	<0.001
Discipline	1.643	6	6.647	<0.0001
Organization	8.226	4	49.928	<0.0001
GlobalChange	0.037	3	0.301	0.824
Residuals	44.936	1091		

Response Variable: Reflexivity

Adj R^2 = 0.276, $F_{21,1091}$ = 21.18, p < 0.0001

Predictor	Sum Sq	Df	F	P
Intercept	0.294	1	4.487	0.034
Year	0.297	1	4.534	0.033
Year^2	0.302	1	4.604	0.032
Observer	1.127	1	17.199	<0.001
Region	0.582	5	1.776	0.115
Discipline	18.550	6	47.177	<0.0001
Organization	2.050	4	7.819	<0.0001
GlobalChange	0.396	3	2.014	0.110
Residuals	71.496	1091		

Response Variable: Non-traditional Quality Control

Adj R^2 = 0.204, $F_{21,1091}$ = 14.56, p < 0.0001

Predictor	Sum Sq	Df	F	P
Intercept	0.130	1	2.013	0.156
Year	0.132	1	2.043	0.153
Year^2	0.135	1	2.088	0.149
Observer	0.000	1	0.002	0.969
Region	0.800	5	2.469	0.031
Discipline	7.439	6	19.133	<0.0001
Organization	4.476	4	17.270	<0.0001
GlobalChange	0.465	3	2.394	0.067
Residuals	70.694	1091		

Appendix 3.1 Complete list of emergent themes and factors

Stakeholder	Context	Process	Outcomes	Challenges
Local stakeholder/ Community	Research history Self government-leadership Local capacity- government personnel Specific gatekeepers Isolation and Community size: Connection to the land; Concerns over youth; Preservation of culture, Understanding of environmental change; Dependence on local aid (cost prohibitive, no adequate training); Isolation makes people more curious about outsiders; treatment of outsiders. Concern over aging trappers and those who use the land traditionally: lowers capacity to respond to needs of researchers. Conflicting lifestyles: traditional vs modern lifestyle Characteristics of the natural environment: access and availability of places of interest. Reputation of academic partners	Early and ongoing communication: Understanding and valuing research objectives; participation in research design; integration of local knowledge; perception of community control over research process. Respect of local culture: Participation in community events; respect of local research process; humility and patience; use of community liaisons; respect for elders.	Relevant knowledge for monitoring and management of environment Training, new skills and professional growth New (for youth) or renewed connection to the land for some Exposure to outside cultures/ people Motivation, inspiration, empowerment Project appropriation Financial rewards Motivation for pursuit of formal schooling Cost sharing and logistical support between scientists and community and among scientists Community cohesion Maintenance of ecological balance of OCF Breakdown of disciplinary boundaries	Cultural / knowledge conflict Power struggles Fear of dependence on outsiders for financial stability Saturation of research Lack of formal youth involvement Lack of local recognition Misuses of funding Overall low community involvement (dissatisfaction)
Researchers/ academic stakeholders	Community interests and motivations Local capacity of individuals and institutions Local gatekeepers Remoteness and isolation: attachment to land and ancestral culture; benefits of delayed exposure to	Time spent in the community. Personality, relationships, friendships Communication Involvement in local events and gatherings Observing cultural protocols Early and on-going	Partnership made research possible: logistics and cost. Experiential or traditional knowledge of natural phenomena: Holistic understanding of conservation; land ethic; connection to land; promotes more respectful and conscientious integration of TK and	False expectations of research Saturation and cynicism Lack of local long term vision of partnership with scientists: place of new knowledge in local sustainability; no clear targets or planning; lack of vision. Local politics, social and

	colonial influence. Unique environment that could allow for multiple projects to occur in different disciplines simultaneously. Local perception and treatment of outsiders. Reward and merit systems, funding, etc. Academic programs Motivation of research directors (PI) and dedication of their students to engagement process.	communication: proposal stage; importance of negotiation in identifying research needs; understanding of research methods including site selection; Adaptation of methods; important factors in regulating power differences and balancing approach to integrating TEK and science. Comfort, integration, acceptance. Results Dissemination Availability of trained local assistants and equipment	science; balances power relations; more accurate and useful results because of conflict between knowledge systems is not neglected. Collaboration between researchers in different fields: professional advancement and training; new perspectives on science; more applicable and accurate results; resource sharing; cost reduction. Adapted communication: local understanding of science enhanced; confidence in researchers; ownership of scientific info produced; legitimacy of science; more local involvement and trust. Better baseline data: knowledge that is considered useful and can lead to strategies for long term sustainability and monitoring. Role models for youth: empowerment; training; capacity building. Model for future research; new perspectives on Northern work; inspiration.	cultural issues, personal conflict. Lack of local trained help; low reliability of assistants; lack of ownership. Loss of academic freedom because of community objectives.

Appendix 4.1 Survey Questionnaire

Exploring Perceptions Regarding Community- Researcher Partnerships in the Canadian North

Canada's Northern research landscape has been changing, from greater use of participatory research methods and more stringent licensing procedures to new ethical requirements. This is challenging both researchers and stakeholders to increasingly consult, employ and communicate with Northern communities and other local agencies. Research funding programs and agencies have now adopted strategies promoting cross-cultural collaboration, public participation and local involvement in science. However, to date, relatively little research attention has been directed at understanding researcher-community partnership processes and outcomes in the North. This study seeks to better understand the benefits and challenges associated with Northern research partnerships in Canada.

The aim in this survey is to build up a picture of the research partnership process from initial contact to project completion with a view to informing future Northern research policy and practice. The findings of the survey should provide valuable insights to the factors that enable or constrain the success of community-researcher partnerships in the North.

We would be very grateful if you would assist us by completing this short on-line survey, consisting of multiple-choice and short answer questions. It should take no longer than 10-15 minutes and is completely anonymous.

Confidentiality:

This is an anonymous online survey. Your responses will not be associated with you or your organization. The results from this survey will be disseminated in the form of a PhD dissertation and publication in peer reviewed journals.

For further information related to the study, please contact Nicolas Brunet, PhD Candidate, Department of Natural Resource Sciences, McGill University, nicolas.brunet@mail.mcgill.ca; +1 514 398 7912; Dr. Gordon Hickey, Associate Professor, McGill University, gordon.hickey@mcgill.ca; +1 514 398 7214; or Dr. Murray Humphries, Associate Professor, McGill University, murray.humphries@mcgill.ca; +1 514 398 7885 If you have any questions

or concerns about your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6831.

Informed Consent:

I understand that my participation in this study is entirely voluntary and that I may refuse to participate or withdraw from the study at any time. I understand that this survey is anonymous and that my name will not appear anywhere in the results of this survey. I consent to participate in this survey.

Please choose **only one** of the following:

- Yes
- No

Section 1:

1. Biographical Information

2 What is your gender?

- Male
- Female

3 What is your age?

- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- 65 and over

4. How many years of experience do you have conducting Northern research or working with Northern researchers in any capacity?

- 0-5
- 6-10
- 11-15

- 16-20
- 21-25
- 26-30
- 30 and over

5 Please select the role(s) that best represent your involvement in Northern research.

Please choose all that apply:

- Federal government representative, employee
- Territorial government representative, employee
- Local government representative, employee
- University researcher (professor)
- Local/ Territorial college professor
- University/College student or post-doc
- Non-government organisation employee
- Other local Northern organisation or association
- Community researcher
- Field assistant/guide
- Funding agency representative
- Community liaison
- Permitting body representative
- Northern community resident/member
- Other:

6 Which provinces or territories have you conducted Northern research in?

Please choose all that apply:

- Yukon Territory
- Northwest Territory
- Nunavut
- British Columbia
- Manitoba

- Ontario
- Quebec
- Labrador
- Other:

Section 2: What makes research partnerships work?

In this section, we are seeking your opinion on the importance of the different components of the research partnership development process.

Based on your experience, please rank the following factors affecting successful research partnerships in order of importance. You may also add comments or new factors that are not listed.

Examples for each of the factors are provided below in the help section.

Please number each box in order of preference from 1 to 7

- Early and ongoing communication
- Community participation in research processes
- Researcher participation in local processes
- Community culture: awareness, perceptions, history
- Local- community capacity
- Geographic factors, characteristics of the natural environment
- Characteristics of academic research and researchers

Below are some examples for each aspect of the research process that we are asking you to rank:

Early and ongoing communication

- Local understanding and valuing of research objectives
- Transparency in results dissemination
- Local understanding of research methods including site selection, negotiation and adaptation in research design

Community participation in research processes

- Local participation in research design
- The Integration of local knowledge is essential in ensuring the success of research partnerships
- Community control over research process
- Community engagement in research design

Researcher participation in local processes

- The respect of local culture (such as researcher participation in community events, communication with elders)
- The respect of the local research process and cultural protocols

Community culture: awareness, perceptions, history

- A positive community history with researchers
- A positive local perception and treatment of outsiders (inc. researchers)
- A strong local attachment, connection to the land and ancestral culture
- A strong local concern over environmental change and sustainability

Local- community capacity

- The presence and engagement of community liaisons
- Self-government and strong local leadership
- The availability of trained local assistants and equipment

Geographic factors

- Adequate access and availability of places of interest for researchers in different fields
- Isolation, community size and remoteness

Characteristics of academic research and researchers

- Academic reward and merit systems and funding opportunities that support long-term partnership development and community engagement in research
- Academic programs and funding opportunities that support long stays in partner communities and informal interaction with local stakeholders
- The motivation of research directors (PI) and dedication of their students to the engagement process through sensitization and education

If you feel that there are other factors that are important to successful community-researcher partnerships that have not already been listed, please provide them here.

Please write your answer here:

Section 3: The outcomes of research partnerships

Previous research suggests that a number of positive outcomes may be associated with successful collaboration between researchers and partner communities.

Based on your experience working in the North, please select and rank the five most important outcomes that you feel are associated with successful research partnerships.

Please select between 3 and 5 answers

Please number each box in order of preference from 1 to 17

Please choose at least 3 item(s)

Please choose no more than 5 item(s)

- Training, new skills and professional growth for students and engaged locals
- Motivation for pursuit of formal schooling for local youth
- Opportunities for new (for youth) or renewed connection to the land for some local partners
- Exposure to outside cultures/ people for local partners
- Motivation, inspiration, and empowerment for local partners
- Opportunities for improving local understanding of science
- Increase local appropriation of research occurring in community

- Financial rewards for engaged community members
- Improve community cohesion
- Collaboration between researchers in different fields
- Resource sharing, logistical support and cost reduction
- Opportunities for researchers to better understand local experiential or traditional knowledge
- Opportunities for the conscientious integration of traditional and local knowledge and science
- More accurate results
- More useful knowledge locally (long term monitoring and sustainability, for instance)
- Reduce Power imbalances between researchers and community members
- Reduce cultural conflicts between researchers and local stakeholders

Are there any other positive outcomes that you generally associate with research partnerships?

Please write your answer here:

Previous research also suggests that certain conflicts can arise during the development of research partnerships which can have negative effects on the research process.

Based on your experience conducting research in the North, please select and rank the five most important sources of conflict which can hinder the research partnership process.

Please select between 3 and 5 answers

- Local dependence on outsiders for financial viability
- Research saturation (too much research, no visible local outcomes)
- Lack of formal youth involvement
- Lack of recognition of local contributions
- Misuses of funding
- Inter-personal conflicts Lack of local trained help
- Low reliability of assistants and guides

- Loss of academic freedom because of overriding community objectives (bias in method selection, analysis and results)
- Misuse, misunderstanding or ignorance of local knowledge
- Divergent research objectives
- Miscommunication of research objectives and associated methods

Are there any other sources of conflict that you believe are important to consider in developing research partnerships?

To what extent do you believe that research partnerships between communities and researchers are beneficial to community (local) stakeholders?

Please select from the following choices. You may also add comments.

Please choose only one of the following:

- Not at all beneficial
- Slightly beneficial
- Moderately beneficial
- Very beneficial
- Extremely beneficial
- No opinion

Make a comment on your choice here:

To what extent do you believe that research partnerships between communities and researchers are beneficial to researchers?

Please select from the following choices. You can also add comments.

Please choose only one of the following:

- Not at all beneficial
- Slightly beneficial
- Moderately beneficial

- Very beneficial
- Extremely beneficial
- No opinion

Make a comment on your choice here:

This is the last question of our survey. Based on your experience, in what ways can Canada's research policy better ensure that the benefits of partnered approaches to Northern science are maintained and enhanced?

Thank you for taking the time to complete this survey. If you would like to receive a copy of the publication resulting from this research please contact Nicolas Brunet at nicolas.brunet@mail.mcgill.ca.

Appendix 4.2 NSERC Northern Research Chairs Program

In response to a concern about the decline of Canadian research in the North, the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC) established a joint Task Force on Northern Research in October 1998. This task force found that Canadian Northern research was in crisis (T.O.N.R. 2000). If action was not taken, Canada would not be able to meet its international science and research obligations or contribute to issues of global importance. Nor would it be able to meet basic national obligations to monitor, manage, and safeguard the Northern environment, or respond to emerging social issues in the North. The Task Force recommended that Northern research be rejuvenated by the establishment of a five-point program to sustain and augment existing Northern research expertise, train a new generation of Northern researchers and increase the amount of high-quality research being done in the North. One element of this program would be Northern Research Chairs. Since 2001, when the program was first announced, only one round of competitions was held. It is now terminated.

The program objectives covered four interdependent and overlapping areas (NSERC 2009). They were as follows:

1. Research: to contribute to the body of knowledge in fields of Northern natural sciences and engineering

"Chairholders will be outstanding researchers with strong programs and a demonstrated commitment to Northern research. This objective is aimed at increasing the amount of high-quality Northern research being conducted. The results of the research, undertaken in partnership with non-university organizations, will help Canada to meet its national and international research obligations and improve knowledge of the North." (NSERC 2009)

2. Training: to train new Northern researchers

"This objective addresses the decline in Northern research capacity and the need to engage Northerners in research activities. The Chairs will provide a training environment for Northern researchers of the future. Where appropriate, close links to Northern communities and colleges will be made, and the Chairholders and their research groups will be involved with the training of students in Northern institutions. This objective also includes the provision of training to

Northern residents in advanced research techniques, transfer of research results and knowledge to Northerners, and use of Northerners' expertise by involving them in the research." (NSERC 2009)

3. Partnerships: to build meaningful Northern research partnerships

"The aim here is to ensure that new knowledge generated in the Chair's research program is relevant to Northern needs. Possible partners in Northern research are diverse and may include Northern and Aboriginal communities and organizations, territorial and provincial governments, federal departments, industry, and non-government organizations (NGOs). All of these groups need research results for their policies, resource management and decision making. A successful partnership would:

- engage the partner(s) in the initial planning of the research questions and objectives;
- use the partner(s)' knowledge in planning the research;
- involve the partner(s) in carrying out the research where possible;
- communicate the research results to the partner(s) in a format that they can use easily;
- involve ongoing communication and interaction before, during, and after the research process; and
- generate new knowledge that will be used as a basis for policies, resource management, and decision making.

The active participation and involvement of a non-university partner is expected in this program. Because of the nature of many Northern organizations, cash or in-kind contributions will not be compulsory. The extent and appropriateness of cash or in-kind support from partner organizations will depend on the nature of the research and the type of organizations that are participating." (NSERC 2009)

4. Communications and promotion: to communicate Northern research issues and promote Canadian university Northern research and training

"As advocates for Northern research, the Chair holders will improve public understanding of the issues affecting the North and its importance to Canadians, and will engage in promotion and dissemination of research in Northern communities. The Chairs and their students will establish meaningful links to Northern institutions and communities. This means that the Chairs will

physically locate in the North for extended periods in appropriate circumstances. Chair programs will lead to close cooperation with Northern communities, colleges, and institutes and with other non-university partners, involve networking with other Chairs and Northern researchers, and lead to an enhanced Canadian capacity for international research cooperation." (NSERC 2009)