UNDERSTANDING THE EVOLUTION OF BELUGA ENTRAPMENT CO-MANAGEMENT IN THE INUVIALUIT SETTLEMENT REGION USING SOCIAL NETWORK ANALYSIS

By John-Erik Kocho-Schellenberg

A Thesis submitted to the Faculty of Graduate Studies of
The University of Manitoba
In partial fulfilment of the requirements of the degree of

Master of Natural Resources Management (M.N.R.M.)

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Abstract

Co-management of fisheries in the Inuvialuit Settlement Region (ISR) began with the establishment of the Fisheries Joint Management Committee (FJMC) in 1986, one of the provisions of the Inuvialuit Final Agreement (IFA) signed in 1984. The agreement between the Inuvialuit and the Canadian Government with regards to renewable resource management was arranged as a collaborative management process that included knowledge and insight from both sides. This thesis uses the case of beluga entrapment in the Husky Lakes, NWT, to explore how co-management between the Tuktoyaktuk Hunter and Trapper Committee (HTC) and the Department of Fisheries and Oceans (DFO) has changed through time in structure and process, and to determine what impacts co-management has had on Inuvialuit involvement in management. Additionally, the linkage between co-management and adaptive capacity at the local level is analyzed in order to better understand how Inuvialuit involvement in fisheries management can have beneficial impacts on cultural preservation, youth education, and employment. This study employed the use of mixed qualitative and quantitative methods within a participatory approach, which aimed at including the community of Tuktoyaktuk in every step of the research process. Qualitative methods included informal discussions, semi-directed interviews, participant observation, and document analysis. Community research partners were also essential in accessing information and interviews. The quantitative method used in this study was the use of questionnaires for Social Network Analysis (SNA) in attempting to describe the changes in the management network over time.

The results show that co-management has improved the quality of knowledge interactions between the Inuvialuit and government scientists, leading to better decision-making and a more integrated approach to conducting community-relevant research. Interactions between the two different forms of knowledge (local and traditional vs. scientific) are of critical importance to the efficacy of co-management. The beluga entrapment issue is currently managed with strategies that have been co-produced by the Inuvialuit, government managers and scientists. As of 2009, the Inuvialuit consider themselves equal partners in the management process and they say they are being treated as such.

Co-management has had positive side-effects on the community of Tuktoyaktuk by providing employment opportunities, opportunities for youth education, and by creating management strategies that incorporate measures to promote cultural preservation when possible. The positive side-effects of co-management (employment, education, and cultural preservation) along with the main benefits (formal HTC-DFO linkage, knowledge-sharing, management strategy co-production, research integration) have served to empower the Inuvialuit to deal with problems, thus increasing the ability of the community to identify and adapt to environmental, economic, and cultural change.

Prior to the IFA, the government controlled environmental decision-making in a top-down fashion with little or no input from the Inuvialuit. The structure of management changed significantly after the IFA due to the establishment of a formalized linkage between the local HTC with the DFO through the FJMC. This formal management network prevented undue influence from special interest organizations that had interfered in management before the IFA. The management process continued to evolve as the FJMC matured and linkages between the HTC and DFO became more sophisticated through time. This study quantifies the structural change of the network in terms of connectedness of key individuals, the density of connections between network members, and the degree of centralization, which is a metric used to approximate how easily knowledge and other resources can flow through the network. The network has progressed from 1966 to the present in several ways: (1) more individuals have been involved in the decisions; (2) key network members include Inuvialuit and non-Inuvialuit; (3) there has been an increasing degree of communication between the network members; and (4) the decrease in centralization indicates that knowledge and other resources can flow through the network more easily.

In conclusion, results from this study show that co-management under the FJMC has been effective and equitable, as judged by the beluga entrapment case. It can be said that the two parties in this co-management arrangement do not have equal power: the Minister of Fisheries and Oceans has the legal right to reject management recommendations from the FJMC. However, this power inequity has not been a roadblock for effective Inuvialuit involvement. The results of this study cannot be generalized to all co-management cases because each situation is unique. However, the major factors leading to effective co-management in this case provide insights for establishing, improving, or assessing any co-management case: a formally established co-management arrangement, structural organization conducive to knowledge sharing, involvement of senior personnel as key individuals, and a long adjustment and trust-building period.

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List of Acronyms

ABWC – Alaska Beluga Whale Committee
ACIA – Arctic Climate Impact Assessment
ACM – Adaptive Co-Management
BSIMPI – Beaufort Sea Integrated Management Plan Initiative
CAPP – Canadian Association of Petroleum Producers
COPE – Coalition for Original People's Entitlement
COSEWIC – Committee On the Status of Endangered Wildlife in Canada
CWS – Canadian Wildlife Service
DFO – Department of Fisheries and Oceans
DIAND – Department of Indian Affairs and Northern Development
EIRB – Environmental Impact Review Board
EISC – Environmental Impact Screening Committee
ENR – Environment and Natural Resources (GNWT)
FJMC – Fisheries Joint Management Committee
GNWT – Government of the Northwest Territories
HTA – Hunter's and Trapper's Association
HTC – Hunter's and Trapper's Committee
IFA – Inuvialuit Final Agreement
IGC – Inuvialuit Game Counsel
IK – Inuvialuit Knowledge
IPCC – International Panel on Climate Change
IRC – Inuvialuit Regional Corporation
IRL – Inuvik Research Laboratory
ISR – Inuvialuit Settlement Region
MPA – Marine Protected Area
SARA – Species At Risk Act
SES – Social Ecological System
SNA – Social Network Analysis
TCC – Tuktoyaktuk Community Corporation
TK – Traditional Knowledge
WMAC – Wildlife Management Advisory Counsel

List of Key Definitions

Adaptive Co-Management – An approach to co-management that focuses on increasing the adaptive capacity of the resources being managed as well as the social network that is doing the managing. Here, management is treated as an on-going experiment rather than a linear problem solving process (Ayles, 2007).

Centrality& Centralization – In SNA, centrality and centralization both refer to different metrics that aim to characterize the organizational structure of the network. In a highly centralized network, most members have few connections to other members and a small number of members have a disproportionately large number of connections. In a decentralized network, most members have roughly equal connections in the network (Scott, 1991).

Community Vulnerability – A combination of the stresses (biophysical, social, economic) on a community and the pre-existing sensitivities that the community has (Ford and Smit, 2004).

Co-Management – A system of resource management that involves power and knowledge sharing between national, regional, and local organizations with an emphasis on power sharing and equality in operational processes (Pinkerton, 1989).

Coping Mechanism – A short term reaction to a change (social, biophysical, or economic) (Ford and Smit, 2004).

Community Adaptive Capacity – The ability of a community to deal with change (social, economic, or biophysical). It consists of cultural adaptations, short-term coping mechanisms, and through long-term adjustments of actions and processes linked to new institutional processes (Berkes and Armitage, 2010).

Connectedness – In SNA, connectedness refers to the proportion of observed connections between network members to the number of total possible connections in a network with n members (Scott, 1991).

Horizontal Linkage – Linkage of communication between organizations or entities that are at the same level (town to town, nation to nation, etc.).

Husky Lakes – A system of brackish water lakes south of the Tuktoyaktuk peninsula of cultural, ecological, and economical significance.

Institution – A recognised social arrangement with its own set of rules and regulations.

Inuvialuit – The Inuit of the Western Canadian Arctic (McGhee, 1974).

Savsaat – A crowding of arctic animals. In this thesis, savsaat refers specifically to a crowding of beluga whales in a breathing hole surrounded by ice (Porsild, 1918).

Social Network Analysis – A method of quantifying the properties of a social network by using certain established metrics that elucidate the network's structure (Scott, 1991).

Traditional Knowledge – "A cumulative body of knowledge, practice, and belief, evolving by adaptive processes, and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes, 2008a).

Vertical Linkage – Linkage of communication between organizations or entities that are at different levels (town to region, region to nation, etc.)

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The famous pingo Ibyuk lies approximately four Kilometers southwest of Tuktoyaktuk

Chapter 1: Introduction

The process of co-management of marine resources in Tuktoyaktuk directly involves the Tuktoyaktuk Hunters and Trappers Committee (HTC), the Fisheries Joint Management Committee (FJMC), and several different organizational levels of the Department of Fisheries and Oceans Canada (DFO). The relationships between these organizations are described in section 14 of the Inuvialuit Final Agreement (IFA), which was the first comprehensive land claims agreement to be signed between Canada and an Arctic aboriginal group (INAC, 1984).

It is important to acknowledge that the level of sophistication and equality of participation in the current co-management processes did not arise solely from the structures that were created in that agreement. The linkages that have been made between these organizations were forged by key individuals, Inuvialuit and non-Inuvialuit alike, who have helped to provide Tuktoyaktuk and the other ISR communities with information, resources, power, and a sense of pride.

The relationship between the Inuvialuit and the Canadian government has not always been harmonious. Disputes regarding the management and use of natural resources have been the norm, not the exception, since the late 1960s when oil and gas explorations began in the area. Even before the pipeline proposals, the Inuvialuit were subject to fines and penalties for harvesting certain animals that had been part of their traditional diet, such as swans. During this time, the only management system in place was that of the Canadian government, in which the Inuvialuit had no voice. The long history of disputation regarding resource management shows how profoundly important the co-management system is in providing benefits for both parties. Linkages between Canadian Arctic Inuit communities and scientific researchers such as those which have arisen in the ISR have proven to be useful for a diversity of studies that have benefited

communities, managers, government, and the scientific community as a whole (Huntington, 2000; Laidler, 2006; Carmack and MacDonald, 2008; Duerden, 2004). The linkages that have developed through cooperation between holders of Traditional Knowledge and Scientists have helped to change the decision-making processes regarding management issues into a much more collaborative effort.

It is well established that communities within the Western Arctic are experiencing rapid changes in climate (Maxwell, 1997), culture, and economy (Ford and Smit, 2004). This is why the relationships formed by the co-management process are becoming increasingly important as a means to help the Inuvialuit adapt to these different types of change (Berkes and Jolly, 2001). In the ISR, each community plays an integral role in the structure of co-management. Through the Inuvialuit Game Council (IGC), the Inuvialuit appoint their representatives to the co-management boards. Thus, understanding the issues that are important to the communities is critical. In order to understand the impacts of co-management from the communities' perspective, this project followed to the greatest extent possible a community-based research approach that involved the community at every stage of research rather than merely extracting information to meet the objectives of a preconceived project (Nuttall, 1995). Community-based research is itself a means of increasing adaptive capacity at the local level because it looks for answers to questions that are relevant to the community and provides results in an appropriate manner. In this way, community-based research can result in findings that are more useful to the community as well as a degree of empowerment (Berkes, 2006).

The case study for this project is beluga whale entrapment within the Husky Lakes. This issue was discussed jointly by my thesis advisor, a representative from the FJMC, and myself before being approved by the Tuktoyaktuk HTC. Whale entrapment in savsaats[1] is a natural phenomenon that has been happening for hundreds of years (Porsild,

[1] A crowding of Arctic animals. In this case, whales in a breathing hole surrounded by ice.

1918), and has occurred in the Husky Lakes sporadically before and since the land claims agreements were signed. However, the management of the entrapments has changed drastically over the years and these changes provide valuable insight into the evolution of the co-management system.

1.1. Objectives

My thesis project is a part of a multi-university team project entitled "Adaptation in a Changing Arctic", sponsored by ArcticNet 2.0. The objective of the larger project is "to identify the relevant institutions, linkages, networks, and policies from local to national that facilitate or constrain adaptation." I worked with a network of institutions (Tuktoyaktuk HTC, FJMC, DFO) that is already known to play an important role in shaping adaptive capacity at the local level by striving for equality in the co-management and research processes, creating an environment for institutional learning and adaptation, and promoting both cultural preservation and education through specific programs (Ayles et al., 2007). The specific objectives of my project are as follows:

1) To understand how knowledge interactions between holders of Inuvialuit knowledge (IK) and scientists influence co-management.

   The intent is to understand the values and beliefs that underpin the two types of knowledge; the factors that facilitate or constrain how well the two kinds of knowledge can work together; and how the two actually work together using the beluga issue as the example.

2) To identify the mechanisms by which co-management with the FJMC increases community adaptive capacity, with a focus on beluga entrapment.

   The intent is to evaluate how decisions about the beluga issue can affect local involvement in management, institutional learning, local culture, livelihood, and education.

3) To describe the changes over time in the network involved in dealing with the Husky Lakes beluga entrapment issue using Social Network Analysis (SNA).

   This objective is about mapping out who communicates with whom among the various people involved in the Tuktoyaktuk HTC, the FJMC, and the DFO. It is focused on how the communication structure has changed through the years.

1.2. Methodology

A participatory approach to community-based social research is one in which the community is involved as an equal partner in research at every stage of the project from planning to dissemination of results. Although my research methods had participatory elements, I was not able to use a participatory approach for the entire project. My thesis is part of a larger project with previously delineated objectives, so the community members were only able to participate in forming the objectives to a certain extent. For this reason, the creation of the research question was more of a collaborative process than participatory. For example, while the Tuktoyaktuk HTC was excited about a project that would look at the evolution of co-management, they expressed a desire for the case study to have a different focus. At the time of my project's proposal, the HTC was more interested in a study on the co-management process regarding the caribou harvest. Another suggestion was a study regarding changes in goose migration and its potential linkages with climate change and air traffic. Unfortunately, studies such as these would have required collaboration with the other first nations groups that access these resources and so would be inappropriate for a project with only one summer field season. Because of these constraints, the Tuk HTC accepted the proposed case study focusing on beluga entrapment in the Husky Lakes.

I used mixed qualitative data acquisition methods, embedded within the case study approach. The flexibility of the case study approach allowed me to use mixed

methods while focusing on the social network responsible for marine natural resource co-management as the specific unit of analysis (Yin, 1994).

I used six methods of data acquisition during my research, including 1) informal conversations with FJMC, Tuktoyaktuk HTC, DFO, and community members; 2) participant observation; 3) questionnaires; 4) semi-directed interviews; 5) document analysis; and 6) hiring community research partners. For data analysis I used an Apple computer program called TAMS to code interview transcriptions and archive documents, and UCINET for graphing and analyzing the attribute and relational data for SNA.

1.3. Geographical and cultural context

Historical Background

The Inuvialuit have occupied coastal land in and around the Mackenzie Delta since prehistoric times that stretch back at least 1,000 years as verified by radio-carbon dating of recovered artefacts from known village sites (McGhee, 1974). Contact with Europeans was initiated in 1799, but trading did not begin in earnest until 1840 with the construction of a trading post by the Hudson's Bay Company at Fort McPherson (McGhee, 1974). Although there are several different classification schemes, it is widely held that there were five major groups that occupied separate traditional lands and were significantly divergent in culture and resource use. The five groups include the Kirgirktarugmiut, Kupugmiut, Kittegaryumiut, Nuvorugmiut, and Avvagmiut, of which the Kittegaryumiut was the largest and strongest. Several epidemics through the mid 1800s and early 1900s brought the traditional Inuvialuit population of 2000-4000 down to approximately 150 in 1910, and cultural change occurred at an unprecedented rate due to increased trade and contact with Europeans and Alaskan Eskimos (McGhee, 1974). The establishment of permanent year-round communities that could be maintained with imported fuels was a major driver for change.

Drivers of the Land Claims Negotiations

In the early 1970s, the opportunities for extracting natural gas from the Mackenzie Delta were being explored by several major oil and gas companies. Several major corporations from both Canada and the United States were busy submitting applications for the creation of pipelines that would take liquefied natural gas thousands of miles from Prudhoe Bay across Arctic tundra through Inuvik and then to most of the provinces as well as locations in the States. Due to the highly sensitive nature of industrial development in the relatively pristine Arctic, The Mackenzie Valley Pipeline Inquiry was commissioned by the Government of Canada in 1974 in order to determine the environmental, social, and economic impacts of the proposed pipeline projects. BC Supreme Court Justice Thomas Berger was chosen to head the three year inquiry (Page, 1986). The public inquiry process involved meetings of experts in Yellowknife as well as community meetings throughout the NWT. The debates on the issue were often extreme, and occasionally even hinted at violence. Local people including the Dene, Gwich'in, and Inuvialuit were often extremely opposed to building the pipeline if the majority of the benefits from the project would go to corporations. Those that were not against the projects outright wanted to ensure that if they were done that they be socially appropriate and fair to all parties involved (Page, 1986). The inquiry determined that due largely to social and environmental reasons, no pipeline should be built through the Yukon, and any potential projects that would go through the NWT should be postponed for 10 years to allow for the issues to be studied further.

The Coalition for Original People's Entitlement (COPE) was the primary aboriginal rights group that represented the interests of all aboriginal peoples in the Mackenzie Delta area with regard to industrial development. However, the differing viewpoints of the various aboriginal groups created stresses in COPE. In the early 1970s, COPE came to represent solely the Inuvialuit. COPE then began a process of documenting the impacts of industrial activities, which led to negotiations for a land

freeze, and then to negotiations for a comprehensive land claims. The negotiations involved COPE, the Canadian government as represented by various departments, and consultants hired by the Inuvialuit. It should be understood that the negotiations for the land claims did not take place solely due to the effort of COPE and the Inuvialuit people. The Canadian government had strong incentives to settle land ownership in the area so that future oil and gas development could be ensured (Page, 1986). The IFA is divided into two main sections: one to deal with regional economics, benefits, and development; and one to deal with environmental management. It was designed this way so that economic interests would never be able to trump environmental issues. One of the most important features of the IFA was that it gave the Inuvialuit a direct say in environment and wildlife issues by setting up the co-management boards. This was a radical change to the status quo that has resulted in a more productive relationship between Canada and the Inuvialuit characterized by mutual trust, respect, and extensive knowledge and resource sharing that is seen as equitable and beneficial by both parties.

The community of Tuktoyaktuk[2] is located east of the McKenzie Delta on the Beaufort Sea in the NWT of Canada in an area that was formerly occupied by the Kittegaryumiut. It is approximately 30km east of the town site of Kittegaryuit. The community is the largest outlying community within the ISR with a population of 870 (Statistics Canada, 2006). Parts of the third and fourth basins of the Husky Lakes are adjacent to the Tuk land section (INAC, 1984). These lands were chosen by the Inuvialuit during negotiations because they were traditionally used by the Kittegaryumiut and because of the high biological productivity of the area.

In the present day, the Husky Lakes area is used primarily by the community members of Tuk for recreational and cultural purposes (Hoyt, 2001).

[2] Tuktoyaktuk means “looks like a Caribou” in Inuvialuktun.

Figure 1.1: Inuvialuit Settlement Region map, available at http://www.beaufortseapartnership.ca/images/loma_homepage_v2.jpg

Many residents build and maintain cabins and there is one main outfitter lodge called Saunaktuk[3] that serves as the hub of activity in the summer months. Some residents of Inuvik have cabins around the fourth basin. The Husky Lakes area is rich in fish and wildlife and is also a site of oil and natural gas exploration. The potential for conflict over use of the area lead to the creation of the integrated Husky Lakes

[3] Saunaktuk means "Place of Bones" and refers to bones of both whales (from hunting and entrapment) and people (from pre-historic Eskimo-Indian wars at Husky Lakes) (Pers. Comm., Randall Pokiak, Aug. 2009).

management plan. The plan was formulated as a multi-stakeholder and multi-use plan with cultural, subsistence, environmental, and developmental considerations (Hoyt, 2001).

During their millennia-long period of seasonally nomadic subsistence in the Mackenzie Delta and Tuk Peninsula area, the Inuvialuit developed cultural practices that were attuned to the natural cycles of the land. Their social organization was such that a chief with great experience and wisdom stayed in power through support from the community. The chief would take advice from other elders and would settle arguments between members, make decisions for the community, and regulate harvesting activities. The chief would always ensure that no animal was overharvested, and that food was given to those in need (Alinuk et al, 2003).

The adaptation strategies of the Inuvialuit enabled them to deal with a high level of uncertainty in terms of weather patterns and resource abundance and distribution. The main strategies included:

1) Mobility and flexibility in terms of group size;
2) Flexibility with regard to seasonal cycles of harvest and resource use backed up by oral traditions to provide group memory;
3) Detailed local environmental knowledge and related skill sets;
4) Sharing mechanisms and social networks to provide mutual support and minimize risks;
5) Intercommunity trade.

(Berkes and Jolly, 2001)

Whale hunting has been an important part of Inuvialuit culture and livelihood for over 500 years. Although there is little data on the size of the subsistence beluga whale harvest prior to the commencement of commercial bowhead whaling in 1888, there is evidence that the subsistence beluga whale harvest was higher in those pre-contact times

when compared with today (McGhee, 1974). Whale hunting was an endeavour that highlighted all of the five coping strategies listed above. Families or larger groups would come together in the summer at Kittegaryuit where whales entered into the shallows of the Mackenzie Delta as they followed schools of fish. Organized community hunts involved upwards of 200 men in Kayaks that acted together by herding the whales further into the shallows before harpooning anywhere from one to six or seven whales per person. Local environmental knowledge and skills were used in catching and processing the whales, after which the meat and muktuk would have been divided and shared or traded according to social customs and necessity (McGhee, 1974). From 1890 to 1910, commercial whaling drastically changed the economy and social milieu of the Mackenzie Delta (Alinuk et al., 2003). During this time, harvesting levels were many times higher than during times of subsistence use and the stock of bowhead whale was nearly depleted.

Although the Inuvialuit are historically well adapted to change through their culture, many of the challenges that they face today result from the loss of traditional culture. For example, the loss of traditional knowledge about sea ice travel has resulted in increased risk to accidents (Andrachuk 2008). Many youth do not know how to read the weather and ice as well as previous generations, and thus are more susceptible to the dangers ice travel poses (Johannson, 2009). Furthermore, change resulting from external forces such as globalization may put stresses on traditional livelihoods and culture that are beyond the current level of adaptive capacity.

A recent vulnerability analysis of Tuktoyaktuk has identified changes in sea ice, high levels of unemployment, decreasing subsistence economy, health, and infrastructure issues as major stresses (Andrachuk, 2008).

Table 1.1: An overview of the Tuktoyaktuk vulnerability assessment (Berkes and Jolly, 2001; Andrachuk, 2008; ACIA, 2005)

	Existing exposure and sensitivities	Short-term coping mechanisms
Social & Cultural	Loss of language and IK, declining food security, health concerns, substance abuse	Some cultural education programs, health studies, healthy foods north[4]
Environmental	Wildlife availability and distribution, erosion, permafrost degradation, and flooding. Damage to infrastructure, no funds for rebuilding.	Shorter ice travel period
Economic & Livelihood	Increased extraction of natural resources, unemployment, high cost of living	Out of town jobs, welfare
	Future exposure and sensitivities	**Future adaptive responses**
Social & Cultural	Community viability, out-migration, further loss of IK with elders, health concerns, substance abuse, low education of youth	Bush skills taught in school to retain culture, potential for organized beluga hunts in Husky Lake, healthy foods north
Environmental	Lack of economic opportunities, unemployment	Industrial development, resource extraction, increased shipping, government funding
Economic & Livelihood	Further loss of traditional language, knowledge, skills	Planning development to consider climatic changes

Andrachuk used the vulnerability analysis framework developed by Ford and Smit (2004), comprised of existing exposure and sensitivities, coping mechanisms, projected future exposure and sensitivities, and projected adaptive responses. I have highlighted some of the major changes that the community is facing, along with some of the accompanying adaptive responses (Table 1.1).

[4] Healthy foods north is an organization that promotes traditional food and activities and also improving diet and overall health of residents of Inuvik and Tuktoyaktuk (http://www.healthyfoodsnorth.ca/).

The community of Tuktoyaktuk will require assistance from multiple levels of institutions in order to increase the range and efficacy of adaptive responses to keep up with the changes it faces. The loss of culture and IK in particular will have negative consequences for adaptive capacity in resource management.

1.4. Rationale

There are several different types of co-management arrangements between indigenous communities and the government in Canada, but their efficacy displays considerable variation (Notzke, 1995). Co-management linkages between organizations from different levels (community, region, state, international) have the potential to increase adaptive capacity at the local level by addressing environmental and social problems, giving a degree of decision-making power to the community, and developing resource access and use schemes that are meant to prevent Hardin's (1968) tragedy of the commons (Armitage, 2005). Co-management must be adaptable in order to successfully respond to the stresses of a changing environmental, social and economic system. This means that both the actual management strategies and the processes used to create the strategies must have a certain degree of flexibility such that they can be amended as needed. Thus, assuming that the current level of adaptability is not higher than it need be to accommodate current levels of change, increasing change must be accompanied by increasing adaptability to cope with stresses (Ford and Smit, 2004). Co-management is adaptable when multiple levels of institutions such as local organizations, government organizations of different levels, business, and boundary organizations communicate and collaborate at every step of the co-management process (Olsson, 2006).

Beluga entrapment as a case study was recommended by FJMC members because of its scale and pertinence. Issues that span too wide a temporal or spatial scale such as the beluga MPAs would be too difficult to document meaningfully in only one field season. The management of this issue is currently changing as new data, experience, and

insights come together and are discussed in the co-management process. The issue is one that the community is passionate about because they believe it could potentially have an effect on the health of the beluga population if not handled correctly. Many people living in Tuktoyaktuk still participate in the subsistence harvesting and processing of marine mammals for economical, cultural, and spiritual reasons. Over the period of 1988 to 1997, Inuvialuit hunters in the ISR harvested an average of 129 belugas per year, with Tuk hunters taking over 33% on average (Joint Secretariat, 2003). The hunting of beluga whales is central to Inuit culture and helps to re-affirm cultural practices and identity (Tyrell, 2007). Many individuals from the community of Tuktoyaktuk are in favour of preventing entrapment of whales in Husky Lakes, but the HTC is limited in what it can accomplish alone. All the organizations involved in the co-management give beluga entrapment special consideration because of the charismatic nature of the whales and the potential for negative media coverage in the event of miss-management (FJMC, 2009).

1.5. Theoretical Background

The vulnerability of a community is dependent on the ability of that community to predict, prevent, and cope with stresses (Adger and Kelley, 1999). Adaptive capacity is the ability to change processes or actions so as to reduce vulnerability (Nelson et al, 2007). Historically, the culture of the Inuvialuit has served to reduce community vulnerability and maintain a level of adaptive capacity necessary to thrive in the Arctic environment. Environmental, economic, and social changes are bringing new stresses to the community. Some of these changes in Tuktoyaktuk are resulting in some degree of cultural erosion, which weakens one of the most important tools for adaptation and vulnerability reduction.

It is useful to conceptualize vulnerability as consisting of exposure sensitivities and stresses, and adaptive capacity as consisting of coping mechanisms and adaptive strategies (Ford and Smit, 2004). Assessing present and future vulnerability and adaptive

capacity can help prepare communities for the future through capacity-building that aims to address weaknesses. Both the vulnerability and the adaptive capacity of a community are the result of broad scale and local scale determinants (Smit and Wandel, 2006). With regards to vulnerability, climate change and globalisation are examples of broad scale determinants with local consequences. Institutional linkages play a crucial role in shaping community vulnerability and adaptability. Bridging organizations serve to link together organizations at different scales and levels that may not communicate effectively otherwise. They are important because their efficacy determines whether power will be shared equitably in a co-management system (Berkes et al, 2005). The key institutions shaping adaptability in marine resource management within Tuktoyaktuk are those that were created from the co-management provisions of the Inuvialuit Final Agreement. Specifically, the FJMC is an important boundary organization that facilitates communication and trust between the Inuvialuit and Canadian government (Ayles et al, 2007).

The increasing variability in the Arctic climate necessitates an increase in adaptive capacity of communities that live there if they are to persist, and this adaptive capacity is shaped not only by interactions internal to the community, but by the network to which the community is linked (Ford et al, 2006).

1.6. Significance of the Study

This study adds to a growing literature on cross-level institutional linkages and their effects on adaptability to change (Berkes and Jolly, 2002; Lebel et al., 2006; Elmqvist et al., 2008). Institutional linkages through adaptive co-management can increase adaptability by providing incentives for collaboration, evaluating programs, re-distributing power, and linking science with policy (Armitage et al., 2009). It has been argued that bridging organizations created in comprehensive land claims such as the FJMC may have the potential to increase adaptive capacity (Berkes and Armitage, 2010).

This study explores the different ways in which the FJMC does this, while providing the historical background that puts the current relationships into context. Although network analysis has been suggested as way of measuring adaptive capacity in Social-Ecological Systems (SESs) (Janssen et al., 2006), studies of co-management that use SNA are rare. Results from the SNA could be used in future research to perform structural comparisons between different networks. This could be a powerful way of understanding why certain co-management bodies function more effectively than others (Bodin et al., 2006), and could potentially be used to trouble-shoot other co-management networks.

Disseminating results to the community is an important part of the community-based research process (Ford and Smit, 2004). My study has practical significance and benefit for the community of Tuktoyaktuk. It has allowed for community members to reflect upon the co-management process in its current and former states, which has resulted in some ideas for improvement. A distilled version of the findings chapters will serve as an educational tool for future use in the community. One poster explaining entrapments was given to the Mangilaluk school, and another poster that summarizes my findings pertaining to change in co-management decision-making in the FJMC over time was given to the Tuktoyaktuk HTC. The finished thesis report will also be sent to all community organizations as well as the FJMC and relevant DFO offices.

I present seven chapters in this thesis. The first three chapters give context and provide an explanation of how the research was done. Chapter one provides an outline of my project; chapter two consists of a literature review, highlighting relevant theoretical and practical concepts and information; and chapter three explains my methodological approach and describes the specific methodological tools I use to gather data. Chapters four through six present and discuss my findings. Chapter four focuses on the factors that enabled co-management to develop and become an effective and equitable institution; chapter five describes the ways in which the FJMC increases adaptive capacity; and

chapter six describes and discusses the structure of co-management using SNA. Finally, chapter seven provides the conclusions of my study.

Freshly cut muktuk curing on a driftwood rack before being cooked as part of a Traditional Knowledge youth program, funded by the Tuktoyaktuk Community Corporation.

Chapter 2: Literature Review

This chapter begins with the concepts of vulnerability, resilience, and adaptive capacity as they apply to community-based research in the Canadian Arctic. The second section discusses adaptive co-management as a means to link multiple levels of organization and increase adaptive capacity of both the local community and the management regime that it is part of. The third section gives background on network theory and talks about the utility of SNA in resource management research. The final section reviews the pertinent history of co-management in Tuktoyaktuk to provide more in-depth context for my specific case.

2.1. Vulnerability of Arctic Communities

The vulnerability of a community is determined both by the biophysical hazards it is exposed to, and the social factors that determine how the system reacts to those hazards (Brooks, 2003). In short, there is a set of things to which a community is exposed, a set of sensitivities to those exposures, and a capacity to adapt and change the levels of sensitivity to particular exposures (Smit and Wandel, 2006). Thus, vulnerability can change either as the level of exposure to hazards changes, or as the social adaptive capacity changes. In many Aboriginal communities of the Western Canadian Arctic, exposure to hazards has been increasing because of climatic change. At the same time, some communities seem to be undergoing cultural change that diminishes their ability to adapt to change through traditional means (Ford and Smit, 2004). It is for this reason that linkages between communities and co-management networks are becoming ever more important as change accelerates.

Many studies have focused on changes in exposure to hazards due to climate change. Since 1989, publications addressing only the impacts of climate change (in the Canadian Arctic) have outnumbered publications addressing adaptations to climate change by a factor of two (Ford and Pearce, 2010). Climatic models have shown that the Western Canadian Arctic is likely to experience an increase in average temperature and, more importantly, an increase in weather variability (Maxwell, 1997). This translates into an increase in the frequency of extreme weather events. The mean temperature in the Mackenzie Delta has increased two degrees Celsius and yearly precipitation in the high arctic tundra has increased by 25% from 1948 to 2005. These trends are expected to continue with projections of +2°C and increases in precipitation of 5 to 8% by the 2020s (Furgal and Prowse, 2008). The IPCC states that climate change in the Arctic has already resulted in the decrease in amount and thickness of sea ice, the melting of permafrost, coastal erosion, and changes to distribution and abundance of many species (IPCC, 2001). Indigenous people have noticed general trends in climate change that have, for the most part, coincided with scientific observations. They have noticed an increase in weather variability, and now express less confidence in predicting weather by traditional means (ACIA, 2005). Inuit have reported an increase in unpredictability of weather patterns and storms. A study of daily weather variability assessed 52 years of annual temperature records in Baker Lake and Clyde River. The measured increases in temperature variance were quite small (Noonan et al., 2005), suggesting that the Inuit are extremely sensitive to environmental change.

Climate change has direct and indirect impacts on Inuit health. As weather patterns become more variable and change more rapidly they become more difficult to predict and thus are potentially more hazardous (Pearce, 2009). The increase in UVB exposure may also prove injurious. Indirect impacts include changes to ice that make travel more dangerous, increase in the range of disease vectors such as biting flies, introduction of new parasites, decrease in permafrost stability, increase in sea level, and increase in air pollution (Furgal and Prowse, 2008). These changes have been observed

throughout the Arctic, and Tuktoyaktuk is no exception. Later freeze up and earlier breakup of the ice have decreased hunting and travel time (Andrachuk, 2008). Extreme weather events have adverse effects on community roads and other infrastructure, which are expensive and difficult to repair. Changes in distribution and abundance of wildlife are having significant impacts on the community, as subsistence harvesting of animals still plays an important economic and cultural role (Andrachuk, 2008).

Most Arctic Aboriginal communities do not regard climate change as the most urgent problem they are facing (ACIA, 2005). One of the more pressing issues is economic livelihood. Many northern communities face extremely high costs of living and have unemployment rates that are over 20% (ACIA, 2005). In Tuktoyaktuk during the early years of this decade, unemployment exceeded 25% (Statistics Canada, 2002). Anecdotal evidence as well as information from the chairperson of the Tuktoyaktuk Community Corporation indicates that unemployment has not improved in recent years (Gruben, 2006). Low income levels often force people to buy low quality foods, which in turn lead to health problems from obesity and cardiovascular disease to depression and suicide (McGrath-Hanna et al, 2003).

Livelihoods that incorporate traditional lifestyles are becoming increasingly difficult to maintain. Changes to Inuit and Inuvialuit livelihoods began with increased use of modern technology, the establishment of permanent settlements, introduction of the wage economy, and changes in access to traditional resources. Costs to buy equipment and supplies needed to hunt have increased, while the fur markets have declined (Ford et al., 2006). Most employers cannot allow employees to leave for months at a time to participate in traditional harvesting activities, thus limiting their time spent on the land and cultural transmission of knowledge (Andrachuk, 2008). Hunting trips must often be planned weeks or months in advance because of work schedules, which sometimes results in increased risk-taking (Ford et al., 2006). In Tuktoyaktuk, these changes have

made it difficult for sport hunt guides to keep their business in operation (Andrachuk, 2008).

The lack of jobs within Tuktoyaktuk forces many people, especially the youth, to move to larger cities such as Inuvik or Yellowknife to find work (Andrachuk, 2008). Out-migration to urban centers in search of better economic opportunity has been shown to be one of many complications that have not been ameliorated by Land Claim Agreements in the Canadian North (Saku, 2002).

2.2. Adaptive Capacity

The concept of adaptation has a long history of use in the biological sciences, anthropology, and sociology (Smit and Wandel, 2006). However, all the different uses are similar in that they refer to a system composed of interrelated parts, called a network (organism, society, or ecosystem) changing its behaviour in order to survive in a changing environment (physical, or social). For the purposes of this thesis, adaptive capacity refers to the ability of a social system to respond to an upper limit of change (environmental, social, or economic) and is strongly influenced by the architecture of entitlements within the system (Kelly and Adger, 2000). In a social system, individuals have endowments, which are assets already in their command or reach. Entitlements are "the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces" (Sen, 1984). In systems where entitlements are easier for all network members to access, the adaptive capacity may be greater than in systems where entitlements are made extremely difficult to access through multiple layers of bureaucracy. Political institutions that shape that architecture play key roles in facilitating or constraining adaptive capacity. In the current literature on adaptation to climate change, adaptive capacity is thought of as a quality of individuals, organizations, communities, or larger networks. The main components of adaptive capacity relate to dealing with uncertainty, retaining socio-ecological memory,

combining knowledge, and self-organization. Folke et al (2003) identify four main aspects of adaptive capacity:

1) Learning to live with uncertainty, change
    - Learn from crises
    - Expect the unexpected
    - Evoke disturbance
2) Nurture diversity for reorganization and renewal
    - Nurture ecological memory
    - Sustain social memory
    - Enhance socio-ecological memory
3) Combine different types of knowledge for learning
    - Combine experiential and experimental knowledge
    - Integrate knowledge of structure and function
    - Incorporate process knowledge into institutions
    - Encourage complementarity of knowledge systems
    - Create opportunities for self-organization
4) Recognize relationship between diversity and disturbance
    - Deal with cross-scale dynamics
    - Match scales of ecosystems and governance
    - Account for external drivers

(Folke et al, 2003)

Coping mechanisms are short-term responses to change that are devised often at the community level when institutional change is slow or lacking, whereas adaptive strategies are long-term responses meant to increase ecosystem health and human well-being (Fabricius et al., 2007). Adaptive strategies are formed on a larger time-scale, and often require social learning and institutional change.

Inuvialuit culture has been and still is one of the most important factors in determining adaptive capacity at the local level. In recent years there have been an increasing number of studies looking at coping mechanisms and adaptive responses in northern communities (Ford and Pearce, 2010). The studies have focused on climate change as the major driver, but recognized that the social and economic dimensions of change are extremely important and closely linked. The table below summarizes some of

the common climate-related changes, their effects, and coping mechanisms used by individuals, families, or communities in the Canadian Arctic.

Table 2.1: Coping mechanisms related to specific climate-related changes, adapted from (Nickels et al., 2002 and Furgal and Seguin, 2006).

Observed Change	Effect	Coping Mechanism
Temperature increase, hot summers	Problems with Food storage, problems with drying fish	Take shorter trips; bring food back to community for storage. Build new smokehouses to keep temperature cooler, adapt smoking techniques Need: community freezer program
Changing animal abundance and migration route	Difficulty in hunting, danger associated with increased travel distance	Organized community hunts
Lower water levels in some rivers and lakes	Reduced access to quality water, increased risk of illness	Use of bottled water while on land
Increase in mosquitoes and biting flies	Summer travel more difficult, health concerns	Consider mosquito conditions in camping areas, use of repellents, nets, screens

Many of the cultural changes occurring in northern Aboriginal communities are strongly linked to economic change. Traditional country foods are increasingly being replaced by western foods which not only have less nutritional value, but also have the potential to cause diseases such as diabetes, depression, and obesity (ACIA, Chapter 12). Inuvialuit in Ulukhaktok are coping with the difficulty in accessing country foods by increasing sharing networks, and by supplementing their diet with store-bought foods if the income is available (Pearce et al., 2009). Nutrition is not the only thing affected by this shift in eating patterns. As the foods are replaced, the knowledge and culture that is

linked to the harvesting of those foods is also disappearing (Ford, 2006). This has implications for the long-run in terms of contribution to natural resource management.

The example of polar bear hunting has both economic and cultural implications. Individual guides are losing potential customers because of the low number of allowable licenses, and younger generations are less interested in learning how to guide because of its dwindling profit margin (James Pokiak, Pers. Comm. Aug 2009). Knowledge about polar bear hunting must be accumulated for many years before a person can start a guiding outfit.

As traditional lifestyle and culture are being replaced by the standard wage economy, northern Aboriginal communities such as Tuktoyaktuk are becoming less self-reliant (Andrachuk, 2008). While vulnerability is increasing because of climatic and economic change, loss of culture is contributing to a decrease in adaptive capacity. Emergent themes from interviews with Tuktoyaktuk community members regarding adaptive capacity are maintaining traditional livelihoods, knowledge and culture, education, employment, Inuvialuit institutions, government agencies, substance abuse, and land claim settlement (Andrachuk, 2008). These themes are key determinants of adaptive capacity from the community perspective. This clearly indicates that residents from Tuktoyaktuk also distinguish between short term coping mechanisms and long-term adaptive strategies. Day to day adaptability may be determined largely by the availability of seasonal employment. Longer term adaptability may be related to an all weather road or increase in gas explorations. But to most interviewees, the most important view is a long term one. They recognize that keeping Traditional Knowledge and culture strong, along with education, will be most important for the adaptability of the community for generations to come. The adaptive strategies that they envision involve changes in social institutions, government linkages, and institutional learning.

2.3. Social Network Analysis

The concept of social structure introduced by Radcliffe-Brown initiated the development of what would become Social Network Analysis (SNA) (Scott, 1991). Radcliffe-Brown believed that physicists dealt with the structure of atoms, chemists with the structure of molecules, and social scientists with the structure of societies, the component units of which were human beings (Radcliffe-Brown, 1940). The development of this concept occurred in three largely distinct branches of study: sociometric analysis, which employed the use of graph theory to mathematically describe network properties; analysis of patterns of interpersonal relations, which aimed at understanding how cliques are formed; and anthropology, which used parts of both other branches to study the structure of tribal communities. All three of these branches of study have contributed to the modern techniques for data collection, manipulation, and analysis in most forms of SNA (Scott, 1991)[5].

Social network theory is being increasingly used as a tool to understand networks of actors involved in Natural Resource Management (NRM) (Bodin et al, 2006). Many of the concepts that are used to define and analyze social networks can shed light on the structure and processes of resource management. This is particularly important in co-management situations where there may be different levels of access to power, knowledge, and resources between stakeholder groups. Some of the most pertinent concepts are connectivity and centrality (Bodin et al, 2006; Janssen et al, 2006). Connectivity is often described by linkage density, which is the number of linkages observed in a network divided by the total number of possible linkages (see section 3.4 for a full description). High connectivity indicates that a greater degree of knowledge and power sharing can occur and that the level of communication is high. The potential drawback is the loss of diversity of opinions (Bodin et al, 2006). Centrality can be analyzed with several different metrics in social network analysis, each of which has its

[5] See chapter two in Scott (1991) for a comprehensive overview of the development of SNA.

strengths and weaknesses (see section 3.4). In the simplest terms, a network where all actors have the same number of linkages (to other actors) is perfectly even, and the centrality is zero: it is completely decentralized. On the other hand networks where most actors have very few linkages and a few actors have a large number of linkages are said to be uneven, or centralized. A high degree of centralization can give an indication of the power relationships that exist in the network (Bonacich, 2007).

SNA is useful in this case study because it allows for a quantitative understanding of how co-management under the IFA affected the structure of the social system involved in managing beluga entrapments.

2.4. Adaptive Co-Management

Co-management is an arrangement in which the payoffs for cooperation between the community, government organizations, and other parties are greater than those of competition. The co-management process focuses on cooperative planning for resource access and sustainable use with long-term thinking (Pinkerton, 1989). The process of co-management requires linkages between multiple levels of organization in order to function effectively. Linkages between communities, boundary organizations, and multiple levels of government form a flexible management network that can combine and generate knowledge and increase adaptive capacity (Berkes et al., 2005). Linkages allow for the flow of resources and knowledge, and the sharing power in the form of governance between public and private stakeholders (Carlsson and Berkes, 2005).

Adaptive co-management (ACM) is an approach that focuses on constantly refining the process of co-management to ensure that social learning is taking place, and that all parties are actively involved in monitoring and decision making. This helps the co-management body to better understand and thus better react to challenges (Armitage et

al., 2009). One of the challenges facing adaptive co-management is that communities are often governed directly or otherwise affected by international processes that they cannot participate in or affect. This raises the question of how effective co-management systems can be when they are constructed of low-level institutions. Linkages between multiple levels of organization are often not sufficient for effective co-management in and of themselves; the direction of the communication flow is extremely important in determining whether decisions will actually be taken jointly (Pinkterton, 1999). Furthermore, there is not one single best structural arrangement for co-management. Although there is a temptation to create a simplified blueprint for co-management systems with standardized procedures, each case is specific and must be treated as a new and unique learning process (Ostrom, 2007). Keeping this in mind, it is still clear that certain attributes are common to effective co-management systems. These are attributes such as power sharing, institution building, trust, focus on process, group problem solving, and governance (Berkes, 2008).

Boundary organizations are a key feature of ACM. These organizations allow for user groups and higher level managers to exchange ideas and knowledge even though they may espouse different world views (Jentoft and McCay, 1995). Boundary organizations act as facilitators in discussions and negotiations between communities and other levels of government or non-government organizations (Folke et al., 2005). ACM systems, using boundary organization as intermediaries, can increase community adaptive capacity while providing valuable local knowledge to the larger scales of organization that would be otherwise inaccessible (Folke et al., 2005). Boundary organizations are also particularly important in that they may provide a forum for Traditional Knowledge holders and scientists to relate to one another and understand each other.

The legal structure of co-management is extremely important in determining the efficacy of the regime. Joint management boards that are created as part of

comprehensive land claims agreements have been shown to increase Aboriginal peoples' influence over natural resource use and management (White, 2002). However, co-management arrangements that arise in response to specific issues that are not part of a larger legal agreement may not result in equal participation in the process (Pinkerton, 1989).

Carlsson and Berkes (2005) have suggested that future inquiries should focus on function rather than structure of co-management bodies, especially in situations where the structure has already been adequately described.

1) Defining the social-ecological system under focus;
2) Mapping the essential management tasks and problems to be solved;
3) Clarifying the participants in the problem-solving processes;
4) Analyzing linkages in the system, in particular across levels of organization and across geographical space;
5) Evaluating capacity-building needs for enhancing the skills and capabilities of people and institutions at various levels;
6) Prescribing ways to improve policy making and problem-solving.

An essential element in ACM is the integration of scientific and traditional knowledge. There are many definitions of Traditional Knowledge (TK), but the one used in this thesis is "*A cumulative body of knowledge, practice, and belief, evolving by adaptive processes, and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment*" (Berkes, 2008a). Inuvialuit Knowledge (IK) means simply the TK as well as local knowledge of the Inuvialuit. TK is characterized as qualitative and experiential in nature and often transmitted orally. Although the division between local

and traditional knowledge is artificial, it is worthwhile to consider where the line should be drawn. Local knowledge in this case is knowledge that has been accumulated by the Inuvialuit in recent times, as opposed to TK which is part of a long multi-generational process of knowledge acquisition and refinement. As cultures with an extensive TK encounter new phenomena due to changes in the environment and in their ways of relating to it (new technologies, new economic uses, etc.), they naturally formulate explanations and beliefs pertaining to the new realities. Through time, these explanations are re-enforced or discarded in much the same way the scientific community ultimately re-enforces or discards its suppositions regarding a phenomenon under study. In this way, contemporary local knowledge could be seen as the first step in the process leading to more established explanations and beliefs of TK which in a way parallels the hypothesis generation and prediction in the scientific knowledge system. Although it may not be as reliable and established as TK, contemporary local knowledge may still help to inform management decisions as part of an adaptive management approach with an emphasis on management as experiment.

Scientific knowledge is defined as knowledge gained through the use of the scientific process, which is based on the cycle of observation, conjecture, prediction, test, and hypothesis. Through time, science has come to focus largely on quantitative testing methods. Written records are essential in scientific experiments, and it is passed on from generation to generation through the use of a formalized education system.

Navigating the differences and discrepancies between Scientific and Traditional Knowledge is certainly one of the greatest challenges faced by co-management boards like the FJMC. Scientists adhering to their method alone do not have any way of validating TK other than to conduct scientific studies using conjectures of hypothesis derived from TK in the creation of tests and predictions. However, this is often impossible due to temporal and financial constraints. At the same time, the Inuvialuit are

often very skeptical of science because it is usually closely connected with political or industrial agendas that are not seen as objective and unbiased.

Researchers have found that in the Alaska Beluga Whale Committee (ABWC), knowledge was integrated through a process by which scientists and holders of TK were both involved in a long term working relationship with one another. The structure of the co-management system is seen as the most important factor in determining how well knowledge will be integrated. The important characteristics are transparency in decision-making, formal and informal interactions between different knowledge holders and formal and informal roles in the co-management process (Fernandez-Gimenez, et al, 2006).

2.5. Co-Management in Tuktoyaktuk

The Inuvialuit Final Agreement (IFA) was signed in 1984 with the basic goals of 1) preserving Inuvialuit culture within a changing society; 2) enabling meaningful participation by the Inuvialuit in the northern and national economy and society; and 3) preserving the Arctic environment and its wildlife (INAC, 1984). One of the provisions of this agreement was the creation of five co-management bodies, each with a specific focus. These co-management bodies bring together the community HTCs and the IGC with various relevant government agencies (Fig. 2.2). Vertical linkages are linkages between different levels of institutions, whereas horizontal linkages bring together organizations that operate at the same level (Berkes, 2005). Horizontal linkages can be an important avenue for information and idea sharing between communities within the ISR, between Inuit communities throughout Canada, and even across international boundaries. In 1988, the Alaska and Inuvialuit Beluga Whale Committee (AIBWC) was formed to promote conservation and international co-management, bringing together the Inuvialuit with the Inupiat of Alaska (Adams et al. 1993).

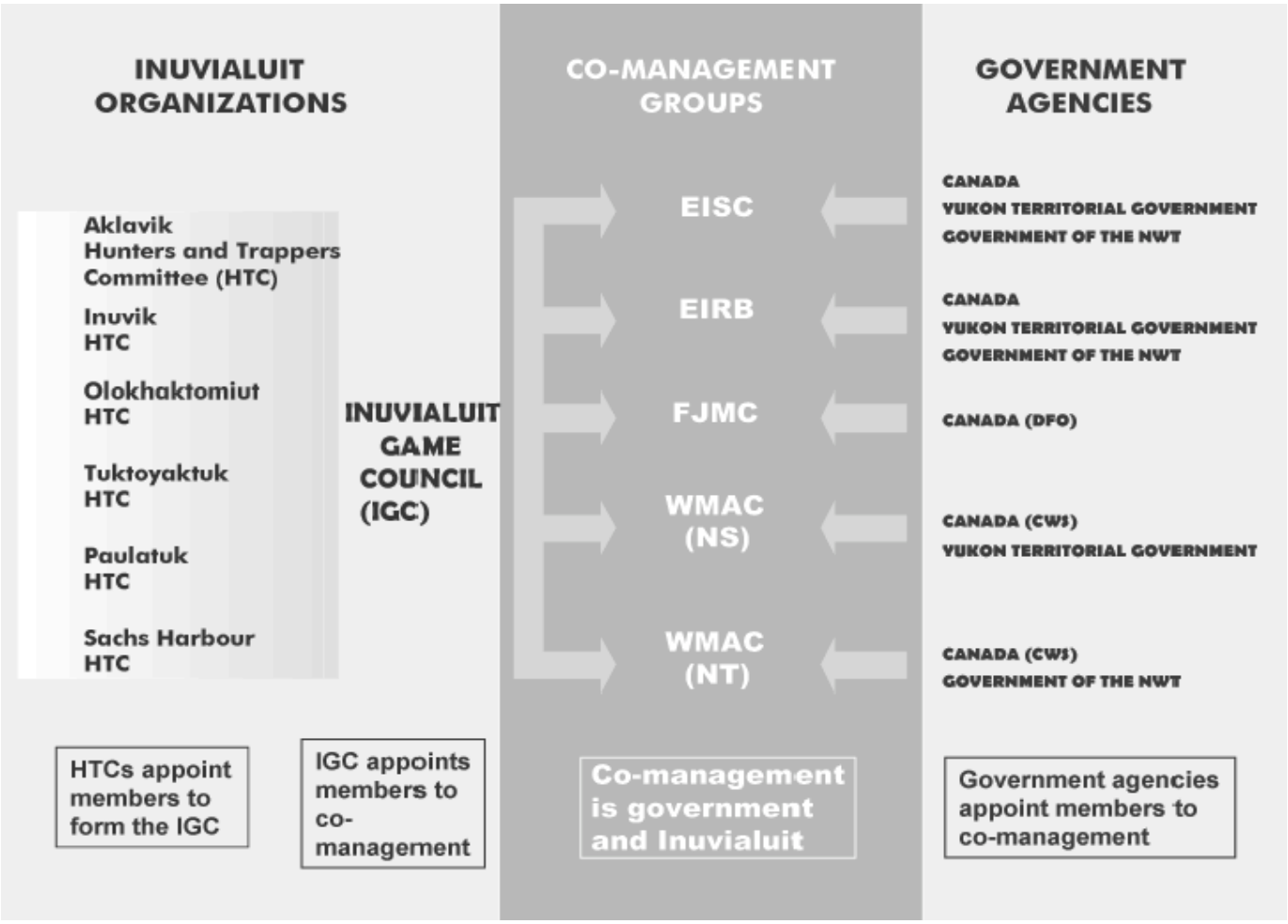


Figure 2.1: Organization of Co-management institutions of the Inuvialuit Final Agreement. EISC – Environmental Impact Screening Committee, EIRB – Environmental Impact Review Board, WMAC – Wildlife Management Advisory Council, NS – North Slope, NT – Northwest Territories, CWS – Canadian Wildlife Service (Andrachuk, 2008).

Since its inception in 1986, the FJMC has evolved considerably and played a key role in the creation of many important management strategies and plans. Community fishing plans incorporate community-based monitoring of harvest rates, TK, ecology and behavioural studies, and habitat studies. These projects have built-in reviews where all stakeholders can provide feedback and suggestions for improvement. They result in

regulations in access to and use of resources that are jointly agreed upon (FJMC, 2002). The FJMC also takes the lead role in the creation of management plans, which are even more of an undertaking. The FJMC describes its management plans in the following way; "Generally more complex than fishing plans, management plans bring together into one document biological information, fishing information, industrial development projections and all other factors that might affect a population" (FJMC, 2002). Recommendations for management strategies are finalized within the FJMC, and then sent to the Minister of the DFO for approval.

In 1991, the FJMC finalized the first Beaufort Sea Beluga Management Plan (BSBMP). The goals of this plan were to maintain a thriving population of beluga in the Beaufort Sea, while also providing for optimal sustainable harvest of beluga by the Inuvialuit. The importance of the beluga whales is best highlighted by the ongoing creation of Marine Protected Areas (MPAs) around the Mackenzie Delta that will serve to protect 1,800 km^2 of critical summer breeding grounds. The three MPAs are called the Tarium Niryutait MPAs, and regulations will protect these areas from disturbance due to hydrocarbon exploration, shipping, or other threats (Canada Gazette, 2010). The process used to create this plan and regulations ensured equal involvement of all stakeholders (FJMC, 2005), as recommendations for the plan could not be made to the Minister of Fisheries and Oceans Canada until a consensus within the FJMC was reached (FJMC, 2001a). It is likely that without the legal protection of the IFA, the outcome of Beaufort Sea Beluga Management Planning would have been quite different due to the pressures of the hydrocarbon industry.

The FJMC also plays a central role in conducting population estimates. Initial estimates made by aerial surveys conducted by the DFO and FJMC put the Beaufort Sea beluga stock at around seven thousand animals. The Inuvialuit believed that the population was much greater based on their observations and traditional knowledge. The DFO would likely have proposed quotas to restrict beluga hunting if not for the IFA.

Further population studies were conducted involving the FJMC that surveyed a larger proportion of the belugas' range and corrected for diving whales. These surveys estimated the population at 19,629 with further analysis putting the population closer to forty thousand (Manseau et al., 2005). This example shows that trust is not implicit in co-management relationships, and that TK is not always given the respect and credibility that scientific studies are given even when the timeframe of observation in TK is on the order of hundreds of years. However, through the co-management process, the Tuk HTC has been able to work closely with scientists on many projects including the Husky Lakes beluga monitoring program to ensure acceptable design, implementation, and review. Co-management has increased the adaptive capacity of the communities by providing plans and guidelines for harvesting and monitoring of beluga populations in a way that combines Inuvialuit culture with modern natural resource management practices (Andrachuk, 2008).

2.6. History of Beluga Entrapment

In the ISR beluga entrapment occurs occasionally at the mouth of the Mackenzie, but most often in the Husky Lakes. The Husky Lakes have traditionally been used for fishing, trapping, harvesting berries and plants, and hunting caribou, geese, and beluga (Hoyt, 2001). Beluga entrapment in this brackish water system is a natural phenomenon that has been observed by the Inuvialuit for as long as their memory extends back (FJMC, 2009). The whales often enter into the lakes through Liverpool Bay (Fig. 2.2) to feed during the summer, and those that do not find their way out before freeze-up become trapped in the lakes. They maintain a breathing hole by actively pushing through and breaking the ice. This situation is referred to as a savsaat, which means a crowding of arctic animals in a small space (Porsild, 1918). Beluga that were trapped within the husky lakes were traditionally hunted (Hoyt, 2001).

The first documented case of beluga entrapment at Husky Lakes occurred in 1966, when at least 50 whales were found trapped. The entrapment was handled by Inuvik Research Station. Samples were taken and attempts to free the whales were made, but the whales did not survive (Hill, 1967).

Figure 2.2: Map of Husky lakes. T= Tuktoyaktuk, X= Gudchiaq, ● = Whale Point, ■ = Liverpool Bay (Map ©Google 2010).

Entrapments occurred again in 1969 and 1974 (Weaver and Richard, 1989). The entrapment in 1989 of over 125 whales in two locations near Whale Point (Fig. 2.2) was the first that took place after the signing of the IFA and the creation of the FJMC. In 1996, 21 belugas were found in a nearby location. Entrapments took place again in 2006 and 2007. Harvesting operations took place in 1989, 1996, and 2006 (Harwood, Pers.

Comm., April 2010). The management of the entrapments has created some controversy with environmental organizations and negative media coverage that did not accurately portray the work that the co-management body had put into the decision (Kotokak and Bill, 2006). Due to the fact that there was no population concern, as well as difficulty with the media, safety concerns, and the Inuvialuit knowledge that entrapment is a natural phenomenon, no hunt was organized in 2007 (FJMC, 2009).

Little is known scientifically about why the whales become trapped. Potential causes range from excessive feeding to disorientation to unusually fast freeze-up that catches the whales off guard (FJMC, 2009). Salinity levels vary across the Husky Lakes with a gradient from normal salt water in Liverpool Bay to increasingly fresh water farther in to the lake system (Macdonald, 1999). This information may be important in monitoring programs because the prey of Beluga whales may prefer certain salinity, and thus salinity monitoring may be useful in predicting possible areas of entrapment. Fish species show strong preferences for certain salinity levels, and beluga seem to have preferences for low-salinity areas during the summer months (Hobbs et al., 2005), thus there may be measurable likelihoods of beluga predation on certain fish species due to salinity.

In 2008 the FJMC, DFO, and Tuk HTC set up and maintained two monitoring stations at narrows in Husky Lakes. These monitoring stations served to gather spatial and temporal information about whale movements in the lake. In an attempt to re-create the effect of strings of whale bones that were once placed at narrows in the Lakes to trap whales, the monitors used sonar beepers to repel whales and thus prevent their entrapment. However, there have been some problems with the monitoring camps. First, some HTC members believe that the monitoring camps were established too late in the season, potentially after some whales were already within the lakes. Second, transportation to the camps had been done by helicopter, which was expensive. Thus, one of the monitoring camps was terminated (FJMC, 2009).

In summary, my research is situated within the context of vulnerability and adaptation studies that are focused on Canadian Inuit and Inuvialuit communities (Ford and Smit, 2004; Ford et al., 2006; Ford et al., 2008; Andrachuk 2008; Laidler; 2009; Pearce et al., 2010). The importance of institutional linkages as a means for increasing adaptive capacity is becoming increasingly recognized in the literature (Berkes, 2008), and this work provides a description of the inter-organizational communication that underlies the linkages. This project also provides insight into how co-management is changing the adaptive capacity of Tuktoyaktuk in order to deal with increases in stress from environmental, cultural, and economic change using the beluga entrapment issue as a case study.

Angus and Evelyn Cockney lead a Traditional Knowledge education program called brighter futures, funded by the Tuktoyaktuk Community Corporation.

Chapter 3: Methodology

3.1. Research Philosophy

My research design is based on a collaborative approach, meaning that I have attempted to involve the research participants in all steps of the research process from the formation of the research question to the verification of analysis. Research that involves the community in this way helps to empower indigenous people (Berkes, 2004). Community involvement also benefits the research. It is more likely that interviewees will give good quality information about questions that the community has had a part in forming, simply because they are interested in them. Cooperation and knowledge integration between groups from different cultures is far more likely to occur when both are involved in creating the research question, designing the study, implementing it, and analyzing its results. The idea of researchers and indigenous peoples as co-authors in the research process is particularly appealing to me because it presents a way in which two cultures with different phenomenological explanations can work together and compromise on management issues which must have a resolution that is held as agreeable by both sides (Davidson-Hunt and O'Flaherty, 2007). This vision of cooperative research involving First Nations and the academic community has helped shape my own research approach.

My project is under ArcticNet and is entitled "Adaptation in a Changing Arctic: Ecosystem Services, Communities, and Policy." The aim of the larger project is to determine what institutions and linkages facilitate or constrain adaptation to change in northern communities. This research is ultimately intended to help the people of the community that I am working in, so I believe that consulting the community at every possible stage of the research is the most important goal. I recognize that my personal values and beliefs, along with the constraints that I have as a researcher shape the way in which I will carry out my research.

3.2. Vetting by the Community

My first step in undertaking this project was a meeting with a Canada-appointed member of the FJMC to discuss potential case studies for the project. Beluga entrapment was suggested as an appropriate case to highlight changes in the co-management system over time. The next step in the vetting procedure involved a trip to Inuvik to present the project proposal to an FJMC meeting. Members of the FJMC and DFO Inuvik were present at the meeting to give suggestions and formally vet the project. Next, I went to Tuktoyaktuk to propose the project to the HTC. Due to timing constraints, it was necessary for me to call a special HTC meeting. The HTC approved the proposal, and made suggestions on the interviewing procedure. I also presented the project to the Tuktoyaktuk Community Corporation, which approved the project and suggested that I aim to include youth and community members as research partners or assistants. Ethics approval was granted from the ethics department at the University of Manitoba. As part of the vetting procedure, the Aurora Research Institute sent my proposal to the relevant local institutions for approval and granted me research license number 14549. After carrying out the field work and writing the first draft of the thesis document, I gave an update presentation at the annual 2010 FJMC meeting at the Freshwater Institute. In the winter of 2010, I took a third trip to Inuvik and Tuktoyaktuk to present results and interpretations to the HTC. At this time I also met up with as many interviewees as possible to verify my interpretations and uses of their quotations. I also created posters that summarize the research project regarding change in co-management over time and a history of beluga entrapment to leave at the HTC office and the Tuktoyaktuk Mangilaluk school. After publication, electronic copies of the thesis document will be sent to DFO Inuvik, the FJMC, the Tuk HTC, and all interviewees that requested it.

3.3. Research Design

I have used a descriptive case study as my strategy of inquiry. It is descriptive in that my aim is to document how fisheries co-management functions in Tuktoyaktuk and how it has changed through time. I employed participant observation and semi-structured interviews as the qualitative data collection methods. Within this qualitative strategy I quantify certain results through the use of a survey. According to current literature, this type of data collection strategy could also be called a concurrent strategy within the mixed methods approach (Creswell, 2003). I prefer to present it as a case study that includes qualitative and quantitative methods of data collection, because case studies may include or even be limited to quantitative data (Yin, 1994).

There are several reasons why the case study strategy is best suited to this inquiry. First and foremost, the aim of the study is to highlight the process of how a management decision is made and case studies are well suited to understand the process of decision-making (Yin, 1994). Second, I am focusing on a specific social network involving multiple organizations that makes up a co-management regime, and the case study is a good strategy for research that has a specific unit of analysis. Third, my project is part of a larger multiple-case design under ArcticNet II, which generates the most meaningful results when each sub-project is framed in a comparable way. Once again, the case study lends itself to this type of framing that makes meta-analysis more meaningful (Yin, 1994).

My case study was initially designed according to the framework proposed by Yin, which suggests using the following major components:

1. Study questions:

   What is the formal and informal structure of the social network that makes up the co-management regime in Tuk?

How has this network changed over time and what are the drivers of change?

How do the linkages between the different organizations (Tuk HTC, FJMC and DFO) affect the community's adaptation to change?

2. Propositions:

   The structure of the social network governs information and knowledge flow.

   Power has been more equally distributed since the signing of the IFA.

   Co-management plays an important role in shaping adaptive capacity at the community level.

3. Unit of analysis:

   The social network in charge of management.

   The organizations involved in that network.

4. Linkage of data to propositions:

   Data collection methods were designed to determine whether the propositions can be supported.

5. Criteria for interpreting findings:

   I will be able to compare my findings with other co-management studies and to the SNA literature.

   Community feedback will facilitate interpretation.

(Yin, 1994)

The design of my case study also includes considerations for construct, internal, and external validity, as well as reliability. To ensure construct validity I have gathered data from multiple sources of evidence (interviews with as many committee members as possible), established a reliable chain of evidence, and had key informants review my interpretations of results and draft reports.

During the process of data analysis I ensured internal validity through triangulation. Specific historical accounts from interviews were matched with all other accounts of the same event and discrepancies were analyzed. The questionnaire included in my methods allowed for a high degree of reliability in my data collection (Yin, 1994).

There are several major assumptions that underlie my research design. The three assumptions of the qualitative component of my project are that 1) the process of co-management rather than its outcome is the principal focus of the work; 2) the process of the qualitative research is inductive, meaning that I will build concepts from the details of the data; and 3) as a researcher I have inherent biases that I must acknowledge and make as clear as possible (Creswell, 2003).

3.4. Data collection Tools

Participant Observation

Starting my data collection with participant observation allowed me to build rapport with individuals that were identified as good candidates for interviews. I use the phrase "participant observation" merely out of convention. In reality, this aspect of research consisted of getting to know the people and the culture. I learned about their vulnerabilities and adaptations and their concerns for the future. Spending time with members of the HTC in the town and on the land gave me opportunities to hear less politically correct historical accounts and perceptions. By taking the time to get to know community members, I believe that I was able to get more depth in the interviews. Spending time one on one with research participants likely helped to reveal perceptions that would not be shared in the group setting. While out on the land I engaged in traditional activities and came to more fully appreciate Inuvialuit culture, knowledge, and relationship with the environment. Observations and insights were recorded in daily field notes.

Questionnaires

Questionnaires were relatively short-answer written surveys used to gather data for SNA. I was able to use questionnaires with several FJMC and DFO members, but I determined early on that the questionnaires did not work well in Tuktoyaktuk because the vast majority of research participants there were more comfortable with talking rather than writing. As a result, I simply incorporated the questions of the questionnaires into the interviews. The questionnaires were designed to gather data regarding communication between the participant and other members of the co-management network (relational data) as well as information about the participant's position, tenure and history of involvement in co-management (attribute data).

Semi-Directed Interviews

My interviews were extended conversations that lasted anywhere from one half to three hours. The first part of the interview consisted of informed consent, wherein I made sure that the participant understood that I may use their information or direct quotations in publications if they agreed. The option for anonymity was given, and permission to record the interview was sought. If permission was given, interviews were recorded electronically and/or by note taking. I used an interview schedule that helped me to remember the main points to be addressed, but departures from the schedule were frequent. This style of interviewing seemed to suit the research rather well, as I could add in new questions to address emergent themes as needed.

The process of determining who to interview was relatively straight forward because membership in the organizations that make up the co-management regime is clear cut, and there is access to good records. I began the process by interviewing FJMC and DFO members in Inuvik to get a general overview of the history of the issue. Through FJMC meetings I was told who from the FJMC and DFO had been involved in previous entrapments, and who had been working on the more recent ones. I was able to

interview almost all of the people recommended. While in Tuktoyaktuk, my first interviewing objective was to interview all of the current HTC members that had been or are were at the time involved in the beluga issue. After completing this task, I obtained a list from the HTC office of past HTC members who were involved in beluga entrapments as well as community members that had been hired for the Husky Lakes beluga monitoring operations. I was able to interview many people who had been on the HTC board during the 1989 and 1996 entrapments as well as most of the community members who had been monitors. I also interviewed several members of the elders committee. I conducted further interviews with FJMC and DFO members in Inuvik and Winnipeg after the summer field season in Tuktoyaktuk. Compensation of $120 was given to the community members for their time and information.

I conducted fifteen interviews with Tuktoyaktuk community members that were not directly involved in the management network, thirteen interviews with Tuktoyaktuk HTC members past and present, four interviews with FJMC members and employees past and present, and five interviews with DFO members past and present who were involved in the management network.

Informal Discussions

Informal discussions with Tuk residents, HTC, FJMC, and DFO members provided information that was missed during interviews, and often gave extra context and depth. Informal conversations were one of the avenues through which I was given new names of people who had been involved in the entrapment issues. Many community members who were not involved in the decision-making processes regarding the beluga entrapments still had something to say about them. For the most part, if they had little knowledge about the entrapments but still wanted to express opinions about what should be done or about how they perceived the management actions, I conducted informal discussions rather than interviews. This is because I had been warned by the FJMC

community liaison that the monetary compensation provided for the interview may attract people who didn't actually know much about the subject.

Document Analysis

Document analysis was an important component to data analysis, especially helpful in gathering information about past entrapments that participants did not fully recollect. Resources included HTC records, FJMC records, the Joint Secretariat library in Inuvik, DFO Inuvik records, and the Freshwater Institute library in Winnipeg. These records included communications between organizations in order to get names of people involved, and minutes from meetings to show documentation of communication between specific individuals as well. I conducted general searches of records that had any relevance to beluga entrapment and specific searches for documents or records that had been recommended by research participants.

Community Research Partners

During my time in Tuktoyaktuk I hired two community research partners to aid in data collection. I was not given direct access to the Tuk HTC records, so I hired the HTC secretary to look for information such as past board membership during entrapment years, lists of people hired as beluga monitors, correspondence between the Tuk HTC and FJMC or DFO regarding entrapment, and minutes from meetings that pertained to entrapment. The second research partner was hired in consultation with the Tuktoyaktuk Community Corporation (TCC). I stipulated that it be a youth who was well known and outgoing in the community because the task for the research partner was to find community members that had insights to offer and were interested in being interviewed. The TCC recommended Jocelyn Noksana. I provided her with a summary of the project's purpose and objectives, and she was able to identify five community members I had not yet consulted that had been involved in the entrapments, or felt that their views on the matter should be heard.

3.5. Data Analysis

Interviews, Documents, questionnaires, field notes

The first step in analyzing data was transcribing interviews. Recorded interviews were transcribed word for word from the audio file, and hand written notes were also transcribed. All documents obtained in the field along with the information recorded in the written questionnaires and my field notes were put into word files. All files were then manipulated using the TAMS computer program, which allows one to code text within word documents for easy recall and sorting. Sorted codes were then tallied as necessary during writing and analysis.

Social Network Analysis

In SNA, a network is conceived of as a web or mesh. Individuals are tied to each other with invisible bonds of relation, which are like threads that make up the web (Scott, 1988). More formally, it has been defined as "any bounded set of connected social units" (Streeter and Gillespie, 1993). According to Streeter and Gillespie, the study of social networks has the following three key elements:

1) Defining the network component units. Network analysis can be applied to a range of social units including individuals, communities, organizations, or even nations.

2) Defining the boundary. This involves the creation of criteria for membership in the network. All social networks are embedded in larger networks, so defining the boundary through specific criteria is a critical first step in the study of social networks.

3) Determining connectedness. Any component of the network that meets the membership criteria must have direct or indirect links to other members in the

network. These links are determined through a variety of data acquisition techniques.

SNA is a means of quantifying attribute and relational information about social networks. Attribute data describe the properties (age, sex, position, etc.) of the network components, which are referred to as actors or nodes. Relational data describe the linkages or "edges" between components, which can be binary, valued and undirected, or valued and directional. Binary data are the most common and indicate "1" if there is a relationship between actors and "0" if there is not. The researcher defines the actors and the meaning of the relationship. Valued and undirected data indicate strength of relationship with higher numbers meaning greater strength. For example, numbers of communications regarding a specific issue could be recorded and used to estimate the "strength" of communication between two people. Both binary and valued data can be used to create directed graphs. In certain circumstances, network actor A may report a relationship with B, but B does not report any relationship with A. In this case, the matrix will be asymmetric and must be analyzed as such (Scott, 1991). Valued data may be transformed into binary by means of a threshold above which a linkage is reported and below which no linkage is reported (Scott, 1991). Data gathered from interviews or questionnaires is entered into matrices for analysis. SNA studies typically take either a sociocentric or egocentric approach. Sociocentric studies focus on the overall structure of the whole network and aim to explain outcomes. They are normally used when the actors of the network are known or easily determined and the network boundaries are defined *a priori,* as is the case in my project (Chung et al., 2005).

Matrices can be constructed in several ways. The above case by case matrix illustrates adjacency. A positive number indicates that the two cases (represented by letters) are linked, a zero indicates that they have no link, and a negative number indicates a negative relationship. Note that the matrix is directed. Another type of matrix

is a case by affiliation matrix, in which network components are on one axis and affiliations (memberships, participation in a specific event) are on the other.

	A	B	C
A		1	0
B	1		0
C	0	1	

Figure 2.1: Case-by-case adjacency matrix using directed and binary data.

Matrices and types of data

If direction is not included, it is assumed that the relationship of B to A is the same as A to B. If the data naturally produce a symmetrical matrix, then there is no need to include direction. Matrices can be analyzed using several different computer programs and then drawn using accompanying graphics programs. I took a sociocentric approach because the network boundaries of the co-management regime are defined *a priori* (Chung et al., 2005). The criterion for network membership is simply membership in one of the organizations directly involved in the co-management regime during a particular time.

I collected valued and undirected data in questionnaires and interviews and entered the information into case by case matrices. Because of difficulties in obtaining valued data from all network members, I was forced to transform valued data into binary data by means of a cut off. If two members recalled communicating with one another, a linkage was considered to be present. If 1 of 2 or neither recalled communication with the other, then no linkage was recorded. It would have also been possible to include the

situation where only 1 recalled communication with the use of a directed graph. However, results from this analysis may be unnecessarily controversial and do not seem to add any depth to the overall analysis. The point is to only record a linkage when both participants have a strong recollection of communication; because that implies that it was substantial communication.

I collected longitudinal data, meaning that I took measurements of the same relationships at fixed intervals of time in order to determine changes in the network structure (Wasserman et al., 1994). There were inherent limitations to this approach because not all of the people that filled particular positions at the DFO, HTC, or FJMC in specific years were available for interview. I used only case by case matrices because there was only one affiliation: involvement in the decision-making process of a particular entrapment. It is appropriate to analyze data using only case by case matrices when the network components all have a single affiliation in common (Scott, 1991).

Network metrics

It has been argued that the most important metrics for describing the structure of Social-Ecological Systems are linkage density, centrality, and connectedness (Janssen, et al., 2006). Linkage density (LD) is the proportion of observed linkages divided by the total number of possible linkages. For non-directed graphs LD is

$$LD = I/n(n-I)/2$$

where I=number of linkages present and n=number of nodes. For directed graphs, one would simply multiply the number of possible pairs by two. A particular node's degree is the number of other nodes it is directly connected to. If the graph is directed then each node has an *indegree* and an *outdegree* which represent the number of linkages to that node as reported by other actors, and the number of linkages to other nodes as reported by that actor, respectively. Centrality and centralization are two way of looking at how well a node is connected to other nodes, with centrality focusing on a node's

degree (local), and centralization focusing on the connection of a node to the whole network (global), which is basically a measure of its influence (Scott, 1991). The degree centrality of a node is simply the number of linkages that node has. This equates to the probability of that node accessing something that is flowing through the network such as knowledge or information (Scott, 1991). However, degree centrality only takes the number of direct connections into account. It does not take into account that not all linkages are as important as others. Eigenvector centrality can be seen as the weighted sum of all directly and indirectly connected nodes of every path length (Bonacich, 1972). The longer a path length is between two nodes, the more indirect their connection (friend of a friend of a friend). In larger networks, the Bonacich centrality takes into account the entire pattern of the network (Bonacich, 2007).

Analysis

I analyzed the matrices using UCINET software. UCINET performs a wide array of mathematical calculations used in graph theory on matrices. The main features of UCINET that I used were linkage density, centrality, centralization, Bonacich centralization, and Bonacich eigenvector centrality. I created three matrices that represent the communication between individuals from the DFO, FJMC, and Tuk HTC in 1989, 1996, and 2006 regarding beluga entrapment in Husky Lakes. The 1996 matrix was missing information regarding linkages between certain nodes because of difficulty in interviewing and obtaining information and was not used in further analyses. I also created network diagrams with accompanying diagnostics. The diagnostics and diagrams illustrate the structure of the network, and comparison between years shows the change in the structure over time. The strength of this type of analysis is that it yields a very tangible result that can easily be compared with the SNA literature and any potential future analyses. Appendix A shows a list of questions that were used to gather the SNA data.

Traditional Knowledge is essential for the safe curing, fermenting, cooking, and handling of muktuk.

Chapter 4: Knowledge Interactions and the Evolution of the Decision-Making Process

Trust and respect are integral components of an effective co-management system, and it takes time for them to develop. Behind every management action there is a decision-making process that includes issue identification, knowledge acquisition, problem solving, consultation, review, and research. In the ISR the management regime has undergone a change that has allowed for the local Inuvialuit Knowledge (IK) to be incorporated into all of the aspects of the management process, but this change was a process in and of itself. The structure of the management was completely reorganized with the signing of the IFA, but there was no guarantee that legal change alone would be able to overcome the political barriers to co-management (Pinkerton, 1992). As with many collaborative efforts, one prerequisite for effective co-management in the ISR was trust building and respect between key individuals (Pomeroy et al., 2001).

The objective of this chapter is to understand the values and beliefs that underpin IK and science; the factors that facilitate or constrain how well the two kinds of knowledge can work together; and how the two actually work together using the beluga entrapment issue as the example. Thus, the first section of the chapter will outline the values and beliefs that underpin both IK and science. The second section will consist of an analysis of the factors that have facilitated or constrained how these two kinds of knowledge work together through time, and the third will show how the decision-making about beluga entrapment within Husky Lakes has changed as a result of increasingly mutually beneficial knowledge interactions.

4.1. Differences in culture and worldview

The Inuvialuit are deeply rooted in the western Arctic and they continue to use the natural resources of their land for subsistence and income (Usher, 2002). Although the

mixed economy has changed their relationship with the land and resources in certain ways, many Inuvialuit are on guard against commoditization or loss of culture (Dressler et al., 2001). In their manner of speaking, being "out in the land" encompasses all the relationships that they have with the living creatures, the landscape, and god or the spirit. Many elders still talk openly about their spiritual connections with the old way of living.

> Even today when I'm out in the land I begin to get calm. And sometimes I get so calm that I can almost see the Great Spirit. Almost. Even if you are out there for not long you come to an understanding, but once you come back into the town it goes away, and then it's just a memory (Roy Cockney, community member, pers. comm., Aug. 2009).

The Inuvialuit possess a deep understanding of uncertainty with regards to weather patterns and wildlife abundance. They are familiar with population cycles of animals and the changing of migration routes. Combining their knowledge of animal abundance and behavior, ecological interactions, population cycles, migration routes, and weather patterns, they are able to estimate population trends to a level of precision that allows for the formulation of management strategies (Nagy, in Anderson and Nuttall, 2004). The time depth of their observations spans hundreds of years, and these observations are made continually year round. Their knowledge of animal physiology, anatomy, and health indicators has been fine tuned by their way of life. In many ways, their relationship with natural resources can be accurately described as adaptive management, although the idea of management is to them a decidedly southern (non-indigenous) concept (Berkes et al., 2000). IK has been described as a holistic way of understanding and reacting to changes in complex systems through simple prescriptions that allows for the creation of adaptable mental models over time (Berkes and Berkes, 2009). The guiding principle is to take what is needed, and use what is taken. The Inuvialuit are quick to self-organize and react to resource issues at the community level through taboos or outright law, as in the case of the creation of grizzly bear quota in 1987 (Notzke, 1995). The Inuvialuit Game Council and the Hunter Trapper Associations

created in the early 1960s were the product of self-organization as a reaction to the threat of industrial development (Robert Bell, pers. comm., Sept 2009).

Scientists have traditionally used the scientific method in order to understand natural phenomena in terms of independent and dependent variables, creating mechanistic models. This paradigm of knowledge acquisition is based on the principles of reductionism and causality, developed in Newtonian physics and classical chemistry and later applied to biological systems such as ecosystems. The shift towards holistic thinking science described by Capra (1983) has been slow. Holistic approaches to management such as resilience-based ecosystem stewardship (Chapin, 2008) have not yet taken root, and many fisheries are still managed under the MSY paradigm. Under this paradigm, the goal is to maximize productivity of a given stock while maintaining sustainable harvest levels. Unfortunately, this approach has failed to achieve sustainability in a surprisingly large number of cases (Botsford et al., 1997). This failure is due to the highly unpredictable nature of the resource and the unwillingness or inability to adapt management strategies in order to link ecological and social systems at multiple scales and levels (Berkes, 2010 in press). In summary, the differences in beliefs, values, and goals that underpin science and Inuvialuit knowledge have often made communication and collaboration difficult. Although it has been and continues to be a slow process, co-management in the ISR has proven to be an effective way to reconcile these different worldviews.

4.2. Developing Collaboration

Effective co-management in the ISR is the result of a legally mandated collaborative effort between groups that have different worldviews, and quite often different ideals for resource utilization (Notzke, 1995). In many cases a great deal of research, consultation and deliberation is needed before an agreement can be made on how best to handle a specific issue. In this section I will examine the critical factors that

made collaboration possible and describe some of the road blocks that made it more difficult in the past.

4.2.1. The IFA: redistribution of power

In the period of time before the IFA was signed, natural resource management in the traditional lands of the Inuvialuit was administered mostly by the department of the Environment and Natural Resources (ENR) within the Government of the Northwest Territories (GNWT). Communication between the community HTAs and the ENR took place through renewable resource enforcement officers that were stationed within the communities. Fisheries were officially managed by the DFO, but with no major office in the area the presence of the department was sporadic and opportunistic. Communication between the DFO and HTC at this time took place mostly through DFO enforcement officers or DFO scientists that were visiting specific communities. Control over the management of natural resources was an important and dynamic issue within the Western Arctic since the 1950s. With aboriginal rights gaining momentum throughout the mid 1960s and into the 1970s, aboriginal involvement in management was becoming a more serious matter that touched upon issues of cultural identity, health, livelihood, and environmental health (Page, 1986).

Collaboration and knowledge sharing between the Canadian government and the Inuvialuit with respect to wildlife and fisheries management did not begin in earnest until the signing of the IFA, which provided legal certainty as well as funding for co-management. Different goals for resource use often prevented scientists, government managers, and Inuvialuit land users from being able to understand each other fully, thus preventing them from working together effectively on resource issues.

> Legal power allowed GNWT to enforce its decisions over the Inuvialuit pre-IFA. As for specific decisions, that's always dependent on the individual officer and the individual issues of the community. Over such issues as marine mammal harvesting and wildlife management rules, yeah there was lots of times there wasn't a good fit. But for the most part, you

> had a single natural resources officer who is out there accommodating, not fighting it (Vic Gillman, pers. comm., Aug 2009).

The Inuvialuit were aware of the effects industrial exploration was having on their land as early as the 1960s. People from the community agree that one of the most significant effects of industrial activity on marine life was due to seismic exploration, which began in 1958 with Imperial Oil. Oil and gas exploration affected Tuk most out of all the ISR communities because it had the only deepwater port in the region (Ayles and Snow, 2002). Although seismic exploration for petroleum had been known to negatively impact fish and other wildlife at the time (Kearns and Boyd, 1965), many projects were approved by the Department of Indian Affairs and Northern Development (DIAND) and the DFO. Pressure for development increased after the discovery of oil at Atkinson point, the Inuvialuit responded by establishing the Committee for Original People's Entitlement in 1970 (Ayles and Snow, 2002). This led to a chain of events that resulted in the request for a land freeze and then negotiations for a comprehensive land claim, which was signed in 1984.

> It was the social mentality of the Inuvialuit that provided the long-term motivation to change the system. We observed that the government's neglect when it came to industrial activities resulted in environmental and social effects. Trappers and hunters saw hardship from these environmental problems (Randall Pokiak, pers. comm., Aug 2009).

The co-management bodies set up in the IFA created an opportunity to establish new relationships between the Canadian government, the Inuvialuit, and Industry. The broad objectives of the IFA were:

1) Preservation of Inuvialuit culture and values within a changing northern society
2) Preparation of the Inuvialuit to be equal and effective participants in the northern and national economies and in society in general

3) Promotion and preservation of the Arctic's wildlife, biological productivity and natural environment

(INAC, 1984)

The FJMC is one of five joint management bodies created under section 14 of the IFA. The joint management bodies are made up of representatives appointed by Canada and the Inuvialuit in equal number, with a chair elected by Canada at the approval of the Inuvialuit. The FJMC is the exception, in which the committee members elect the chair (Binder and Hanbidge, 1991). Legally, its role is to advise the Inuvialuit and DFO on matters of marine mammal and fisheries management. Under the IFA, the FJMC receives funding from the Government of Canada, which flows through both INAC and the DFO (Ayles, Pers. Comm. May, 2010). Through collaborations on specific projects, the FJMC also attracts additional funding from various agencies and government departments, including the DFO. The FJMC allocates $500,000 annually to researchers that align their research questions with those of the FJMC (Joint Secretariat, 2007).

Under the IFA the community HTAs were changed to HTCs, allowing for better community access to funds for wildlife management. The HTC board members were given honoraria for attending meetings, which was a step up from what was in their perspective volunteerism, considering the amount of time invested in the HTC processes. Although the IFA made room for a considerable amount of power sharing through the co-management boards and HTCs, Canadian negotiators made sure that it left the final say in the hands of the Canadian government. “The Government will continue to regulate development activities and will retain ultimate responsibility for environmental management” (INAC, 1984).

During the process of negotiating the IFA the Inuvialuit were able to select certain lands that had been part of their traditional territory. Much of their land selection was based on the presence of natural resources and wildlife. Areas of high biological

productivity were chosen first. However, a large proportion of their traditional land was not available for selection, including all lands that contained proven oil or gas reserves. Also, the Inuvialuit were given rights to the beds of lakes, rivers and water bodies within their claimed lands, but the crown continued to own the water in order to be able to manage fish and migratory birds. The IFA aimed to integrate the Inuvialuit into the existing structures, functions and decisions regarding wildlife management in the settlement region. The stated goal was to apply knowledge from both the Inuvialuit and scientific community in conservation and management efforts.

Even though the IFA stated that legally the Inuvialuit had to be meaningfully integrated into the management process, the reality was that government managers were not used to sharing power in decision making. To deal with their new responsibilities as defined by the IFA, the DFO created a new Area Office in Inuvik in 1986 as part of the Western Arctic Region. This came at a time when the DFO was cutting many projects and decreasing its size, but the funds were necessary to make co-management work.

> And of course there was funding that came from the department to do this. Not a great deal, but it couldn't be ducked because it was one of the provisions. So then they set out to hire an area manager who was going to be charged with the implementations of DFO's responsibilities under the Final Agreement and I was the first person hired to that position (Vic Gillman, current FJMC chair, pers. comm., Aug 2009).

Prior to this, the DFO office closest to Inuvialuit territory was in Yellowknife and communication between the DFO and the local community was through individual researchers and haphazard at best (See chapter 6 for a full account of inter-organization communication structures). It should be noted that a Conservation and Protection station had been established in 1980, and that the DFO did operate through this station to a certain extent through its Habitat Management and Fisheries management braches (Gillman, Pers. Comm., July, 2010).

The first Area Manager for the DFO Inuvik office pointed out that the legal provisions of the IFA did not change the operating procedures of the DFO immediately, but rather it took time for the DFO to react to the new legal climate (Gillman, pers. comm., Aug 2009). Thus, one of the challenges facing the FJMC was the re-education of new DFO managers as to the new rules of the game. New DFO managers coming into the co-management system sometimes came from areas where no land claim existed, thus they had a different set of expectations in terms of aboriginal involvement in decision-making. These managers would assume that they could develop the decision-making processes, and then involve the Inuvialuit once the process had already been established. However, the FJMC took on the responsibility of ensuring that the Inuvialuit are involved as equal partners in the entire management process.

It is important to note that there is a process within the IFA that prescribes what to do in case the Minister of Fisheries does not agree with the advice of the FJMC. It consists of a back and forth between the organizations such that there are several chances to revise and edit the recommendations to suit both parties (INAC, 1984). Fortunately, this process has rarely been used. The vast majority of recommendations made by the FJMC are approved by DFO Yellowknife because of the DFO's trust in the FJMC's processes. This is partly due to the fact that almost all of the Canadian appointees to the FJMC have been former DFO employees.

The IFA created a legal climate in which top-down management was no longer an option. It also created financial conditions that enabled the community HTCs, the FJMC, and the DFO to participate in co-management with less economic strain. Naturally it took time for the system to respond to the legal changes, but it allowed for trust to begin to develop. After the critical structural changes were made with the IFA, it was trust between the Tuk HTC, FJMC, and DFO is what allowed real knowledge sharing and management collaboration to occur.

4.2.2. Knowledge Interactions

This section shows how scientists and Inuvialuit have exchanged knowledge about the environment and its flora and fauna over the years. More importantly, it shows a trend of increasing equality in knowledge exchange. The phrase knowledge interaction can mean anything from the use of IK in pre-designed scientific studies (*e.g.* the best place and time to collect fish samples) to collaborative knowledge-generating processes. Meaningful knowledge interactions can only occur when two groups are able to understand and validate the basis of each other's way of knowing. This type of interaction presents an opportunity for people with different worldviews to understand each other's motivations for decisions about resources, and is at the heart of co-management. The reason science and IK work so well together in the FJMC is because the FJMC encourages interactions between expert knowledge holders from both traditions who meet in a climate of respect. This finding is supported by other research into the FJMC's processes in co-management. Iwasaki-Goodman (2005) also observed that mutual respect between holders of TK and scientists was a key ingredient in the successful functioning of the FJMC as a co-management body with true power-sharing. Iwasaki-Goodman (2005) goes on to list twelve instances of knowledge integration in the FJMC, the most relevant of which are that 1) TK regarding white fish was studied and evaluated by scientists (knowledge transfer through data collection); 2) a sea ice study was done that incorporated both TK and scientific knowledge (two-way knowledge transfer); and 3) knowledge from land users and scientists was used in the creation of regulations for the hunting of beluga and polar bears that both parties agreed to (knowledge integration). As discussed previously, scientists and Inuvialuit have not always seen eye to eye on management and nor do they today. The difference is that today the two groups take each other's input seriously.

There are three major categories of knowledge interactions that I noted during interviews and informal conversations: one-way knowledge transfer through data

collection, two-way knowledge exchange, and knowledge co-production. Before co-management in the ISR, IK was rarely incorporated into any management decisions.

Table 4.1: Three forms of knowledge interactions

	Type 1: Use of IK for pre-designed scientific study	Type 2: Knowledge Exchange: the standard for co-management	Type 3: Co-production: local and global knowledge together lead to fuller picture
How does Information flow?	Information flow from local to higher level	Information flows in both directions	New understanding of phenomena synthesized using both knowledge sets
How is TK perceived?	TK used in data collection only	TK valued as local knowledge	TK and associated practices valued as an adaptive relationship between human society and the ecosystem
What is the process underlying the interaction?	Collected only when desired or needed	Occurs through established procedures	Requires extended periods of knowledge sharing, occurs through modified procedures created through cooperative processes
How is knowledge communicated?	Lack of communication about meaning of knowledge	Each group interprets and explains their knowledge to the other group	Both groups see the gaps in their knowledge sets and see value in learning what the other knows
How are results of interaction disseminated?	Difficulty in bringing back results to communities	Formal project review provides opportunity for feedback	Outcome of co-production is being reviewed while being created. Formal project review occurs after knowledge is put to use.

Type 1: Use of IK in pre-designed scientific studies

> In the mid 80s, science was seen as the ultimate solution to all problems. You could manage natural systems so as to maximize the economic benefits. Harvest up to a precise amount and maintain natural capital. Folks wanted a sophisticated knowledge acquisition process so they could get the maximum economic return (Robert Bell, former FJMC chair, pers. comm., Sept 2009).

The use of IK in scientific studies is often seen in a positive light by scientists and aboriginal people alike. It is the first step in terms of knowledge sharing, and it can serve as a way to introduce IK into a process that has been exclusively scientific in nature (Huntington, 2000). It allows for vertical communication in that information flows from local to regional or national, and horizontal communication in that multiple communities can often provide TK. Perhaps the most important aspect of this type of knowledge transfer is that it has the potential to foster the trust and respect that will allow the co-management process to grow and mature. It can also give aboriginal people a measure of pride in knowing that their knowledge and beliefs are taken more seriously. However, if TK is used and nothing is returned, trust can be lost. The Inuvialuit are wary that their knowledge may be collected and used with nothing given back in return, or worse, for purposes that may have negative consequences for the Inuvialuit themselves. As an example, many community members of Tuktoyaktuk have expressed the concern that if they inform government organizations about decreases in wildlife populations, an undesirable quota system could result.

The beluga entrapment that occurred in 1989 resulted in a knowledge interaction that can be classified as use of IK by scientists to reinforce a pre-made decision. In this case, the knowledge interaction between the DFO and the Tuk HTC occurred after the decision to organize a community hunt had already been made by the DFO. This is not to say that the decision was forced on the Inuvialuit, only that they were not directly involved in its formulation. A full analysis of this decision-making process is made in section 4.2. The knowledge interaction occurred both immediately preceding the harvest as well as on-site. It was a limited interaction in that the only type of knowledge sought

out by the DFO was the Inuvialuit historical knowledge about entrapment, as well as the practical knowledge regarding the organization and execution of a hunt on the ice.

It is important to note that the type of knowledge interaction that occurs is closely linked to the nature of the specific issue being addressed. Each management issue has its own peculiarities, and is on a particular point in its time line. Some issues must be assessed with certain scientific procedures that are prescribed at the national level. For example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is responsible for determining the harvest level of threatened or endangered species through the Species at Risk Act (SARA). Depending on time constraints in making management recommendations, it may be that the only way to incorporate IK in these cases is to collect it as data and attempt to align it with the required scientific data. Issues such as these may take much longer to progress towards more sophisticated forms of knowledge interaction in the co-management process, whereas issues that are specific to a particular community may progress more rapidly.

Type 2: Two-way knowledge exchange

In the Type One knowledge interaction described above, information flows directly from the IK holders to the scientists, but only diffuses from scientists to IK holders. This may be because scientists are not able to explain their knowledge acquisition or data analysis techniques fully, because IK holders have a lack of trust in the scientists, or a mixture of both. The next step in the evolution of knowledge interactions is two-way knowledge exchange.

> There was incidents in the past when the DFO dismissed hunters' knowledge about fish and whales. That still affects the hunters, and some of them don't want to talk too much because of it. But communication is a lot better than it used to be. Not only does the DFO listen to us now, but we listen to the DFO too (Charles Pokiak, Tuk HTC board member, pers. comm., July 2009).

Two-way knowledge exchange is currently the standard in the co-management regime. The knowledge interactions occur before any management decisions are taken or research projects are begun. Binder and Hanbidge (1991) state that, "Traditional knowledge plays a strong part in Inuvialuit management systems, from data collection and general wildlife observation, to decision-making, to implementation and enforcement of decisions." For example, the DFO regularly presents proposals for science projects to the Tuk HTC. A detailed explanation of the project's goals, methods, and potential impacts is given, and the HTC then makes any recommendations it has to offer and generally approves the project pending incorporation of the recommendations. This process generally occurs within Tuktoyaktuk during the HTC's regular meetings. During this time the results and interpretations of past projects are brought up and discussed as well. This provides an opportunity for the DFO and HTC to talk about future directions for research.

> If the community doesn't want a particular science project done there, it can be rejected. All DFO science projects are presented to the HTC and other relevant community organizations for approval (Larry Dow, DFO Inuvik DM, pers. comm., Aug 2009).

The FJMC also provides many opportunities for two-way knowledge exchange. Representatives from the FJMC often attend the HTC meetings with the DFO representatives so as to cut down on airfare. During this time the FJMC rep can bring up additional concerns relating to the research projects and add insight to the results from previous projects. These regular meetings also help to develop familiarity between members of the different organizations. The FJMC's community tours allow for a deeper level of knowledge exchange in that any individuals from the community who choose to attend can have their voice heard. The tours start out with a feast provided by the FJMC, which encourages higher attendance. During the meeting, the Inuvialuit are able to learn about the co-management process, identify issues that they think need further research, give critiques of current management strategies, ask question about scientific methods, or share their knowledge about any current issues.

Apart from the community tours, the FJMC's four day annual general meeting in Winnipeg and regular meetings in Inuvik provide additional opportunities for knowledge exchange. Scientists, Inuvialuit, researchers, and occasional representatives from industry are present at these meetings, informing the committee of important issues that need attention.

> Let's put it this way...you went from this culture where the Fisheries Research Board and the DFO did basically anything they wanted in relation to science investigations in the Arctic, and community consultation was something way down low on the level if it existed at all. But with the land claim agreement all of a sudden you couldn't go anywhere you wanted to and you couldn't do anything you wanted to and you certainly couldn't arbitrarily pick some species that you wanted to work on, so life changed. There was lots of resistance to that and there was a period of time where it was pretty unpleasant. I think the turning point was when I invited the director general to come to a meeting of the FJMC in the western Arctic and we sat down and talked about provisions of the IFA and he said I understand now that the game has changed, and he went back and actually started working with his directors to say this is how it's gonna be (Vic Gillman, pers. comm., Aug 2009).

The FJMC has also directly facilitated the scientific education of Inuvialuit. They are hired as research assistants on specific projects and are able to learn science first hand as opposed to hearing a brief explanation in a community presentation. Under certain circumstances, scientists who work with Inuvialuit in their research are able to learn about IK while in the field.

Type 3: Co-production of Knowledge

"We have our own university, and our own Ph.D.s" - Boogie Pokiak

A history of extensive knowledge sharing is a prerequisite for knowledge co-production, and trust is the key element in this type of knowledge interaction. Co-production goes beyond using TK to provide local knowledge into a larger framework. It allows for the knowledge and belief system of aboriginal people to be as important and

influential in prioritizing and decision-making as that of the Canadian government (Davidson-Hunt, 2006). This type of knowledge interaction did not exist between the Inuvialuit and the DFO before the IFA, and even after the IFA it took several years for it to develop.

Knowledge co-production differs from knowledge exchange in that it is a synthesis of science and TK that aims to answer or define a particular question, design a research project, or create an action plan for a specific issue. Neither system of knowledge is seen as superior. It involves both sides re-evaluating their knowledge in order to produce new knowledge. All knowledge co-production requires knowledge exchange, but not all knowledge exchange results in co-production. It is critical for knowledge holders from each tradition to be familiar with the processes involved in each other's methods of knowledge acquisition and verification. One example of knowledge co-production comes from a study done by Carmack and Macdonald (2008) with the help of Tuk elder Jimmy Jacobson as a research partner, funded in part by the DFO. In this study, IK was used as the basis for planning and measurement of sea ice characteristics that were especially relevant to winter travel and fishing. This revealed important information about potential future sensitivities to development or climate change. A study of the Alaska Beluga Whale Committee by Fernandez-Gimenez (2006) argues that equality in power and transparency in process within the co-management group are prerequisites for knowledge co-production.

Co-production is the product of extensive work and interaction between key individuals from the DFO, FJMC, and Tuk HTC as well as Tuk community members. Both the Inuvialuit and the Canadian government appointed members to the FJMC that were not only experts within their own systems of knowledge, but also in the social dynamics of management and inter-cultural relations. The small northern co-management board was able to attract both PhD-level research biologists and long-time land users with a deep concern and respect for the resources.

> I think that the problems themselves are really interesting problems, and the science is really exciting. The book on Beaufort sea beluga has been completely re-written, and the FJMC has been heavily involved in that. We mapped out what needed to be done, and had the funds. So it's an intellectual challenge on the science level, and it's a different sort of interaction on the human level. The Game Council appointees have been magnificent. They have been knowledgeable and committed and generally able to hold their own in discussion. The third point that brings everybody to the table and makes everybody want to stay is Billy Day's favorite word, which is respect. Respect both ways was expected. The FJMC actually acted a group: dinners, hockey games, cross-cultural (Robert Bell, pers. comm., Sept 2009).

The FJMC, DFO, and Tuk HTC organize workshops on specific issues that are designed to allow for knowledge co-production. This type of workshop is normally reserved for issues that are of special concern for the community. In the case of the Husky Lakes beluga entrapment, the FJMC organized a community-based workshop after the 2007 entrapment. Back to back entrapments had never been previously recorded, and the committee felt that it was necessary to not only hear what the communities had to say but also for an action plan to be constructed and agreed upon by the FJMC, DFO, Tuk HTC, and all ISR communities.

> When there's a particular thorny issue that the committee is uncomfortable dealing with in its own envelope, they'll find a way to consult with the communities, and the last beluga entrapment is an example of that. No one could answer the question about what to do next. Should we try to keep them out of there? Should we try to do a science project on ice movements? So we asked for a workshop with Elders and we knew that some communities don't harvest belugas, but they still had representatives there because this affects the whole Inuvialuit Settlement Area. It may not be the harvest itself, but the image of the ISR may be affected by what happens with the entrapments (Vic Gillman, pers. comm., Aug 2009).

Knowledge co-production can also occur in the field during research activities or management exercises. Community members are heavily involved in monitoring and sampling projects such as the Beluga Monitoring Program, which has a youth education component. These exercises are often educational for the scientists as well. As an

example, setting nets for species richness and abundance studies can benefit from knowledge co-production. Inuvialuit fishers know the best locations where catch per unit effort is high as well as the optimal habitats for each species of fish at all different times of the year.

In most cases, scientific research projects involve the communities at all stages from planning to review. With regards to University projects, there is a formal procedure in place administered by the Aurora College that requires project approval by relevant community organizations such as the HTC. As mentioned previously, DFO science projects also gain approval of the HTCs in order to proceed. The FJMC contributes significantly to scientific research by facilitating the integration of IK through direct exchange with scientists, and also through a research funding mechanism. The FJMC creates a list of priorities and research questions and any researchers who choose to align themselves with those priorities have the potential to receive FJMC funding. This process still has its shortcomings. The FJMC's research priorities are finalized some time after the community consultations, which occur in June and November. The DFO and many researchers from academe begin planning their projects in October or November, so by the time the FJMC decides what it is willing to fund most researchers have already organized and funded their field seasons. The committee is currently working to improve the timing involved in this process.

Knowledge co-production is probably the most equitable type of all the three categories of knowledge interactions. It ensures that all knowledge interpretation and verification is done with all the knowledge holders present. In the case of knowledge co-production that leads to an action plan, the final product is created on-site with the approval of all attendees.

In summary, collaboration between Traditional Knowledge holders and scientists is at the heart of co-management. It has been greatly facilitated by the changes in the structure of the management regime due to the IFA, but also by key individuals from both

sides that have created an atmosphere of respect. The organizations involved in the co-management regime are always looking to improve the way that they work together instead of simply adhering to operational procedures. Although each issue is at its own developmental stage in the co-management process, the overall trend has been towards the treatment of science and IK as equals.

4.3. Husky Lake beluga entrapment decision-making process by year

Co-management has changed the way in which IK interacts with scientific knowledge, and I will highlight how the changes in knowledge interactions have influenced the decision-making process with regards to the Husky Lakes beluga entrapment. I will describe the decision-making process involved in the 1966, 1989, 1996, 2006, and 2007 entrapments as well as the 2008 entrapments workshop. Residents of Tuktoyaktuk at large and members of the HTC past and present agree that the overall trend has been from a DFO-driven process with community consultation added on when it was convenient (Fig. 4.1b), towards a higher level of Inuvialuit participation in the process (Fig. 4.1c). In recent years, the decision about what to do regarding specific entrapments has been made at the community level and carried out as a cooperative effort between the Tuk HTC, FJMC, and DFO.

4.3.1. The 1966 entrapment

The 1966 entrapment was one of several documented entrapments of beluga whales in Husky Lakes that occurred before the IFA was signed. Other entrapments occurred in 1969 and 1974 (Weaver and Richard, 1989), but I have chosen to discuss only one of the pre-IFA entrapments because of the difficulty in locating sufficient data and information regarding the other events.

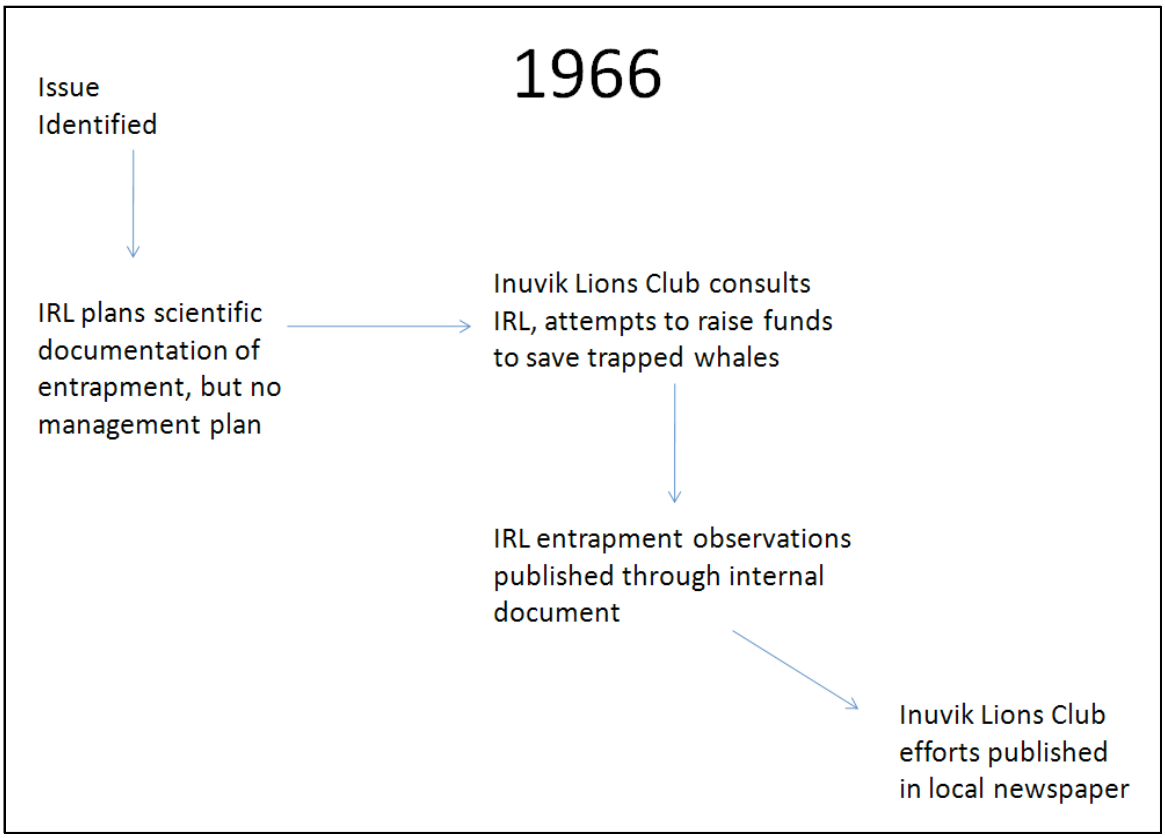


Figure 4.1a: Decision-making process for 1966 Husky Lakes beluga entrapment. The decision of how to handle the entrapment did not involve any Inuvialuit.

The entrapment in 1966 was identified by pilots and the Inuvik Research Laboratory (IRL) was alerted. After freeze-up, three separate holes were seen near whale point (Fig. 4.2).

There was no consultation or communication between the IRL and the community of Tuktoyaktuk (Fig. 4.1a). The IRL had been established by the Department of Indian Affairs and Northern Development to conduct arctic research (Ayles and Snow, 2002). The IRL conducted scientific observation of the whales, recording dive length, sounds, and a variety of other behavioral information (Hill, 1967). Management of the entrapment was taken over by the Inuvik Lions Club, which formed a 'save-the-whales' committee

that was able to raise $526 in cash and $5,500 in equipment to feed the whales and maintain their breathing holes (Northern Information Service, 1967).

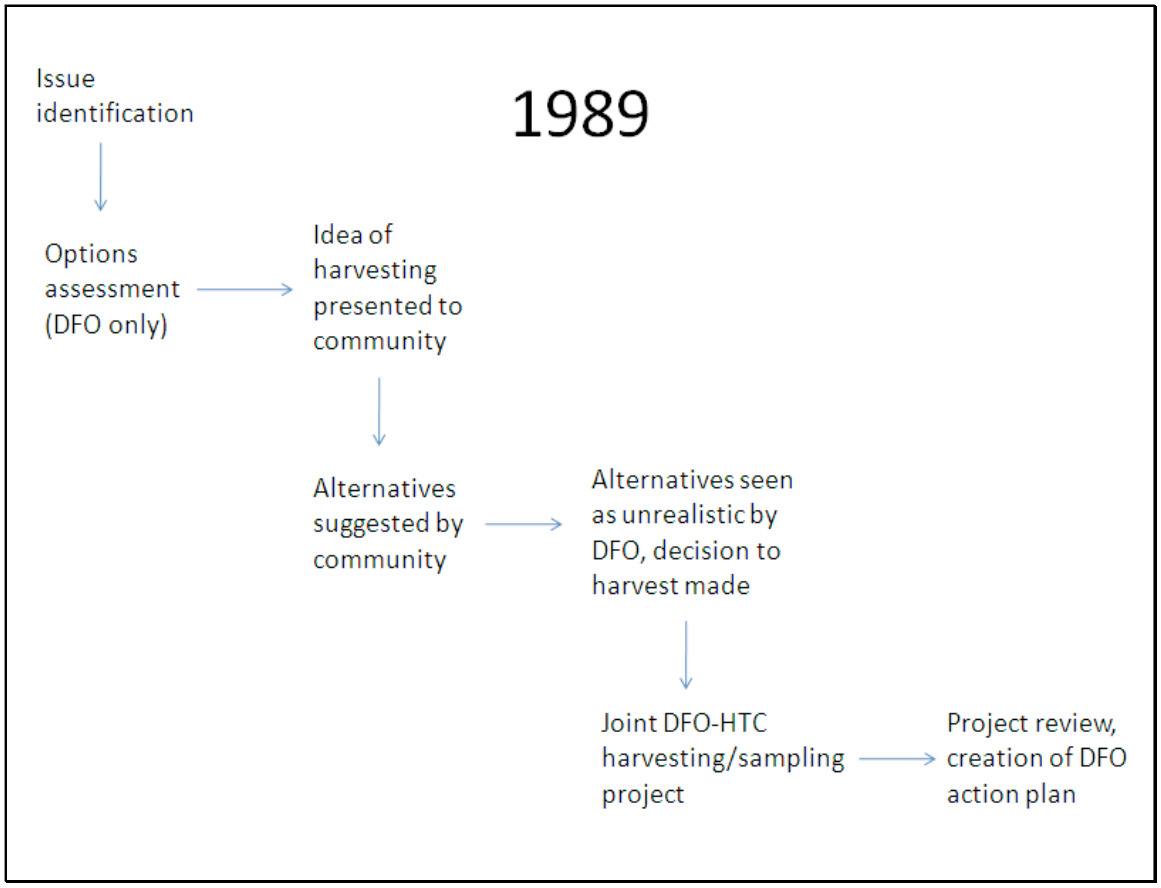


Figure 4.1b: Decision-making process for 1989 Husky Lakes beluga entrapment. The initial stages were DFO-driven but later came to involve the Inuvialuit.

Their efforts were unsuccessful, as the whales did not seem to eat the lamb chops and ground fish that had been provided, nor did they use the extra holes that had been cut for them (Hill, 1967). It is clear that the decision-making processes used during this entrapment did not involve the Inuvialuit.

4.3.2. The 1989 entrapment

The 1989 entrapment of over 250 beluga in Husky Lakes was considered by the DFO to be their issue.

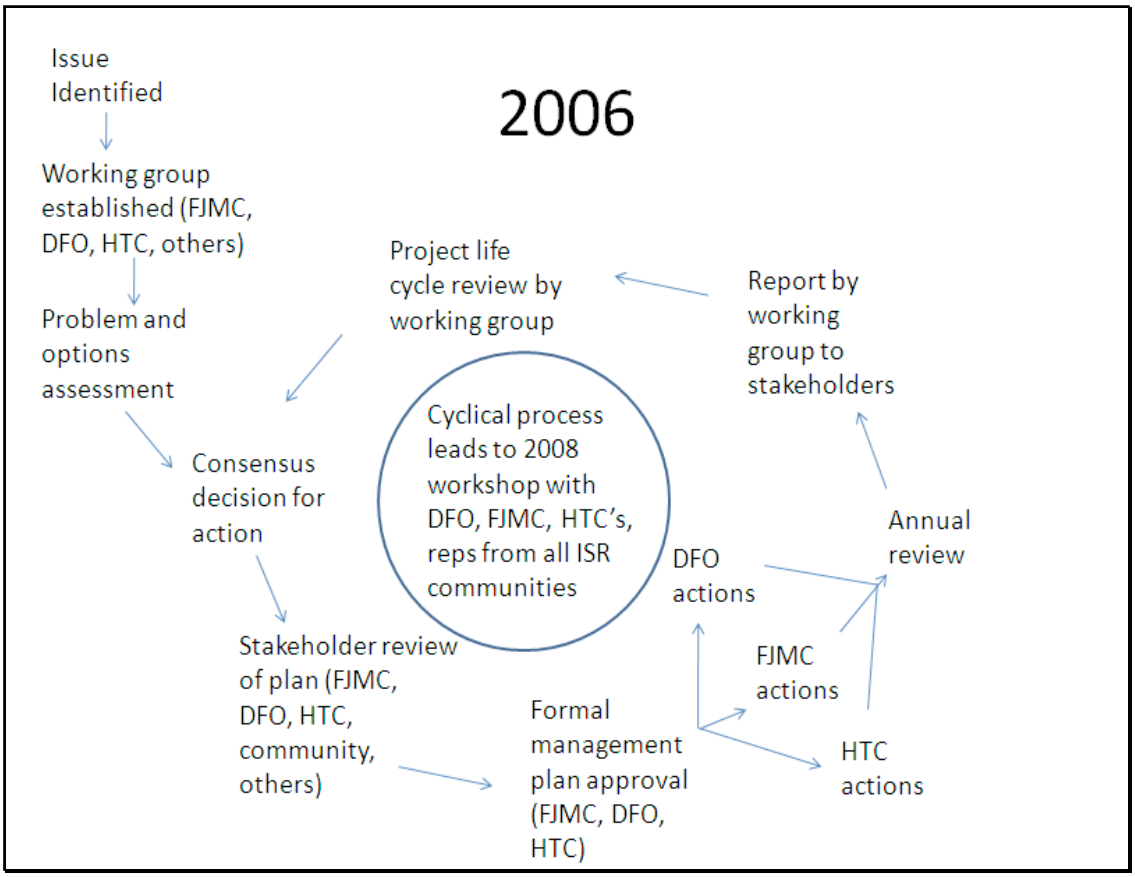


Figure 4.1c: Decision-making process of the 2006 Husky Lakes beluga entrapment, adapted from Ayles et al., 2007. This process indicates the use adaptive co-management.

Even though the FJMC had already formally existed for three years, the consultation procedures between DFO, FJMC, and HTCs had not yet been fully established. The DFO felt pressured to act quickly and decisively on the issue because the previous year there had been a gray whale entrapment off the coast of Alaska that had received international attention in the media (Stafford et al., 2007).

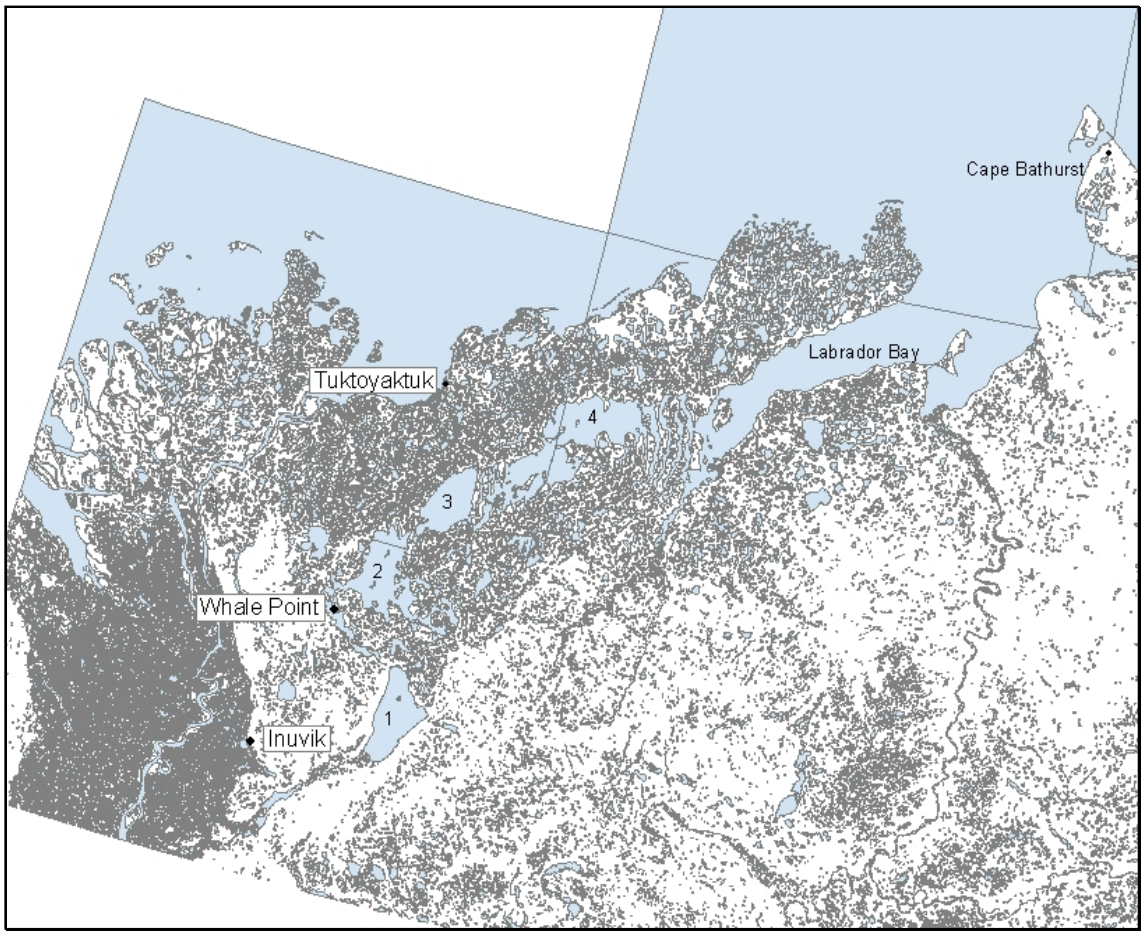


Figure 4.2: Map of Husky Lakes area with basin numbers.

In that case, offers to help feed or free the entrapped whales came in from across the globe and the whales were ultimately freed by a soviet ice breaker. The DFO knew that the beluga entrapment in Husky Lakes had the potential to receive the same media attention. To complicate matters further, there was no reliable information on the stock of the Beaufort Sea beluga at this time. Thus, it was unknown whether the death of the entrapped whales could affect the overall population. The initial stages of decision-making regarding this entrapment were done by the DFO alone. The process involved consultation between the DFO arctic area managers from Hay River, Inuvik, and Iqaluit and the DFO director of fisheries (Ayles, pers. comm., Oct 2009). During their

consultation they realized that feeding or freeing the whales was impractical and that community harvests would be the best option. After that a decision was made the DFO consulted with the FJMC, Tuk HTC, and Inuvik HTC.

> Community consultation would have been after we decided we wanted to do a community harvest. Well, can we get them to do that? We'll go and tell them that this is what we think is the best thing.... All I can remember is that I cannot remember having discussed this with anybody. Maybe Vic Gillman might have talked to some of the people locally about it, but we, DFO, saw it that we were the ones that were going to have to answer it. We were going to have to have a communication plan. It was going to be me and Vic that were going to have to talk to the press about why we weren't using an ice breaker or something like that. And so it wasn't a co-management initiative at all (Burton Ayles, pers. comm., Oct 2009).

The 1989 directors of the Tuk HTC were had their doubts as to how the process would go due to the novelty of the situation. The Tuk HTC initially requested funding for an attempt to herd the whales out using 3-4 boats. Dennis Raddi was a director of the HTC at the time and believed herding could be done, however the DFO did not agree to fund the operation because they did not think it would be an effective use of resources.

> The IFA was pretty new at the time, so there was a question as to how it would play out. We didn't really know...who has the rights and authority to make the decision? Who has the money to do that kind of project? We wanted to just herd them out. We figured it would be easier in the lake than in the ocean, and that's how we hunt them in the ocean. We knew we could do it, but the DFO didn't have anything written down and they didn't see our traditional knowledge as credible so they wouldn't fund it. So then we pushed for the slaughter because we don't like to see the animals suffer (Dennis Raddi, former Tuk HTC board member, pers. comm., July 2009).

Although the herding plan was not funded, the community-based harvest was agreed upon by all. No one wanted the whales to suffer more than they had to, and no one wanted to attract any negative media or be portrayed in a negative light. The consultation between the DFO, FJMC, Tuk HTC and Inuvik HTC resulted in the following arrangement.

> An update on the numbers and location of beluga currently in HL was given, and there was discussion about what should be done about the situation. It was agreed that DFO and FJMC would collaborate with the HTCs on this, and would contribute by providing transportation for whale monitors and enforcement officials to the sites. At the same time, hunters could be transported. FJMC and DFO cannot fund subsistence hunting, but would be responsible for enforcement and biological sampling. The HTC would be responsible for the harvesting. Vic thought he might have about 3 K available for charters with the Inuvik HTC and would work out a similar arrangement with the Tuk HTC. HTC would be responsible for equipment and fuel (FJMC minutes, 10/89).

An interesting point to note is that the community members that were hired for the hunt by the HTC were largely unaware that the DFO was involved in the decision at all, thus they were under the impression that it was a community-led initiative. Two out of five hired hunters did not recall the presence of any DFO employees at the slaughter, and four out of five called themselves community volunteers because the pay only covered their expenses.

> We didn't know it was DFO or anything, I know Hunters and Trappers were involved. We were hired from Hunters and Trappers to do the shooting and it was a bad place that Saunaktuk at the time because it never freezes up (Angus Cockney, community member, pers. comm., June 2009).

The biological samples were taken for analysis by the DFO and the meat and muktuk was distributed throughout the ISR to people in need, although much of it was of poor quality. See section 5.3 for a full account of the worth of the slaughter from the communities' perspective. After the slaughter the DFO created an action plan so as to be ready for future entrapments, but it was unfortunately lost (Vic Gillman, pers. comm., August 2009). The DFO, FJMC, and Tuk HTC worked together for formulate a monitoring plan to prevent future entrapments. Although the monitoring history is relevant to this section, I am treating it separately because it provides a strong example of institutional learning over time. Section 5.2.2 contains a full treatment of the monitoring programs associated with the entrapments.

4.3.3. The 1996 entrapment

The monitoring program implemented after the 1989 entrapment ran until 1995. In the summer of 1996, the Tuk HTC board made a request to the FJMC for continuation of the monitoring program. Their main concern was the protection of the fish stock within the lakes from beluga predation (Tuk HTC, 1996). The FJMC was unable to fund the project, and an entrapment occurred later that fall. Aerial surveys were taken and no whales were seen in Husky Lakes in late summer, but after freeze-up a savsaat domed over with ice was found and reported to the Tuk HTC. Because of the urgency of the situation, the decision-making process was streamlined. The process was also easier because the situation was not new and there was already a precedent. Funding for the project was secured from FJMC and DFO for sampling of the harvested whales. Twelve community members worked on a volunteer basis, having only their groceries and transportation costs covered. The meat and muktuk was once again distributed throughout the ISR. Less than one month after the entrapment, a new HTC chairman took office. One of the board's first actions was to make a new request for a monitor. This request was completed in a far more formal manner, with all costs of transportation, food, wages, and supplies calculated.

4.3.4. The 2006 entrapment

By 2006, the process of decision-making had undergone a transformation. Passengers in airplanes noticed about 200 whales within Husky Lakes in late summer of 2006. Immediately, the Tuk HTC met with the FJMC and DFO to discuss options. It was decided that aerial surveillance would be used to monitor the number and position of the whales. Eight surveys were conducted beginning on September 6th and ending on November 22nd. These surveys included DFO, FJMC, and HTC members as whale counters and were flown in a grid pattern with the use of photographic equipment. When it was determined that approximately 80 whales were trapped, the HTC at the request of the community of Tuk decided to do a harvest. The community was relatively split on the

issue so it was difficult for them to make their decision, but all of the Tuk HTC directors eventually agreed on the harvest. In stark contrast to previous entrapments, the decision-making process regarding what action was to be taken in 2006 took place in Tuktoyaktuk among the Inuvialuit. It is important to remember that decisions about entrapments had been made this way for hundreds of years before the Canadian government was ever involved, so in one way this was more of a return to normalcy than an unprecedented shift in power. After the community members had expressed their wishes to the HTC, the FJMC and DFO were consulted and a hunting/sampling project was organized.

> Hunters from Inuvik and Tuk carried out a mercy hunt in mid-Nov, which lasted 9 days. This course of action was supported by both the DFO and the FJMC. The team was composed of 10 local men from Tuk, 3 from DFO and 2 cooks from Tuk. Base camp was established on a small island a few kilometers from the savsaat, N 68.82, W 132.85 (Orr, 2007). In total, 37 belugas were successfully harvested, while 2 were struck and lost. As an exact number of entrapped whales was unknown, it is not known how many perished of natural causes (FJMC, 2009).

Community employees were hired with full wages through the HTC, which was given funds from the DFO for their participation in the operation. A hunt captain was chosen by the HTC who directed the day to day proceedings in order to ensure the safety of all participants as well as a humane and efficient slaughter. DFO and HTC members were the ones most involved in the hunting/sampling project. In specific projects such as these, the FJMC often contributes funding for coordination, as their budget does not cover operations costs.

4.3.5. The 2007 entrapment

Back to back entrapments occurred in Husky Lakes in 2006 and 2007. This event immediately raised several questions: are entrapments becoming more frequent? Is climate change or industrial activity responsible? Could it have an effect on the population? Could a study be done?

Local reports of whales in Husky Lakes led to survey flights. Approximately 200 belugas were observed in the second Husky Lake on August 21st. As of November 1st, approximately 80 whales had become entrapped. The Tuk HTC consulted the community once again.

> But back in 2007 when we had that meeting we just wanted to do what the public wanted and we decided to just leave them and see what happens...we didn't do anything and there's two areas where there were whales stuck. So we did go out there just to keep an eye on them with DFO at the Husky Lakes narrows, Gudchiaq, there was about 50 plus stranded in there. We went back again 10 days later and it was all frozen (Chucky Gruben, Tuk HTC board member, pers. comm., Aug 2009).

There were several reasons that no hunt or sampling was organized in 2007. From the community perspective, safety was a major concern. All 10 community members that mentioned the 2007 decision during interviews mentioned safety. While there had not been serious injuries in past harvests, there had been some incidences of people falling in the water and being pulled out with ropes. In 2007, the ice was particularly thin in the area surrounding the entrapment. It was thought that pulling the whales out might break the ice. Only two community members out of 25 commented positively on the quality of the meat and muktuk from the 2006 entrapment, so this was also presumably a reason that another hunt in 2007 was not supported. Three out of ten community members mentioned funding as another reason. Some people in the community were in favor of a harvest, but they were told that it was an extremely expensive project. One community member mentioned that the number of whales was too low to justify a harvest. The chairman of the HTC at the time brought up the idea that they should let nature take its course.

> You know, one of the things I introduced was the fact that maybe we were bothering the ecosystem. Doing that, harvesting the whales...maybe it's part of a mother nature's course in taking care of the ecosystem, so we left it based on that (Paul Voudrach, former Tuk HTC chairperson, pers. comm., July 2009).

The DFO members interviewed cited safety and Inuvialuit dissatisfaction with the results of the 2006 hunt as the reasons that no harvest was carried out in 2007. The meat and muktuk were not of good quality, but the cost of distributing them to all the ISR communities was extreme.

4.3.6. The 2008 workshop

After the back to back entrapments of 2006 and 2007, the issue went to the top of the priority list for the Tuk HTC. During a meeting between the Tuk and Inuvik HTC's in 2007, it was agreed that a plan for dealing with future entrapments was needed. In response to this, the FJMC decided that a community workshop would be the best way to co-produce an action plan. The FJMC contacted the DFO Inuvik Area manager, who agreed to partially fund and take the lead in the workshop. The Tuk HTC agreed that it would be good to have representation from all the ISR communities meet with managers and scientists to discuss all the options available.

> Well that workshop came about because we very rarely see whales get trapped in consecutive years like that. Something had to be done. We had to come up with something that we could work with. And that's basically why we brought in all these kinds of people from the surrounding communities, the scientists, and our people also you know, and sat them down and they went through a lot of these things. Basically it was a fact finding mission. They wanted to see how it was done years and years ago when the whales got trapped in there versus now. They used to say it was an act of god. Nobody told those whales to go in there; they just went in on their own. So it's a natural occurrence, and then now after not seeing it for decades, all of a sudden it happens two years in a row, bang bang. A little better than 10 years from the first one that happened in my lifetime. So something was bringing them in there, and today they still don't know why they go in there. People tell them there's good feeding in there, they go in for the blue herring, and we believe that (James Pokiak, current Tuk HTC chairperson, pers. comm., Aug 2009).

As previously stated, the action plan was the result of knowledge sharing and co-production between representatives from all the ISR communities, the FJMC, DFO, and

academics. Of course certain aspects of the plan were not a decided upon unanimously, but the plan as a whole represented the views of the majority of those present.

As with many management issues within the ISR, beluga entrapment within Husky Lakes has been treated differently over the years. As shown above, there are many factors that play into these decisions. The trend in the decision-making process brought about by co-management has been described as positive by all parties involved. The process has been inverted in that top-down decision-making has been replaced with bottom-up. Consultation and communication between the DFO, FJMC, and HTC's has become increasingly sophisticated and, in the words of several community members, "The playing field has been levelled."

In summary, the first section of this chapter provided an analysis of the factors that allowed the collaborative process of co-management between scientists and traditional knowledge holders to mature. These factors ranged from changes in the organization of the entire system and relationships between organizations made by the IFA to changes in attitudes at the level of the individual. The second section showed how these changes manifested themselves in actual cases of decision-making. There has been a clear transition away from top-down science-based management to multi-level knowledge co-production. Co-management in the Western Arctic has not and will not reach an end point because the needs of and the relationships between the organizations are constantly changing.

Many Inuvialuit still rely heavily on fish and game for their livelihoods, which necessitates extensive interaction with the environment.

Chapter 5: The Effects of Co-Management on Community Adaptive Capacity

The Inuvialuit have a long tradition of adaptability to changes in weather patterns and wildlife abundance that is embedded in their culture and social structure (McGhee, 1988; Friesen, 1999; Berkes and Jolly, 2001). However, exposure sensitivities and stresses are increasing through unprecedented climate change (Maxwell, 1997), and social change (Ford and Smit, 2004). Integration into the wage economy has had a broad range of impacts on self-reliance. In Tuk, the increasing reliance on the wage economy exacerbates problems related to the influences of southern culture, which have strained the transmission of Inuvialuit culture (Andrachuk, 2008). This has had the effect of reducing the potential for adaption to change through means of IK alone at the local level.

The objective of this chapter is to use existing studies as well as my own data to show the ways in which co-management between the Tuk HTC, FJMC, and DFO is bolstering adaptive capacity at the community level. Community adaptive capacity is refers to the ability of the community to cope with and respond to social, cultural, bio-physical, and economic changes. I will begin this chapter by discussing how linkages between the DFO, FJMC, Tuk HTC, and other organizations have helped the Inuvialuit to increase their adaptive capacity. I will then describe some community perspectives on current and future stresses relating to resource management and explain how those changes have impacted the communities' adaptive capacity. Finally, I will present selected community perspectives regarding the beluga entrapment to show the diversity of opinions and goals that the co-management system is faced with. This section will also provide insight from community members into potential future responses to entrapment.

5.1. Facilitating community adaptive capacity

Adaptive co-management (ACM) refers to an iterative and experimental approach to managing natural resources that involves linkages between organizations at multiple scales that serve to equitably distribute knowledge, material, and financial resources (Armitage et al., 2007). It can be argued that the process of ACM within the FJMC has helped the community of Tuktoyaktuk to increase its own community adaptive capacity.

With regards to process, an important aspect of adaptive co-management is to strive for the equitable involvement of all member organizations. Adaptive co-management is unique in its emphasis on institutional learning as a means to achieve this goal. The key aspects of the adaptive management are 1) feedback between monitoring and decisions; 2) iterative decision-making; and 3) accepting risk and uncertainty as a means to improve understanding. Passive adaptive management is focused on gaining knowledge by monitoring and assessing management strategies and then using that information to inform new strategies. Active adaptive management has an emphasis on experimentation, in effect, changing management strategies completely in order to test new hypotheses (Walters, 1986). Adaptive management approaches focus on developing a range of management alternatives, developing indicators, and finally designing and implementing, and assessing an effective monitoring system (Walters, 1986).

By providing long-term incentives for collaboration between organizations at different levels, adaptive co-management arrangements have the potential to monitor and evaluate management strategies and decision-making processes to ensure equity among member organizations, and to link research to policy directly (Armitage et al., 2009). The co-management arrangement between the DFO, FJMC, and HTCs meets the the criteria for co-management according to Pinkterton (2003), including most notably the ability to exclude outsiders, cooperation, power sharing with the local levels, and horizontal negotiations leading to cooperation with multiple players. This regime operates on

formalized processes that involve all member organizations throughout the entire adaptive cycle of decision-making from issue identification, from an annual review to a 3-5 year project review (Ayles et al., 2007). In the previous chapter I gave examples of how the FJMC has engendered equality between the DFO and the Tuk HTC. The next section shows how co-management has increased adaptive capacity in Tuk through 1) increasing horizontal and vertical communication; 2) creating processes that foster institutional learning; 3) widening the range of alternate responses to management issues; 4) providing co-management related jobs; and 5) working to help educate youths and preserve Inuvialuit culture.

5.1.1. Increased Horizontal and Vertical Linkages in Communication

Good communication a necessity for effective co-management. It is clear that all the mechanisms by which co-management in the ISR increases adaptive capacity at the local level require communication. Chapter 6 provides a full analysis of the communication structure between the different organizations that were involved in the management of beluga entrapments in the Husky Lakes from 1966 to the present. In this section I show how the improvements in communication have facilitated community adaptation.

Horizontal Linkages in communication

There has always been fairly good communication between communities within the ISR when it comes to issues of fisheries and marine mammal management. In the past when news of entrapment would circulate in the ISR, the Tuk HTC would get calls from the other communities wondering what Tuk was going to do about it (James Pokiak, Pers. Comm., Aug 2009). The interactions between communities are deeply cultural in nature. Inter-community trade helps to maintain family contacts and friendships, as well as helping to increase availability of specific resources. Communication between the communities facilitated the sharing of the meat and muktuk from the 1989 slaughter.

The 2008 Husky Lakes beluga entrapment workshop is an excellent example of how the FJMC and the whole co-management process increases horizontal communication. On this occasion, it was thought that all the communities should be represented while constructing the action plan. Elders from all the ISR communities were flown to Tuk for the meeting to share their knowledge of entrapments and give their opinion on what could and should be done. The Tuk HTC was happy to be able to get the perspectives and advice that elders from other communities had to offer. Another benefit was that there would be no surprises about what would occur in case of an entrapment.

> I like the idea of monitors being there every year – so if you can add two more, if special request made this year, then it'll improve activity. At some point, FJMC and/or DFO will get involved with a whale crisis anyway. If you have funding to do this right now, then please help us. The locals have the knowledge to support data etc. and vice versa already (FJMC, 2008). Minutes for 2008 beluga workshop, representative from Paulatuk.

Vertical Linkages in Communication

The communication linkages that have been formed between the community HTCs and the IGC with regional, national, and international governments and industry have provided many benefits to the Inuvialuit which have had positive impacts on adaptive capacity. Vertical communication between these organizations has in one way or another allowed for the flow of knowledge, power, and resources into Tuk that would not otherwise be accessible. For example, scientists and consultants are occasionally flown in to the Arctic to attend FJMC meetings and share information with the HTCs and community members. More effective communication of IK to higher-level organizations has resulted in an increased acceptance of IK as a reliable source of information for use in natural resource management decision-making. In recent years the FJMC has met with the minister of the DFO and even the senate to discuss co-management and the importance of the meaningful participation of the Inuvialuit in Western Arctic fisheries management.

5.1.2. Institutional Learning through Husky Lake beluga Monitoring: then and now.

There have been two HL beluga monitoring projects. The first began in the summer of 1989 as a response to the entrapment that had occurred the previous winter. The second began in 2008, after the back-to-back entrapments of 2006 and 2007. As mentioned in section 4.2, the monitoring projects were an essential aspect to the decision-making process regarding the entrapments. Monitoring is a preventative rather than a reactionary measure; thus, this part of the decision-making process is an example of institutional learning. Both monitoring projects show their own specific examples of institutional learning, but I will argue that the level of institutional learning during the second monitoring project was far higher than in the first.

In 1989, the FJMC, DFO, and Tuk HTC met to review the success of the 1989 harvest and it became clear that the community wanted to prevent future entrapments if possible. The three year project that came out of the meeting was funded by the FJMC and relied heavily on traditional knowledge.

> We asked the community: what is your highest priority? 'To prevent that [entrapment] from ever happening again'. They wanted to use whatever technology was available in spring and summer to bar whales from Husky Lakes. Marine Mammal science thought it was not a good idea. They said 'we don't know what to do'. TK came into play because Whale Point was traditionally a capturing point. The process that was used to keep the whales in could be used to keep them out. The FJMC agreed, contrary to science advice, to fund a community initiative to use whale bone rattlers to keep out whales. The first [monitoring project] was 3 years long, right after 89 (Robert Bell, pers. comm., Sept 2009)

Interviews with the monitors that worked on this project reveal gaps in communication and a lack of institutional learning. Two pairs of monitors who worked in successive years recalled having the same problems:

1) Lack of food. Resupply planes bringing groceries were supposed to come weekly, but never came. They solved this problem by digging a hole in the permafrost to store caribou;

2) Lack of gasoline. Hauling wood and water without gas was impossible due to camp location. The lack of gas also rendered them unable to deter whales by herding;

3) No return flight. Monitors had to pay for their own charter plane to go back to Tuk;

4) No communication. The radios were working, but they could rarely contact anyone from Tuk or Inuvik;

5) Unreasonable expectations. Monitors were asked to stay through freeze-up, but they had not been told to prepare to do so;

6) Low pay. After paying for their charter back, the small amount they earned was barely worthwhile.

These problems persisted between years because there was not an effective mechanism for project review. Not only did these conditions make the day to day living difficult for the monitors, but it also made their job next to impossible because they were unable to deter whales without gas for use in boats. Furthermore, the monitors did not complain about the conditions at the time because it was not considered appropriate to do so within the community due to cultural taboos. During this first monitoring project, the success was on the shoulders of the monitors alone. They brought all their own gear and skills and had little or no contact with the organizations that had hired them.

The monitoring project that began in the summer of 2008 shows clear improvements in institutional learning. This project was born out of the 2008 workshop discussed in section 4.2.5, and is a combination of traditional knowledge and science. In the first year of the project there were two camps: one at the DFO camp, and one at Gudchiaq. The DFO camp was located between Liverpool Bay and Husky Lake basin 4, and the camp at Gudchiaq was located in the narrows between basins 4 and 3 (Fig. 4.2).

The DFO camp was meant to be an observational camp that would warn the deterrence camp if they saw whales. After the summer monitoring, there was a thorough project review process that included the DFO, FJMC, Tuk HTC, and the monitors. During this time it was decided that the outer camp was not as effective as the inner camp. The decision was made to take the resources from the outer camp and use them to increase the amount of time monitors could stay in the inner camp where they were more effective. They also used the resources to buy pingers and sonar blasters, which could work at night with the flip of a switch. Not only were the resources used more effectively, but costs were also lowered.

> Sometimes they have these programs and there's kind of a communication gap between the HTC and FJMC and DFO. After that first year, the HTC was thinking "how can we cut costs?" So we shut down that one camp there. And we need to charter a helicopter to haul all the stuff out, we need to charter a float plane to haul the stuff to the site. The HTC was finding ways to save money...we can haul the fuel in the spring, haul the firewood in the spring, DFO can provide boats so they don't have to rent a boat and motor off a monitor. We see how we can cut costs so we gave them a lot of information about how to cut the costs in half when you do stuff like that. So right now, with a crew change we use a two oh six float plane whereas the year before they were using helicopters (Chucky Gruben, pers. comm., Aug 2009).

Other revisions to the monitoring program after the first year were shorter stays for monitors with more frequent crew changes and more supplies. Jeffery Adam, a monitor in 2008 and again 2009, remarked: "Every problem we had last year they made sure that it was fixed this year. Now we got living quarters, a big kitchen, freezers, generators, heaters, a kerosene heater, we got lots of wood" (Jeffery Adam, pers. comm., Aug 2009). Both monitoring projects are cases of institutional learning, but it is clear that the efficiency has improved greatly. This shows a productive integration of TK and science.

> I think the idea of success in monitoring on that side [Husky Lakes] has always been community people on the ground monitoring, and then

potentially using technologies that could be effective as an assistance (Louie Porta, pers. comm., Aug 2009).

However, the integration of TK and science in the project review and revision stages of the adaptive cycle is equally as important as the integration of TK and science in the exercises of monitoring. Review and revision is where institutional learning is put into action, thus equity in these steps is crucial. Instead of just reacting to management problems with short term solutions, the organizations in the co-management regime equitably plan far into the future but review and renew their processes every year. The Husky Lakes beluga monitoring project is an example of adaptive management that shows how the co-management organizations

5.1.3. Increasing the range of technical solutions

Some of the most concrete and direct examples of how co-management has increased the adaptive capacity of Tuktoyaktuk are seen in the expansion of the range of responses to phenomena or change. The Inuvialuit are very active managers. When a problem or issue arises, they are often the first to detect it because they spend so much time on the land. Whether it is a declining fish stock, changing sea ice patterns, increasing bear populations, or the presence of a savsaat, they will likely be the first to notice. If a particular management strategy is not working, they are quick to point it out. The range of responses to beluga entrapments has increased dramatically through co-management, thus giving the Inuvialuit a greater ability to implement their decisions and retain their cultural preferences.

The harvesting projects conducted in 1989, 1996 and 2006 resulted in thousands of pounds of beluga meat and muktuk. It was decided by the community that sharing the extra food with neighboring Inuvialuit communities would be the best decision. Elders and other people from all ISR communities unable to hunt whales were given the muktuk for free. Transporting this amount of weight to distant communities would have been impossible for the Tuk HTC without support from the FJMC and DFO. Beyond the

obvious nutritional and caloric benefits to the recipients, the culture of sharing was also reinforced. Although the meat and muktuk was not top quality, the inter-community sharing is still seen by the Inuvialuit as an important cultural practice.

During the 2008 beluga entrapment workshop the Inuvialuit were given presentations about the usefulness of state-of-the-art scientific tools such as GIS and satellite mapping to detect whales. Scientists discussed the potential for research aimed at understanding more about why the whales get trapped using everything from archived satellite data to genetic and morphological data from trapped whales. With regard to future monitoring, the pros and cons of using acoustic devices were discussed and debated. Thus, the action plan was made with a much wider range of options available than had been in the past. It was decided that if no harvest was carried out, aerial surveys could be used to determine approximately how many whales were actually trapped in order to determine whether or not entrapments may affect the overall stock. In the event of a harvest, distribution of the meat and muktuk to the communities would take place as it had in the past. However, during the workshop concerns were raised about brucellosis[6]. In response to this, DFO science proposed a mechanism by which samples from whales suspected to have brucellosis could be sent to DFO laboratories for analysis prior to consumption. The range of responses was expanded here at three different levels: the potential courses of action, tools for carrying out the actions, and mechanisms to assess the results.

[6] Brucellosis is a visually undetectable bacterial disease that can be carried by certain marine mammals including beluga whales and may be harmful or fatal to humans. The disease can be contracted through contact with ungulates; however, it is not known whether the disease can be contracted through contact with whales.

5.1.4. Providing co-management-related jobs

Unemployment is a serious problem in Tuktoyaktuk. From 2001 to 2006 the unemployment rate has varied from 27 to 33% (Statistics Canada, 2006). Since the IFA, co-management-related jobs have provided a significant amount of income for the community. Financial benefits to the community also facilitate with community buy-in to the co-management process (Berkes, 2008a).

> In my early times, all of the really small outlying communities, people were content, but without anything really to do. There are very few jobs. The land claims brought in a whole new set of ways for there to be an honorable exchange of government money for meaningful contributions to wildlife management. It was cash, but also self-respect. The processes of the FJMC was good. It paid HTC members when they were meeting with FJMC. Projects always had community jobs. Harvest studies spread money around. The claims process and the FJMC process helped economically and socially (Robert Bell, pers. comm., Sept 2009).

Jobs provided through co-management were designed to be beneficial to employees and employers alike. For example, Joseph Felix Jr., who had worked at the 1989 slaughter, had also been a research assistant in a DFO fisheries study at Husky Lakes. His job was to set nets of certain mesh sizes in order to determine what kinds of fish were in the lakes at different places. He described the research by saying "I also did one in the spring time...you know tape measurements from jigging 80 trouts for three springs in a row. [i.e., collecting length data from trout] Get paid for it, and it's like a holiday." Hiring fishermen to fish enables scientists to get their data more quickly and efficiently (due to the skill and local knowledge of the fishermen), while at the same time providing the fisherman with an opportunity to get paid for being out on the land.

Several of the elder community members and HTC directors mentioned that there was a negative side to co-management jobs. The most frequently mentioned problem was that money has the effect of attracting people who are not interested in the issue itself.

Thus, you can end up with people in the positions that do not do them to the best of their ability. In earlier years people would volunteer to help out in a harvest, and it meant that they really wanted to be there. The HTC board of directors, which usually does the hiring, tries to prevent this by choosing people that they know to be knowledgeable.

5.1.5. Youth education

The FJMC facilitates the education of youth through the student mentoring program. Through this program, Inuvialuit youth can get hands-on experience in conducting scientific research. This style of education is much closer to the traditional methods of education, wherein education is not separated from traditional activities but rather a product of them. Youth from Tuktoyaktuk have the opportunity to participate in the long-running Hendricks's Island Beluga Monitoring Program. Members of the community feel that programs like this aid youth in learning skills that will help them on an individual level by increasing career opportunities while also having benefits for the entire community in terms of knowledge.

The Husky Lakes beluga monitoring program is designed to pair elders with youth. This set up was chosen specifically because youth would be able to learn from elders while out on the land.

In summary, the adaptive capacity of the Inuvialuit has been diminished by cultural change, driven largely by economic globalization and the loss of power in making decisions about resource management. Since the establishment of the FJMC, the number of mechanisms by which the co-management process has bolstered adaptive capacity at the local level has increased. It should be noted that these mechanisms are not static: new ideas for reinforcing adaptive capacity emerge through the on-going process of adaptive co-management, and they often start at the community level.

5.2. Community perspectives on the beluga entrapment

The three year Husky Lakes beluga monitoring project is currently in its second year of implementation. By the time the project is up for review, the Tuk HTC will have elected a new chair and board of directors that will have to decide whether to keep the current action plan as is (Appendix B) or make modifications. In this section I will provide perspectives and comments from Tuk residents regarding the existing management strategies as well as their ideas for future alternative management strategies.

ISR communities have put an emphasis on prevention of entrapments in order to 1) avoid wastage of the resource and cruelty in allowing the animals to starve; 2) prevent the possibility of decline in the stock; 3) ensure that no restrictions be put on beluga harvesting; and 4) avoid any negative media attention (FJMC, 2008). The concern of the beluga's impact on fish in Husky Lake was also brought up repeatedly. Respected community elder David Nasogaluak stated that "We should always keep them out. One whale can use 35 pounds of fish a day. If there's 200 whales, you know what might happen." The majority of research participants from the community are in support of the monitoring program, but some suggestions for improvement were made.

Table 5.1: Favored Management Strategies of Community Members for Entrapment, N=44[7]

Favored Strategy	Monitoring (as a measure for prevention)	Herding (as a measure for prevention)	No action: let nature take its course	Put money into research
Percentage of participants	73%	11%	11%	5%

[7] This includes information from 28 formal interviews, questionnaires, and 16 informal conversations with community members

The main suggestion for improving the monitoring program was an increase in the monitoring period. Whales are able to enter Husky Lakes from the moment it thaws until the day it freezes, thus the monitors should be there the whole time for maximum efficacy. One participant regretted not being able to attend the 2008 workshop, and asked if his suggestion could be included in my report. Angus Cockney was a monitor, and had had trouble with whales entering at night. He recommended that dogs be kept right next to the narrows at Guchiaq because of his observation that dogs will usually bark when whales are nearby. The dog's excellent senses of hearing and smell could help alert sleeping monitors to the presence of whales.

Herding was proposed as the most effective and cheapest form of prevention by 5 research participants. Four others agreed that it could be done, but believed that monitoring would be more reliable. Those who believed in herding said that it would require about 4 or 5 experienced whalers, each with their own boat.

> You would go out there [Husky Lakes] in August if the whales were in there. The first few years would be just for learning how to coordinate people and herd effectively as a group. Later an educational component would be added on. We have to think about the future. If the beluga's migration patterns change and they don't come by Hendrick's Island in the future, we will need Husky Lake as a location where we could trap whales like long ago. We would have to know the cost of organizing an entrapment, including the creation of storage facilities down there (Boogie Pokiak, Inuvialuit signatory of IFA, pers. comm., Aug 2009).

Another idea was that the Tuktoyaktuk Community Corporation (TCC) and HTC could team up and organize an open water hunt if the whales were still in Husky Lakes at the end of the summer. The TCC would be able to provide partial funding through the brighter futures program, which would allow children to learn beluga hunting and processing skills.

> We asked the DFO “if we fly over and they are trapped why do we wait so long? Why don't we go out there?” A lot of people get funds with brighter futures (A funding program run by the Community Corporation) and we

> could get people out there earlier, harvest the whales when they are still in good shape. Why wait till later when it gets dangerous to harvest and the whales are so skinny that no one wants them? And that's where full immersion kicks in. They could teach them how to make fermented muktuk. These kids don't know that. We're teaching them some things, but not all that they should know (Chucky Gruben, Pers. Comm., July 2009).

These alternative strategies offer a solution to the immediate problem while simultaneously addressing the long-term issues of cultural change and transmission of IK to the youth. The Inuvialuit are able to use the system of ACM to promote their own adaptive capacity.

5.3. Emergent stresses relating to resource management

Sampling bias

This study is not intended to provide a broad analysis of cultural, economic, and environmental change as seen by the Inuvialuit. Studies that focus on Inuvialuit perceptions of change, vulnerability, and adaptive capacity have recently been conducted in Ulukhaktok (Pearce et al., 2010) and Tuktoyaktuk (Andrachuk, 2008). My interviews with community members were focused on people who had been involved in co-management process between the FJMC, DFO and Tuktoyaktuk HTC. (See chapter three for a detailed description of methods.) It could be argued that the following information may not accurately represent the views of the community at large due to the sampling bias. However, this section endeavors to describe stresses and adaptive responses specifically relating to natural resource management and the co-management process. Thus, the opinions and perceptions of community members who had little or no involvement with this particular co-management process were not considered. That being said, due to the interconnections between co-management, economy, specific livelihoods, culture, and education, research participants did not limit their discussion only to resource management issues per se. Without being guided to do so by specific questions, all

participants brought up stresses that are limiting the adaptability of the Inuvialuit and diminishing the prospects of future generations. The data in this section serve to show the importance of the co-management system's means of increasing adaptive capacity at the community level.

Cultural change

The social dynamics and cultural practices of the Inuvialuit served as the only source of adaptive capacity in the unpredictable arctic environment until the advent of the wage economy. Although the modern economy of Tuk is largely wage-based, all of the culturally-embedded adaptive responses (Berkes and Jolly, 2002) remain in use to varying degree. Trade within and between communities is still widely practiced. For example, it is rare for residents from Tuktoyaktuk to catch arctic char, but beluga is usually harvested in abundance. In Ulukhaktok beluga are harvested less regularly, but Char are caught in abundance. These resources are often traded pound for pound (Boogie Pokiak, Pers. Comm., Aug 2009), helping to increase the diversity of available country foods and reinforcing friendships. Environmental knowledge and related skill sets, and flexibility in harvest timing are still prevalent, although some perhaps not as widely as in the past.

> Our culture…a lot of it is sharing. It gets passed on from generation to generation and depending on who you are and what community you live in sometimes it's easier to get something and sometimes it's not. Sometimes you have to go out of your way to get something, or you have to go out of your way to give something to somebody (James Pokiak, pers. comm., July 2009).

Group mobility and flexibility in terms of size has changed considerably since the shift away from the nomadic lifestyle, but with the amount of travel, camping and outdoor living that occur it is still quite important. Although the Inuvialuit are creative in finding ways to maintain their culture, the forces of globalization are often difficult or impossible for indigenous peoples to resist (Jentoft et al., 2003). Change is an intrinsic

aspect of culture, but the driver of the change is critically important. If change is coming from outside and there is no control over it at the level of the individual or society, it may become destructive even if it was designed to be productive. There is a need to consider the often invisible losses to culture, identity, autonomy, knowledge, and economic opportunity when creating resource management policies (Turner, et al., 2008). When policies do not take these considerations seriously they can result in abrupt cultural transitions that can cause social distress (Csonka and Schweitzer, 2004). I have organized some of the stresses that emerged during interviews that were relevant to adaptive capacity in resource management based on the frequency of identification.

The following is a selection of quotes relating to the data in table 5.1.

> Not long ago, people would come here and dance all night long. We didn't have competitions for prizes like we do now; you would just dance whenever you wanted. These dances here came over from Alaska; see how they all move the same? Aren't many Siglit dancers left. There you improvise as you go, but not many kids want to learn that these days (Roy Cockney, pers. comm., Aug 2009).

> Elders had a lot of knowledge, but not many people have that anymore because most people are economy-based. In the old days, only cripples didn't hunt, nowadays a lot of guys don't even leave town. Culture is changing and their knowledge isn't being used anymore (Dennis Raddie, pers. comm., July 2009)

> In the past, we did our whaling through well-organized community hunts. That way they made sure everyone got what they needed. Today it's all done on an individual basis. Well not everyone has enough money to go whaling. Now, some people get too much and other people don't get enough (Boogie Pokiak, pers. Comm., Aug 2009).

Table 5.2: Emergent stresses to present and future adaptive capacity relating to resource management. Numbers in parentheses represent the number of respondents identifying a particular issue, N=28. All but two interviewees were over forty year of age, and thirteen were considered to be elders.

Economy	Livelihood	Education
Tuk HTC gets same $ as other HTCs but has greater expense due to community size (9)	Increasing cost of gas and supplies coupled with high unemployment (33%)* make many traditional pursuits impossible (18)	School system prevents children from participating fully in traditional activities (14)
Private, as opposed to communal ownership of lodges (3)	Increase in wage-based employment puts IK into disuse, decreases potential for transmission (10)	Decrease in the amount of IK passed on from one generation to the next (21)
All-weather Tuk-Inuvik road will increase influx of southern culture (5)	Selling fish and game can help retain traditional livelihoods, but it also can give an incentive to overharvest (5)	Little to no transmission of Inuvialuktun, which is critical for understanding the environment (7)

*(Statistics Canada, 2006)

Community members of Tuktoyaktuk are concerned that language loss and decreased IK transmission to youth, and other stresses (Table 5.2) may negatively impact their involvement in the co-management process in the future. The concern is that there may be fewer and fewer community members who are as knowledgeable about the land and the animals as the current community leaders and elders, which would result in a lesser degree of IK in the co-management process.

In summary, the issues of loss of traditional livelihood, lowered transmission of IK to youth, and loss of culture are inextricably linked. The Inuvialuit feel that these changes have been almost entirely driven by external forces. These themes of cultural and livelihood change that emerged in my study have also been linked to issues of food security, health (Hild and Stordahl, 2000), and political change (McElroy, 2005). Any potential solutions to these problems must result from local empowerment through linkages with higher level organizations. It has been argued that capacity enhancement is

required for community empowerment in co-management arrangements (Jentoft, 2005), and it is clear that the fisheries co-management arrangement in the ISR encourages this in at least five ways (Fig 5.1).

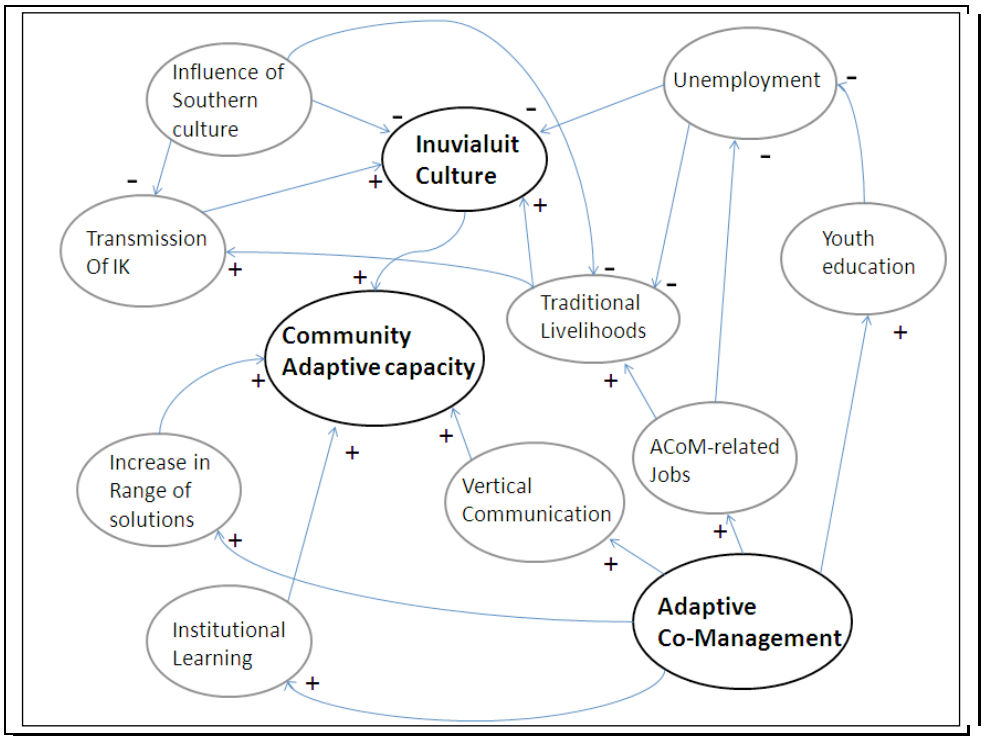


Figure 5.1: Connections between Inuvialuit culture, ACM, and community adaptive capacity. The arrows in this graph indicate that the content in one oval has a direct impact on the one it is connected with, the quality of which is designated by the positive or negative sign. For example, co-management provides jobs, which reduce unemployment. Unemployment itself has a negative impact on Inuvialuit culture, thus lessening the positive effect of Inuvialuit culture on adaptive capacity. Based on 28 interviews and 16 informal conversations.

It should be noted that there exists a dualistic perspective in the community, and even within individuals from the community of Tuktoyaktuk regarding the effect of the wage-based economy on subsistence livelihood and culture retention. On one hand, the

wage-based economy adversely affects subsistence livelihoods by lessening time available for hunting, trapping and fishing. This diminished ability to find the time to get out on the land also can have negative impacts on the transmission of IK to the youth, who get less experience on the land and develop more interest in the wage-based economy. On the other hand, there is the fact that subsistence activities are fairly expensive to pursue in modern times. More often than not, hunting, fishing, and trapping do not pay for themselves. Thus, those who are unemployed often cannot pursue subsistence activities and traditional livelihoods because of the expenses involved. This dualistic reality of the wage-based economies effect on subsistence activities is hard to reconcile, but it seems that a balance between the two can be met under the right circumstances. There are many individuals in Tuktoyaktuk that are involved full or part time in the wage economy, while being able to pursue subsistence activities to a satisfactory degree.

Chapter 6: Network Analysis of the Organizations Involved in Co-Management of Husky Lakes Beluga Entrapment

This chapter describes the change in the structure and connectivity of the social network responsible for making decisions regarding beluga entrapment in Husky Lakes. The components of this network have changed in the past several decades with a major re-organization occurring in 1984 with the advent of the IFA and subsequent modification occurring through to the present. The study of social networks has three key elements: defining the network component units, defining the boundary, and determining connectedness (Streeter and Gillespie, 1993). The first section of this chapter defines the network in terms of component units and boundaries. The first part of the second section shows the change in the management network at the organizational level through graphical analysis and diagrammatic representation. This provides an overview of the change. The second part of the second section looks at the change in the network at the level of the individual positions within the organizations, analysing the structure and importance of the relationships between members within and between organizations. The final section discusses the changes in the networks' properties with special consideration to different measurements of centrality and connectedness.

6.1. Network Definitions

Network component units

Network component units can be individuals, organizations, nations, or any social group that interacts with other social groups (Streeter and Gillespie, 1993). There are two different sets of network component units used in this analysis: organizations and individuals. The reason for this is that it was not possible to interview enough people that were involved in the pre-IFA entrapment; thus I was only able to use organizations as the

component unit in that case. It should be noted that the weakness of this analysis is that it was often not possible to interview more than one representative from an organization. The main difficulty here was that the DFO system of communication is far-reaching and employees constantly move from one area to another. This means that the perceptions of communication between two DFO offices in this analysis are often based on information from just a few people from each office. It would have been beneficial to interview several people from each office, but this was not always possible.

For entrapment events after the signing of the IFA, I was able to interview enough individuals to create network diagrams with individuals as the component unit. This was possible because of the small number of organizations involved, and the relatively small number of people involved in these specific decisions. Although analysis with the organizations as network component units does not provide as much information as one focused on individuals, it still gives a good picture of the general trends in terms of institutional linkages. Another important consideration in choosing individuals as the component units was that it would elucidate the informal aspects of the network as well as the formal. Informal relationships can often be as important to consider as formal ones because the actual communication structure of a social network may depart significantly from the formal communication structure (Wasserman and Faust, 1999). In other words, a network member may officially report to a certain manager, but in reality have little contact with him or her. Analyzing a network based on the formal titles of the network members is called positional analysis. This could be done with the use of the organization's own organizational structure diagrams or documents without ever interviewing any of the network members. Although it is the easiest information to access, positional analysis is seen as the weakest and least accurate method for organizational analysis of management systems. It has been argued that positional analysis should be used in conjunction with reputational or decisional analysis to allow informal and more realistic trends in the network to be elucidated (Tichy et al., 1979).

Decisional analysis requires interviews with network members in order to discover which other members they actually interact with while making specific decisions.

This chapter uses positional data mixed with decisional data to capture both the formal and informal structures in the management network. The data are positional in that the members of the networks are described by position in the network key (table 6.1). The actual diagrams of the network illustrate the informal structures of the network through decisional data. These diagrams show how the network members communicated about the specific events. The connecting lines in the diagrams are arranged by the computer program in a configuration so as to be visually intelligible. Patterns in the connectivity of a network will certainly be visible in the network diagram, and will thus give a "feel" for how the network is connected, but it does not suffice only to look at the diagrams for analysis.

A formal relationship may be carried out in different ways. For example, a reporting relationship of one organization to another may involve communication only between the heads of those two organizations or it may involve communication between multiple members from each. In this case, the former would be referred to as more hierarchical, and the former as more organic, meaning its organization has elements of top down and bottom up communication (Tichy et al., 1979).

Network boundaries

Network boundaries serve to separate the network under analysis from larger networks in which it is embedded. In many cases this can be a very sensitive issue, but in the case of groups with pre-determined memberships it is relatively simple (Streeter and Gillespie, 1993). The first step involved in defining the boundary is to identify the organizations that were officially involved in entrapment decision-making processes. All the organizations that were involved comprise what I will refer to here as the management network.

The management network structure before the IFA was not very integrated. Community HTAs were minimally funded through the Government of the Northwest Territories and had only sporadic communication with the DFO. This occurred when DFO scientists were conducting a study on Inuvialuit land and sought consultation (Vic Gillman, Pers. Comm., Aug. 2009). At this time the DFO did not have an office in Inuvik. The HTAs that existed within the Inuvialuit communities before the IFA, along with the pre-IFA "version" of the IGC were the result of self-organization that relied heavily on Inuvialuit leader Billy Day (Robert Bell, Pers. Comm., Sept. 2009). This means that these organizations were created in a culturally appropriate way that undoubtedly reflected the Inuvialuit view on power sharing and decision-making regarding natural resources. Thus, election to the board of the HTA depended upon one's level of practical experience and standing in the community. The elections were open to any member of the community who was considered an adult (Dennis Raddi, Pers. Comm., Aug. 2009).

Since 1984 the organizations involved in making these decisions have been the FJMC, DFO, Tuktoyaktuk HTC, and to a lesser extent the Inuvik HTC. The IGC has also been involved indirectly as it is made up of HTC members from each ISR community and is responsible for appointing two members of the FJMC. It is important to realize that the specificity of the boundary imposes restrictions on extrapolation of the results presented in this chapter. This analysis does not necessarily apply to all fisheries co-management within the ISR, nor does it apply to all co-management decision-making processes within Tuk. This analysis depicts the social network that was responsible for handling the beluga entrapments in Husky Lakes. Other decisions may involve the same organizations, but the issues they deal with may change which members must interact and thus change the entire structure of the network.

Defining Membership

The organizations listed above represent the boundary of the entire management network, but it is important to consider the boundary of each of the organizations as well. Membership to the DFO is determined by employment in a specific office. The DFO is divided into six Regions. The Northwest Territories is under the jurisdiction of the Central and Arctic Region. There is a matrix approach to management, whereby department branches of "science" and "fisheries management" of the Central and Arctic Region are headquartered at the Regional Office in Winnipeg while specific geographical regions are administered by Area or District Offices (Ayles, Pers. Comm. Aug. 2010). In the Western Arctic, the DFO has an Area Office in Yellowknife and a District Office in Inuvik. The branches of the DFO that are directly involved in co-management in Tuk are the Freshwater Institute (FWI) in Winnipeg (Central and Arctic Regional Office), the DFO Area Office in Yellowknife and the Inuvik District Office. ISR Co-management authority for DFO resides in the Central and Arctic Regional Office and is delivered by the staff of the Area and District offices, who are supported by regional and national staff of DFO as needed. For example, in 1989 the Area Manager (AM) from the Eastern Arctic Area Office in Iqaluit was also consulted regarding entrapment decisions. Although there is extensive communication between DFO offices and branches, the District Manager (DM) from the Inuvik District Office is the principle DFO liaison for ISR co-management. In the case of the beluga entrapments, the DM received support from fisheries biologists, conservation officers, and communications specialists are involved as necessary. According to the legal structure of the co-management system the Minister of Fisheries and Oceans has final authority on management decisions and therefore must ultimately approve, modify, or reject all recommendations made jointly by the FJMC and DFO offices. However, she is rarely in direct contact with any members of this management network.

Membership in the FJMC is determined by official appointment made by either the Government of Canada through the Minister of Fisheries and Oceans or by the Inuvialuit through the IGC. As the IFA states in section 14.62;

The Committee shall have a Chairman and four (4) members. The Inuvialuit Game Council and the Government shall each appoint (2) members. The Chairman shall be appointed by the four (4) members. Through bilateral agreements between native groups, membership may be extended to include other native representatives who have recognized traditional interests within the Inuvialuit Settlement Region, provided that equal representation between government and native membership be maintained. (INAC, 1987).

The IGC was indirectly involved in the decision-making processes by having appointed two of the FJMC members. The IGC itself is comprised of at least one member from each community HTC within the ISR. Each HTC elects a voting member and an alternate to represent its community on the IGC.

14.(75) Each Inuvialuit Community Corporation shall establish a community Hunters and Trappers Committee and determine the qualifications for membership therein. In determining those qualifications, regard shall be had to any agreements between the Inuvialuit and other native groups.

The process of establishing the Tuk HTC was fairly simple. As described by an anonymous Tuk resident who served on the board of directors both before and after the IFA, "Not a whole lot was involved. We just had to change the name from HTA to HTC and do some paper work, but it basically operated the same way." In Tuk, any resident who is a beneficiary of the IFA is eligible to become a member of the HTC at the age of 16. The HTC members at large select a board of directors and chair in an annual election. The election process to the HTCs is not necessarily static: it can be changed by the community as they see fit. During the summer of 2009 there was a Tuktoyaktuk Community Corporation (TCC) meeting to determine whether the election for the HTC should be moved to coincide with the rest of the community organization elections or kept separate to ensure that only especially interested community members would vote. The establishment of the Inuvik HTC proceeded similarly, with little changing other than

the source and magnitude of funding. Under the improved funding conditions, all the HTCs were able to support an administrative assistant and compensate board members on a per meeting basis. In summary, membership in the Inuvialuit HTCs, as well as the process by which membership is determined, is controlled by the communities in a culturally appropriate way.

6.2. Change in the Structure of the Management Network: Two levels of analysis

6.2.1. Organizational Analysis of Management Networks in 1966, 1989 and 2006

The management network in place before the IFA was very much a "top-down" management system that had been organized by the Canadian Federal and provincial governments. At this time there were no co-management processes, and the issue of beluga entrapment was treated as a phenomenon for scientific investigation and management. See section 4.3.1 for a summary of how the 1966 entrapment was handled. The Inuvik Research Laboratory was established by the Department of Indian Affairs and Northern Development (Ayles and Snow, 2002), and was the organization responsible for managing the beluga entrapment of 1966 under the direction of Dick Hill. The management network of 1966 involved the IRL and the Inuvik Lions Club, which was involved in efforts to attempt to save the entrapped whales. The IRL did not prohibit or actively discourage hunting because it was the legal right of the Inuvialuit to harvest beluga at that time according to the DFO (Hill, 1967). However, there was no documented record of consultation or communication between the IRL and the community HTAs (Hill, 1967).

Few research participants from Tuktoyaktuk recalled specific entrapments before 1989. Those who did recounted the same story about environmental activists trying to

blow up the ice with dynamite to set the whales free and then building a shelter and unsuccessfully attempting to feed the whales meat to keep them alive through the winter when the dynamiting did not work (Boogie Pokiak, Fred Wolki, Angus Cockney, Pers. Comm., Jul-Aug 2009). All of these participants said that the HTA had not been consulted, and that the government and the environmental activists treated the issue as their own. Figure 6.1 shows the communication between organizations involved in the entrapment of 1966. The ties between the Inuvik Lions Club and the community HTAs represent counter-productive communication, as the Lions Club's save-the-whale committee was openly against any slaughter of the whales.

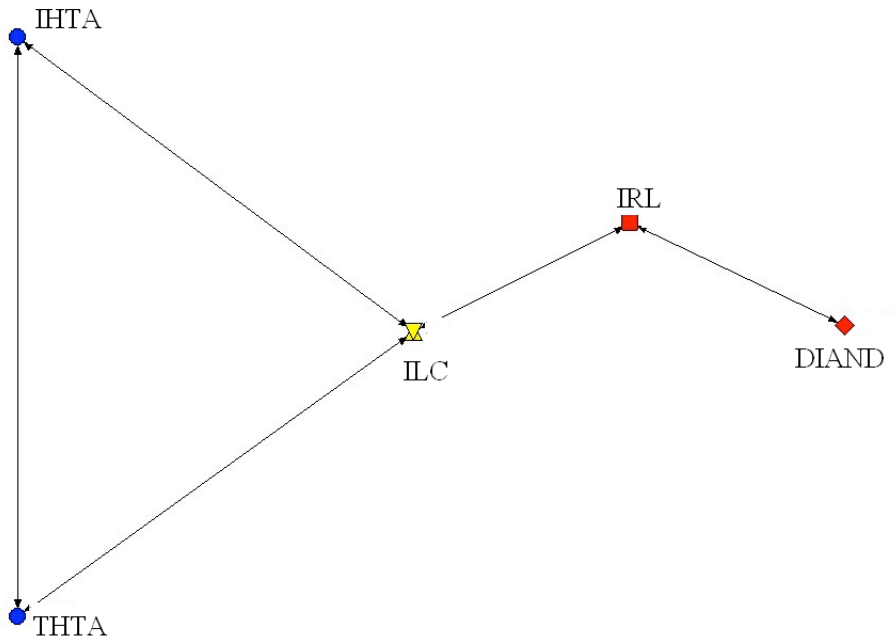


Figure 6.1: Member organizations of the Management Network in 1966.

The acronyms in the following network diagrams are listed below for clarification (Table 6.1).

Table 6.1: Network Diagram Key

Position Titles	Organizations	Locations
RDGFM – Regional Director General of Fisheries Management	HTA – Hunter Trapper Association	I - Inuvik
AM – Area Manager	ILC – Inuvik Lions Club	T - Tuktoyaktuk
DM – District Manager	DIAND – Department of Indian Affairs and Northern Development	Wpg - Winnipeg
Can – Canadian Appointee to the FJMC	IJS – Inuvialuit Joint Secretatiate	Ott - Ottawa
FJMCinu – Inuvialuit Appointee to FJMC	IRL – Inuvik Research Laboratory	Yknife - Yellowknife
ST – Sampling Technician		
CO – Conservation Officer		
SO – Sampling Officer		
Rb – Resource Biologist		
Hc – Hunt Captain		
Org – Camp Organizer		

In 1986 the FJMC was established and the DFO had created an area office in Inuvik to deal with its new responsibilities as described by the IFA. The entrapment of 1989 involved these new organizations as well as the HTCs of Tuk and Inuvik, but there were still remnants of a top-down system of management. Figure 6.2 represents communication in the initial stages of decision-making during the 1989 entrapment (Fig. 2). The communication between DFO Inuvik and the FJMC was between the DFO area manager and the FJMC Chair rather than a meeting of the organizations. This DFO-led decision-making process resulted in the idea of a community harvest. Although the formal system had been changed, the FJMC had only been in existence for three years

and had not yet had time to integrate the network to the level where all participating organizations were involved at all stages of the decision-making process.

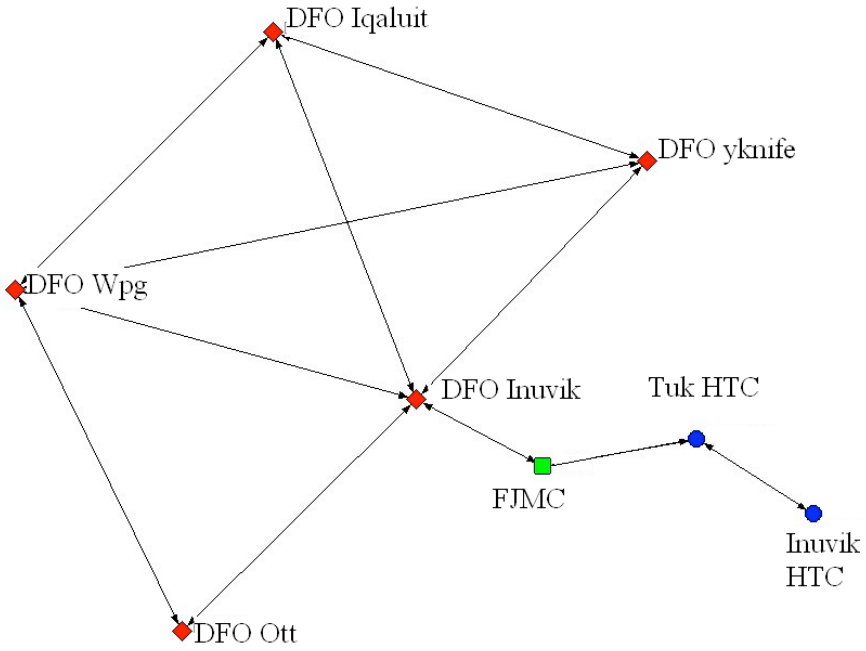


Figure 6.2: Communication between organizations involved in initial decision-making process of 1989 entrapment.

At the time of the 1989 entrapment, the FJMC was still going through the process of determining what its responsibilities were and what decisions it should be involved in (Robert Bell, Pers. Comm., Sept 2009). Communication with the HTCs was also not as easy at that time and was usually only possible at scheduled meetings. Although there was not full involvement of all co-management organizations in this part of the process, there was considerably more communication in the process of refining and implementing the decision to harvest (Fig 6.3). It should be noted that the node represented as "DFO Iqaluit" (Fig. 6.3) does not represent extensive communication with the Eastern Arctic Area Office in Iqaluit. In this case, only the Area Manager from that office was consulted because of his experience. Vic Gillman was the DFO area manager of Inuvik at the time

and explained the situation by saying that, “If the HTC had not agreed to do the harvest, the DFO would have then taken steps to determine what would be an appropriate course of action” (Pers. Comm., Aug 2009). In 2006, the network of organizations involved in first responding to the entrapment and deciding what to do included DFO offices, FJMC, and community HTCs (Fig. 6.4). This shift represents a co-management approach by including all the stakeholders that will be affected by the decisions from the beginning in a process where the decision is not handed down from the top level. Rather, in this case, the HTC had the role of deciding what should be done with the entrapped whales.

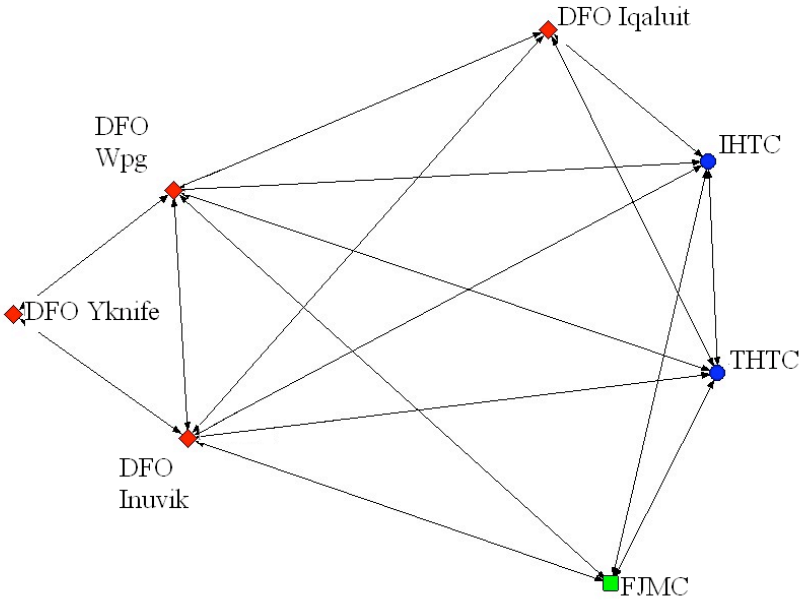


Figure 6.3: Communication between organizations involved in refining and implementing the decision in the 1989 entrapment.

The stages of refining the decision-making process and implementing the decisions involved the same actors, who were in frequent communication during the course of the entrapment event. The increase in linkage density (see section 3.4) observed

from Figure 6.3 to Figure 6.4 (table 6.2) shows that there was a higher degree of communication and knowledge sharing between the organizations in the management network. The high linkage density here is in part due to the increase in technology. The ability to have a conference call with all the organizations on the line makes a linkage density of .9048 logistically simple whereas in the past it would have been impossible. The measurements of network centralization show that the initial stage of the decision-making was highly centralized among the DFO actors, whereas in the later stages of the process communication was more evenly spread out among actors.

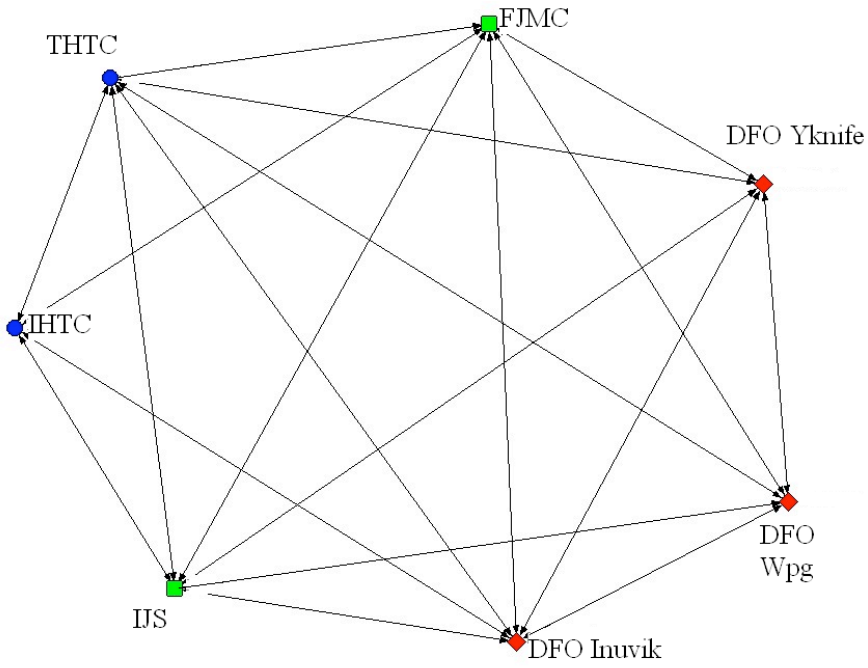


Figure 6.4: Communication between organizations involved in the 2006 entrapment initial decision-making process.

In 2006, network centralization was further decreased because lines of communication were open between more organizations. Because of the simplicity of these graphs, it is appropriate to use only degree centrality to measure centralization (Bonacich, 2007).

Degree centrality is a measure of centrality that does not take into account the relative weights of the adjacent actors, which is important in larger and more complex networks. This integration of the management network led to the emergence of adaptive co-management, whereby equal involvement of all member organizations in the entire lifecycle of every project is ensured through a standardized procedure (Ayles et al., 2007).

Table 6.2: Differences in network metrics between Fig. 6.2, 6.3, and 6.4.

Network Metric	Fig. 6.2 (1989 initial stage)	Fig. 6.3 (1989 refinement and implementation)	Fig. 6.4 (2006 from initial stage onward)
Linkage Density	.39	.76	.90
Network Centralization (Degree Centrality)	43%	33%	13%

6.2.2. Positional and Decisional Analysis of Management Networks in 1989 and 2006

The organizational structure of the management networks changed considerably from 1989 to 2006. Changes within the organizations as well as changes in their relationships contributed to the increase in connectivity of the network. This increase has facilitated information exchange across organizations. In both years, certain key actors were involved who made more connections between organizations than other actors. Not surprisingly, these key actors were mostly organization Chairs and FJMC members. However, it is interesting to note that members of the DFO who were on the ground and involved in the entrapments (e.g. sampling officers, marine mammal technicians, and conservation officers) were most often better connected in the network than were senior

managers. The DFO members who were on site were in communication with the bridging organization, the community and HTC members, and of course their DFO higher-ups. Thus, they were responsible for much of the feedback that went to the higher levels of DFO. It should be recognized that long-standing relationships between these technicians and a particular community can be a valuable part of the co-management process. The FJMC recognized Jack Orr (DFO marine mammal sampling technician) by giving him their co-management award in 2004 for this very reason. Unfortunately, many scientists and technicians are not involved in the co-management process for the long term. The members of the Tuk HTC from 1989 did not recall seeing the DFO technicians who were at the 1989 entrapment again after the harvesting that occurred that winter.

It is important to remember that Fig. 6.5, below, corresponds to Fig. 6.3 in that it represents communication that occurred after the initial DFO meeting. Although all of the people in positions listed in Fig. 6.5 did communicate regarding the entrapment at one point or another during the process, there was an initial consultation that did not directly involve the HTC members, and only minimally involved the FJMC members.

It is clear from looking at the diagram that the HTC members (circles) are closely linked to one another as well as some DFO (diamonds) and FJMC (squares) members, but that certain senior DFO members are not in direct contact with the HTC members (Fig 6.5). The FJMC's involvement in this entrapment was not as thorough as it would later become. There is no mention of the entrapment in the FJMC's 1989-1990 annual report, whereas the issue is covered in full in the 2006-2007 annual report.

Between 1989 and 2006 there were some calls for change in structure of the DFO. Lane and Stephenson (1998) argued for a shift from the top-down, science-based DFO management strategy to a "fisheries management science" that includes multiple actors at various levels of organization in a cooperative manner in management processes.

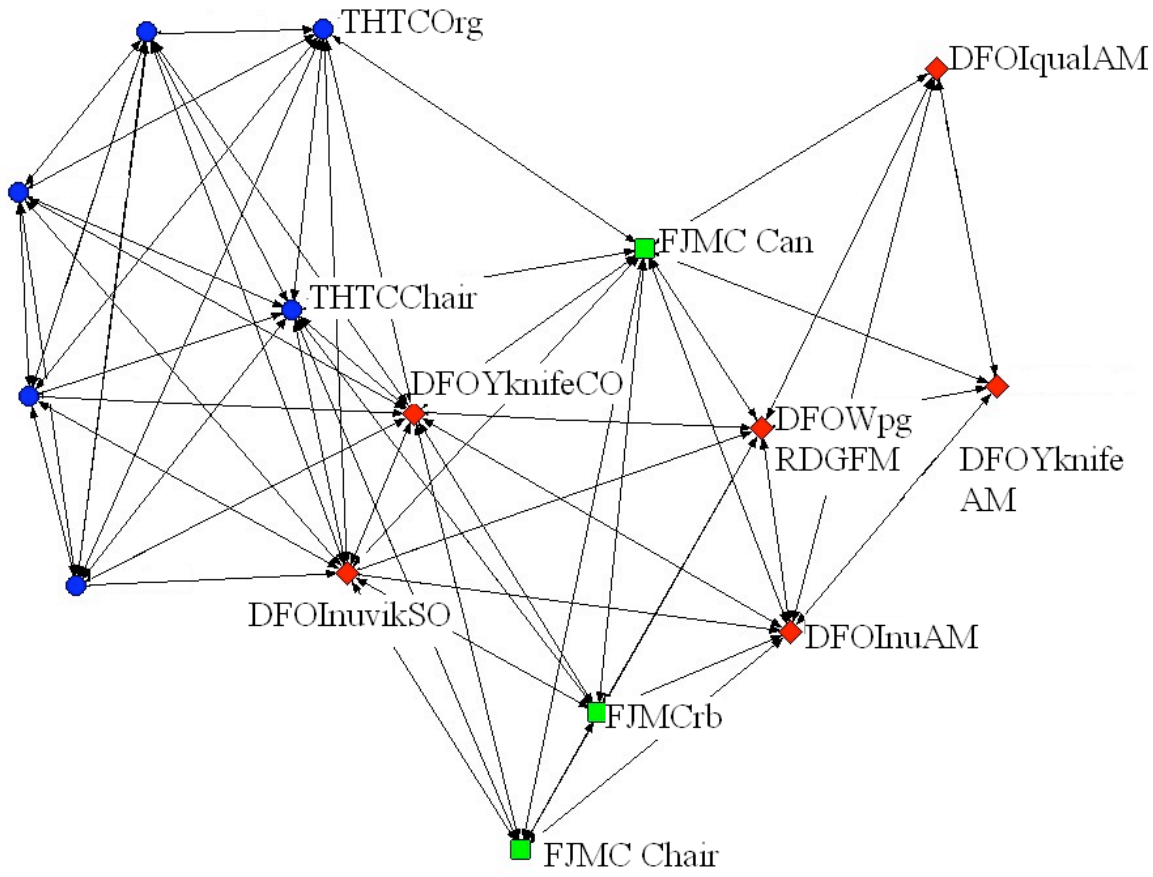


Figure 6.5: Sociogram of all individuals comprising the management network from 1989 with organization positions as nodes. The four unlabelled nodes on the left represent the four members of the Tuk HTC board.

However, the differences in the structure of the 1989 and 2006 decision-making processes are the results of changes at the local level in the ISR, and cannot be attributed to any shift in the DFO's approach to fisheries management in general.

It has been argued by members of DFO that the dominance of the science branch within the DFO has actually hindered the Department's functioning and that a bottom-up approach to management would be better suited to the creation of interdisciplinary decision-making processes that are necessary in modern times (Lane and Stephenson, 2000).

Changes in the structure of the DFO offices had a significant impact on the FJMC. Originally, the FJMC communicated to the DFO primarily through what was then the Inuvik Area Office. At that time, the Inuvik Area Office was one of three Area Offices in the Arctic (Eastern, Central, and Western) whose managers reported directly to the Regional Director (RD). However, due to budget cuts in the early 1990s and the establishment of Nunavut, the structure was changed by combining the Central and Western Arctic Areas into one Office with headquarters in Yellowknife. The Inuvik office became a District Office that reported to the Yellowknife Area Office, and it has remained this way up to the present.

> Instead of being considered one of three offices in the north, Inuvik was now just part of the second one. The manager in Inuvik had always come to the FJMC meetings as the DFO contact, but the person in Yellowknife decided they wouldn't do that. They named a coordinator who was based in Inuvik that sometimes was acting as the manager of Inuvik and sometimes wasn't, but it was definitely a downgrade in the level of contact that we had with the hierarchy that we (The FJMC) needed (Burton Ayles, Canada-appointed FJMC member, Pers. Comm., Sept. 2009).

Not all the changes in the structure of the network were due to official changes such as these. Under the IFA one directive of the FJMC is to review the role of the HTCs and determine their reporting requirements as well as their level of involvement in gathering information regarding subsistence harvest statistics (INAC, 1986). This relationship has been refined jointly through the process of co-management, resulting in the higher level of communication and information exchange (Robert Bell, Pers. Comm., Sept. 2009).

The 2006 management network (Fig. 6.6) shows increases in the number of nodes, ties, linkage density, and centralization as measured by degree centrality, and a decrease in centralization as measured by Bonacich centrality relative to the 1989 management network. There is also a slight decrease in Eigenvector variance, which may reflect an increasing equality of influence among all network members.

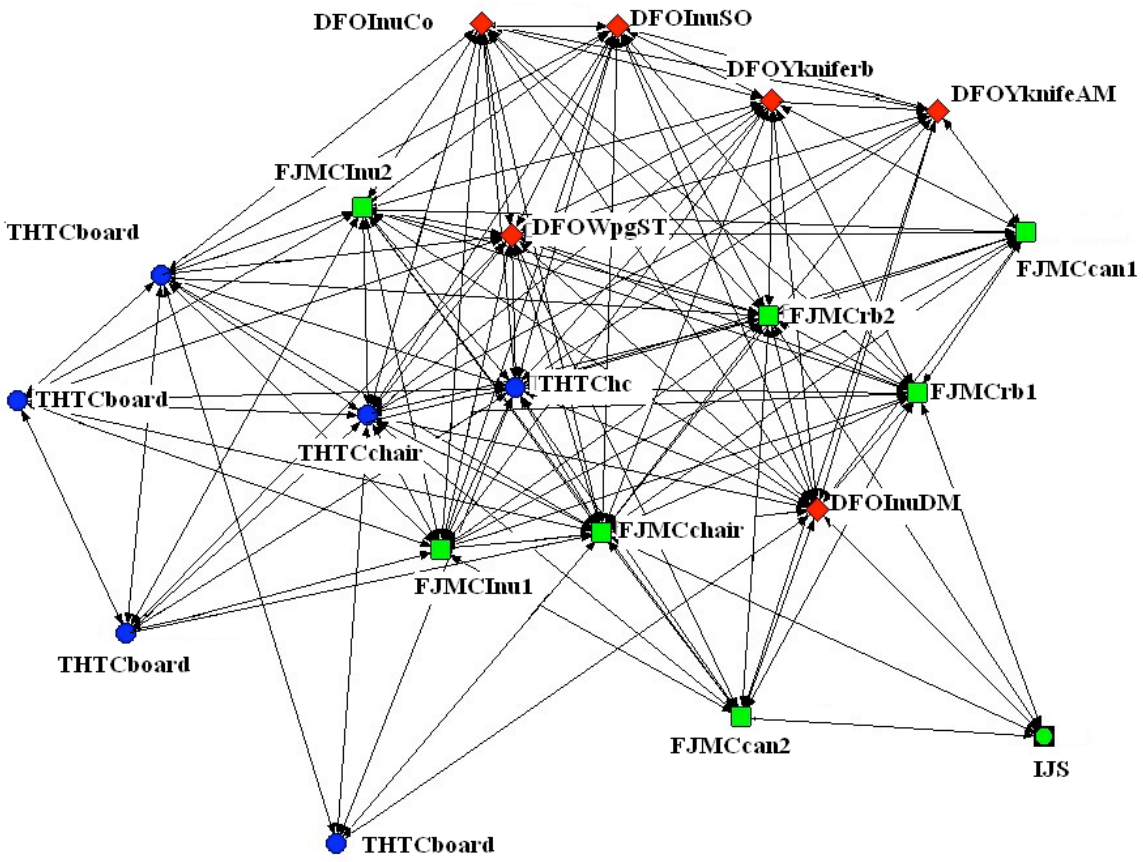


Figure 6.6: Sociogram of individuals comprising the management network from 2006 with organization positions as nodes.

The increase in the number of individuals involved and the density of their linkages clearly shows a trend towards a higher degree of connectedness. In this case, the increase in centralization does not mean an increase in top-down governance. The top 5 most influential actors in the 2006 network are the FJMC chair, THTC hunt captain, DFO sampling technician, THTC chair, and FJMC Inuvialuit member, who is from Tuktoyaktuk.

The increase in centralization as measured by degree centrality is a result of the increase in the number of linkages between these five actors and other actors in the network at large. Bonacich centrality measures the centrality of each point in a graph by

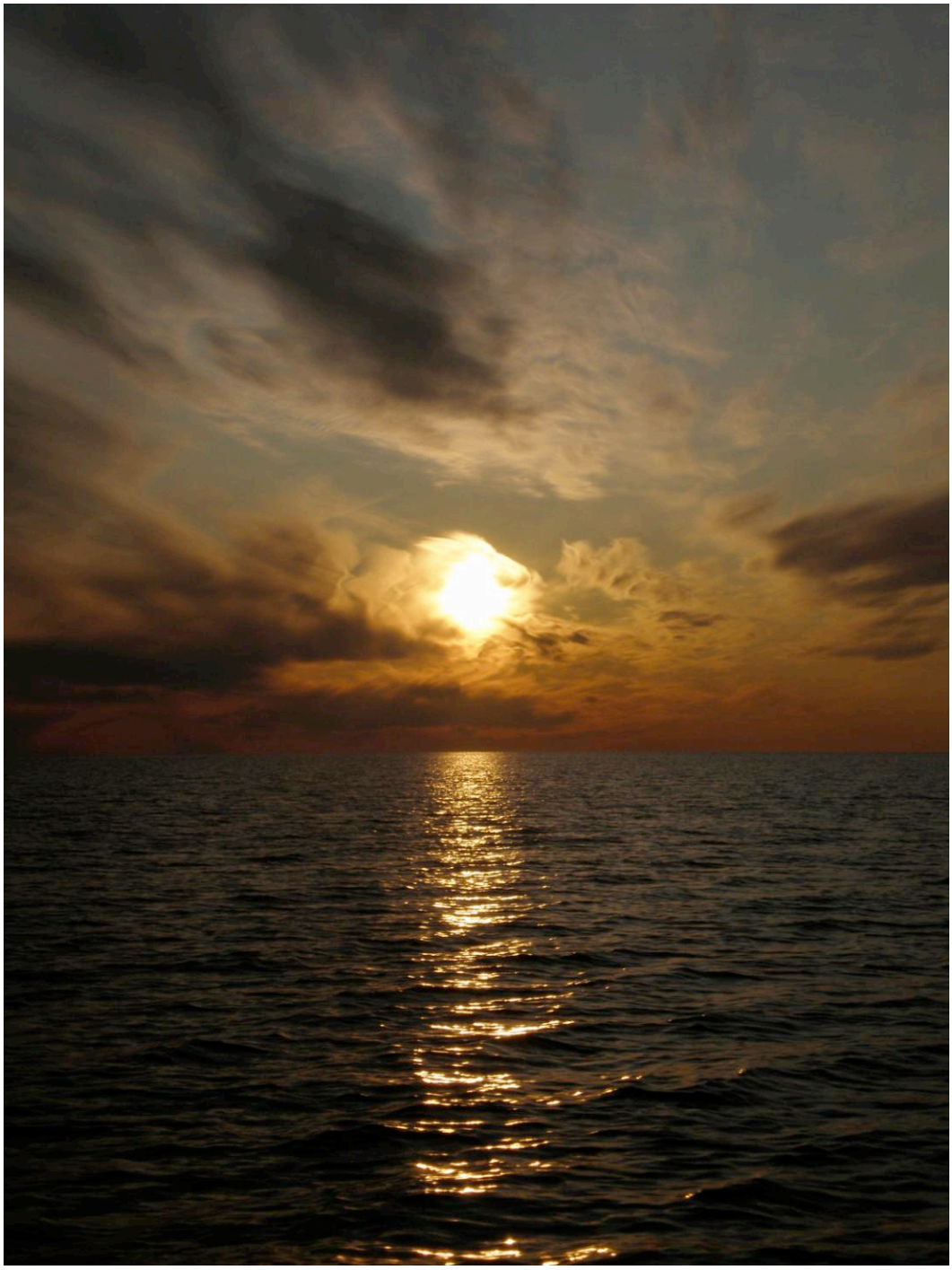
adding the centralities of all adjacent (linked) points (Bonacich, 1972). According to Bonacich, this measure is more accurate in that it gives a better picture of the overall pattern of a complex network (Bonacich, 2007). Eigenvector centrality is a measure of an individual's centrality in the network, which corresponds to that person's ability to access network resources such as knowledge, information, or materials.

Table 6.3: Comparison of network metrics for Fig. 6.5 and Fig. 6.6.

Network Metric	1989		2006	
Nodes	15		20	
# of ties	118		256	
Linkage D ensity	.56		.64	
Network Centralization Index (Bonacich Centrality)	25.1%		14.2%	
Network Centralization (Degree Centrality)	34.1%		36.3%	
Top 5 best connected actors (Actor: Bonacich Eigenvector Centrality)	DFOInuvikSO:	.368819	FJMCchair:	.289121
	DFOYknifeCO:	.368819	THTChc:	.283198
	THTCchair:	.321327	DFOWpgST:	.276939
	FJMCcan:	.288346	THTCchair:	.270973
	HTCorg:	.271091	FJMCinu1:	.265132
Mean Eigenvector value	.247		.215	
Standard deviation of Eigenvector	.074 (29.9% of mean)		.06 (27.9% of mean)	

A high variance in eigenvector centralities among network members would then indicate that certain members have easier access to these network resources than others. A decrease in the variance as seen from 1989 to 2006 (Table 6.3) indicates that actors in the 2006 network had more equal access to network resources than in 1989.

In summary, network analysis indicates that both the size of the network and the level of connectivity between individuals therein have been increasing throughout the years. Members of lower level organizations have a higher degree of connectivity and centrality in the network, meaning that they have become more influential and more likely to receive information and resources that are flowing through the network.



Sunset on the Beaufort Sea from a fishing boat in early autumn.

Chapter 7: Conclusions

My case study has described how the institution of co-management has changed the way in which beluga entrapments in the Husky Lakes are dealt with (chapter four), and how this change has impacted the community of Tuk in terms of adaptive capacity (chapter five). In chapter six I described the changes in the co-management network through social network analysis, the results of which have confirmed and supported the findings in chapter four and many of those in chapter five.

The efficacy of the FJMC depends on several key factors including 1) legal mandate of the IFA; 2) the involvement of key individuals and experts; 3) a long period of trust-building, leading to; 4) knowledge exchange and co-production. A major factor in the efficacy of the FJMC is respect. Without respect, it is difficult if not impossible for indigenous land users and scientists to interact productively. By encouraging knowledge exchange between Inuvialuit land and resource users and scientists, the FJMC has been able to create solutions to problems that are agreeable to both groups. Both the Inuvialuit and the Canadian government scientists and managers involved in the FJMC believe that mutual respect has allowed for a level of integrated problem solving that was not possible in previous years, and that each group has benefited greatly from the knowledge and skill sets of the other.

The issue of beluga entrapment is extremely important to the people of Tuktoyaktuk and the DFO. The issue is particular sensitive because of the wish to prevent unnecessary suffering of the whales, and the desire to make decisions that are not criticized by the Canadian and international media that could negatively impact the reputation of the management network. In the past, the orchestrated entrapments as a means of securing muktuk and meat, but in recent decades this harvest has become unnecessary and the community has decided that it is better to prevent the entrapments

from occurring if possible. The DFO's support of the Tuk HTC's decisions in recent years has shown just how effective the co-management system has become, with a system that was previously top-down being transformed into a collaborative multi-level stakeholder process that can also work from the bottom up under certain circumstances. With the help of the DFO and FJMC, new responses such as equipping monitors with acoustic whale deterrents have become available because of scientific knowledge as well as financial and logistical support. The FJMC has played an increasingly central role in the communication and decision-making stage in the management of the entrapments.

The increased level of flexibility and equality of the management system has benefited both parties. Scientists from the FJMC and DFO have a closer relationship with the Inuvialuit, who are increasingly involved in research projects through sharing TK. In addition to this, the community of Tuktoyaktuk has experienced an increase in adaptive capacity through its relationship with the DFO and FJMC that goes beyond just beluga whale management and into cultural preservation, youth education, and economic opportunity.

The first objective dealt with understanding the factors that facilitate or constrain cooperation between Inuvialuit land and resource users as represented by the Tuk HTC and scientists as represented by the DFO. These two groups often have different values, beliefs, insights, and priorities that should both be taken into account in management processes. In the past, scientific knowledge was placed unambiguously above IK because of its lack of written documentation and scientific rigor. This resulted in research that did not systematically include Inuvialuit perspectives or knowledge, leading to a long-lasting resentment from the community that may still have lingering impacts on knowledge sharing and co-production. The IFA changed the relationship between these two groups by giving the HTC a legal role in the management process. Changes at the structural level were important, and they were not easy to come by. The Inuvialuit, with the help of COPE, demanded to be involved in the economic development of their traditional lands.

The Canadian Government's interest in oil and gas development in the Mackenzie Delta played an important role in shaping the political climate in which the IFA was negotiated. It has been suggested that the Canadian Government's interest in securing rights to oil and gas development in the Mackenzie Delta area was the primary reason that the Government agreed to engage in negotiations (Page, 1986).

The IFA created a framework for collaboration with regard to natural resource management through the co-management boards, but this relationship took time to develop and mature. During this process, key players that were dedicated to co-management were important in bridging the gaps between science-based managers and the Inuvialuit land users. Realizing the advantages of collaboration, there were key players from both the Canadian government and the Inuvialuit that helped make the FJMC function. Because of this, there has been a trend towards knowledge co-production between the Inuvialuit and scientists whereas in the past the Inuvialuit were only sporadically consulted when studies were being conducted on their traditional lands. This process evolved little by little to the point where the Inuvialuit are now often involved in helping to frame the research questions and interpreting the results.

In the 1966 and 1989 entrapments, decision-making power was still more in the hands of the Canadian government than the Inuvialuit. In both cases, the government regarded the entrapments as their issue to deal with and considered community consultation after a decision had already been reached. In 2006 and 2007, the decision-making process was a joint effort between the organizations that were part of the co-management network. The belugas were monitored with aerial surveys that included Inuvialuit and scientists, and different options for action were discussed. It was ultimately left up to the Tuk HTC to decide whether to harvest the whales or not. In 2006, the HTC decided to do the harvest, and in 2007 they decided to let nature take its course. Both decisions were accepted and facilitated by the FJMC and DFO. This shows a clear transition away from top-down science-based management to multi-level knowledge co-

production that has been built over years of continued interaction. The co-management system has served the Inuvialuit by providing a social space where their knowledge is seen as legitimate, important, and useful. Inuvialuit and Government of Canada members of the co-management network see the institution of co-management as a relationship that is always changing and adapting to new situations. There are always new ideas about how to connect local, regional, and national organizations in more productive ways. Disputes within the co-management system are usually the result of instances where national-level processes take precedence over the system, as in endangered species issues.

In certain co-management cases, formal institutions are accused of knowledge extraction, whereby the scientific paradigm is still paramount and local knowledge is merely used to fill gaps in scientific knowledge as needed (Berkes, 2009). According to Nadasdy (1999), knowledge integration between aboriginal peoples and the Canadian Government consists of collecting TK as "data" for incorporation into the scientific paradigm of management. Based on a wildlife co-management case in Yukon, Nadasdy (2003) observes that there are political blocks to legitimate knowledge integration between First Nations and government scientists. Moreover, some commentators believe that, because of power differentials, co-management can never be a partnership of equals (Stevenson (2006); Nadasdy, 2003). The concern with co-management arrangements in general is that the higher-level organization is still able to "strong-arm" lower-level organizations, and that there is in fact little sharing of power.

Based on the findings of this thesis, "strong-arming" by government does not seem to be the case in FJMC's beluga co-management. In most situations, the FJMC's operating procedures display all the characteristics of knowledge sharing and knowledge co-production, both of which go beyond incorporation of IK into the scientific paradigm. Management strategies as of 2006 are based on a mixture of both IK and scientific knowledge. It would be appropriate to describe this situation as "management strategy

co-production" through knowledge integration. The advent of knowledge sharing and co-production reflect the fact that the processes of co-management have changed, in fact evolved, since the inception of the FJMC in 1986, even though the legal mandate and directives of the FJMC have remained the same. In the case of managing the beluga entrapments, co-management through the FJMC has succeeded in distributing power equitably between the local, regional, and national levels, to the extent that the HTCs are satisfied with their level of involvement.

The second objective was concerned with determining how co-management has changed adaptive capacity at the community level. The case study demonstrates mechanisms by which the FJMC facilitates adaptive capacity of the management network in terms of response range and flexibility. Many aboriginal communities in Canada's Western Arctic are experiencing changes that are presenting new social, environmental, and economic challenges (Smit and Wandel, 2006). Bolstering adaptive capacity at the community level in Tuk is extremely important because of the stresses and exposure sensitivities the community is faced with (Andrachuk, 2009). This study has shown that residents of Tuk are experiencing difficulty in maintaining traditional livelihoods due to the high expenses associated with them. Cultural change through language loss and decreased transmission of traditional practices to youth is a major concern to many elders in the community. Co-management through the FJMC has proven to be one way to help respond to some of these changes. The FJMC has helped to increase communication and power sharing between the Inuvialuit and the DFO. The result has been that management decisions are more in line with Inuvialuit culture now than they have been in the past. DFO research projects also take Inuvialuit concerns into account and often offer employment opportunities to Inuvialuit as monitors or research assistants. These positions involve time on the land and temporary employment as well as allowing for a sense of pride and participation.

Results of this thesis support the notion that co-management can be a powerful means by which to increase local adaptive capacity through increased horizontal and vertical linkages. Cross-scale linkages can serve to open up the exchange of knowledge, resources, and power, all of which serve to increase the range of coping mechanisms and adaptive responses to changing environmental, social, and financial conditions. The FJMC has matured to a state where the Inuvialuit and Canadian Government work together to devise management strategies through a process that both are familiar with. This has had tangible benefits for the community of Tuktoyaktuk. For example, programs for youth education that accompany some FJMC activities are a result of the input and insistence by the Inuvialuit members. The FJMC's activities have provided financial returns for the community, which are an extremely important part of co-management practice in terms of community buy-in. Also, perhaps more importantly, the FJMC encourages researchers to align themselves with Inuvialuit research interests by offering some research grants.

The last objective of the case study was to map out the co-management network and get an alternate perspective of its connectivity and change over time using social network analysis. This analysis showed the change in the composition of the management network first at a rough scale and then at the level of the individuals involved. After the network transformation that occurred due to the IFA, the network still underwent significant modification. The beluga issue attracted more attention over the years and the number of participants increased as well as the proportion of linkages between members of the network. Perhaps more importantly, the FJMC played an increasingly central role the decision-making process as shown by their increased presence in the top five best connected actors from one to two. In 1989 the FJMC chair was the only FJMC member in the top five best connected actors, whereas in 2006 both the FJMC chair and an Inuvialuit member were in the list. The Tuk HTC chair and hunt captain also were in the top five, meaning that they were well connected with members from all other organizations involved. The differences observed through SNA between 1989 and 2006

management networks confirm the findings reported by individuals affiliated with the three organizations that there has been an increase in communication and connectedness within the network as shown by an increase in linkage density (the number of linkages observed between members of the network divided by the number of possible linkages in a network of that size). There was also a decrease in the standard deviation of the eigenvector value, which is a SNA metric that approximates a member's level of connectivity in the network. A decrease in the standard deviation means that there was a greater degree of equality in that decision making process because if there was a standard deviation of zero, then all members would be equally connected within the network.

The use of SNA has allowed for a quantitative description of the co-management network transformation with regard to the beluga entrapment decision-making process. These data show progress over time in terms of network connectivity and centrality, which approximate the relative influence of network members in the management processes. These quantitative results clearly align with the qualitative data from network members that indicate an increase in equality within the decision-making process. Longitudinal data in SNA gives the advantage of describing change in a network over time. When combined with qualitative data, quantitative data provide a deeper understanding of changes in management structure. It is important to understand that SNA results are particular to the decision-making process regarding beluga entrapments, and should only be interpreted as such. The SNA results by themselves cannot be taken to mean that co-management networks have progressed towards better and more equal connections in general, regardless of the management issue. However, when analyzed alongside the qualitative data that describe how the management process has changed in general, it seems that a more comprehensive SNA study of the management network could test if the results are generalizable.

Critics of co-management may argue that there are inequalities in power relationships between the HTC and the DFO, despite the results of this thesis. Although

SNA can give approximations of how well specific organizations or individuals are able to access network resources and how that has changed through time, they cannot directly be used to interpret power relations. The Minister of Fisheries and Oceans does indeed have the final say in all management decisions, but the reality is that the co-management process has done a great deal to increase Inuvialuit involvement in every aspect of management in this specific case. Concerns about inadequate power sharing with the local level are best addressed by asking the officials from the local level about their level of involvement and power in the decision-making process. Members of the HTC agree that in the case of the beluga entrapments, their involvement went from "negligible" in 1966 to "partial" in 1989, to "adequate and fair" in 2006 and 2007. These results show that effective co-management can take place despite structural inequalities.

The extent of Inuvialuit involvement in the management of beluga entrapments in the Husky Lakes has varied widely since the Canadian Government has become involved. For several decades before the IFA, the decision-making power rested with the Canadian Government and the Inuvialuit were not involved in devising or implementing the management strategies. Through the introduction of the co-management system under the IFA and the subsequent refinement of the FJMC's operating procedures over the course of twenty years, the Inuvialuit have come to share and co-produce knowledge and management strategy with the Canadian Government. The processes surrounding cooperatively designed, implemented, and assessed management strategies have had positive financial, social, and cultural impacts for the community of Tuktoyaktuk. The FJMC, Tuk HTC, and DFO continually work at refining the co-management processes with the goal of creating a more widely adaptable management network whose activities potentially benefit the environment and fisheries resources, the Canadian Government, and the Inuvialuit.

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Appendix A: Questionnaire for Social Network Analysis

The following questions are meant to determine who you communicated with among the different organizations involved in handling the 1989[8] Husky Lake beluga entrapment. Please answer the questions in the space below.

Your name:

During the 1989 entrapment, what organization were you involved with? How long had you been involved with the organization and what was your position at the time?

Please list the names and positions (Chair, board member, etc.) of the DFO members (please indicate Inuvik, Yellowknife, Winnipeg, other) that were involved in handling the entrapment in some way. Rank them by putting the person you communicated with most in position 1, the person you communicated with second most in spot 2, and so on.

1.

2.

[8] There were separate questions for 1989, 1996, 2006, or 2007.

3.

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10.

Please list the names and positions of the FJMC members that were involved in handling the entrapment in some way. Rank them by putting the person you communicated with most in position 1, the person you communicated with second most in spot 2, and so on.

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Please list the names and positions of the Tuk HTC members that were involved in handling the entrapment in some way. Rank them by putting the person you communicated with most in position 1, the person you communicated with second most in spot 2, and so on.

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If there are any people from other organizations (Joint Secretariat, IGC, consultancy firm, etc.) that you communicated with regarding the 1989 beluga entrapment, please list their names and positions below.

1.

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Appendix B: Draft Husky Lakes Beluga Entrapment Plan

DRAFT

Three Year Husky Lakes Beluga Entrapment Action Plan

Beluga whales have been entrapped in Husky Lakes for generations. Recording of entrapments began in the 1960's and has included 7 entrapment occurrences since then. More entrapments may have occurred but were not observed or recorded. The last two years (2006 and 2007) belugas have been entrapped both years. This represents the first time since recording entrapments that belugas have been trapped in Husky Lakes two years in a row. Recently media has become more interested in events such as whale entrapments. In 2006 the whale harvest and sampling program at Husky Lakes got international media attention. This media attention does not always reflect the image the Inuvialuit, Department of Fisheries and Oceans (DFO), or Fisheries Joint Management Committee (FJMC) wish to portray.

In 2007 when whales were once again entrapped in Husky Lakes, the Tuktoyaktuk Hunters and Trappers Committee (HTC) with agreement from the FJMC and DFO, decided to take no action, with the knowledge these events are naturally occurring. However, these organizations also committed to holding a Working Meeting with other HTC members, DFO and FJMC to develop an Action Plan to determine the best approach for handling future occurrences of beluga entrapment in Husky Lakes. There was no media coverage of the 2007 entrapment.

Although the entrapment of beluga whales into Husky Lakes is considered a natural event, communities in the ISR would prefer to prevent further entrapments for the following reasons:

- It is a waste of a resource and cruel to allow these animals to starve to death.
- Concern that beluga numbers may decline over time if entrapments occur on a more regular basis. They do not want to see what has happened to caribou and the restrictions now in place for these animals, also happen to beluga. These animals are important food sources for the people.
- Media attention which can occur sometimes reflects poorly on the community. Southern and international press, do not always understand the context of this issue.

This draft of the three year Action Plan is the result of discussions held at the Husky Lakes Beluga Entrapment Working Meeting, held in Tuktoyaktuk, June 16-18, 2008. There appeared to be complete consensus at the meeting for the draft Action Plan. The Action Plan will also be coupled with a communications plan. The communications plan will be developed for use by the HTCs, FJMC and DFO.

Activity	June	July	August	September	October and on
	appropriate deterrent devices (2008) • DFO to train monitors on deterrent devices (as required)	and report on effectiveness of deterrent devices. (all years)	and report on effectiveness of deterrent devices. (all years)		success between different types of deterrents. (all years)
DFO Survey& Count	n/a	n/a	• Conduct aerial survey 2nd week of August • If whale estimate is over 100 in southern portion of Husky Lakes refer to option 1 and 2. (all years)	• Conduct aerial survey to determine if any whales still in Husky Lakes. (all years)	• Use survey counts for assisting with evaluating effectiveness of deterrents or herding. (all years)
Move beluga whales out of south Husky Lakes (Option 1)	n/a	• Organize teams to move beluga from South Husky Lakes. • HTC contracts • Initiate moving whales if required	• Initiate or continue moving if required.		• Review level of success for Option 1. (If option in not viable then consider removing from plan)
Hunt/Sampling (Option 2)	n/a		• Organize open water hunt (HTC lead) and sampling program if desirable. • Conduct hunt and sampling end of August	• Complete hunt • Share muktuk and meat with all communities if possible.	• On-ice sampling program (DFO lead). • Review level of success in hunt and sampling.
Science Projects		• Seek interest			• Science to

Activity	June	July	August	September	October and on
	appropriate deterrent devices (2008) • DFO to train monitors on deterrent devices (as required)	and report on effectiveness of deterrent devices. (all years)	and report on effectiveness of deterrent devices. (all years)		success between different types of deterrents. (all years)
DFO Survey& Count	n/a	n/a	• Conduct aerial survey 2nd week of August • If whale estimate is over 100 in southern portion of Husky Lakes refer to option 1 and 2. (all years)	• Conduct aerial survey to determine if any whales still in Husky Lakes. (all years)	• Use survey counts for assisting with evaluating effectiveness of deterrents or herding. (all years)
Move beluga whales out of south Husky Lakes (Option 1)	n/a	• Organize teams to move beluga from South Husky Lakes. • HTC contracts • Initiate moving whales if required	• Initiate or continue moving if required.		• Review level of success for Option 1. (If option in not viable then consider removing from plan)
Hunt/Sampling (Option 2)	n/a		• Organize open water hunt (HTC lead) and sampling program if desirable. • Conduct hunt and sampling end of August	• Complete hunt • Share muktuk and meat with all communities if possible.	• On-ice sampling program (DFO lead). • Review level of success in hunt and sampling.
Science Projects		• Seek interest			• Science to

Activity	June	July	August	September	October and on
		from ENR and CWS about science projects which could be executed from observation or deterrent camps. (2008-2009)			identify research opportunities in support of understanding beluga entrapment and prevention. (2008) • Examination of ice conditions in offshore and Liverpool Bay areas for last 10-20 years to determine if ice conditions are different in entrapment years. (2008-2009)
Miscellaneous		• Inquire about potential for IRC funding of herding or hunting as a cultural activity. (2008)			

Decision Tree: