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Evaluation of Approaches to Depicting First Nations, Inupiat and Inuvialuit Environmental Information in GIS Format: Options for the Handling of Spatial Information in the Arctic Borderlands Ecological Knowledge Co-Op Database

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EVALUATION OF APPROACHES TO DEPICTING FIRST NATIONS, INUPIAT AND INUVIALUIT ENVIRONMENTAL INFORMATION IN GIS FORMAT: OPTIONS FOR THE HANDLING OF SPATIAL INFORMATION IN THE ARCTIC BORDERLANDS ECOLOGICAL KNOWLEDGE CO-OP DATABASE

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this Research Paper.

I authorize Ryerson University to lend this Research Paper to other institutions or individuals for the purpose of scholarly research.

Signature ______________________________

ABSTRACT

As the pace of climate change continues to accelerate in the North, traditional environmental knowledge systems are increasingly recognized by researchers, land use planners, government agencies, policy-makers and indigenous peoples as important contributors to environmental impact and climate change assessment and monitoring. Increasing temperatures, melting glaciers, reductions in the extent and thickness of sea ice, thawing permafrost and rising sea levels all provide strong evidence of increasing temperatures in the Arctic. This warming climate has the potential to change migration patterns, the diversity, range, and distribution of animal and plant species, and increase contaminants in the food chain from atmospheric transport of organic pollutants and mercury, thus raising concerns regarding the safety of traditional foods. Since 1996, the Arctic Borderlands Ecological Knowledge Co-op (ABEKC) has systematically recorded First Nations, Inupiat and Inuvialuit observations of landscape changes in the lower Mackenzie, Northern Yukon and eastern Alaska. Time-series data (regarding berry, caribou, fish, weather, ice and snow, plants, and other animal observations) have been obtained through annual interviews with the most active fishers, harvesters and hunters in the communities of Aklavik, Arctic Village, Fort McPherson, Kaktovik, Old Crow, and more recently, in Inuvik, Tsiigehtchic, and Tuktoyaktuk. An evaluation of the spatial utility of the ABEKC database and the many steps that are involved in the collection, storage, and organization of the Co-op's data was documented. The ABEKC database provided an excellent opportunity to explore the problem of depicting complex qualitative information on northern landscape change in an intelligible GIS format. Initial attempts to develop the database in spatial format were critically evaluated and recommendations were provided in order to explore whether the data gathering and subsequent mapping process can be improved, whether more useful information can be obtained from the data, and to ensure the proper handling of the data in future years.

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CHAPTER 1: INTRODUCTION

1.1 Research Context

Climate change poses a severe threat to Arctic wildlife and the growth and distribution of vegetation, as well as the northern indigenous populations who rely on the land and harvest its resources (Environment Canada, 2005; Yukon Government, 2005a). Arctic ecosystems are particularly sensitive to changes in temperature and weather conditions. These changes are manifested in the melting of permafrost and sea ice, the surging of glaciers, the disruption of migration patterns, and the contamination of food sources (Environment Canada, 2005). In the past fifteen years concerns have been raised over the safety of traditional foods from levels of persistent organic pollutants and mercury (from atmospheric transport) in fish and marine mammals (Eamer, 2004; Northern Affairs 2003; Yukon Government, 2005a). According to Environment Canada (2005), global warming may cause the Northern Yukon to have faster melt period in spring, warmer summers and greater snowfall in winter. These conditions are changing the structure of snow in the Arctic Borderlands, resulting in harsher traveling and feeding conditions for caribou and may be contributing to the observed decline in population of the Porcupine Caribou Herd (PCH) (Environment Canada, 2005; Griffith et al., 1999). As the pace of change continues to accelerate in the Arctic region, indigenous knowledge systems are increasingly recognized as tremendous contributors to environmental impact and climate change assessments (Department of Indian and Northern Affairs, 1993a). Indigenous populations have developed an intimate knowledge (which is unique, traditional and local) of the distribution of resources, the functioning of ecosystems and the relationship between the environment and their culture and are therefore aware of the ways in which northern landscapes are changing (CEAA, 2004; Chambers et al., 2004; Grenier, 1998). This knowledge is referred to as traditional environmental knowledge (TEK) and is the outcome of complex interactions between a culture and the natural environment developed through everyday activities such as harvesting and hunting. It provides a detailed description of local environments where conventional scientific knowledge is relatively scant (Duerden and Kuhn, 1996; Duerden and Kuhn, 1998). The objective of this research is to investigate how indigenous perceptions of change can be usefully captured and made intelligible in geographic information system (GIS) format.

1.2 Research Objectives

The focus of my investigation is the Arctic Borderland Ecological Knowledge Co-op (ABEKC), a co-operative effort between Gwich'in and Inuvialuit communities in northern Canada and Alaska which, since 1994, has been committed to strengthening the role of aboriginal knowledge in environmental assessment and increasing the integration of local and scientific knowledge to improve understanding of landscape change and ecological trends (Eamer, 2004). Since 1996 ABEKC has systematically recorded First Nations, Inupiat and Inuvialuit experience of landscape changes in the lower Mackenzie, the Northern Yukon and eastern Alaska (ABEKC Questionnaire, 2003-2004; Eamer, 2004; Taiga, 2005). The time-series data have been obtained through annual community-based interviews in Arctic Village and Kaktovik in Alaska, Old Crow in the Yukon, and Aklavik, Fort McPherson, Inuvik, Tsiigehtchic, and Tuktoyaktuk in the Northwest Territories (ABEKC Questionnaire, 2003-2004; Eamer, 2004; Taiga, 2005). These interviews are an excellent way to use TEK for monitoring plants, animals (particularly the PCH) and weather conditions in the traditional homelands of northern communities. The surveys include questions about berries, weather, fish, human activity, caribou and other animals, and are used to learn what is changing in the environment and why the changes are occurring (ABEKC Questionnaire, 2003-2004).

Since 1999, observations have been rendered into map format using ArcView (ESRI Inc.) and descriptive data from the questionnaires have been entered into a Microsoft Access database. An identifier is used to relate the two types of data so that the Access database can be used to describe the spatial data. Ideally this should provide a basis for tracking changes over time. Currently the maps are somewhat cursory, and while they show where interviewees described landscape phenomena, they do not tell a useful story about landscape and landscape change.

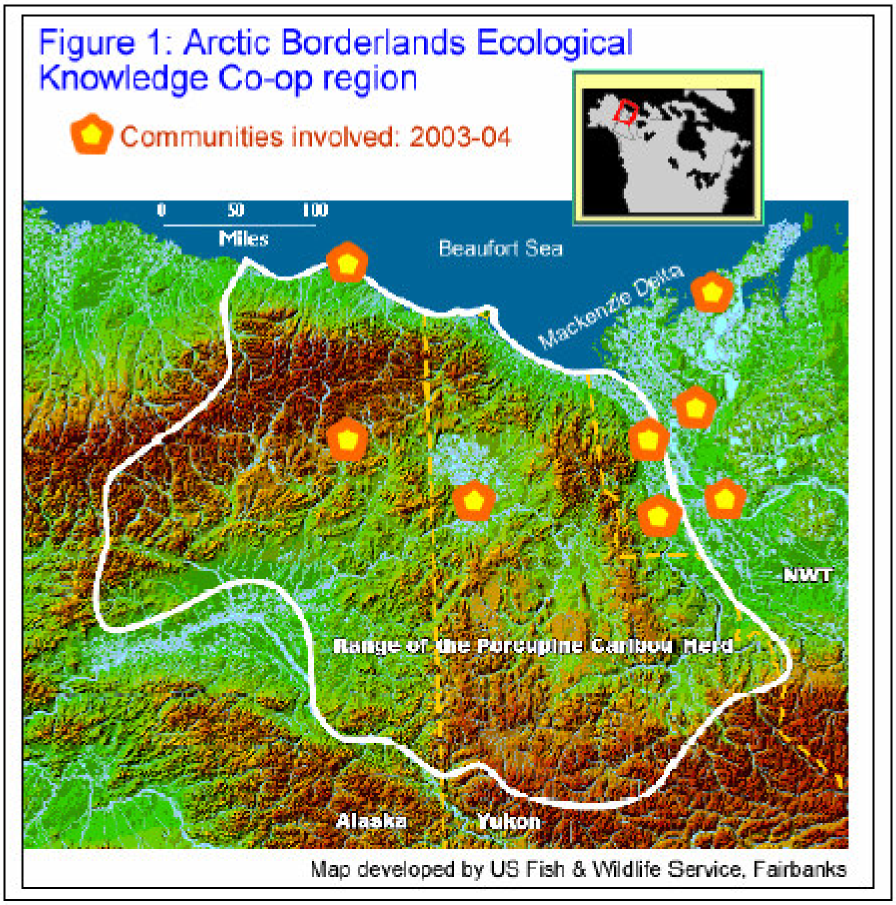
The nature of the relationship between the databases is complicated as the knowledge collected from conducting community interviews was originally expected to serve as a tool for government to monitor ecosystems but was not designed with GIS in mind (ABEKC personnel, 2005). However, the power and flexibility of a GIS ideally make it suitable for environmental analysis and should allow the ABEKC data to be organized, catalogued, stored, and analyzed. The data contain a vast number of observations and complex interrelated pieces of information that have been georeferenced. Therefore the structure and nature of the database lend itself to the use of a GIS, but since GIS was considered as an afterthought, rendering the data into a GIS is challenging.

This study is not an intensive TEK or land use study; rather it is an evaluation of the spatial utility of the ABEKC database and an evaluation of the manner in which data are represented to explore the possibility that the data can be used more effectively in future years. It is a technical study and does not look at confidential information about indigenous land use. The two research questions that will be explored are whether the data gathering and subsequent mapping process can be improved, and whether more useful information can be obtained from the data. These questions are addressed through a review of relevant research, meetings and discussions with key players involved in TEK-based initiatives in the Yukon and in ABEKC database development, and an analysis of the database. From meetings with these personnel, it is evident that user groups have been somewhat dissatisfied with the structure, rigidity, and utility of the data. There is a large amount of information contained in the database that is not being used because of the complicated design and nature of the database. There is an increasing demand for TEK in resource management and monitoring as climate change continues to accelerate in Arctic regions (Yukon Government, 2005a). Traditional hunting and harvesting are at risk from climate change as warming has the potential to greatly change ecosystems and increase the level of contaminants in the food chain from atmospheric transport of organic pollutants and mercury (Environment Canada, 2005). There is also a demand for this knowledge because Arctic and sub-Arctic regions are very data poor. The quality of existing conventional scientific data can be enhanced by incorporating the ABEKC database. It is anticipated that this research will increase the efficiency of data collection and storage, help tease out more useful information, and assist in making the database more accessible and easy to use, therefore lending itself to more environmental monitoring applications.

1.3 The Arctic Borderlands Ecological Knowledge Co-op

ABEKC is an alliance of First Nations communities, Inupiat and Inuvialuit organizations, co-management boards (e.g., Wildlife Management Advisory Council of the Yukon North Slope and the Canadian Porcupine Caribou Management Agreement), government agencies and university researchers (Kofinas, 2002). An integral part of the program is that it is owned and controlled at the local and regional level and although Environment Canada plays an important role in the Co-op, the program has been developed and managed co-operatively (Eamer, 2004). The geographic focus is the U.S.-Canada Arctic Borderlands, defined by the range of the Porcupine Caribou Herd (PCH) and nearby coastal environments (250,000 km²) (see Figure 1.1) (Eamer, 2004; Kofinas, 2002).

Figure 1.1 The Arctic Borderlands Ecological Knowledge C-op Region



Source: Eamer, 2004.

The Co-op was created from a meeting between researchers, scientists, aboriginal leaders, government managers, and community representatives in Dawson City, Yukon in the fall of 1994 (Eamer, 2004). The focus of the meeting was to create a plan to improve ecological monitoring in the range of the PCH due to measurably warming temperatures and changes in snow conditions in the region as well as the observed decline of the population of the herd

(Eamer, 2004; Griffith et al., 1999). From this meeting came the idea to put into action a community monitoring program that would use local observations, TEK, science-based research and monitoring, and government records. Joan Eamer is the person responsible for spear-heading the ABEKC ecological monitoring program. The original vision of the Co-op was to monitor climate change, regional development and contaminants (Eamer, 2004). There are two components to the Co-op's program: indicators of basic environmental measurements (e.g., temperature and ice-free period), and community-based ecological monitoring. Data collected from the latter are the focus of this research.

The Co-op's monitoring program was launched for many reasons. First, a program initiative of Environment Canada in 1994, the Ecological Monitoring and Assessment Network (EMAN), was established as a national response to global warming. Regional offices were provided funding to establish "EMAN sites" to monitor ecosystem changes (Kofinas, 2002). Environment Canada Yukon reviewed the directive and recognized the need to think beyond study sites and view the region as a system with human communities (Kofinas, 2002). The proposed area of focus was the PCH range and the communities for whom caribou are a vital subsistence species. Past oil and gas-driven research and historically, the marginal involvement of First Nation peoples in any meaningful input into how, where, when or why resource development occurs on traditional territory, at first left many local communities unwilling to participate (Eamer, 2004). According to Campbell (1996) this lack of input and control over what happens in the traditional territory around them is the most critical issue facing First Nation communities. At the first workshop held in 1994 to introduce the EMAN concept a university-trained biologist suggested that local people would require a formal education in order to be involved in the program (Kofinas, 2002). Local representatives contested that community experts are more knowledgeable about their area than scientists and from this discussion the idea of community monitoring emerged as a key component of the program (Kofinas, 2002). The initial investigation of community concerns determined that climate change, regional development, and contaminants should be the focus of the Co-op. Another objective of the monitoring program is to track conditions over time (Kofinas, 2002). A workshop in 1996 where participants discussed how best to document local knowledge became the first "annual gathering" (Eamer, 2004). A gathering is held every year in one of the participating communities to discuss the Co-op's programs, review indicators, and compare observations (Eamer, 2004). There are now ten communities involved in the community monitoring program, two of which are in Alaska, whose population are predominantly aboriginal (Inupiat in Alaska, Inuvialuit in Canada, and Gwich'in in both Alaska and Canada) (Eamer, 2004).

Since relatively little has been written about ABEKC, a picture of its development was obtained through meetings with major players in the database development process. A representative for the Co-op explains that in the beginning, "the Borderland's database was different [than other databases] because it was based on a biological entity (e.g., caribou) as opposed to geographical regions (e.g., parks)" and it introduced TEK for monitoring landscape change, a very new idea in 1994 (ABEKC personnel, 2005).

1.4 Problem Identification

It was clear from discussions with groups associated with ABEKC and government agencies in Whitehorse that the ABEKC database is seen as a ground-breaking approach to depicting Arctic landscapes and yielding information to assist First Nations in land and resource decision making. However, it is problematic. The problems are identified through experimentation with the database and comments from practitioners obtained through interviews in Whitehorse.

1) Problems observed through experience with GIS and GIS output:
   a) Current data format is not user-friendly
   b) Maps are difficult to translate
   c) Weak metadata
   d) Discrepancies in the codings used to identify spatial observations

2) Problems identified by practitioners:
   a) Current data do not provide enough information for making management decisions
   b) A lot of data but little analysis has been done
   c) More raw data should be made available so that decision and policy-makers can incorporate the data with their own data for analysis
   d) Format of data makes it difficult to apply to specific applications
   e) Bias involved in digitizing – polygons become a hard line, which they are not

1.5 Organization of the Paper

This paper consists of three major components, a review of relevant literature, discussions with key players involved in TEK-based initiatives in the Yukon and ABEKC database development, and an analysis of the database, including possible approaches to more meaningfully depict community observations. This research first examines the relevant literature regarding the increasing popularity of TEK-based data, the special relationship that First Nations, Inupiat and Inuvialuit people have with the land, the use of GIS by indigenous governments and co-management bodies, climate change in the north and various TEK-based initiatives used to monitor this change, and the integration of TEK with other types of data. The production of knowledge by ABEKC is deconstructed in chapter four, largely a result of conversations with key players in Whitehorse and from suggestions made by ABEKC Questionnaire respondents (interview years 1996-97 to 2001-02). Critical comments regarding the efficiency of the process are provided in chapter five. Next is an investigation of the possible approaches that can be employed to obtain more useful information from the ABEKC data. It is determined whether the maps yield new information or if they can be used to supplement existing information. Recommendations are provided and techniques are suggested which can provide a better picture of what is changing in and on the landscape. The final chapter summarizes the findings of the research, provides recommendations to ensure proper handling of the data in future years, describes the limitations of the project and suggests points for further investigation.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This research first examines the relevant literature regarding the increasing popularity of TEK-based data, how it is being made more accessible, its increasing use alongside conventional scientific research to monitor changing northern landscapes and caribou herd movement, and translating it into GIS format. The use of GIS by First Nations, Inupiat and Inuvialuit peoples is increasing as an effective way to manage community-based information and monitor the natural environment. Many northern communities are dependent on subsistence activities, such as harvesting and hunting, for their health and survival and are therefore susceptible to the effects of a changing climate on ecosystems. The continued healthy existence of these native communities is dependent on the ability to predict phenomena such as weather and the timing of wildlife migration, particularly the PCH. In Northern Canada and in other Arctic and sub-Arctic areas, the ecological knowledge of First Nations, Inupiat and Inuvialuit peoples is more comprehensive, geographically and temporally, than scientific knowledge. TEK is increasingly being integrated with other conventional types of data to monitor accelerating climate change and is being used in various types of research being conducted in the Northern Yukon.

2.2 Traditional Environmental Knowledge

The lack of conventional scientific knowledge in remote regions of the world often demands the introduction of TEK into ecological monitoring practices. For this reason, and also due to recent concerns regarding the impacts of climate change, TEK has gained recognition over the past twenty years (Brockman et al., 1997; Davis, 1993). It is increasingly employed along with conventional scientific investigation for historical climatic research, ecological monitoring, land-use planning, resource management and understanding changes in northern landscapes attributed to changing climate (Brockman et al., 1997; Davis, 1993; Department of Indian and Northern Affairs, 1993a/b; Parlee et al., nd; Usher; 1987). Thorpe (1998) points out that TEK is also beneficial to decision makers as this type of knowledge is rich with critical environmental information that can be used for a multitude of resource management activities, in particular those requiring proposed land uses to be considered (Thorpe, 1998).

TEK-based and scientific data both stem from the physical properties of the resource (e.g., berries, fish, caribou, precipitation) therefore it is possible to move among systems and use the different knowledge contained in each to monitor the environment and landscapes (Hutchinson and Tabor, 1994). Since the natural resources included in the ABEKC database are spatially variable and resource classification is based on observable characteristics, remote sensing data can be used to develop reasonably homogenous sampling strata to which ground samples (e.g. responses from interviewees) are located. In this way, remote sensing and scientific data from different dates and scales can be used to supplement the TEK-based database, and vice versa. In the context of monitoring the PCH, science-based methods provide estimates of calf survival and herd size (and how these are affected by snow conditions) whereas TEK provide an understanding of how caribou migrations and feeding patterns are influenced by snow conditions (Eamer, 2004). In addition, harvest study records often provide incomplete records of total harvest however the community-based monitoring program provides invaluable information on whether the seasonal needs of caribou have been met for each community (Eamer, 2004). Another example of how TEK and scientific knowledge can work together is when local experts in Old Crow observed that the lakes in

Old Crow Flats were drying up, scientists followed up these observations with remote-sensing and ground-truth observations and continue to track the observations. TEK is traditionally oral and has a long, rich history of use, but the problem of translating it into mapped format is challenging. The oral and qualitative nature of the information, its subjectivity, and determining a way to assess its accuracy, make the integration of GIS and TEK a difficult task.

TEK is made more accessible through documentation and can be used in conjunction with other information (Huntington, 1998). Government agencies, private researchers, academics and various co-operatives are increasingly gathering this knowledge to be used in a research context. Semi-directed interviews and questionnaires (much like the ABEKC procedure for community monitoring) are popular methods used to gather TEK (Huntington, 1998). Maps have also been employed to document this research and create an environment that is conducive to discussion (Cruikshank, 1981). Huntington (1998) uses semi-directive interviews to produce informative discussions about belugas, the nearshore ecosystem, and human interactions with belugas and other harvested species in Point Lay, Buckland, and Norton Bay, Alaska. Interviews can be used to describe migratory patterns, feeding practice, prey patterns, calving, human influences, and other ecological interactions (Huntington and Mymrin, 1996). For the Vuntut Gwitchin of Old Crow and the Inuit of Umingmaktok (Bay Chimo) and Kingaok (Bathurst Inlet), caribou are of particular importance, since the Porcupine Caribou and Bathurst herds, respectively, migrate through and calve in areas nearby (Thorpe, 1997). The health and survival of these herds are dependent on the health of the ecosystem as every element of the environment is connected. Caribou knowledge from a First Nation perspective includes knowing the relationships between the spiritual, cultural, ecological, and physical characteristics of the environment (Thorpe, 1997). Collectively, this knowledge of the environment is referred to as TEK.

In remote parts of the world, such as Northern Canada, the ecological knowledge of First Nations, Inupiat and Inuvialuit peoples is more comprehensive, geographically and temporally, than scientific knowledge (e.g., Johnson, 1992). As noted by a representative from the Canadian Wildlife Service (CWS), speaking of caribou knowledge, TEK is "…invaluable to us because we (as scientists) cannot get out on the land and monitor body condition" (CWS personnel, 2005). Through field experience, Thorpe (1998) is able to make the statement that aboriginal men "have special knowledge about caribou, particularly concerning interactions between caribou and the land, for example, grazing, rutting, migration, and calving behaviour" (p. 405) and that "men appear to have better knowledge about caribou and ecosystem relationships at a holistic level, whereas women have superior knowledge at a specific level" (p. 406). Women are able to discuss the quality of the meat and are therefore excellent monitors of an animal's diet and overall health (e.g., bad odour may indicate a sick caribou) (Thorpe, 1998). However, both men and women are able to provide valuable insight into the relationship between an animal and the land.

Thorpe (1998) points out some of the benefits that community members enjoy from recording and being able to access TEK. Cultural continuity exists through the act of storytelling which is a result of sharing and documenting TEK. Community pride is also cultivated through the interaction between elders and community members (Thorpe, 1998). With the potential positive impacts of uniting traditional and scientific ecological knowledge to deal with environmental problems, it is important that concerns of First Nations regarding how scientists may participate and how managers may ultimately use their knowledge, be dealt with (Wavey, 1993). Some interviewees may be reluctant to share their information, such as hunting routes, as it may reveal secrets and sensitive information. If there is an air of distrust between the interviewer and interviewee, the respondent may filter or withhold the information (Ferguson, 1997).

It is now widely accepted that the management of Arctic wildlife populations and the monitoring of northern landscapes will improve as TEK and its land and time-specific detail become more widely accessible and acceptable as an equally important information source. Feit (1988) points out that "…full integration [of TEK with conventional scientific knowledge] may not (and perhaps should not) be accomplished because of unique assumptions and decision-making processes inherent to each (aboriginal and Euro-scientific) culture." Through the integration of TEK with scientific knowledge, future herd distribution changes may be able to be projected and a predictive model may someday be able to be created (Ferguson, 1998). The acceleration of climate change in the North makes the collaboration between scientists and First Nations, Inupiat and Inuvialuit peoples even more urgent (Ferguson, 1997; Ferguson, 1998).

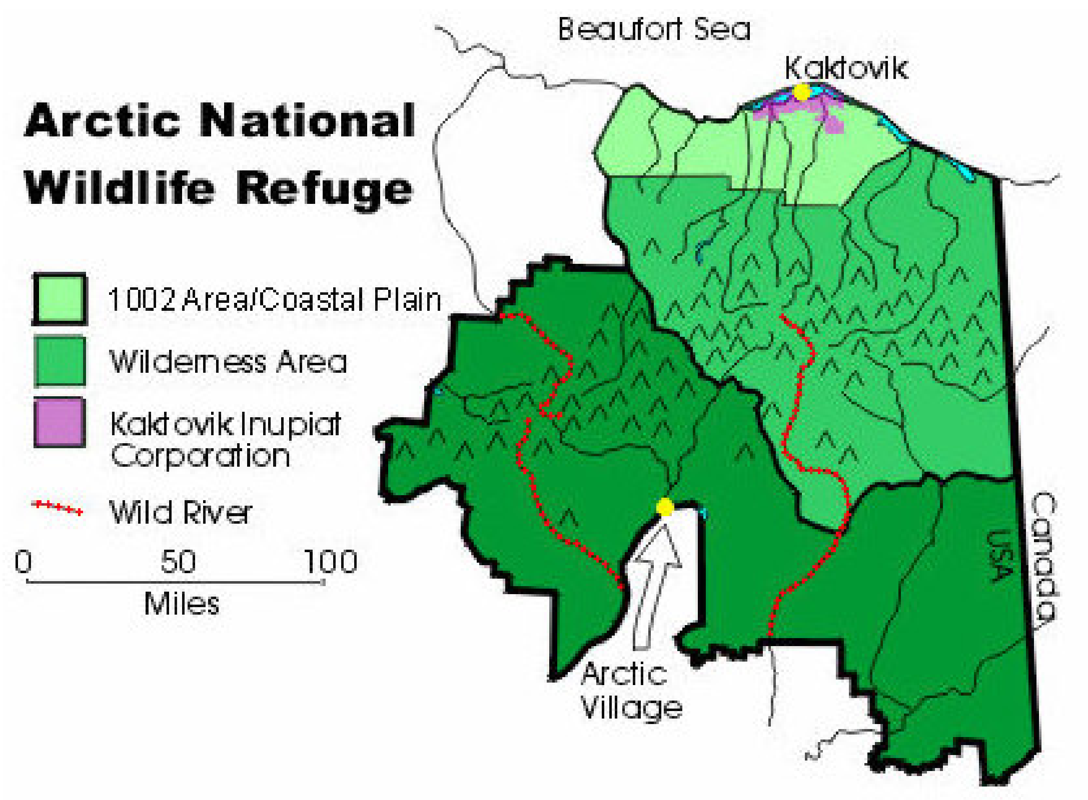
2.3 Subsistence in the ABEKC Region

Subsistence is viewed by many indigenous hunters of North America as a way of life that links wild food resources such as caribou to the livelihoods, identity and wellbeing of indigenous peoples (Kofinas and Russell, 2004). For the Vuntut Gwitchin of Old Crow, caribou are of particular importance since the PCH migrate through and calve in areas nearby. For 20,000 years caribou have been the mainstay for people on the Porcupine Caribou range and have been hunted by ancestors of the Gwich'in, Northern Tutchone, Han, Inuvialuit and Inupiat peoples (PCMB, 2005). Old stories of the Gwich'in depict caribou as sentient beings whose sacred gifts have ensured human survival for millennia

(Kofinas and Russell, 2004). This indigenous perspective of land and animals is a guiding principle maintained since ancient times when people were caribou and caribou were people (Kofinas and Russel, 2004). Many remote caribou communities (such as Old Crow and Arctic Village) cannot be reached by road therefore caribou meat is an invaluable nutritious staple which has no replacement. All parts of the caribou are used; there is no waste. The skins are used to make traditional clothing (e.g., hair pieces, moccasins), furs line mukluks and parkas, bone and antler are made into tools, and caribou heads, bone marrow and hooves are prepared and eaten (PCMB, 2005).

The caribou prefer the tundra and therefore remain north of the treeline until snowstorms in the fall force them southward to winter ranges in eastern Alaska and the Yukon (Taiga Net, 2005c). They begin to migrate north again as soon as possible and by May the spring migration towards the calving grounds is in full swing. Weather has a strong influence on caribou migration and therefore each year's migration pattern to and from the calving area in the 1002 lands of the Arctic National Wildlife Refuge (ANWR) is unique. However, they are faithful to these calving grounds which define the Porcupine Caribou as a herd. The health and survival of the herd is dependent on the health of the ecosystem as every element of the environment is connected (Thorpe, 1997). Beneath the calving grounds of the PCH, in the 1002 lands of the ANWR there are potentially vast quantities of oil (see Figure 2.1). The expression "1002 lands" refers to section 1002 of the Alaska National Interest Lands Conservation Act (ANILCA) and is known to the Gwich'in people as "the sacred place where life begins" (PCMB, 2005). The geological assessment of the region in 1987 by the United States Department of the Interior stimulated an ongoing environmental debate since First Nations, Inupiat and Inuvialuit peoples depend on the herd (Kofinas and Russell, 2004). A CWS representative states that "there is a strong correlation between the health of a community and needs being met with the abundance and distribution of caribou" (CWS personnel, 2005). Figure 2.2 shows that critical caribou access areas for the community of Kaktovik are in the 1002 lands. Drilling for oil in these calving grounds has the potential to devastate a critical habitat area for the PCH and jeopardize First Nations' health and traditions (PCMB, 2005; Taiga Net, 2005c; WWF, 2005). The utility of mapping exercises such as that coming from ABEKC is that it yields and depicts critical information on habitat and land use that is not found in any conventional studies.

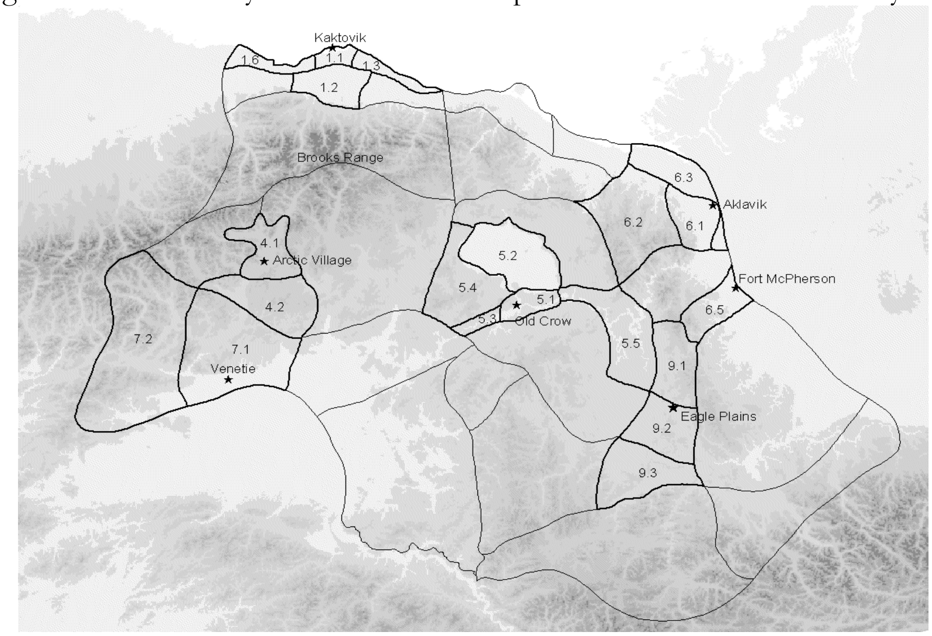
Figure 2.1 The Arctic National Wildlife Refuge



Source: Alaska Wilderness League, 2005.

The continued healthy existence of native communities is dependent on the ability to predict phenomena such as weather, snow and ice conditions and the timing of wildlife migration (Riedlinger, 1999). Caribou movements are dictated by the weather. For example, Aklavik of the Northwest Territories is located on the eastern margin of the PCH. Residents must intercept caribou at key times of the year and are therefore vulnerable to the changes in, and unpredictability of, the migration routes. In the past five years the PCH has shifted to a more western migration route (Kofinas and Russell, 2004). Snow melt was late across northern North America in 2000 and, coincidently, surveys of herds revealed that spring migrations were delayed, calving occurred south of the calving grounds, early calf survival was lower and calving was delayed (Kofinas and Russell, 2004). Climatologists predict that summers will become warmer and snowfall will increase in northwestern North America (Taiga Net, 2005c). Higher snow depth results in caribou being more abundant in some communities and scarce in others (Kofinas and Russell, 2004). It is also harder for caribou to get at their winter food (mainly lichens) when the snow is deep. Communities will face different impacts of climate change of varying degrees. Since vegetation growth, snow depth, temperatures and winds affect the ability of caribou cows to build up enough body reserves to give birth and raise their young, the health of the herd, and consequently, the health of the community members, is at stake. Being able to map the distribution of caribou using knowledge from First Nations, Inupiat and Inuvialuit peoples has the potential to help ameliorate the impacts felt by the communities.

Figure 2.2 Community Access to the Porcupine Caribou Herd in the Study Area



Community Access	Zone
Kaktovik	1.1 Near
	1.2 Far
	1.3 Far
	1.6 Far
Arctic Village	4.1 Near
	4.2 Far
Venetie	7.1 Near
	7.2 Far
Old Crow	5.1 Near
	5.2 Far
	5.3 Far
	5.4 Far
	5.5 Far
Aklavik	6.1 Near
	6.2 Far
	6.3 Far
Fort McPherson	6.5 Near
	9.1 Near
	9.2 Far
	9.3 Far

Source: McNeil et al., 2005.

2.4 The Use of GIS by Indigenous Governments, Agencies and Co-Management Bodies.

GIS are sophisticated tools that allow georeferenced data to be stored, retrieved, displayed, analyzed and mapped. Database management systems provide a method for organizing, cataloging, and analyzing collections of related information (Bonham-Carter, 1994). The power and flexibility of GIS and related database management systems are ideally suited to environmental analysis where large numbers of complex interrelated pieces of information are usually georeferenced (Borrough, 1986; Dueker and Delacy, 1990). The real-world spatial component within a GIS permits the inclusion of measurement capabilities within a GIS analysis (Johnson, 1997). By combining these tools, we are able to better comprehend complex issues and make more informed decisions. Moreover, the update capabilities of GIS allow dynamic conditions in the real-world to be incorporated into the analysis (Johnson, 1997). Because of these characteristics, Duerden and Keller (1992) and Duerden (2004) suggest that GIS is an effective way to manage the vast amount of community-level knowledge on the subject of environmental change. Thus, GIS is increasingly used to depict indigenous interests and has been used to record oral tradition and create a visual picture to show the story of what has happened in the past (Chambers et al., 2004; Duerden and Keller, 1992). The management of data is dependent on database management system (DBMS) software. Such systems are based on relational concepts, wherein tables of data are linked together by common fields. This internally-referencing system facilitates powerful analyses and maintains a logical and straightforward structure (Johnson, 1997).

Currently, there are many projects underway which are investigating the use of GIS by First Nations, Inupiat and Inuvialuit groups for the management of the natural environment. The Gwich'in GIS Project is a co-operatively funded project which involves three community-based organizations: the Gwich'in Tribal Council, Gwich'in Renewable Resource Board, and the Gwich'in Land Use Planning Board (NRC, 2005). The project will create and maintain a comprehensive GIS that will be used for spatial mapping to monitor land and water resources. Each organization will employ GIS as a functional tool for project work and decision management at the community level (NRC, 2005). In another example, in order to help manage its forest and wildlife resources according to traditional values, the Nacho Nyak Dun First Nation is upgrading its computer systems to use satellite imagery and other digital map products (NRC, 2005). The Sustainable Communities Initiative (SCI) is partnering with the Athabasca Chipewyan First Nation (ACFN) to develop a traditional land use study in order to promote the development, preservation, and utilization of the community's traditional knowledge, to help protect and monitor the natural environment, and to involve youth in the collection and comprehension of TEK (NRC, 2005). As a result of the Inuit Tapirisat of Canada SCI Agreement, Natural Resources Canada will partner with the Kivalliq Inuit Association (KIA) to help develop a system to manage their land involving the use of a GIS to organize, store, and analyze data for map productions as well as GPS for collecting data for the regions of Rankin Inlet, Baker Lake and Arviat (NRC, 2005).

The Yukon Department of Environment (YDOE) has been involved with capturing indigenous knowledge to spatial databases. One interviewee comments that he has worked with the Council of Yukon First Nations in the Polar Geomatics unit (YDOE personnel, 2005). The Council organized knowledge from one First Nations group in British Columbia and two groups in the Yukon. This knowledge included mostly harvest information (e.g., moose here, berries there, fish over there) for the Carcross Tagish First Nation from 1992 to 1995 and was originally gathered to be used as a land use planning tool (YDOE personnel, 2005). Acetate layers were used for each interviewee. Some interviewees drew polygons and others talked while interviewers drew polygons for them. All layers based on one theme were piled together for the database. The sample size was only 12 to 20 elders but polygon layers and map algebra were able to show the concentration of use very well (YDOE personnel, 2005). After converting to raster, collapsing all polygons to derive a frequency of occurrence involves a relatively straightforward methodology. The polygons were largely overlapping which indicates a high concentration of use and so it becomes fairly easy to indicate areas that are important to the people in order to justify land claims or indicate areas of high priority for protection (YDOE personnel, 2005). However, it must be recognized that TEK-based data collection is often fuzzy and the data are not that precise.

2.5 Climate Change

There is an increasing body of literature exploring the impact of climate change in the Arctic, Yukon and Northwest Territories. Researchers have investigated surging glaciers, regeneration of plant communities in the central Yukon and geomorphological and ecosystem responses to environmental change, many of which are ongoing (Allen, 1981 in Eamer, 2005; Barendregt, 1994 in Eamer, 2005; Bartleman, 1997 in Eamer, 2005). There is extensive literature concerning the broad topic of permafrost and climate change (Burn, 1982 in Eamer, 2005; Burn, 2001 in Eamer, 2005; Coultish, 2001 in Eamer, 2005; French, 1967-88 in Eamer, 2005; Wolfe, 1999 in Eamer, 2005; Woo, 1998 in Eamer, 2005). Studies of human impacts include investigations of the origin and development of human modes of adaptation in the Northern Yukon (Cinq-Mars, 1979 in Eamer, 2005), community vulnerability to climate change (Gad, 2001 in Eamer, 2005) and the impact of change on human activity in northern communities (Duerden, 1998 in Eamer, 2005).

Only a few studies (Cohen, 1997; Riedlinger, 1999; 2001) explore the value of TEK in relation to climate change in the North (Cohen, 1997; Riedlinger, 1999; 2001). Even more scarce is literature regarding the application of TEK to GIS for evaluating climate and landscape change. However, increasingly more research is incorporating traditional knowledge. Gill et al. (2001) point out the need to document traditional and local knowledge concerning climate change in order to provide a better understanding of the changes as they are occurring across the North. Duerden (1998 in Eamer, 2005) examines past climate stresses and community perceptions of change in order to ameliorate the impacts of climate change. Cruikshank (1999-2002 in Eamer, 2005) examines perspectives about the impacts of the Little Ice Age from Southwest Yukon First Nation communities through the documentation of oral tradition. Communities and hunters are also integral to several programs which monitor the condition of caribou and other animals in order to track changes in the landscape (Cooley, 1991-present in Eamer, 2005).

Gill et al. (2001) suggest that due to the site specific and detailed nature of TEK, it is needed to provide a more holistic, long-term perspective of change because scientific knowledge is often at a broader scale, is less integrated and encompasses a short-term perspective. However, the increasing concern over impacts of climate change has led to an awareness of the benefit of using both knowledge systems (Gill et al., 2001). Remotely sensed data and community-based monitoring are being used in Old Crow, Yukon to detect recent changes in the extent of thawed lakes, frozen shallow lakes, vegetation and soil temperatures (Duguay, 1994 in Eamer, 2005; Eamer, 1994 in Eamer, 2005; Johnstone, 1997, 2001 in Eamer, 2005; Labrecque, 2000 in Eamer, 2005). Hutchinson and Tabor (1994) discuss the use of TEK in combination with remote sensing data and GIS for sustainable development purposes.

2.6 Investigating Caribou Herd Movements

Recently there has been particular interest in analyzing the impacts of climate change of caribou herds (Kofinas and Russell, 2004). Wildlife and vegetation are greatly affected by winter snow depth and the timing of snow melt. Not only does snow provide a winter habitat for small mammals, but also insulation to vegetation. Snow melt affects the timing of food availability for many animals and influences the reproduction and development of vegetation. Winter caribou migration can be compared with corresponding snow conditions, precipitation, temperatures, and other weather patterns. The results would likely be counterintuitive, as more snow would cause caribou to be concentrated in the community and thus be an advantage. However, less snow translates to caribou being widely dispersed and as a result, community members have to travel far to hunt and are therefore at a disadvantage (CWS personnel, 2005). The CWS is leading a project looking at the effects of weather on caribou movements in which Environment Canada is "re-constructing" the weather at each of the caribou satellite collar locations and relating that to subsequent caribou movements by season (YDOE personnel, 2005). Range use and migration routes are being examined by studies conducted by the PCMB. These are not definitive studies but provide an idea of migration and range routes used by the herd.

Attempts have been made to use TEK in studies of both the Beverly and Porcupine Caribou Herds but little analysis has been performed (CWS personnel, 2005). Being able to combine TEK (e.g. spring caribou migration from the Co-op's community monitoring database) with scientific knowledge (e.g., radio-collared caribou point files) in a GIS will produce more holistic data with less error and assumptions for areas where little data exist. In order to generate a more precise estimate of the timing and location of migration routes of the herd Van der Wetering (1997) suggests a three-pronged approach: maintaining a minimum number of satellite collars as a co-operative project; documenting the date for first and last caribou sighting in the fall and spring, from communities, outfitters, etc.; and examining the Dempster highway hunter harvest location data.

For over 20,000 years the PCH have been central to the culture of First Nation peoples within the herd's range, and still is today (PCMB, 2005). Protection of the herd is critical for preservation of ancient traditions and is therefore a pressing concern. Monitoring herd size and location is a key approach to understanding the health of caribou herds. Since the late 1970s, the use of radio-collars has simplified the PCH's census process (Kofinas and Russell, 2004). In the PCH there are approximately fifty conventional radio-collared caribou and thirteen satellite collared caribou, giving managers the confidence that they can locate the vast majority of caribou during the post-calving period (Taiga Net, 2005c). Every three to four years the Yukon Government records spring composition counts of the PCH through telemetry flights flown in March (YDOE personnel, 2005). This census count also gives a rough indication of the winter distribution of the herd (Van der Wetering, 1997). The last count was conducted in 2001 but was cancelled in 2004 due to heavy smoke from forest fires and in 2005 because the weather did not get warm enough (YDOE personnel, 2005). If temperatures are too cool, the herd does not aggregate and therefore composition counts are difficult to conduct and have to be cancelled. Using the data from the radio-collared caribou and the composition counts by the Yukon Government, the size of the PCH from the years 1971 to 2001 has been calculated by the PCMB (PCMB, 2005).

Every year, during the month of June, the US Fish and Wildlife and the Alaska Department of Fish and Game record caribou birth rate, calf survival to one month of age and nine months to three years of age using radio-collared caribou (YDOE personnel, 2005). They have also just finished year two of a three-year study documenting adult cow survival through monthly flights observing all radio-collared caribou from September to April. A computer program was used by the PCMB to calculate the calving range and concentrated calving areas from 1983-2000 based on the calving locations of radio-collared cows (ADFG, 2001). However, several First Nations, Inupiat and Inuvialuit peoples do not agree with putting radio-collars on the caribou and therefore feel that documenting TEK and community observations are better and more cost-effective ways to monitor caribou and their migration patterns. As noted by a CWS representative, harvest rates are the hardest to obtain in terms of biological records and interviews with hunters is the only way to get this information. There are approximately one dozen harvest monitoring studies (each with its own methods) being conducted in all three jurisdictions (Alaska, Yukon Territory and the NWT) (YDOE personnel, 2005).

The CWS and YDOE are currently working on establishing body condition of the PCH as it "…is interconnected with what was happening on the land for that year" and has a direct impact on hunting patterns and communities (CWS personnel, 2005). Estimates of caribou body condition are generated by examining samples submitted by trained hunters in Old Crow and Fort McPherson (YDOE personnel, 2005). However, body condition and linkages between fat rates and pregnancy, health, calf mortality, etc., can only be established if there are enough observations for it to be quantified (CWS personnel, 2005).

2.7 GIS and TEK-Based Initiatives in the Yukon

In the Northern Yukon limited information is available on year-to-year population numbers for individual species, but the quality of existing scientific data can possibly be enhanced by incorporating TEK databases (such as the Co-op's community monitoring database) with scientific databases such as the Old Crow Ice-Free Period (Water Survey, Environment Canada), duck populations on Old Crow flats (obtained by the US Fish and Wildlife Service through aerial surveys) or data for soil temperatures, collected since 1997 as part of study of long-term monitoring of vegetation and soil temperatures at Old Crow (Taiga Net 2005a; 2005b).

All natural resource departments in governments in the Yukon are involved in GIS-based mapping of community source information regarding various aspects of the land and environment (YDOE personnel, 2005). First Nation governments are increasingly asserting their rights to gather and manage information from their beneficiaries/members and are establishing protocols regarding access to this information. Much of the work currently underway is focused on organizing the massive amounts of interview information collected for a variety of reasons into searchable text and GIS formats. As one interviewee comments, "procedures for interviews and data management have not been standardized, although many systems are based on the Key Wildlife Area mapping project that began in the 1980s led by the Yukon Fish and Wildlife Branch" (YDOE personnel, 2005). Key areas are locations used by wildlife for critical, seasonal life functions and are identified by interpreting observed locations of wildlife at key times through various data sources (Yukon Government, 2005b). Many different systems of information gathering have been attempted to yield information relevant to various types of natural resource use decisions (YDOE personnel, 2005). There is also a mandate for the Yukon Land Use Planning Council (YLUPC) and the YDOE to use TEK in land-use planning. A planner with the YLUPC adds that it is "…almost impossible to monitor wildlife without community input" (2005).

The YLUPC has been involved in various TEK-based initiatives (YLUPC personnel, 2005). An example is the generation of a habitat suitability map for the Old Crow flats region that was created almost entirely through the use of community input (YLUPC personnel, 2005). The objectives of the research were to determine important places for wildlife as well as habitat suitability. Community input was collected through surveys with the following variables: reference number, map number, polygon ID (unique code), land use, comments, species, seasonal use, habitat function by species, and year. Biotic terrain coverage is classified into eco-regions and then smaller eco-districts. According to a land-use planner with the YLUPC, elders were asked to comment on changes to biophysical characteristic and as the different classifications were discussed, they were also asked about habitat suitability (2005). The habitat suitability maps were created based on seasons as some species (e.g., caribou) are only around during particular seasons (winter) but habitat suitability for some animals (e.g., moose) was mapped for all four seasons. A possible application of this project is to provide recommendations to government to protect habitats or land (YLUPC personnel, 2005). As one land-use planner observed, in referring to conventional data that has been spatially transcribed, "the Northern Yukon is very data poor" and since there is an absence of survey information for many regions in the Northern Yukon, similar habitat attributes can be extrapolated and used as a foundation for future studies (2005).

The Yukon Land Use Planning Council was also involved in using TEK to perform a simple overlay analysis in the Northern Yukon in order to determine which areas are needed for development and which areas should be protected from development. Each community involved in the study delineated the habitat of 8 to 10 species on a map with a scale of 1:250,000 (YLUPC personnel, 2005). A simple overlay analysis was conducted with the Co-op database in order to determine the location of most common features (those areas with the highest values). There is a wealth of knowledge waiting to be documented and used but the key is translating TEK into actual land use planning strategies while overcoming the various issues associated with confidentiality (YLUPC personnel, 2005). For this particular initiative, the next step for regional resource managers is to determine what to do with these areas for land designation or zoning for the region. Through conversations with various government workers and researchers, the general consensus is that TEK has a lot to tell us about the environment and changing landscapes, but how to tease out specific information, apply it to specific projects, and maintain a high degree of confidentiality, are concerns that need to be addressed.

In a current study aimed at bringing together local and scientific knowledge, PhD student, Aynslie Ogden (UBC), and Champagne and Aishihik First Nations elders are being asked about their experience with patches of spruce beetle activity (an increase of which is associated with warmer winters) in order to develop various scenarios (e.g., if spruce beetle results in decreasing spruce grouse populations, what is the alternative food source?) (CWS personnel, 2005). Since there has been a low incidence of lightning strikes in the area (Southwest Yukon), the renewal process has been prompted by insect activity (specifically, the spruce beetle). The study is aimed at determining the resilience of the system of gathering country food and will construct a static database (as resources are not available to continue the study and make a temporal database) (CWS personnel, 2005).

2.8 Conclusion

There is an increasing body of literature surrounding the topic of TEK, particularly relating to the North where conventional scientific knowledge is scarce. Many remote communities in Northern Canada and Alaska are experiencing the effects of a changing climate and are employing GIS to manage their land and water resources. Caribou are of particular importance to First Nations, Inupiat and Inuvialuit peoples. The migration patterns of the PCH are strongly influenced by temperature and weather patterns and therefore the monitoring of the herd is receiving attention from researchers. Various GIS and TEK-based initiatives are currently underway in the Northern Yukon and have the common goal of ameliorating the effects climate change. ABEKC's community monitoring program is one such project which uses GIS and TEK to monitor changes in the landscape.

CHAPTER 3: METHODOLOGY

The preceding chapter established the research context and established the urgency and relevance of this research. In order to address the first research question concerning whether the data gathering and subsequent mapping process can be improved, the way in which ABEKC produces knowledge was critically examined. The second research question regarding whether more useful information can be obtained from the current ABEKC data was examined through investigating: possible approaches for depicting polygon overlap; the suitability of the data for time-series analyses, the integration of the Co-op data with satellite data from radio-collared caribou; and unmapped information in the ABEKC database.

3.1 Evaluation of the Production of Knowledge

Three types of sources were assessed for their critique of the process. Before data are entered into the Access database and observations are digitized, there are several steps that the Co-op follows. The components of knowledge production were compiled through discussions in the Yukon with personnel with the CWS, Environment Canada, NatureServe Yukon, North Yukon Planning Commission, YDOE, YLUPC, as well as a private consulting company, educational institutions (University of Alaska Fairbanks and Yukon College), and other key players involved in the stages listed in Table 3.1. These steps were explained in terms of how, why and by whom they are performed and were critically evaluated based on user-friendliness, overall efficiency, room for error and subjectivity:

Table 3.1 Sources of Critique for Each Aspect of the Production of Knowledge

Production Stage	**Community Respondents 96-97 to 01-02**	**Personal Communication With Key Players**	**Author's Experience with the Database**
Structure of the questionnaire	X	X	X
Designing the questions	X	X	X
Selecting the community interviewers		X	
Selecting the community interviewees		X	
Conducting the interviews	X	X	X
Recording information on the questionnaires	X	X	X
Making map references on the hard copy maps	X	X	X
Digitizing the polygons from the hard copy maps		X	X
Map reference codes		X	X
Database design - transferring information from questionnaires and maps to Access and ArcMap/ArcView		X	X
Analysis of the ABEKC data	X	X	X
Applicability of the ABEKC database		X	X
Information dispersal	X	X	X

In chapter five, a critique of the knowledge production process was used to establish where improvements to the data gathering and mapping process should be made. Critical comments regarding the efficiency of the process and recommendations to improve the usability of the database were derived from exploration of the Access database, spatial database and how the two relate, interviews with key players involved in ABEKC database development and other TEK-based initiatives in the Yukon, and suggestions from community experts interviewed during interview years 1996-97 to 2001-02. Community experts expressed concerns regarding the process of knowledge production used by ABEKC. At the end of the questionnaire respondents are asked to provide any additional comments that may improve the interviews. These responses were recorded in an attribute table in the ABEKC_Community Access database.

3.2 Obtaining More Information from the ABEKC Database

The second research question, i.e. whether more useful information can be obtained from the current ABEKC data, was addressed by examining possible alternative approaches for depicting community observations. Four aspects were investigated: first, methods for depicting polygon overlap were described; second, the suitability of the data for time-series analyses was evaluated; third, depicting the ABEKC data with satellite data in order to yield new information was investigated; and fourth, the use of unmapped information to describe observations was explored.

Using critical cartographic analysis, the project evaluated the comparative and practical value of ABEKC's approach and explored new techniques that can provide a better picture of what is changing in the landscape. In the ABEKC GIS, polygons depict respondent land-use observations. Features of ArcMap 9 and ArcView 3.2 which enable the user to manipulate polygon display in different ways were employed. Highly significant areas are those where observations coincide and presumably conservation values should be highest here as well. Three options for displaying areas that are cited the most frequently by community experts were explained and examples were provided for each. The first method, dissect overlaps, is an ArcView script that creates a frequency count of each overlapping polygon and therefore allows for a range of the frequency of occurrences to be displayed.

The overlay function in ArcMap 9's ArcToolbox is the second method used to display overlapping polygons but makes no distinction between the quantities that are overlapping. Converting features to rasters using the Count field created from the dissect algorithm is the third option used for determining the areas with the highest concentration of observations, and also facilitates fast overlays with complex data.

All respondents' observations of fall and spring caribou migration (2000-20004) were mapped in ArcMap 9 in order to evaluate the suitability of the database for time-series analyses. The number of observations for each year is examined in order to explain variations in caribou distributions. Suggestions are also provided to improve the potential use of the database for time-series analyses.

Next, satellite data from radio-collared caribou in the PCH were employed to determine whether the maps yield new information about the herd, or if the maps can be used to supplement existing information. Fall and spring caribou migration, spring calving, and winter caribou observations were mapped in ArcMap 9 using both Co-op and satellite data and discrepancies in the two data systems were discussed.

For the 2001-02 interview year there is a vast amount of unmapped information contained in attribute tables in the Access database which were used to describe the spatial information. Using the Polygon ID as the common field, shapefiles for this interview year were related to the Access tables to explore predatory kills of caribou, caribou rutting areas, spring calving, fall and spring caribou migration, and winter caribou observations in ArcMap 9.

The final chapter summarizes the findings of the research, provides recommendations for better data collection and depiction, explains the limitations of this project and suggests points for further investigation.

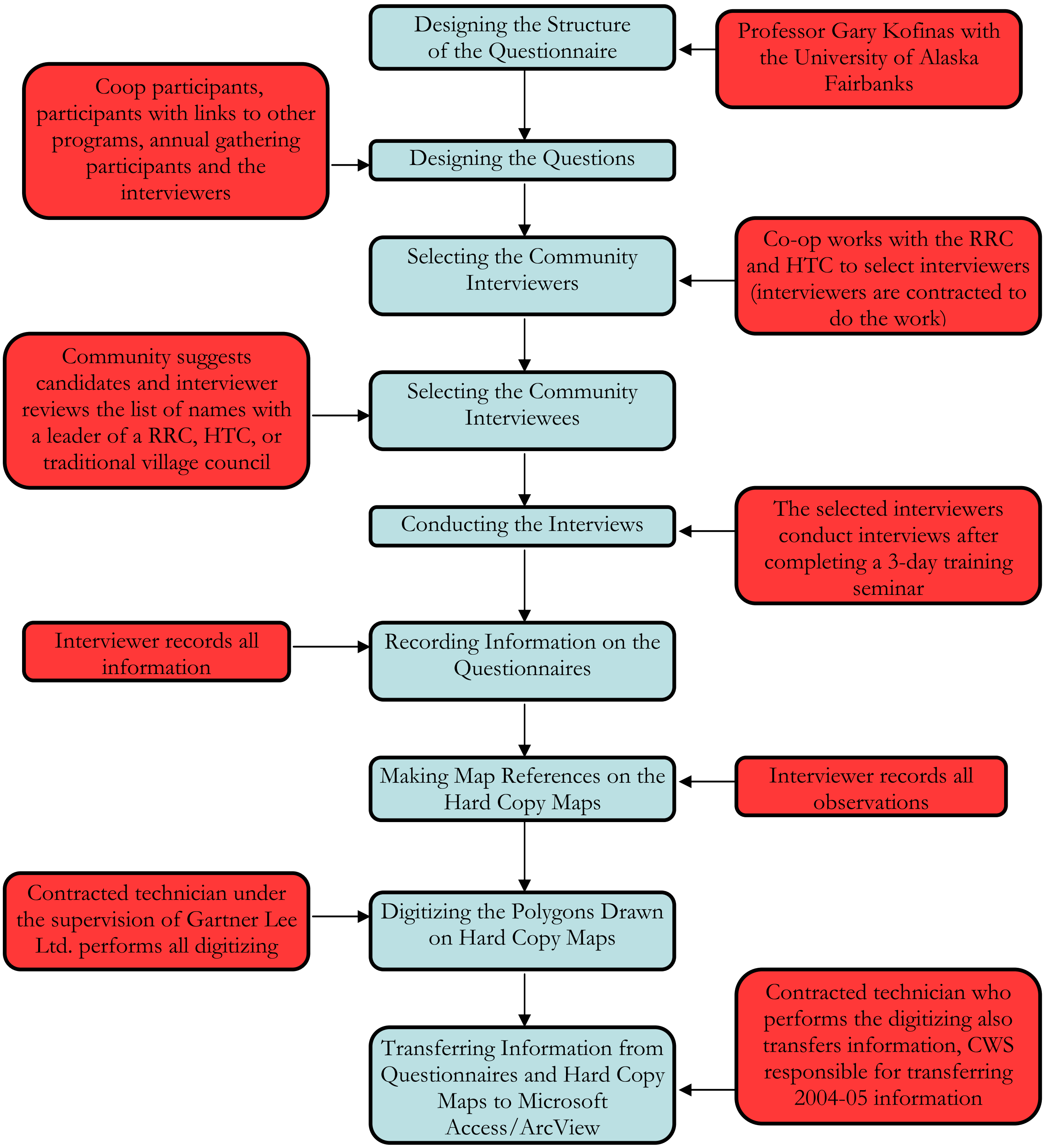
CHAPTER 4: PRODUCTION OF KNOWLEDGE BY ABEKC

There are many steps involved in the production and depiction of knowledge in the Co-op's community monitoring program. Because the GIS application evolved from the original database process, limited attention was given to the way in which the components of the map production process relate. Based on interviews and literature reviews a flow-chart has been compiled showing the way in which knowledge is created and depicted through the ABECK data monitoring process (Figure 4.1.), and this helps to usefully deconstruct the data gathering and assembly processes as a basis for critical analysis. The blue boxes contain the steps involved in the production of knowledge and the red boxes contain information regarding "who" is responsible for each step. An explanation is provided in the main text of this work regarding how local knowledge is collected and eventually stored in digitized format. Throughout the ten years of the program, the structure of the questionnaire, the types of questions and the accompanying maps have been modified to allow for improved spatial referencing but the sequential method of knowledge production has remained consistent (Kofinas, 2002). The following chapter discusses the manner in which information flows, from the selection of interviewers to the transferring of information from the interview map sheets to shapefiles in ArcView.

4.1 Designing the Structure of the Questionnaire

The original structure of the questionnaire was designed by Dr. Gary Kofinas, University of Alaska Fairbanks. Dr. Gary Kofinas was also responsible for the major updates of the structure and questions, based on consultation at the initial community gatherings (CWS personnel, 2005). The questionnaires have been modified substantially since 1996 when the

Figure 4.1 Flowchart of the Community Monitoring Process



community monitoring first began. The questionnaire has increased in length over the years (30 minutes to complete in 1996-97 and now one and a half to two hours for the most recent questionnaire). The number of spatial questions has also increased. Appendix A contains the caribou section from the latest 2004-05 questionnaires.

4.2 Designing the Questions

Local experts are asked questions about weather, berries, fish, caribou, other animals, human activity, and the overall condition of communities. Questions are both closed and open-ended and allow for experts to elaborate where necessary. Interview questions on weather include respondents' impressions of storminess, snow levels, snow pack, water levels, freeze-up, break-up, and overflow on ice. Berry pickers are asked about the annual quality and quantities of blueberries, cranberries, and salmonberries and are asked to compare their crop to the previous year and also to "average years". With regards to caribou, experts are asked about the seasonal movements of herds, size of observed groups, body condition, observed abnormalities, predation, availability, unusual observations and other issues relating to the health of caribou. After the first annual gathering meeting, the ABEKC questionnaire has been reviewed and updated annually by Co-op participants (including those involved in the design and delivery of the Co-op program), participants with links to other programs for specific areas (such as for caribou and for marine mammals - to make the questions more useful to those involved with science and management programs), participants as a whole (reviews through the annual gathering), and, very importantly, the interviewers. Annual updates are made from the suggestions of interviewers (especially the more experienced interviewers), based on what was relevant, easy to understand, and more meaningful (such as splitting the questions about freeze up into lakes and rivers) (CWS personnel, 2005). Also, some of the key directors from the communities contributed significantly to the review at various stages. In 1997, community members asked that a set of questions be added to the surveys which assess the experts' level of experience (Kofinas, 2002). In 2001-02, age, on-the-land travel routes, and respondents' lifetime use area were added to the questionnaires, the latter also being added to the mapping exercises.

4.3 Selecting the Community Interviewers

Every year the Co-op sends a letter to community Renewable Resource Council (RRC) and Hunters and Trappers Committee (HTC) offices to let them know that the interviews are going to be conducted. The mail-out includes an outline of the program, expectations and contact information, and a reminder that their support is needed to ensure continued success of the program and that they will be contacted to make arrangements to hire the interviewers (ABEKC personnel, 2005). The RRC and HTC offices are asked to identify members of the community who may be interested in doing the interviews and are also provided with an advertisement for the position which they are asked to post (ABEKC personnel, 2005). The Co-op then works with the RRC and HTC to select an appropriate individual to conduct the interviews in the community. The Co-op usually agrees with the suggestions by the offices, but ultimately, it is the Co-op's choice of who is hired. The individual interviewer then works directly with the Co-op and is contracted to do the work. All interviewers (new and experienced) attend a three-day training session and are provided with a training booklet that includes the proper way to ask for an interview, what to bring, how to conduct an interview, and tips for better mapping (ABEKC, 2005; ABEKC personnel, 2005).

4.4 Selecting the Community Interviewees

The Co-op depends on the community to select local experts who have been out on the land during the past (and previous) year(s), are good observers, and know a lot about the land (ABEKC, 2005). Although elders have a great wealth of knowledge, they are not active on the land and therefore current hunters, fishers, trappers and harvesters are the best monitors. Obviously, the more experience interviewees have on the land, the better. However, they do not necessarily need experience in all areas the Co-op is interested in questioning them about. For instance, if they pick berries, but do not hunt then they will then be interviewed about their berry-picking and not about their hunting experience (ABEKC personnel, 2005). The interviewer will interview another local expert regarding their hunting experience. Before the interviews take place, the interviewer is encouraged to review the list of names with a leader of a RRC or HTC, the traditional village councils of Kaktovik and Arctic Village, as well as one or two well-respected individuals in the community to confirm that these people were active on the land during the past year (ABEKC, 2005). In some communities the Co-op has contracted the same interviewer for several years and, in this case, interviewers know exactly which local experts they have interviewed in the past and return for their "annual interview", which has come to be expected in some communities (ABEKC personnel, 2005). In addition, an effort is made to select a group of local experts that represent the full spectrum of community family groups (Kofinas, 2002).

4.5 Conducting the Interviews

The training booklet for interviewers was introduced in 2004 to serve as a reference tool for conducting the interviews (YDOE personnel, 2005). The intensive mapping training was included in the training manual in response to concerns raised by the technician and others involved in the mapping procedure. Prior to 2004, personnel from Environment Canada and the University of Alaska conducted the training sessions and emphasized practicing questioning and interviewing. Although every interviewer has their own style, the training manual advises interviewers to ask the questions as they are written down on the questionnaire (ABEKC, 2005). The interviews are conducted where the interviewee feels most comfortable, which is often in the respondent's home. Interviewers are careful to keep the maps where people cannot see them and avoid discussing what respondents had to say, especially when talking about locations of observations. The number of interviews conducted in the communities can be seen in Table 4.1 below.

Table 4.1 Number of Interviews Conducted in Northern Communities (1996-2004)

Community	1996 /97	1997 /98	1998 /99	1999 /00	2000 /01	2001 /02	2002 /03	2003 /04	Total
Aklavik Gwich'in	12	13	15	9	20	22	20	-	**111**
Aklavik Inuvialuit	11	20	23	20	21	20	14	20	**149**
Arctic Village	-	-	-	-	10	14	15	20	**59**
Fort McPherson	14	18	22	19	21	20	20	20	**154**
Old Crow	15	30	21	32	20	21	20	19	**178**
Kaktovik	-	-	-	-	-	8	-	-	**8**
Inuvik Gwich'in	-	-	-	-	-	-	-	13	**13**
Inuvik Inuvialuit	-	-	-	-	-	-	-	18	**18**
Tsiigehtchic	-	-	-				-	20	**20**
Tuktoyaktuk	-	-	-	-	-	-	-	20	**20**
Total	**52**	**81**	**81**	**80**	**92**	**105**	**89**	**150**	**730**

4.6 Recording Information on the Questionnaires

The narratives of respondents are documented by the interviewers, who record every response on the questionnaire. Interview comments are written down on the questionnaires by the interviewer and are tagged with personal identifiers (which were deleted for the purpose of this research). This personal information is protected so that local experts remain anonymous in the reporting of monitoring results but it exists so that it is possible to make comparisons from one year to the next. Interviewers capture the ideas of local experts as best they can (Kofinas, 2002). Tape recorders are used for one general question on change, so that respondents are free to speak on topics that are more general (CWS personnel, 2005).

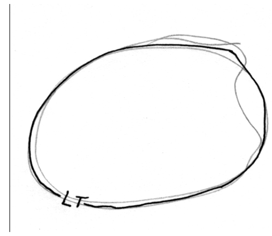
4.7 Making Map References on the Hard Copy Maps

Interviewers are reminded to write neatly so that the technician can decipher what is written while transferring all the information from the interview sheets to the computer. Some suggestions for better mapping include:

- Use one map per interview for all observations
- Write interview identification number on map, matching it with interview form number.
- Use special fine-point pens provided
- Try to not write on map upside down
- Keep all notes on map clear and legible
- Label all marks on map with reference numbers and or notes (ABEKC, 2001b)

Interviewers are also made aware of the fact that "many people are especially sensitive about other people seeing what they have mapped" and are advised to "keep the maps where people can not see them" (ABEKC, 2005, p. 6). The technician transfers all of the information from a hard copy map to the computer. Interviewers do all of the writing and drawing on the maps, however occasionally an interviewee will use a pencil to draw their polygons and the interviewer traces over the markings with a black pen (see Figure 4.2). They are advised to draw either lines or polygons for everything they are mapping and to label each feature clearly with the map reference code.

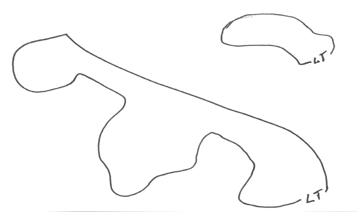
Figure 4.2 Circle Depicting a Monitor's Lifetime Use Area



Source: ABEKC, 2005.

As seen below (Figure 4.3), a tessellated polygon is sometimes better to use than a circle as it more accurately represents people's movements, particularly if they travel along a coast or river (ABEKC, 2005).

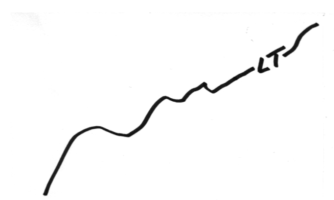
Figure 4.3 Polygon Depicting a Monitor's Lifetime Use Area



Source: ABEKC, 2005.

A line is sometimes used to show a lifetime use area (LT). In this case, the "LT" is inserted into the line to label it (see Figure 4.4 below) (ABEKC, 2005). Often when people move through an area on a river or road they only know the area right beside the route (ABEKC, 2005). When the maps are digitized, the line shows up as a skinny polygon that is approximately two kilometers wide (ABEKC, 2005).

Figure 4.4 Line Depicting a Monitor's Lifetime Use Area



Source: ABEKC, 2005.

If the map becomes cluttered with references, the map reference code is placed off to the side and marked with an arrow (see Figure 4.5 marking a sick caribou observation).

Figure 4.5 Recording an Observation on a Cluttered Map

Source: ABEKC, 2005.

The squiggle and arrow are used to tell the technician that this is not a trail or route. In addition, the interviewer records the details of the observation on the questionnaire. Interviewers are encouraged to record messages on the map to the technician so that they know what every line and polygon means (ABEKC, 2005). Notes are often made on the hard copy maps when the interviewer feels that the line or polygon should be wider than it is. The following figure shows a polygon depicting a caribou observation in the spring during migration. The arrow is used to depict the direction the herd was traveling.

Figure 4.6 Spring Caribou Migration Map Reference

Source: ABEKC, 2005

4.8 Digitizing the Polygons Drawn on Hard Copy Maps

Heads-up digitizing was used to digitize the polygons in ArcView (Gartner Lee Ltd., 2003). The points, lines, and polygons on the hard copy map sheet depicting the Tuktoyaktuk area (Figure 4.7) are digitized by the technician, resulting in the representation seen in Figure 4.8. All the interviewers liked this base map because the main rivers were a brighter blue than the creeks, and the big rivers had thin black or dark blue boundaries, like the lakes (YDOE personnel, 2005). The map in Figure 4.7 was used in the training session for interviewers to illustrate how difficult it was for digitizers to work with maps that were not well labeled and to show the assumptions that a digitizer made and the need for thin lines and clearly marked polygons. The digitizer has commented that markings on the maps from the 2005 interviews were much clearer (ABEKC personnel, 2005).

The digital base data that were used to produce the hard copy maps were also used as the base data for all digitizing efforts and were provided by Environment Canada (Gartner Lee Ltd., 2003). All shapefiles and the base data are in the same projection (Albers Conical Equal Area projection) (Gartner Lee Ltd, 2003). Once the technician digitizes the maps, they are sent to Gartner Lee Ltd.

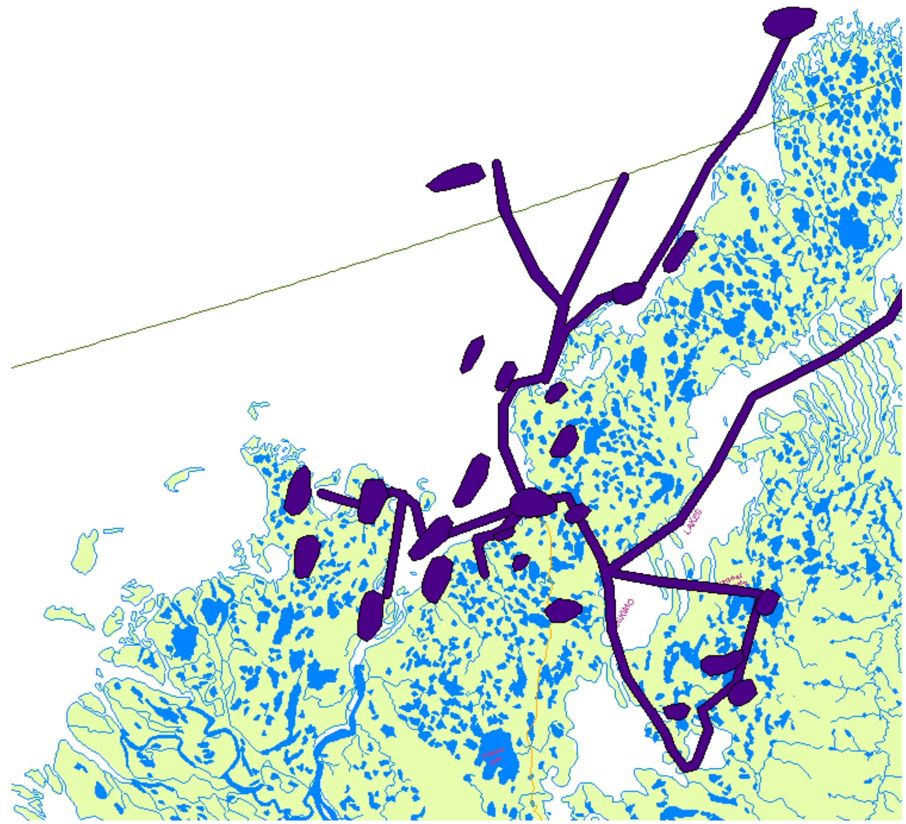
4.9 Transferring Information from Questionnaires and Hard Copy Maps to Access and ArcMap/ArcView

Data from the 1996-97, 1997-98, 1998-99, 1999-00, 2000-01, 2001-02, and 2002-03 questionnaires were collated and organized into a Microsoft Access database by ABEKC personnel. Access is used as the database management system software because it is based on relational concepts and permits various tables of data to be linked together by common fields. Data recorded on hard copy maps during interviews were also entered into an Access database table using an Access data entry form provided by Environment Canada. As each polygon was digitized and attributed in ArcView, map reference code information marked on hard copy maps was entered into the Access table (see Table 4.2). Polygon IDs, assigned

Figure 4.7 Example of a Respondent's Map Sheet with Map References (Tuktoyaktuk, 03-04)

Source: ABEKC, 2005.

Figure 4.8 Digitized Version of the Map Sheet in Figure 4.7 (Tuktoyaktuk, 03-04)



Source: ABEKC, 2005.

during polygon digitizing, were also entered into the Access table and the data written on the questionnaires are used to describe the Polygon IDs in Microsoft Access. Gartner Lee Ltd. was responsible for linking the two Access and ArcView databases together (ABEKC personnel, 2005). The Polygon ID field is a unique code that identifies each digitized polygon and is a combination of the Interview ID and the number assigned to each sequential digitized polygon. The Interview ID number is automatically generated to identify all interviews conducted since 1996 (e.g., if 10 polygons were drawn on a hard copy map by a respondent during interview number 356, each polygon is numbered 1 to 10 and the Polygon ID for the first digitized polygon would be 356.01.

The Polygon ID field is common to both the shapefiles and Access databases and can be used to link or relate these databases (see Tables 4.2 and 4.3). Therefore data from both the Access database and the shapefiles can be linked and viewed simultaneously in ArcMap/ArcView. Map reference codes are codes used during interviews to represent information about fish, wildlife, marine mammals, berries, weather and land conditions. The Object ID is a unique number identifying each feature within the database and is required to relate an Access table in ArcMap. Shape, area and perimeter fields are standard attribute fields that are automatically generated in ArcMap/ArcView and describe the spatial attributes of the digitized feature.

Table 4.2 Attributes of Access Table

Attribute Name	**Description**
ObjectID	Unique number identifying each feature within the database
PolygonID	Polygon ID. A combination of the interview ID and polygon number.
MapRef	Code referenced from the hard copy maps when digitizing
Notes	Miscellaneous notes

Source: Gartner Lee Ltd., 2003.

Table 4.3 Attributes of ABEKC Shapefiles

Attribute Name	Description
ID	Unique number identifying each feature within the database
Shape	Polygon
Area	Area of the polygon in meters
Perimeter	Perimeter of the polygon in meters
Poly_ID	Polygon ID. A combination of the interview ID and polygon number
Community	Location of polygons
Year	Year of interview

Source: Gartner Lee Ltd., 2003.

For interview years 1996-97 to 2001-02, data from the questionnaires can be found in the Access database called ABEKC_Community (see Figure 4.9 below). Each table in the database (e.g., mtBerryObservations or mtFish) contains attribute information about each type of observation. Tables that contain the word "list" (e.g., listBerries or listFishNames) contain the meaning of number codes present in the "mt" tables. For example, in Figure 4.9 BerryID 1, which is found in mtBerryObservations means cranberries. There are several tables (for each type of observation), including a summary table (which enables you to determine the year and community that corresponds to each Autointerview ID) and a table called mtPolygons with all of the Polygon IDs, corresponding map references, and a Notes variable. The Notes variable contains information from the questionnaires that describes each polygon. For example, in Figure 4.10 interviewee 117 drew their first polygon and the map reference code is R meaning red (colour codes were used for map references in 1999-00 and 2000-01) which are miscellaneous observations. From the Notes field it is clear that this particular polygon is depicting where the interviewee observed freeze-up. The meaning of the colour codes used in 1999-00 and 2000-01 can be seen in Table 4.4.

Table 4.4 Description of Colour-Based Codings

1999-00	2000-01
Green = fish	Blue = caribou spring
Black = caribou	Red = caribou fall and winter
Red = all other observations	Black = all other observations

Figure 4.9 ABEKC_Community Database for Interview Years 1996-97 to 2001-02: Attribute and Identification Tables

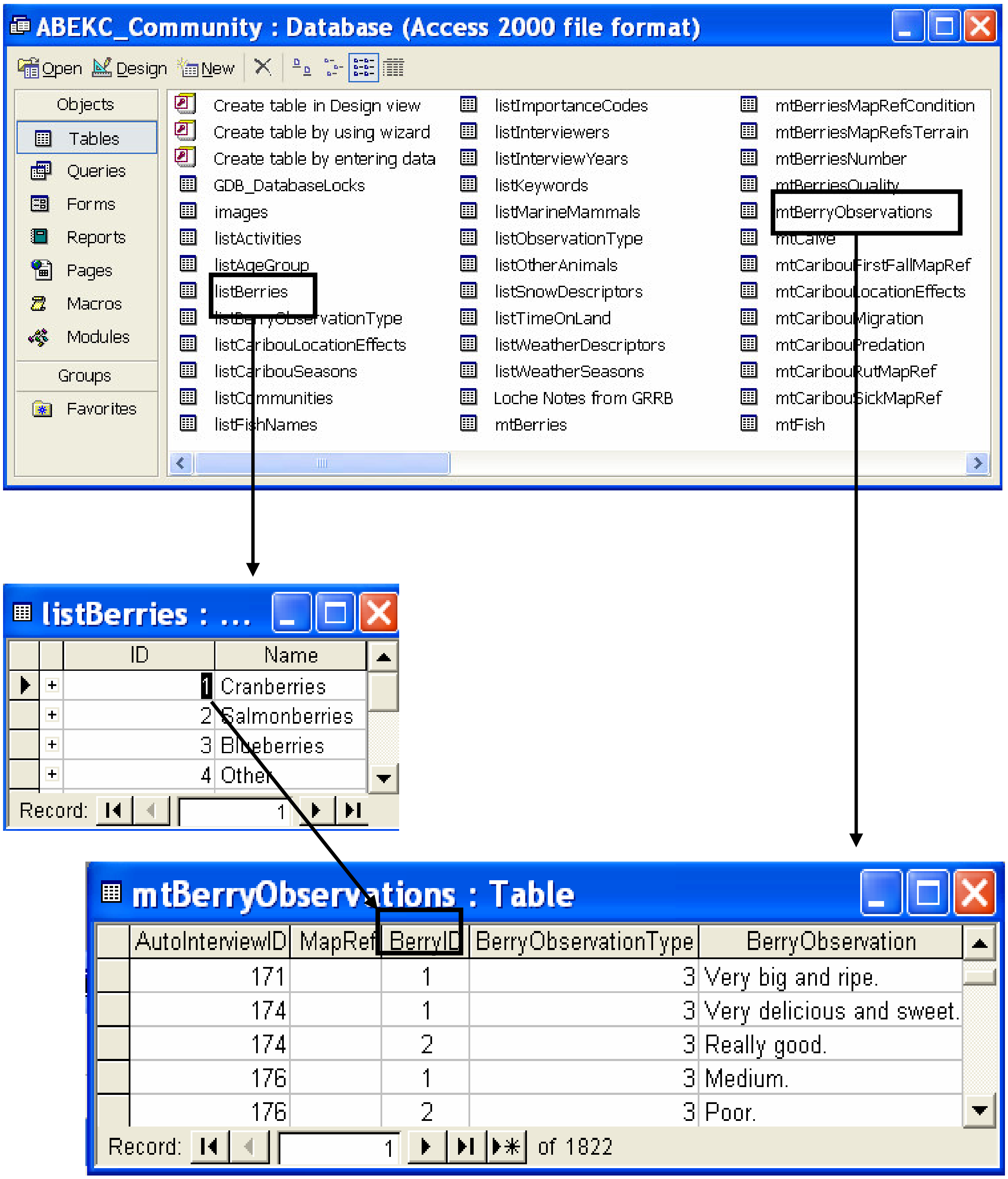
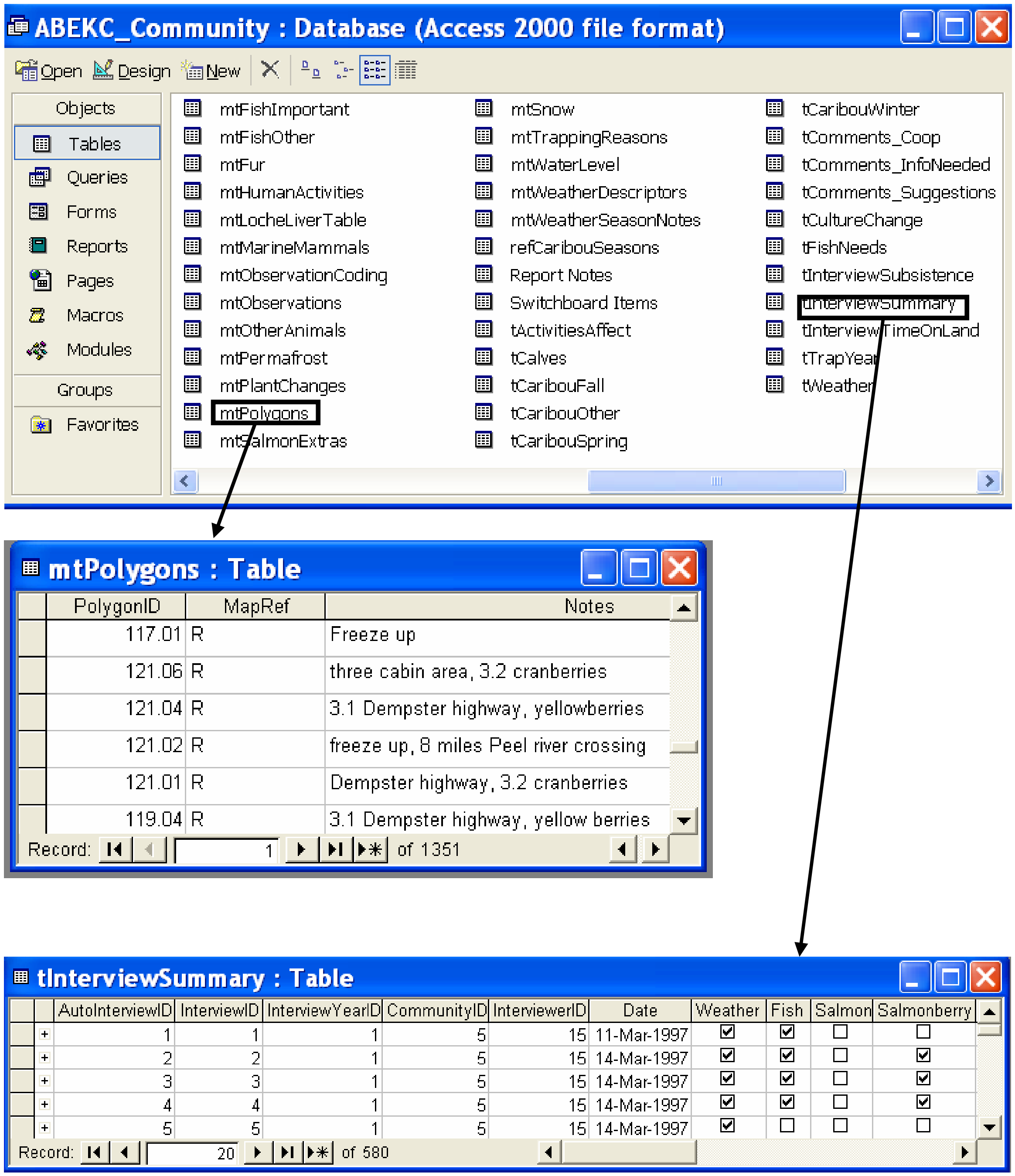


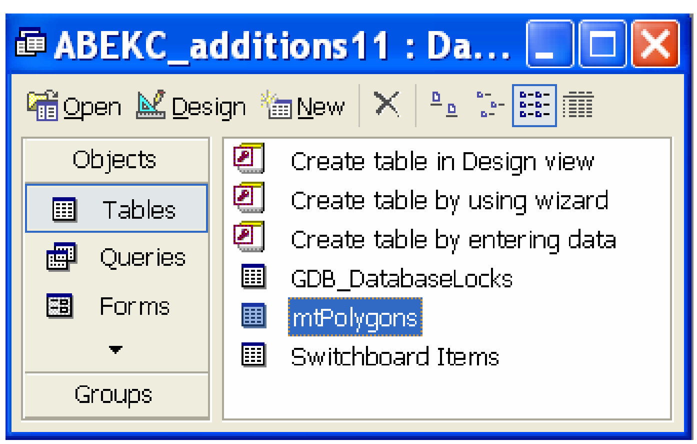
Figure 4.10 ABEKC_Community Database for Interview Years
1996-97 to 2001-02: Polygon and Summary Tables



Using the Polygon IDs, a vast amount of data can be attached to each spatial observation. However, spatial information is only available for 1999-00 to 2003-04. Map observations prior to interview year 1999-00 were not rendered into digital format. Therefore there is attribute data available for 1996-97 to 1998-99, but no spatial information. There is more spatial information for interview years 2001-02, 2002-03, and 2003-04 than years 1999-00 and 2000-01. This can be partly explained by the more detailed, lengthy questionnaires used from 2001-04 and also because 1999-00 and 2000-01 use colour codes for map references (only three categories therefore less specific types of observations) and 2001-2004 questionnaires use codes for each type of observations. The list of map reference codes used in 2001-02 can be seen in Table 4.5.

For the 2002-03 interview year, data from the questionnaires can be found in the Access database called ABEKC_Additions. The database contains an updated mtPolygons table (with 1996-97 to 2002-03 data) but no attribute, identification or summary tables. Therefore, there is only one table in the database, an updated table like the one in Figure 4.10., also called mtPolygons (Figure 4.11). There is a Notes variable in the mtPolygons table, but for 2002-03 few notes have been made, most of which only refer to assumptions made during the digitizing process and not the actual observations themselves. Examples of some of the notes include, “trouble reading the code”, “last moose? (hard to read writing)”, “line divisions are not clear” and “not written on map; assumption” (ABEKC_Additions).

Figure 4.11 ABEKC_Additions Database for Interview Years
1996-97 to 2002-03: Polygon Table

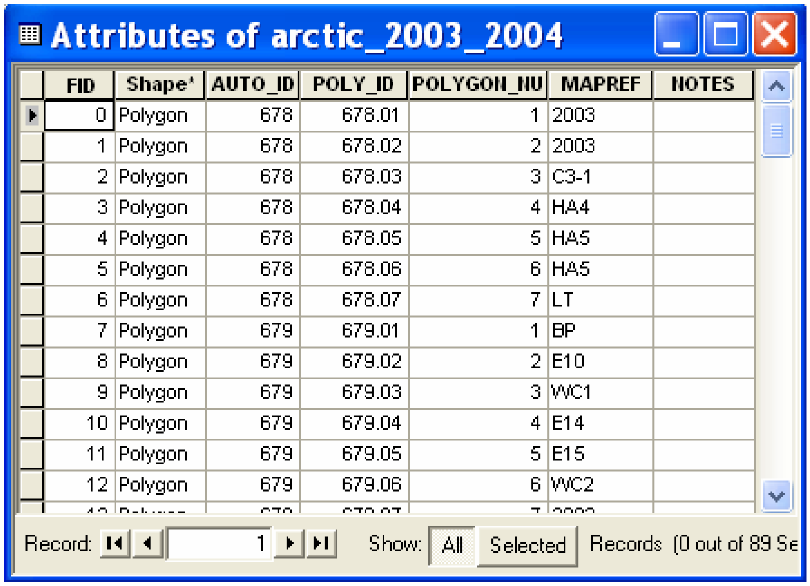


The 2003-2004 interview year data was entered directly into ArcView by CWS personnel (ABEKC personnel, 2005). Therefore the only data that are available are contained in the shapefiles (one for each community) and include the ID and shape of the digitized feature, a Polygon ID, AutoInterview ID, Map Reference, and Notes field (see Figure 4.12). The ABEKC_Additions Access database was not updated with the 2003-04 data. Therefore, there is no Access database for interview year 2003-04.

Table 4.5 Map Reference Codes for the 2001-02 Interview Year

Map Reference Codes	Species/ Question
BG	Beluga
BH	Bowhead
BP	Birds of prey
BR	Bear
Calves	Caribou calves in spring
CB	Cranberries
FC	First Caribou fall arrivals
FM	Fall Caribou Migration
FREZ	Freeze up location
FR	Furbearer
HA	Human activity
Kill	Caribou predator kill sites
LL	Loche liver abnormalities
LX	Lynx
MO	Muskoxen
MS	Moose
Perm	Permafrost
PT	Changes in plants and trees
Rut	Caribou rutting areas
SB	Salmonberries
SL	Seal
SM	Spring Caribou Migration
SO	Small birds observation
UC	Unhealthy or sick caribou
WC	Winter caribou observations
WF	Waterfowl observations
WL	Water level
WM	Waterfowl migration observations
WV	Wolf

Figure 4.12 Attributes of 2003-04 Arctic Village Shapefile



Attributes of arctic_2003_2004

FID	Shape*	AUTO_ID	POLY_ID	POLYGON_NU	MAPREF	NOTES
0	Polygon	678	678.01	1	2003	
1	Polygon	678	678.02	2	2003	
2	Polygon	678	678.03	3	C3-1	
3	Polygon	678	678.04	4	HA4	
4	Polygon	678	678.05	5	HA5	
5	Polygon	678	678.06	6	HA5	
6	Polygon	678	678.07	7	LT	
7	Polygon	679	679.01	1	BP	
8	Polygon	679	679.02	2	E10	
9	Polygon	679	679.03	3	WC1	
10	Polygon	679	679.04	4	E14	
11	Polygon	679	679.05	5	E15	
12	Polygon	679	679.06	6	WC2	

Record: 1 Show: All Selected Records (0 out of 89 Se

This chapter deconstructed the process used by ABEKC to collect TEK from community experts, store the information in an Access database, and display the observations as shapefiles in ArcView/ArcMap. The potential for error is great as the data pass through several individuals and organizations and there is no method used to check the data's level of accuracy.

CHAPTER 5: CRITIQUE OF THE PRODUCTION OF KNOWLEDGE BY ABEKC

In this chapter the process of knowledge production is critiqued and approaches to improving the process are provided. The strengths and weakness of the knowledge production process are investigated. Recommendations from community experts, key players involved in ABEKC database development and my own personal recommendations and concerns regarding deficiencies in the mapping process and the production of knowledge by ABEKC are provided to ensure the proper handling of data in future years. This chapter is used to determine whether the data gathering and subsequent mapping process can be improved and if more useful information can be obtained from the current data.

5.1 Structure of the Questionnaire

The first step involved in the production of knowledge is designing the structure of the questionnaire. Some respondents feel that the questionnaire is too lengthy (ABEKC Questionnaires, 96-97 to 01-02). Exhaustion is being experienced in many northern communities from the amount of questionnaire research being conducted by various researchers and organizations (YLUPC personnel, 2005). However, the length of the questionnaires has been increased in response to the requests for additional information to be collected by community respondents and other Co-op participants (ABEKC personnel, 2005). The earlier questions have been retained to maintain consistency.

Thus, there was a workshop in April 2005 aimed at demonstrating to communities that the Co-op data are important and that the data are for the communities and not for the benefit of other agencies (YLUPC personnel, 2005). Shortening the number of questions could prompt more complete, detailed answers about specific topics but because the Co-op does not operate as a top-down research group that restricts the questions asked to those standardized questions asked in previous years, the length of the questionnaire increases with each year. There should be a periodic check of the questions asked during the interviews in order to assess whether the Co-op is collecting what it desired from the interviews and whether the Co-op and respondents understand the questions in the same way (YLUPC personnel, 2005).

From the viewpoint of policy-makers, resource managers, or decision-makers, questionnaires should be designed to meet the local and traditional knowledge data needs and address specific concerns (YLUPC personnel, 2005). It is important to know what the data are going to be used for before the interviews are conducted. This way the focus of the interviews should be the questions that relate specifically to the desired output. When designing the structure of the questionnaires, expectations of both communities and resource managers need to be analyzed with respect to the information resulting from the interviews. Other concerns with the contents of the questionnaire include the type of questions being asked and how open they are to interpretation.

5.2 Designing the Questions

Designing the questions is the second stage involved in the production of knowledge. From personal experience with the database, the most important issue with regards to the data being easy to translate into GIS format is to ask the same questions each year. Although this was difficult during the beginning of the community monitoring program, it is important that the Co-op take the recommendations made in previous years about the type of questions to be asked and apply it to future questionnaires. Another critical element of the questionnaires is the codes that are used. The same map reference codes should be used every year, which translates to the same questions being asked every year. For example, if fish observations are going to be broken down by species (e.g., where did you fish for salmon, whitefish, coney, loche, char?) then a map reference code should be created for each species. The following year careful attention must be made to not ask, “where did you fish last year?”, but “where did you fish for salmon, whitefish, etc.?”

A contractor with the Wildlife Management Advisory Council (North Slope) [WMAC(NS)] is currently working on a summary of the Co-op’s information from Aklavik Inuvialuit and is the first person other than Joan Eamer to work on the Access database. The size of the database and the codings that are used make summarizing the information a challenge. Changes in the way questions are worded also make it difficult to summarize and organize the data (ABEKC personnel, 2005). In addition, for all interview years, regarding the location of berry picking activities, respondents are asked to provide the “…general area, not exact locations, and note on map” (ABEKC Questionnaires). More precise locations would be better for mapping purposes as polygons for general area questions are too large to extrapolate meaningful information on berry harvest locations.

At the end of the community monitoring questionnaires, there is a section for other observations that the respondent may wish to share. There should be another section after this one that asks respondents if there are any other spatial observations that they would like to share. This way each respondent can mark important locations which may have been overlooked during the interview process. These spatial observations could be locations where unusual sightings have occurred. For example, “there has been an unusually high number of ground squirrels in this area” (ABEKC Questionnaire, 96-97 to 01-02). The section in the questionnaire that asks about other animals includes muskoxen but there should be a new section in the questionnaire dedicated to muskoxen observations. Some respondents have expressed concern over these animals (e.g., "Why are they here?" and "What can we do to remove these animals to protect our land and caribou; We don't want to end up like the Sachs Harbor region with no land to hunt the caribou") (ABEKC Questionnaire, 96-97 to 01-02).

Community interviewees suggested including questions on other animals: herring ("used to catch thousands, now people don't catch any – used to be big runs all summer"), fur-bearing animals (e.g., mink and marten), squirrels, mice, muskrats ("they are coming back now and seem to be healthy"), otters ("getting thick, a lot of them"), ptarmigans ("disappeared, but have all come back"), beavers, and small birds (especially robins). Respondents interviewed from 1996 to 2002 would like to be asked more questions about plants, particularly blueberries and willows (e.g., they are now growing in lakes). They also suggested recording data on environmental conditions: water levels, ice thickness, permafrost melting and lakes collapsing, snow depth, water ("rivers running dry such as the Peel River and river banks are caving and being cut out because permafrost is thawing, which could change fish"), and human activity (which produces pollution and acid rain which may affect caribous' ability to store fat) (ABEKC Questionnaire, 96-97 to 01-02). In addition, the community experts made comments about improving the process of knowledge production: "Less of a question format, but more conversation", "Provide questionnaire beforehand, then we'll be more prepared" and recording greater detail concerning days of the year spent out on the land and important traditional places to local people (ABEKC Questionnaire, 96-97 to 01-02).

5.3 Selection of Interviewers

Interviewers are selected through the process described in the previous chapter. The training booklet and seminar are very thorough and provide comprehensive advice for the smooth execution of the interviews. Another strength identified in the selection of interviewers is that the Co-op tries to maintain the same interviewers for each community for each year. There is a level of trust that must exist between interviewer and interviewee in order for the most complete answers to be given. Maintaining the same interviewers is an excellent way to secure this trust. If an interviewee feels comfortable with the interviewer then more detailed descriptions and observations are revealed.

5.4 Selection of Interviewees

It was clear from conversations with ABEKC personnel that the method of selecting the interviewees is thorough and efficient. It incorporates the perspectives of those who are in constant contact with community experts and are therefore in the best position to make the judgment of who the experts are. However, one problem is that the number of land use experts and active hunters is declining therefore the sample size is going to "…decrease with newer generations who spend less time on the land" (YLUPC personnel, 2005). Many of the older generation of northern aboriginal people grew up on the land and moved from camp to camp to where the animals, fish and plant life were plentiful. The following generation (now between 30 and 50) were born and raised on the land, but spent their young adulthood living in a settlement or town. Their children in turn experienced a similar change as few young people were born in the outpost camps and many have only brief summertime experience of the land. Schooling in English has led to the loss of aboriginal languages and alienation from aboriginal culture. Many northern aboriginal people now depend on wage employment, subsidized housing, social assistance or unemployment insurance and live in houses in settlements and towns rather than living freely on the land. Thus, although it is desirable to maintain the same interviewees in each community it is becoming increasingly difficult as more people leave the community to work and it is challenging to find the required number of experts (fifteen berry experts, fifteen caribou experts, fifteen fish experts) and conduct the preferred total of twenty interviews.

5.5 Conducting the Interviews

One of the strengths associated with the conducting of the interviews is that interviewers ask questions in the same way, using the same words; thus there is consistency between interviewers. Careful instruction is also given to the interviewers about how to avoid leading people to answer in a certain way (ABEKC, 2005). As a land-use planner with the YLUPC states, "trying to quantify TEK is difficult" (2005; Wolfe et al., 1992). Government agencies evaluating ABEKC data see great value in the potential uses of TEK and feel that the Co-op has the greatest potential to collect this information (Johnston, 2005).

Respondents to the ABEKC Questionnaire suggest that the efficiency of the interview process can be improved by using more native communication procedures and a Gwich'in interviewer/interpreter to explain questions better (especially to older generation). They also suggest that getting younger people involved with the interviews will help them to learn and gain knowledge of what is happening with the land and animals.

5.6 Recording Information on the Questionnaires

Many ABEKC Questionnaire respondents expressed the concern that it is difficult to remember what occurred last year and even more so, when and where specific observations occurred. They suggest that each interviewee should be provided with a calendar, equipped with a map and enough writing space for comments so that a more detailed account of activity over the course of a year can be recorded and maintained. As a respondent interviewed in 2001-02 suggests, "Have people keep a log book on the different categories of this interview. It will make it easier to remember some activities that take place over the months." (ABEKC Questionnaire, 96-97 to 01-02). Maintaining a small calendar harvest book while traveling on the land would make it easier to record weather observations, harvest information and animals that are caught and to note specific locations and dates.

With continual documentation, monitoring information will be more meaningful and the data will be more creditable and complete. Including a map on each month of the calendar would allow respondents to more accurately illustrate their observations, on a month to month basis. From personal experience with the codings, it is important that each interviewee be provided with a list of map reference codes so that polygons can be drawn on the calendar map and labeled. The map should be structured as a grid with cell sizes that respondents feel comfortable with. This would help eliminate the fear of revealing a secret hunting or fishing location and also standardize the data. Then, if every respondent refers to the same list and uses the same codes, it would be much easier to digitize the maps and render the data into GIS format. It would also eliminate many of the errors and inaccuracies encountered during the digitizing process. The list of map reference codes (Figure 4.5) should be expanded to include plant and animal species that respondents feel were missing from the surveys.

5.7 Making Map References on the Hard Copy Maps

While in Whitehorse to meet the key players involved in ABEKC database development, discussions were held with the technician who digitized the polygons and transferred the data from the hard copy maps into the computer for the 1999-00 interview year (the first year the spatial data were digitally recorded) up to and including the 2003-04 interview year under the supervision of a consulting company, Gartner Lee and Associates. The technician was able to show me some of the hard copy maps from selected interviews and discussed some of the problems associated with the maps (e.g., cluttered maps, missing map references, thick felt pens and the extent of polygons being unclear). One interviewee points out that "the mapping was always considered a back up and enhancement of the questionnaires" and does not currently "…provide a critical analysis of land use changes, as [the Co-op was] not mapping land use changes" (CWS personnel, 2005).

However, respondents make the common complaint that the interview uses "bad maps [with] no detail" that are "…too small [and] hard to follow" and make the suggestion to "…get better maps" that are "…more accurate [and have] more detail…especially around the border area of the Yukon and Northwest Territories" (ABEKC Questionnaire, 96-97 to 01-02). Improving the quality of the maps (e.g., more landmarks, proper names, smaller scale) would enable respondents to mark important observations with more accuracy and precision. However, the need for vagueness in mapped information that will be seen by others is a force that works against precision. Respondents need to be comfortable with the level of detail on the maps and interviewers make judgments about what their community experts will tolerate (YDOE personnel, 2005). Nonetheless, there are several locations which are not on the base maps which respondents made reference to when answering spatial questions. If there were more detail on the base maps then the respondents could more clearly identify their hunting grounds and harvesting areas. In the surveys, the question is asked whether fish and berries were found in their usual or regularly-used areas. It would be beneficial to be able to see the areas that are supposedly regularly used. Interviewees should be asked what reference points would make it easier to delineate their observations on the maps. More reference points might also give rise to new memories and observations.

In addition, some of the inaccuracies when marking observations on the hard copy maps occurred because a respondent may have made an observation (e.g. a sick caribou) near their camp and do not feel comfortable giving its location. ABEKC (2005) suggests that one way to overcome this hurdle is for interviewers to obtain permission to draw a larger polygon around the observation or the name of the camp is sometimes permitted to be written on the questionnaire but not marked on the map. Doing this, however, makes the data less accurate and therefore a grid system may be the best solution as it allows respondents to record observations on a standardized scale they feel comfortable with.

The ABEKC technician explains that "marking polygons on the maps have improved in recent years [e.g., thinner markers, referencing more clear, etc.] but still many problems and subjectivity exist" (2005). For example, on some maps there are lines drawn along the coast and it is unclear whether they should be enclosed (polygons).

From investigating unmapped information in the database, it is evident that there are numerous references made to specific locations when interviewees are asked about their observations but no information is placed on the maps. It is recommended that during the interviews, when a respondent makes reference to an exact location (e.g., Crow Mountain) this observation should be recorded on the hard copy maps so that the technician digitizes all spatial observations. If there are more spatial observations, then the maps yield more information and are more usable. There would be a lot more location-based responses if point-based sightings (e.g., of caribou) were recorded on the map sheets and subsequently, digitized. It is important to check for data that are not being used that would usefully lend itself to GIS.

5.8 Digitizing the Polygons from the Hard Copy Maps

According to the technician who digitizes the polygons from the hard copy maps, the map reference codes used to label observations on the hard copy maps are often difficult to decipher (2005). The technician codes the points, lines and polygons according to her own understanding, therefore there is a lot of subjectivity involved in the mapping portion of the community monitoring program. This type of inaccuracy is compounded as the maps pass hands (ABEKC personnel, 2005). According to the training manual for interviewers (ABEKC, 2005), the technician is often "unsure how big to make the blobs, where exactly the blob should go, and what a few of the lines [are]". The procedure for handling such problems in the digitizing process are:

1. If there is a polygon with no map code associated with it the code is determined by looking at the interview and the colour used (for 1999-00 and 2000-01 maps that use colour codes). If this can not be done, the problem is noted.
2. If there is a map code not associated with a polygon, a small polygon is drawn around the general area.
3. If there are scribbles inside other large polygons and they have no map code(s) associated with them, they are assumed to be mistakes and are ignored.
4. When in doubt, a note of the problem is made and the digitizing is continued.
5. For the purpose of data entry, if a map sheet is missing an ID, it is labeled 999.01
6. Aklavik Inuvialuit maps with no Interview ID's are given a Polygon ID beginning at 900.01 (ABEKC, 2001a).

Furthermore, researchers and biologists who looked at the ABEKC data as part of Johnston's surveys (2005) identified three general flaws relating to the spatial information: the polygons are not well defined; there is a bias of how you draw them; and when they are digitized, they become a hard line, which they are not. In addition, hunters may be reluctant to accurately indicate the best hunting areas. Thus, the maps are useful for providing a general sense of where a species resided during any year and how that changed over time, but there is no way to quantify the level of accuracy or precision of the mapping component of the community monitoring program. On the other hand, other data provided by TEK can still be very useful and provide insight about impacts of climate change over time.

5.9 Map Reference Codes

Inconsistencies in the type of map reference codes and level of detail of observations (e.g., caribou observations vs. caribou rutting areas) make time-series analysis difficult to perform. The 2001-02 interview year should be used as a model for map reference codes (as these codes include many different types of observations) so that they are transferable from year to year. For interview years 1996-97 to 2001-02, additional attribute data are included in tables in Access. These attribute tables should be updated with data from all subsequent years. For interview years other than 2001-02, only some information from the questionnaires was entered into the computer, but very little commentary exists (YLUPC personnel, 2005). Such characteristics as the spring timing of fish, location and timing of the run, or notes about taste and firmness of fish are important pieces of TEK that complement the map references and any existing conventional scientific data.

From my personal experience with the database, it is evident that it would be desirable to have layers for each interview year for each type of observation so that an overlay analysis could be performed (for example, wolf observations for 1999-00 to 2003-04, sick caribou sightings, or dog salmon fishing locations). Using only three colour codes (as was done for 1999-00 and 2000-01) limits the layers that are possible. For 1999-00, fishing location could have been broken down by locations of different fish species and therefore several layers could be created (one for each fish species). It is recommended that map reference codes be assigned to each type of vegetation, animal species, and, for caribou, each season. Without map reference codes for each species or type of observation and no accompanying side notes, it is often unclear as to what some of the polygons are depicting.

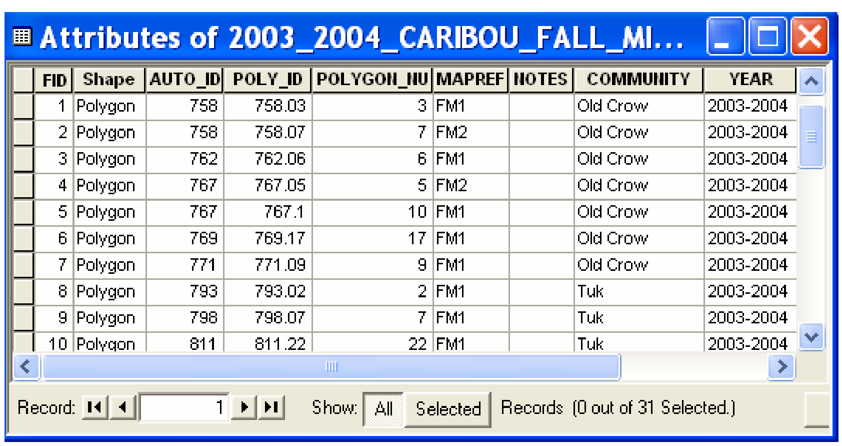
5.10 Database Design - Transferring Information from Questionnaires and Hard Copy Maps to Microsoft Access and ArcMap/ArcView

ABEKC data from 1996-97 to 2002-03 are contained in two Access databases and 2003-04 data are in map format as shapefiles. Data from interview years 1996-97 to 2001-02 are contained in an Access database called ABEKC_Community. In this database there is a table called mtPolygons that contains Polygon IDs, map reference codes and available notes. There are several attribute tables in this database that only contain information from the 2001-02 interview year. The second Access database is called ABEKC_Additions and contains only one table (also called mtPolygons) with observations from 1996-97 to 2002-03. The table contains Polygon IDs, map reference codes and available notes. There are no attribute tables in the ABEKC_Additions database.

The structure of the databases can be improved to make them more user-friendly, to permit more analyses, to ensure proper handling of the data in future years and to more effectively describe the spatial information contained in the shapefiles. The first, and perhaps the most important recommendation is to maintain the same map references for each type of observation for every year. Map reference codes were not recorded on 1999-00 and 2000-01 maps (but are recorded on the 2001-2002, 2002-03, and 2003-04 maps). Instead, interviewers coded the information using different coloured pens (see Table 4.4). It was suggested by Environment Canada project monitors that the information be entered into the Access database coded by color. There were a number of situations where map reference codes recorded on hard copy maps did not correspond to the codes listed in the questionnaire, but project monitors suggested that when correct map reference code interpretations are made after reviewing original questionnaires, the records can be selected and updated. To facilitate this exercise codes were provided in a list with Interview ID numbers. However, the map reference code "Blk" could represent any number of observation types (e.g., berries, break-up, fish, etc.) and are therefore not useful for mapping purposes. Categorical map references (such as those for 2001-02 listed in Table 4.5) make rendering into a GIS more feasible.

Entering the data from the hard copy maps directly into a program such as ArcView is efficient. This was the process used to enter the 2002-03 and 2003-04 data. However, for 2002-03, data from the hard copy maps were also entered in the mtPolygon table in the ABEKC_Additions database (see Figure 4.12). For 2003-04, ABEKC_Community and ABEKC_Additions were not updated and the only information that was digitally recorded for this interview year is found in the shapefiles. Contained in the shapefiles are an Autointerview ID, Polygon ID, Polygon Number, Map Reference, Year, Community and Notes field as seen in Figure 5.1 for the 2003-04 fall caribou migration.

Figure 5.1 Attributes of 2003-04 Fall Caribou Migration Shapefile


Attributes of 2003_2004_CARIBOU_FALL_MI...

FID	Shape	AUTO_ID	POLY_ID	POLYGON_NU	MAPREF	NOTES	COMMUNITY	YEAR
1	Polygon	758	758.03	3	FM1		Old Crow	2003-2004
2	Polygon	758	758.07	7	FM2		Old Crow	2003-2004
3	Polygon	762	762.06	6	FM1		Old Crow	2003-2004
4	Polygon	767	767.05	5	FM2		Old Crow	2003-2004
5	Polygon	767	767.1	10	FM1		Old Crow	2003-2004
6	Polygon	769	769.17	17	FM1		Old Crow	2003-2004
7	Polygon	771	771.09	9	FM1		Old Crow	2003-2004
8	Polygon	793	793.02	2	FM1		Tuk	2003-2004
9	Polygon	798	798.07	7	FM1		Tuk	2003-2004
10	Polygon	811	811.22	22	FM1		Tuk	2003-2004

Record: 1 Show: All Selected Records (0 out of 31 Selected.)

Data from the questionnaires should also be entered into Access tables (as was done for interview years 1996-97 to 2001-02) with map references codes and the Polygon IDs assigned during digitizing so that the field is common to both the shapefiles and Access tables and can be used to link or relate these databases. Currently there are several attribute tables in the ABEKC_Community Access database. Some of the tables (e.g. berry conditions, calving observations, marine mammals, etc.) contain map references, but these tables contain 2001-02 attribute data only. There are several tables (such as mtBerries and mtFish) that contain various fields which describe specific types of observations for all interview years contained in the database (1996-97 to 2001-02). However, most attribute information is for 2001-02 only. These attribute tables in the ABEKC_Community database only contain an AutoInterview ID as an identifier (see Figure 5.2).

Figure 5.2 2001-02 Attribute Table for Caribou Migration

mtCaribouMigration : Table

AutoInterviewID	CaribouSeasonID	MapRef	DateSeen	Direction	NumberSeen
490	2	FM1	September - October	yes towards co	more than 500
491	2	FM1	September - October	yes	more than 500
494	2	FM1	October	yes	100 to 500
495	2	FM1	September - October	yes	just a few
496	2	FM1	September - October	not moving	100 to 500
497	2	FM1	September - October	yes	more than 500
501	2	FM1	September - October	moving south	more than 500
503	2	FM1	July - August	moving south	more than 500
506	2	FM1	July - August	yes	more than 500

Record: 338 of 575

Currently, joining the mtPolygons table (see Figure 5.3) with an attribute table (Figure 5.2) can only be done if an extra column is created in the mtPolygons table called AutoInterview ID (omit the decimal values from the Polygon IDs) (Figure 5.4).

Figure 5.3 Current mtPolygons Table

mtPolygons : Table

PolygonID	MapRef	Notes
572.01	FM1	
521.07	FM1	
494.04	FM1	
493.05	FM1	
534.04	FM1	
508.02	FM1	
495.03	FM1	

Record: 459 of 1

Figure 5.4 Revised mtPolygons Table

mtPolygons : Table

PolygonID	AutoInterviewID	MapRef	Notes
572.01	572	FM1	
521.07	521	FM1	
494.04	494	FM1	
493.05	493	FM1	
534.04	534	FM1	
508.02	508	FM1	
495.03	495	FM1	

Record: 459 of 1351

Once this is done, the common field, AutoInterview ID, can be used to assign a Polygon ID to the observations in the attribute tables (Figure 5.2). This way, the Polygon ID can be used to link the spatial observations in the mtPolygons table with other attribute tables. The attribute tables can then be linked to the shapefiles using the Polygon ID as the common field (Figure 5.5).

Figure 5.5 Attributes of 2001-02 Fall Caribou Migration Shapefile

Attributes of 2001_2002_CARIBOU_FALL_MIGRATION_region

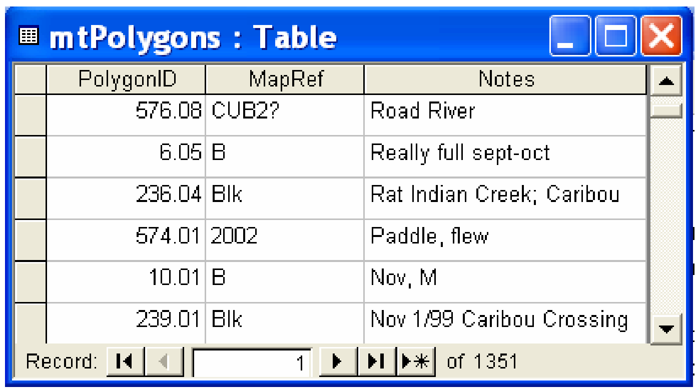
FID	Shape*	AUTO_ID	POLY_ID	MAPREF	COMMUNITY	YEAR	DATESEEN	DIRECTION	NUMBERSEEN	GROUPTYPE	TERRAIN
1	Polygon	512	512.01	FM1	Old Crow	2001-2002	August		50 to 100	bulls	
2	Polygon	512	512.02	FM1	Old Crow	2001-2002	September		more than 500	bulls	
3	Polygon	515	515.03	FM1	Old Crow	2001-2002	20050901		more than 500	mixed groups	
4	Polygon	516	516.03	FM1	Old Crow	2001-2002	Sept	moving south	100 to 500	mixed groups	river crossing
5	Polygon	517	517.02	FM1	Old Crow	2001-2002	Sept	moving southwest	just a few	mixed groups	on the Porcupine
6	Polygon	521	521.02	FM3	Old Crow	2001-2002	Sept	moving south	more than 500	mixed groups	river crossing
7	Polygon	521	521.04	FM2	Old Crow	2001-2002	Oct		50 to 100	mixed groups	mountain
8	Polygon	521	521.07	FM1	Old Crow	2001-2002	December	not moving	100 to 500	mixed groups	Crow Flats, lakes
9	Polygon	524	524.01	FM1	Old Crow	2001-2002	Sept	moving south	more than 500	mixed groups	river crossing
10	Polygon	525	525.03	FM1	Old Crow	2001-2002	Sept	moving south	more than 500	mixed groups	river crossing

Record: 8 Show: All Selected Records (0 out of 23 Selected.) Options

The collection of data is an ongoing process. As traditional land use inventory develops over time; it evolves. Therefore, because this information is not static, the database needs to be updateable. The mtPolygons table (Figure 5.6) in the ABECK_Additions database was updated with 2002-03 but instead of replacing the previous mtPolygons table in

ABEKC_Community it as saved as a new table in ABEKC_Additions. The mtPolygons tables only contain a Map Reference, Polygon ID and Notes field. Attribute tables in ABEKC_Community should have been updated with 2002-03 data (see Figure 4.9 previously). This allows the attribute data to be used for various queries and mapping purposes. The mtPolygons table in ABEKC_Community should be updated every year and used at the main, updateable record of the polygons drawn on the map sheets.

Figure 5.6 mtPolygon Access Table Updated with 2002-03 Data


mtPolygons : Table

PolygonID	MapRef	Notes
576.08	CUB2?	Road River
6.05	B	Really full sept-oct
236.04	Blk	Rat Indian Creek; Caribou
574.01	2002	Paddle, flew
10.01	B	Nov, M
239.01	Blk	Nov 1/99 Caribou Crossing

Record: 1 of 1351

As was previously discussed, the mtPolygons table should be modified to include an Autointerview ID field, updated every year and saved in ABEKC_Community. Attribute tables in ABEKC_Community should also be updated every year. The Polygon ID should be used as the common field between the attribute tables, the mtPolygon table, and the shapefiles. Observations marked on the hard copy maps are digitized in ArcView and organized by community and year. The Access attribute data can be joined to these shapefiles to create layers for each observation type for each year. Appendix D outlines how to link two tables in a one to many relationship in ArcMap 9 and ArcView 3.2. Once the structure of the Access database is altered to include Polygon IDs in each attribute table, the methodology described in Appendix D can be used to attach descriptive data in Access to the spatial data in ArcMap or ArcView.

While one respondent to the 2001-02 ABEKC Questionnaire said "just make sure it's done. We depend on subsistence", the general view is the community monitoring process can and should be done better. The overall consensus from meetings conducted with key players involved in ABEKC database development seems to be that there are numerous people involved in the Co-op's community monitoring data collection, storage, and organization, but that individuals have very specific roles in the process and cannot lend insight into the other related processes. The database is rich with information from community experts that conventional scientific data, such as satellite information from radio-collared caribou, cannot provide. This information will be more accurate and useful if it is easier to record and it will be more fully used by community members and the scientific community if it is easier to use. As with all GIS management, awareness by all involved of all the potential uses by all identified users is a current best practice.

5.11 Analysis of the ABEKC Data

Brian Johnston, working with Mike Gill under contract for the Co-op, recently critiqued the utility of the ABEKC database and suggested some next steps (Johnston, 2005). Johnston submitted a questionnaire to fifty individuals who have had an active role or interest in the Co-op, and/or who have a policy or decision-making role with respect to environmental management in the Borderlands region (Johnston, 2005). One criticism of the Co-op's community monitoring program was that the "…sample size is so small that it is difficult to make conclusions" (Johnston, 2005).

The ABEKC database is useful for examining effects of unusual events. If there was an unusual occurrence during the year, if you go the ABEKC database, you can see landscape observations for that particular time (CWS personnel, 2005). While it can be argued that there is no point confirming what you already know, he says that TEK helps to tease out new information especially if comments from the community are used to add qualitative observations to a map (for example, "migration rate changed this year, we had to go to Bell River" and "quite high population of caribou in mountains, but not as many as other years"). An ABEKC contractor discussed the unusually warm weather experienced in 1998 and the ability to link this phenomena with community monitoring responses that the caribou were staying on coastal areas and that the warm winter changed hunter's hunting patterns as the caribou could forage in usually deep snow areas (2005). An interviewee said that the ABEKC database has great potential to monitor landscape change as it is a dynamic database (ABEKC personnel, 2005).

Another common criticism of the Co-op's database from practitioners is that there are a lot of data but not much analysis and that the information from the questionnaires is interesting to read but difficult to apply to specific applications and needs (Johnston, 2005). The request has also been made by one community expert, interviewed in 2001-02, that the Co-op "Compare [its database] with other data e.g., harvest information, weather patterns, etc."

Thus, criticism of the database relates to its small size, its qualitative nature, its subjectivity, discrepancies in the codings used each year, and the difficulty in using the information. Despite these faults, the consensus from Johnston's surveys (2005) and from my experience with the data is that the information collected by ABEKC is valuable.

5.12 Applicability of the ABEKC Database

Recent discussions suggest the database could be used for monitoring land-use changes. The Peel Watershed Planning Commission has just recently requested permission to

"…access, query and utilize the Arctic Borderlands Ecological Knowledge Co-op database (and associated digital data files) for those records observed and spatially contained within the Peel Watershed Planning boundary" (YLUPC personnel, 2005). It is anticipated that the database will be used for "…preliminary identification of some traditional use areas, distributions of animal populations/habitats, and occurrences of other resources of interest to stakeholders for those communities that contribute to the ABEK database" (YLUPC personnel, 2005). It is expected that ABEKC's digital data will provide an important base-layer of information from which to build a larger regional database of communities' areas of importance. It is also desirable for the database to serve as an "…important stand-alone source of information that can be overlayed and integrated with other spatially explicit datasets for land-use planning" (YLUPC personnel, 2005).

5.13 Information Dispersal

In terms of the Co-op's information dispersal, one land-use planner with the YLUPC explained that "Native people need to see the information in a report" and that the community people want the information and that it should be more geared towards them than scientists (2005). One respondent interviewed in 2001-02 suggested that interviewees should "Get some report back - let us know what is really happening or what we're learning from the reports".

Reporting back to the communities is an essential part of the monitoring process. There is a demand for information about the land, landscape changes, and wildlife, particularly the PCH. Respondents recognize the legitimacy of the community monitoring program and feel that the Co-op should "Continue doing this monitoring and compare each year's report from the year back and send reports out to the community" and "If [the Co-op] got the information back to the people, people would be move responsive to these questionnaires." (ABEKC Questionnaire, 96-97 to 01-02). Local people require "…more information about caribou…caribou health", "more Porcupine Caribou news, keep it up", "more information about the caribou; shared and taught to the younger generation" and "…more information about the caribou and fish, on issues such as diseases" (ABEKC Questionnaire, 96-97 to 01-02). Communities feel that the "caribou update was useful" and that "hunters want to know where the caribou are" (ABEKC Questionnaire, 96-97 to 01-02).

Respondents would like more information about caribou and fish for hunting/fishing purposes but also on issues such as diseases. Muskoxen information is also desirable. This information should be given to HTC, RRC and wildlife offices as this is where community members obtain updates about the land, water, caribou, and fish. Small mail-outs and pamphlets would help distribute the information, however, illiteracy makes it difficult for some people to get the information they need. One respondent from the 2001-02 questionnaire says that the "Renewable Resource officer gives me information because I can't read". Therefore, when preparing this research for the community members, maps should be the emphasis of the report as they overcome language and literacy hurdles. Temperature recordings, water survey information, snow fall readings, and how frequently heavy winds come up are additional topics that communities would like to be able to obtain more information about.

Every year there is an annual gathering held in one of the participating communities. A separate report will be created for this meeting in February so that all those who have been instrumental in the success and continuation of the program can see the maps produced from their observations. It would be rewarding for each participant to see the results of the time and effort they put into the completion of the questionnaire every year. One interviewee was able to provide advice as to the structure that the community report should take (YDOE personnel, 2005). It was suggested that diagrams be used to summarize and simplify findings and that illustrations be integrated in the text with captions.

This chapter has reviewed suggestions and recommendations, provided by key players involved in ABEKC database development and respondents from interview years 1996-97 to 2001-02 that will help improve the data collection and subsequent mapping process. I have evaluated those critiques and also made suggestions. The objective of the critique was to provide recommendations which will increase the user-friendliness of the database and the analyses produced from its use, decrease subjectivity and room for error, and increase the overall efficiency of the production of knowledge by ABEKC. All the above mentioned sources have been instrumental in providing suggestions to correct current data collection, reporting and visualization deficiencies.

CHAPTER 6: POSSIBLE IMPROVEMENTS TO MORE MEANINGFULLY DEPICTING SPATIAL INFORMATION

Can existing ABEKC data be better used to tell a more useful story about the study area? Currently the manner in which observations are depicted tend to be highly generalized and confusing. In terms of applications, apart from monitoring landscape change, the data should ideally assist in identifying priority areas for protection and conservation and provide ancillary information in support of wildlife monitoring. There are four sections used to address the second research question which will be explored in this chapter:

1) Three approaches to using the data to identify high priority areas for conservation
2) The possible application of the ABEKC database for time-series analyses
3) The potential role of the Co-op's data in supplementing (or even substituting for) radio-collar monitoring of caribou
4) Ways in which unmapped data could be depicted to yield more information

6.1 Determining Areas with Concentration of Observations

Currently, for each type of observation there are numerous overlapping polygons. Figures 6.1 and 6.2 show the digitized polygons from the hard copy maps depicting observations of caribou migrating in the spring and fall seasons, respectively, in 2001-02. Similarly, each polygon in Figure 6.3 shows where one respondent reported observing the first arrival of caribou after the summer season and Figure 6.4 depicts winter caribou observations for 2001-02. For all of these maps, the location, shape, and extent of each polygon are not clear due to overlapping observations. In order to determine the areas that have the highest

Figure 6.1 2001-02 Spring Caribou Migration: All Respondents

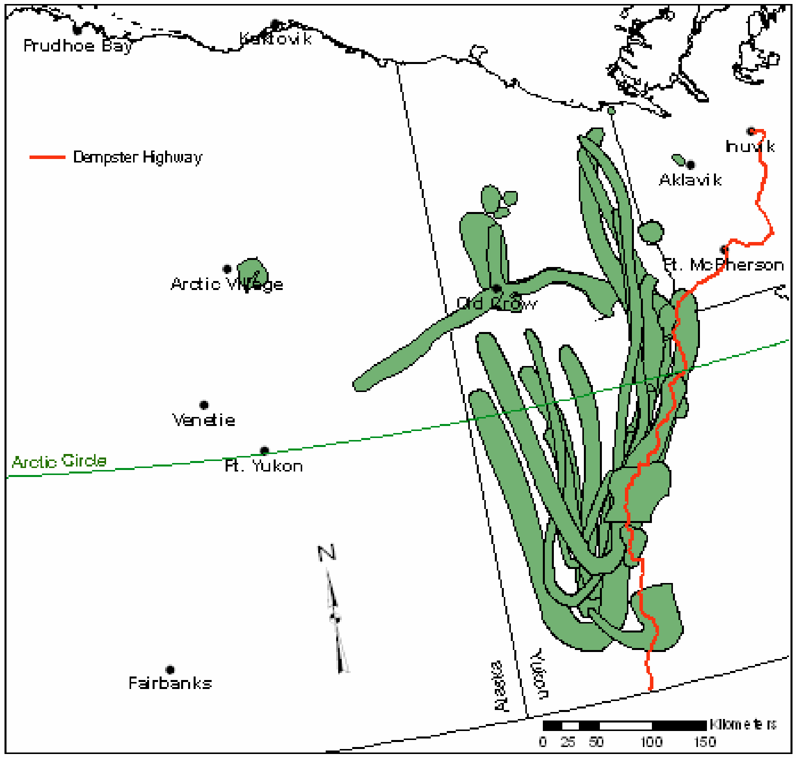


Figure 6.2 2001-02 Fall Caribou Migration: All Respondents

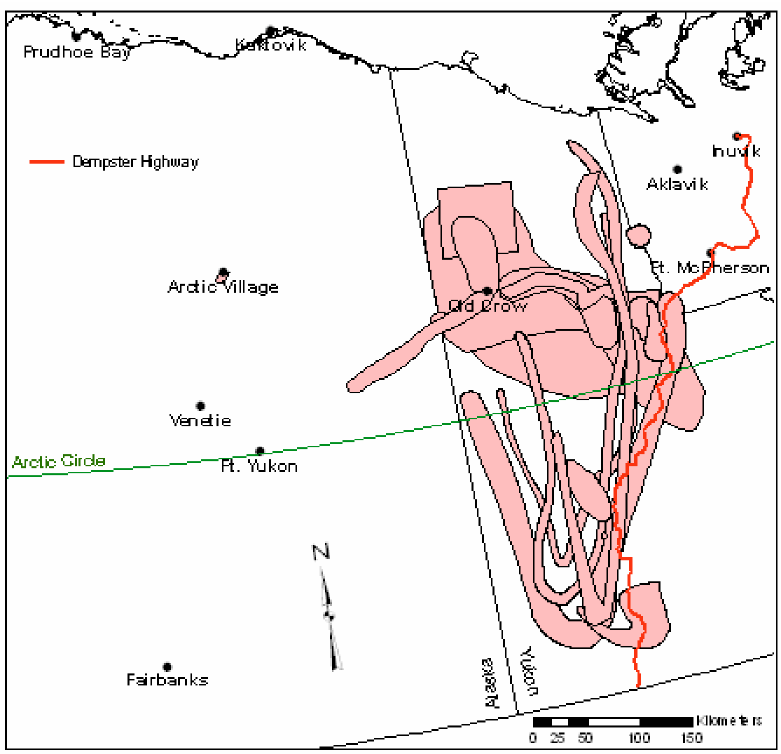


Figure 6.3 2001-02 First Caribou Fall Arrivals: All Respondents

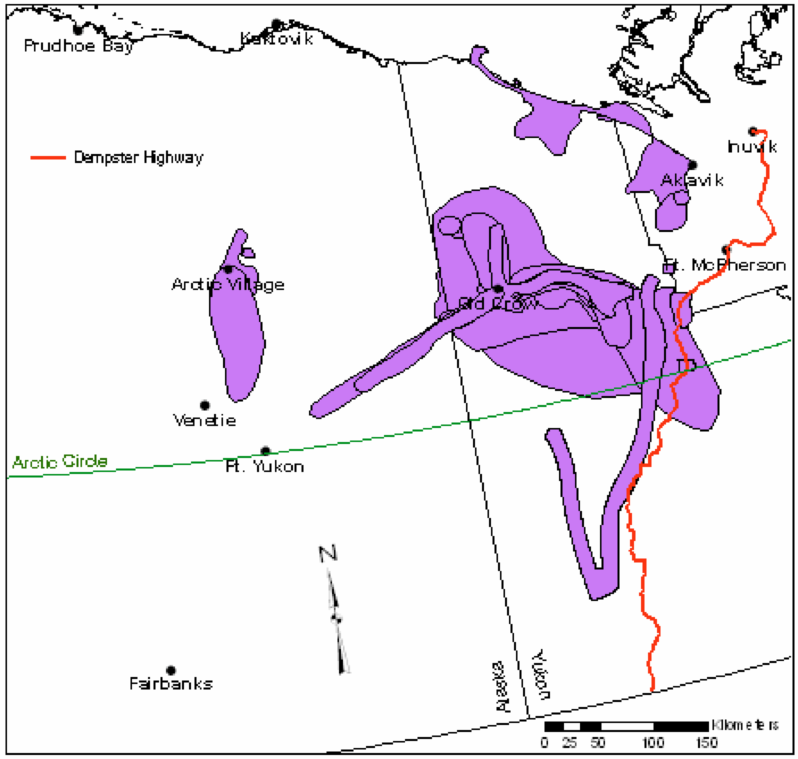
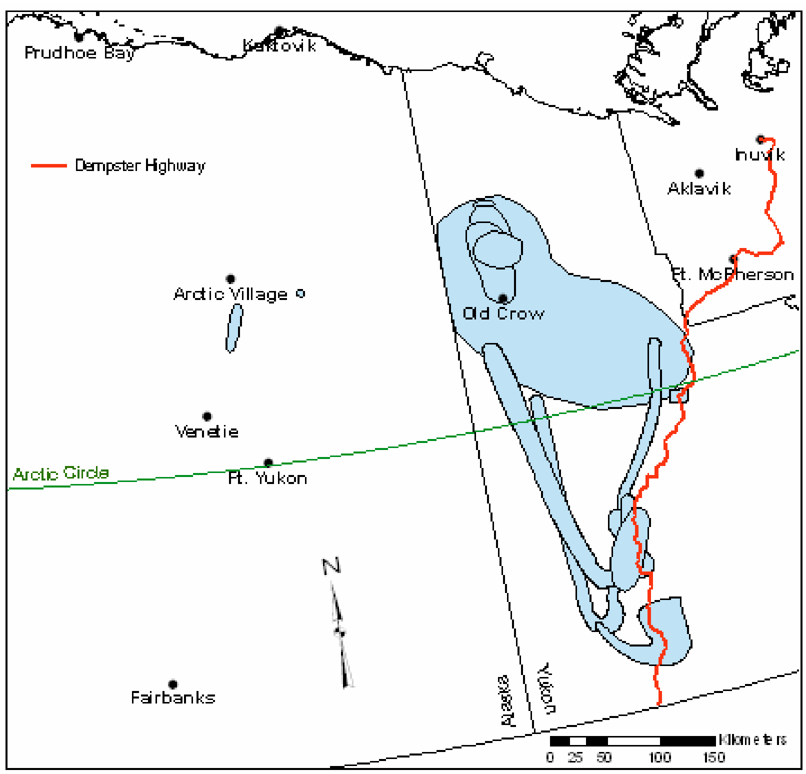


Figure 6.4 2001-02 Winter Caribou Observations: All Respondents

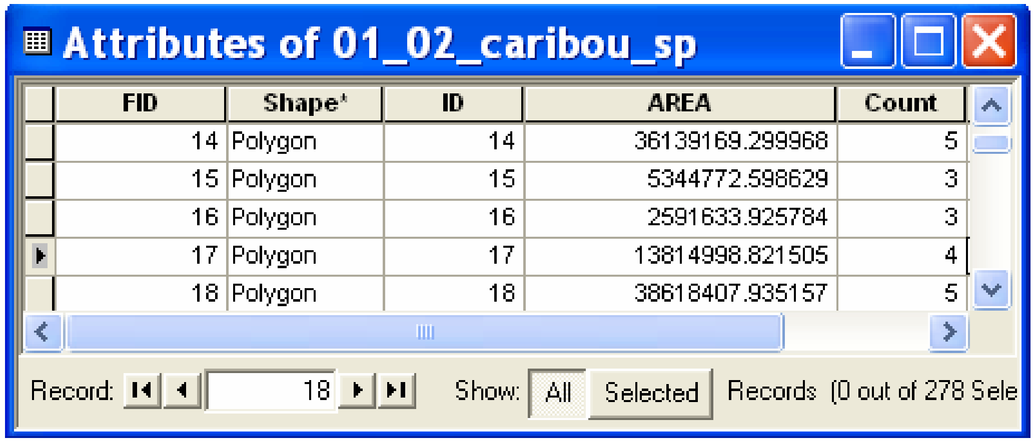


concentration of observations, three different approaches will be used, described, and evaluated. The maps might be more meaningful if only overlapping polygons are depicted because these are the areas where more than one respondent reported seeing the observation.

6.1.1 Dissect Overlaps

The first approach to determining areas with concentration of observations, the Dissect Overlaps option in ArcView, is used to "summarize, analyze and remove overlapping polygons in a theme" (ESRI, 1999). This extension provides a Theme menu item ("Dissect") that converts an active polygon theme into a new one having no overlaps. Using the Dissect script each overlap is cut out of the overlapping polygons and made into a new feature. All new features are provided with identifiers (ID), area, and a count of the number of overlapping polygons (Count). The polygons in the active layer are added together and their sum is displayed in the Count field (Figure 6.5). This method is useful since it not only shows which polygons overlap, but how many polygons are overlapping (i.e. it is possible to see areas where three, four, five, etc. respondents observed the observation in question. The highest concentration of observations can be selected and displayed on the map. Land use planning and conservation activities are two examples of when it would be desirable to know where the highest concentrations exist, to deter development and increase preservation efforts. However, an ecosystem is an intricate, interrelated system and therefore it should be noted that all areas used for subsistence activities (and surrounding regions) are important. Figures 6.6 to 6.9 show the overlapping areas and the number of overlapping observations made by community experts during the spring and fall caribou migration, at the end of summer, and during the winter of 2001-02.

Figure 6.5 Dissect Overlaps: Attribute Table of 2001-02 Spring Caribou Observations


Attributes of 01_02_caribou_sp

FID	Shape*	ID	AREA	Count
14	Polygon	14	36139169.299968	5
15	Polygon	15	5344772.598629	3
16	Polygon	16	2591633.925784	3
17	Polygon	17	13814998.821505	4
18	Polygon	18	38618407.935157	5

Record: 18 Show: All Selected Records (0 out of 278 Sele

Figure 6.6 Multiple Responses: Spring Caribou Migration Observations 2001-02

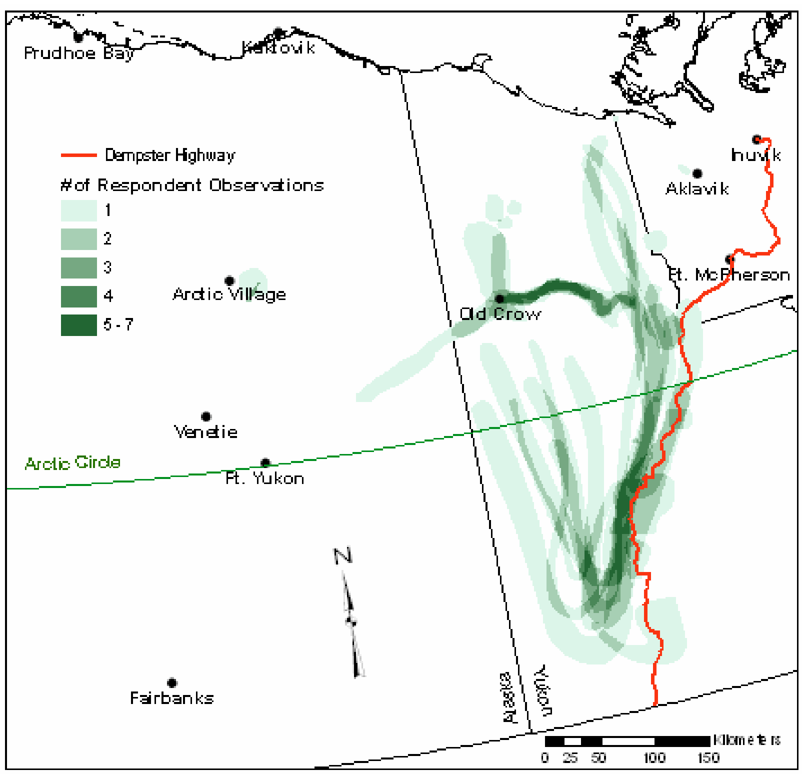


Figure 6.7 Multiple Responses: Fall Caribou Migration Observations 2001-02

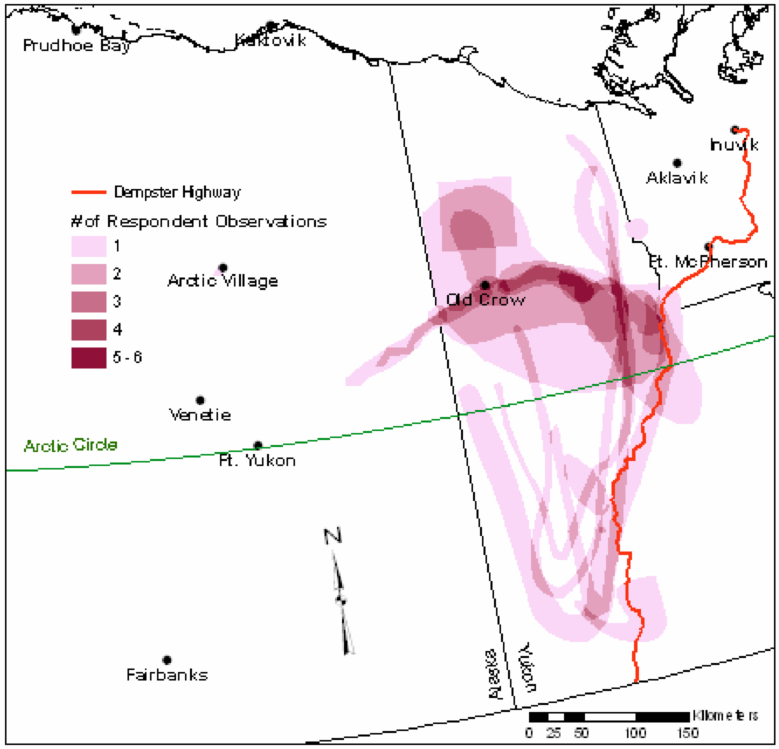


Figure 6.8 Multiple Responses: First Caribou Fall Arrivals 2001-02

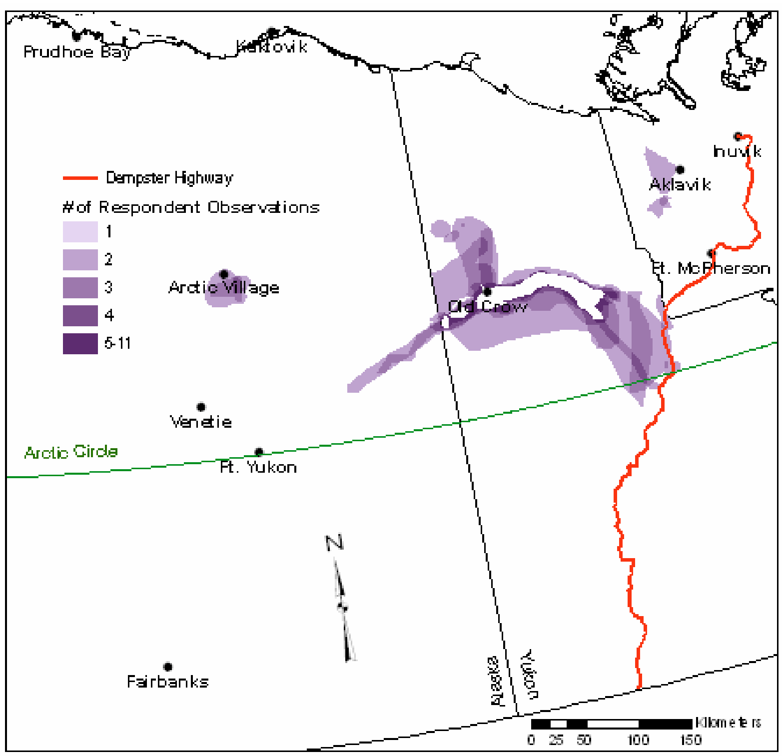
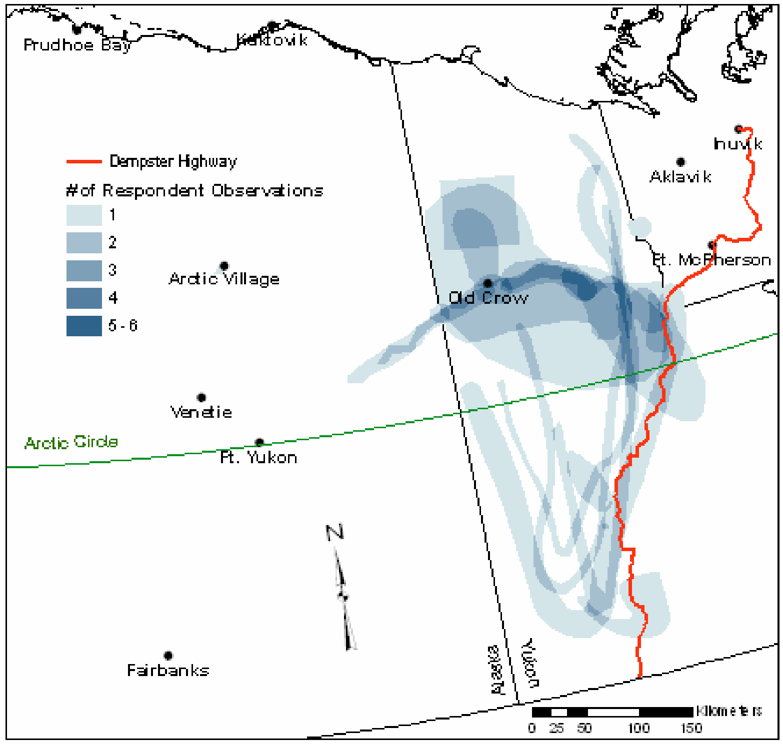


Figure 6.9 Multiple Responses: Winter Caribou Observations 2001-02



6.1.2 Overlay of Intersecting Polygons

The second approach to determining areas with concentration of observations is the Intersect tool in ArcGIS' ArcToolbox which calculates the geometric intersection of any number of feature class and feature layers. Thus it is a useful tool for discovering polygon overlap (ArcGIS Desktop Help, 2005). This approach can be used to determine the areas where at least two respondents reported the same observation. The polygons or portion of polygons which are in common (i.e. intersect) are written to the "Output Feature Class" using the Overlay > Intersect function in ArcToolbox. This method differs from the "Dissect Overlaps" approach in that no extra field is created to show the number of overlaps and therefore it is not possible to determine how many polygons are overlapping. However, this method does help to clean up the original respondent maps. The same observations as

Figures 6.1 to 6.4 can be seen in Figures 6.10 to 6.13, but only those locations where two or more respondents noted the observation are visible on the maps.

Figure 6.10 Intersecting Polygons: 2001-02 Spring Caribou Migration

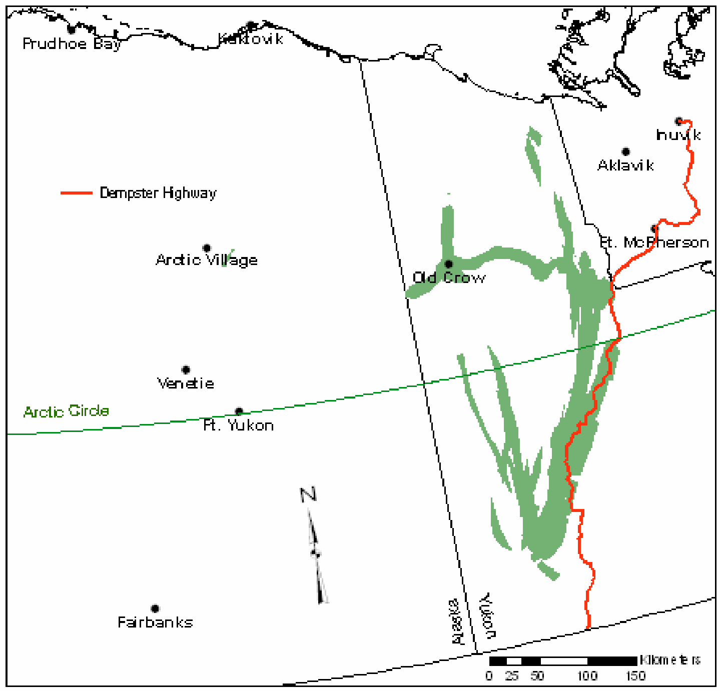


Figure 6.11 Intersecting Polygons: 2001-02 Fall Caribou Migration

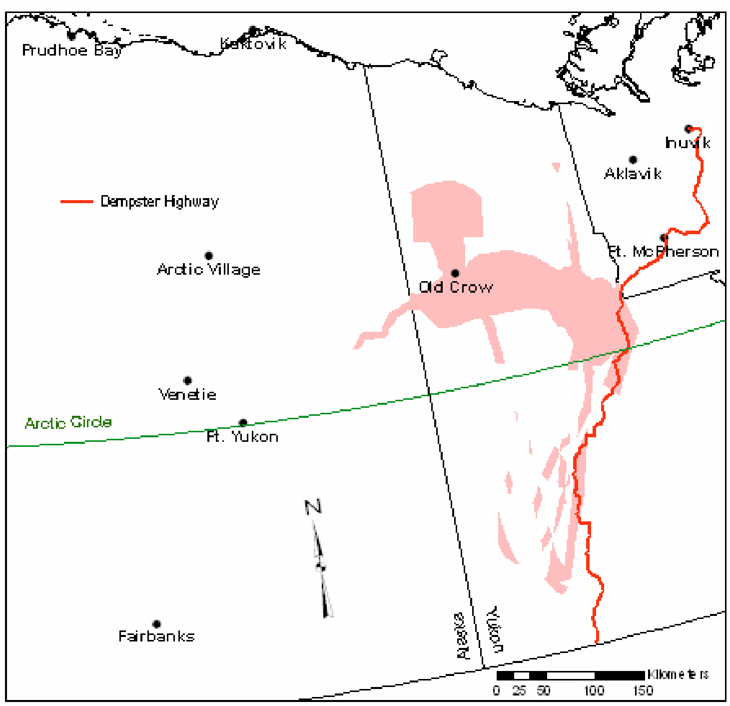


Figure 6.12 Intersecting Polygons: 2001-02 First Caribou Fall Arrivals

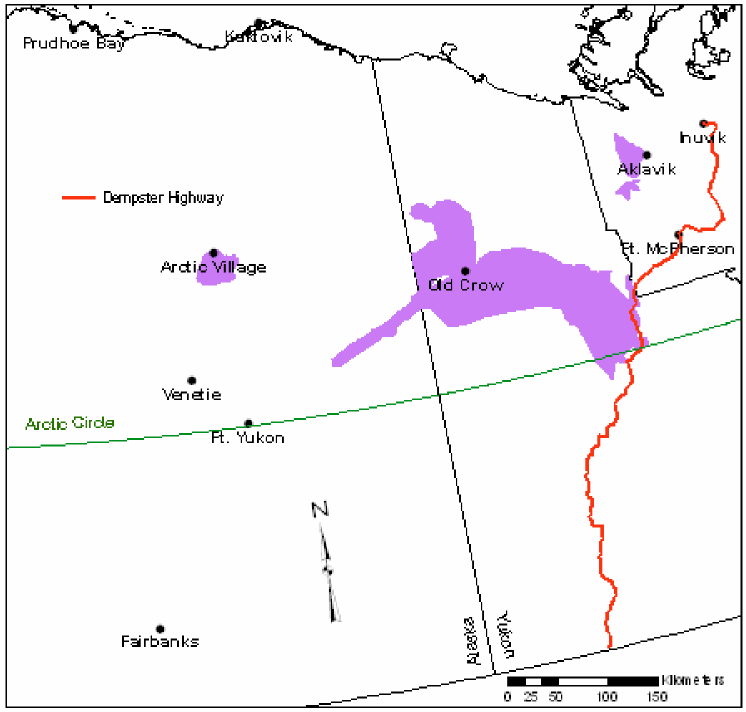
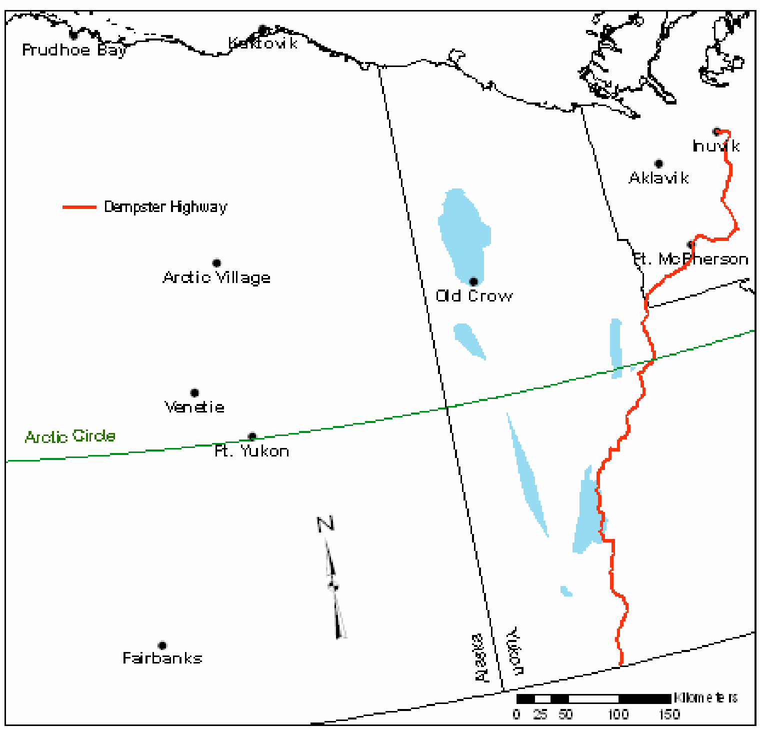


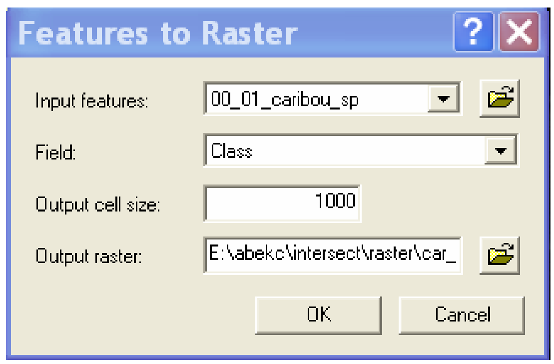
Figure 6.13 Intersecting Polygons: 2001-02 Winter Caribou Observations



6.1.3 Raster-Based Data

Another option to identify areas with concentration of observations is to convert polygons from being vector to raster using the Count field created from using the Dissect algorithm. In raster format, geographic space is divided into a grid. Polygon features were converted to grids using 1 square kilometer as the default cell resolution size (see Figure 6.14 below).

Figure 6.14 Converting Features to Rasters



Each cell has an associated value referring to a characteristic of the geographical space. For example, for a binary raster, each cell in which the observation occurs (e.g., winter caribou observations) is assigned a value of one and cells where the observation does not occur are stored as zeros. It allows overlays to be easily combined. Winter caribou observations for 2000-2004, for example, could be displayed on one map to determine the highest concentration of observations for any one year or for the five years of data by adding the layers together. So for the five year period, cells with a value of five depict areas with continued use in terms of wintering caribou, while areas with a value of three depict areas used by wintering caribou for three of the five years and those areas where there were no reported caribou for the five years have a value of zero.

It is useful to convert all features to rasters, not only as a means of depicting the concentration of observations, but also to permit various features to be displayed together in one map. Another option is to display winter caribou observations for 2001 with a human activity layer for 2001 in order to see where high concentrations of caribou coincide with increased human activity. Since the same cell-based structure is used to represent all feature types, a variety of geographic features can be combined in one query, overlay, or expression (ESRI, 2001). For example, a surface (e.g., elevation) can be combined with polygon features (e.g., spring caribou location from ABEKC's community monitoring program), linear features (e.g., rivers) and point features (e.g., spring caribou location from radio-collared caribou).

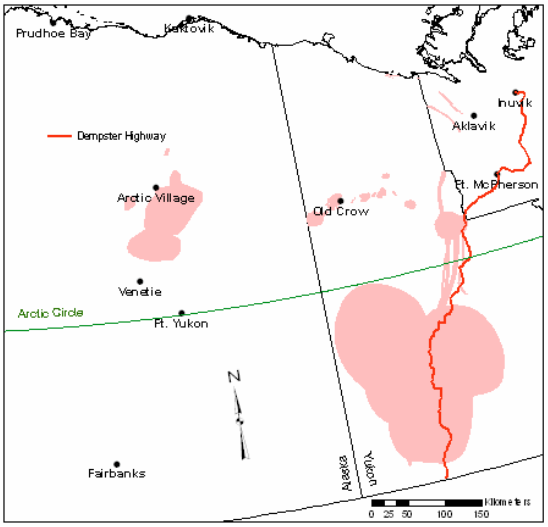
Therefore, using the ABEKC database, the best approach to determining areas with concentration of observations is to convert polygons to raster using the Count field created by the dissect algorithm. Although the "Dissect Overlaps" and raster approach produce the same maps, raster data format allows for various queries to be performed with the data.

6.2 Suitability for Time-Series Analyses

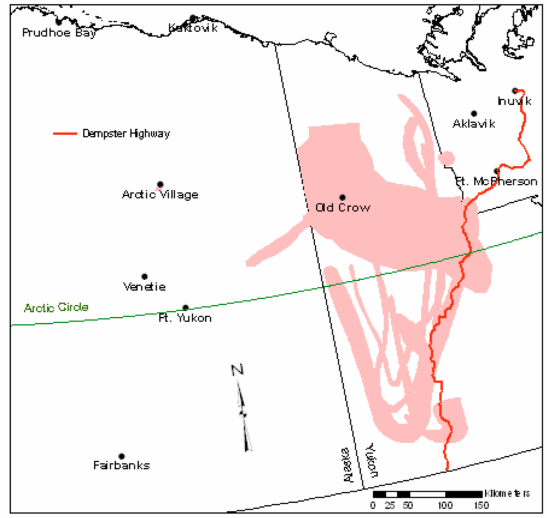
Currently, four years of caribou observations can be depicted on seasonal maps. The 1999-00 data are not suitable to be used for seasonal caribou depictions because all caribou observations are grouped as one layer because they were assigned only one map reference code). Changes in the questionnaire, particularly the level of detail involved in the map reference codes, make it difficult to use some of the earlier data in time-series analysis. Thus not all years can be mapped for all observations. Sightings of caribou during fall migration can be examined from 2000 to 2004 (Figure 6.15).

Figure 6.15 Time-Series Analysis: 2000-2004 Fall Caribou Migration

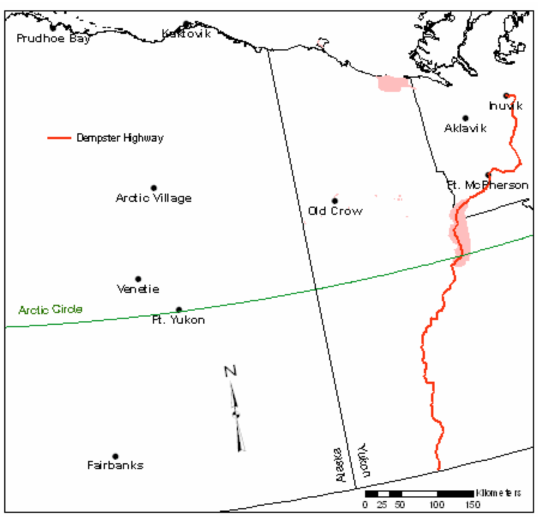
2000-2001



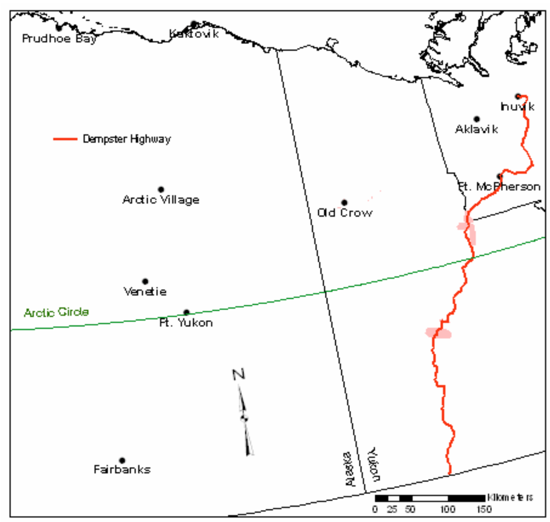
2001-2002



2002-2003



2003-2004

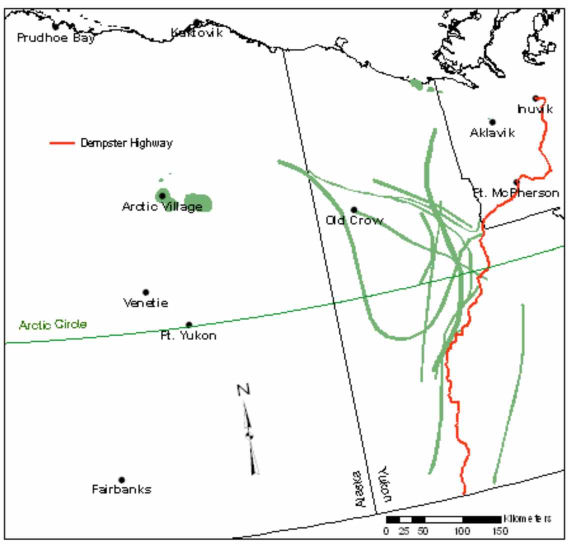


Patterns are currently not discernable for the four interview years of fall and spring caribou migration data. Variations in the distribution of caribou from year to year may be attributed to the imprecision of data collected through TEK. Possible reasons for changes in seasonal caribou locations can be explored using scientific data. For example, it appears that the presence of caribou in the south decreased substantially in years 2002-03 and 2003-04.

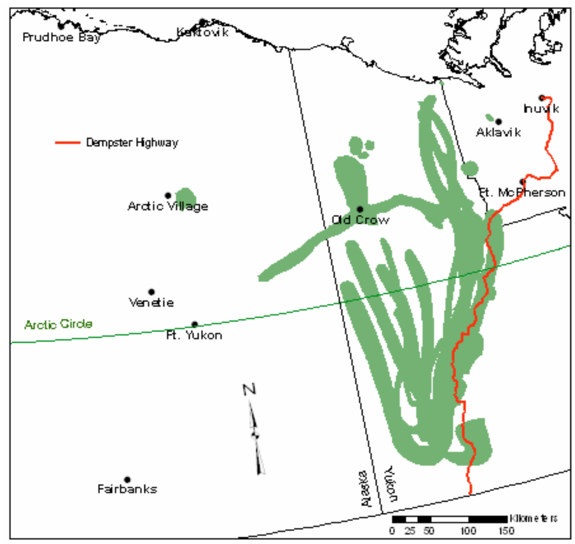
Snow conditions and temperatures from these years could be investigated to see if caribou migration could have been affected by weather and climate. It is also important to point out that sample size and composition change from year to year (Table 6.1). For 2000-2001 wintering caribou observations were recorded using the same map reference code as fall migration observations and therefore this explains the higher number of sightings.

Figure 6.16 Time-Series Analysis: 2000-2004 Spring Caribou Migration

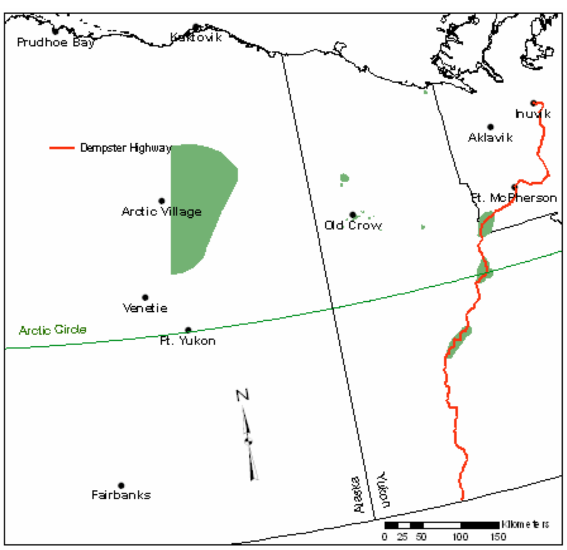
2000-2001



2001-2002



2002-2003



2003-2004

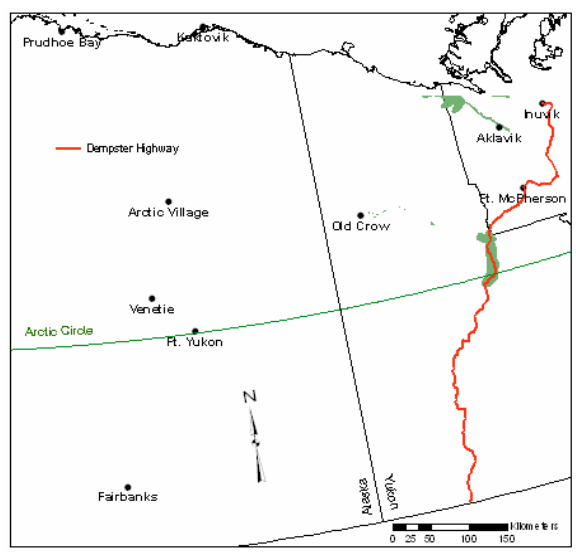


Table 6.1 Number of Observations of Fall and Spring Caribou Migration

	2000-2001	2001-2002	2002-2003	2003-2004
Fall Migration	63	23	40	31
Spring Migration	26	37	33	37

Although the data are not suitable for time-series analysis, depicting observations (such as migrating spring caribou) for various interview years can be used to draw out important events and conditions which may have been occurring or present on the land during a particular year. Therefore, displaying the ABEKC data in time-series format assists in answering the second research question that more useful information can in fact be obtained from the data.

6.3 Combining TEK with Satellite Data

Seasonal range use and migration patterns of the PCH are documented by the Porcupine Caribou Herd Satellite Collar Project. It is a co-operative project between a number of wildlife agencies and boards that uses satellite radio-collars to document the herd's movements. Satellite tracking has replaced older location techniques. Previously, scientists had to use airplanes to locate caribou wearing conventional collars (currently, there are almost fifty conventional collars on caribou in the Porcupine herd, and about 10 of these are on bulls) (Taiga Net, 2005c). Flying a plane in the north is often held up by weather and darkness. The radio-collars consist of a special transmitter which sends a signal to a passing satellite which automatically picks up the signal in the dark and through snow storms. A computer on board the satellite calculates the location of the caribou and sends the information to one of three ground stations (Taiga Net, 2005c). Satellite collars are useful for monitoring the movements of animals which travel long distances or with animals which live in harsh or remote areas. Currently, there are thirteen radio-collared cows being monitored by the project. Cows are collared because the main reasons for keeping collars on this herd are to document calving rates, and so that the caribou can be located in order to conduct the composition counts.

Thirteen caribou is not a large sample and therefore the most comprehensive information about the herd can be obtained by combining the satellite data with community knowledge from the ABEKC database. Given the scarcity of conventional scientific data in the range of the PCH, the Co-op's community monitoring database has the potential to be of great use in monitoring landscape and landscape change in these remote areas. Data obtained from the radio-collars of selected caribou in the PCH were obtained from the CWS and can be displayed alongside the Co-op data to get an idea of the similarities and discrepancies between the two data systems. Figures 6.17 and 6.18 show the location of caribou during spring migration in 2001-02 and the fall migration from 2000 to 2002, as recorded by radio-collars and respondent observations. The satellite data are invaluable as they provide information in areas where community experts are not active on the land (such as calving grounds). The community expert knowledge is also invaluable as it not only provides locations of caribou, but also caribou availability, body condition and herd health. The two systems of knowledge are therefore complementary to each other.

Similarities between the two systems are apparent when examining calving observations and satellite calving locations during the spring of 2001 (Figure 6.19). Therefore, the additional attribute information contained in the ABEKC database can be used to tease out new information about the health and movements of the PCH. For example, herd composition, feeding characteristics, terrain, and location effects such as snow conditions

Figure 6.17 Satellite Data and TEK: 2001-02 Spring Caribou Migration

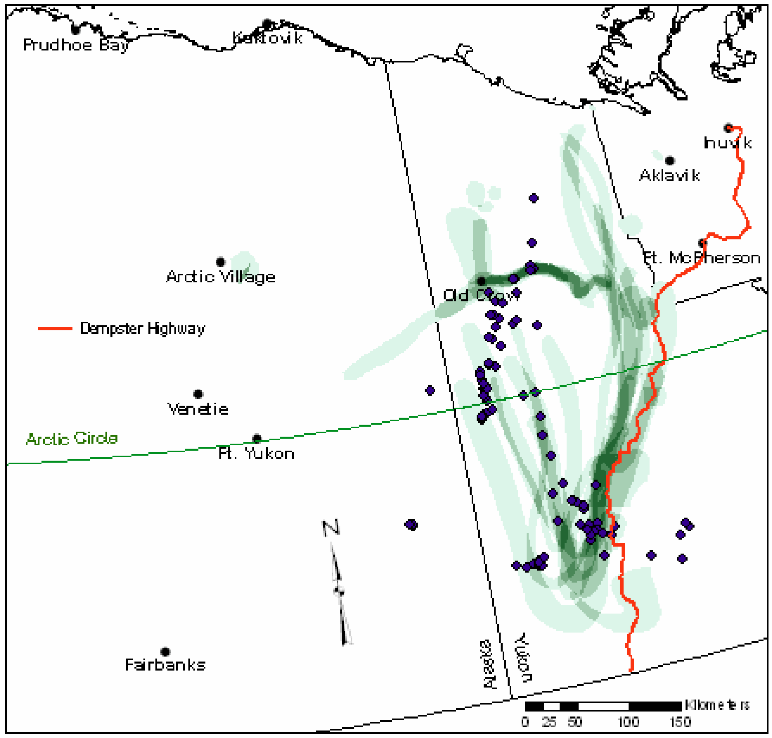
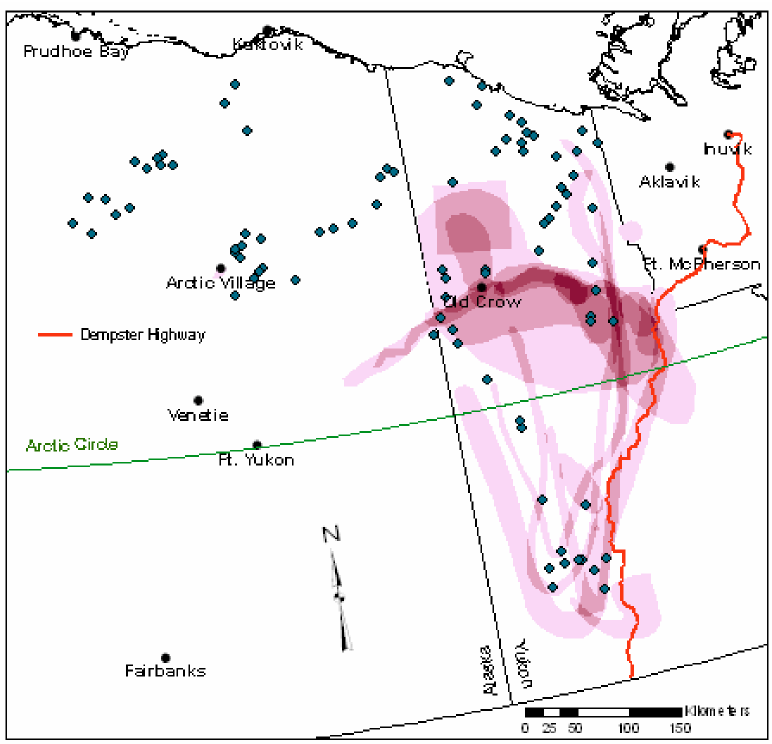


Figure 6.18 Satellite Data and TEK: 2001-2002 Fall Caribou Migration



(e.g., too much or not much), other weather conditions (e.g., ice conditions and wind), the quality of feeding areas, predators, and human activity are all variables relating to herd health and migratory patterns contained in the ABEKC database.

The locations of wintering caribou in 2000-2004 observed by community experts are strikingly similar to the distribution depicted by the radio-collars. The differences between the two knowledge systems can be attributed to the extent of the lifetime use area of respondents. Community experts are only able to provide observations in the area where they have traveled for subsistence in their lifetime. The satellite data are therefore useful for monitoring areas where community members do not travel (i.e. areas north of Arctic Village and Old Crow). Gaps in one knowledge system can therefore be filled by the other. It should also be noted that there are perhaps additional locations where caribou are present that have not been captured by community knowledge or satellite data.

Figure 6.19 Satellite Data and TEK: 2001-02 Spring Calving Observations

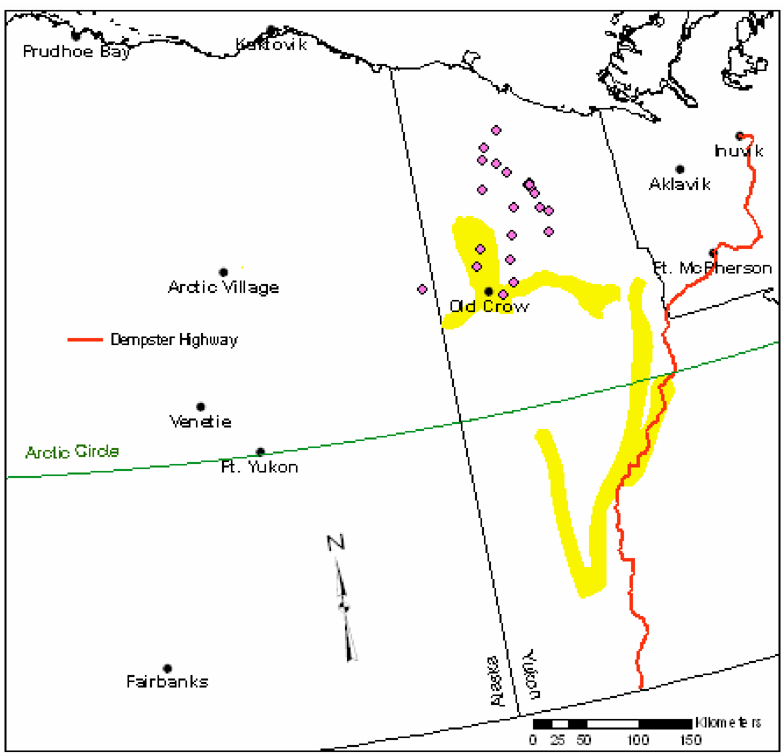
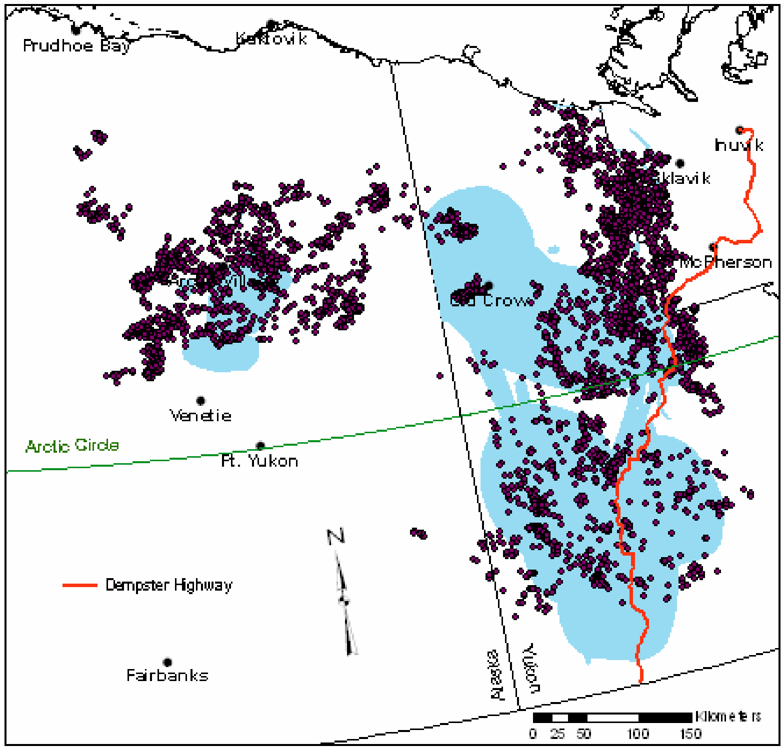


Figure 6.20 Satellite Data and TEK: 2000-2004 Winter Caribou Locations



6.4 Using Attribute Data to Describe Observations

There is a vast amount of unmapped information contained in the Co-op database which can be used to describe the spatial information. The previous chapter suggested creating attribute tables for each type of observation (i.e. attached to a Polygon ID). Since the most complete attribute tables found in the ABEKC_Community database are for the 2001-02 interview year, the spatial data (e.g., as shapefiles) for this interview year can be related to the Access tables using the Polygon IDs. These other variables can be used to create thematic maps such as caribou location effects, herd health, feeding characteristics and predatory sightings.

If data recorded on hard copy maps during interviews are entered into an Access database table using appropriate Polygon IDs and data from the questionnaires, then more detailed analyses could be performed. This was the process used to enter the 2001-02 data and therefore the 2001-02 dataset is the most complete. For example, Figure 6.21 contains the type of predator (Predator variable) and the notes made (Notes variable) regarding the sighting of predatory kills of caribou.

Figure 6.21 Attributes of 2001_2002_PREDATION_region.shp

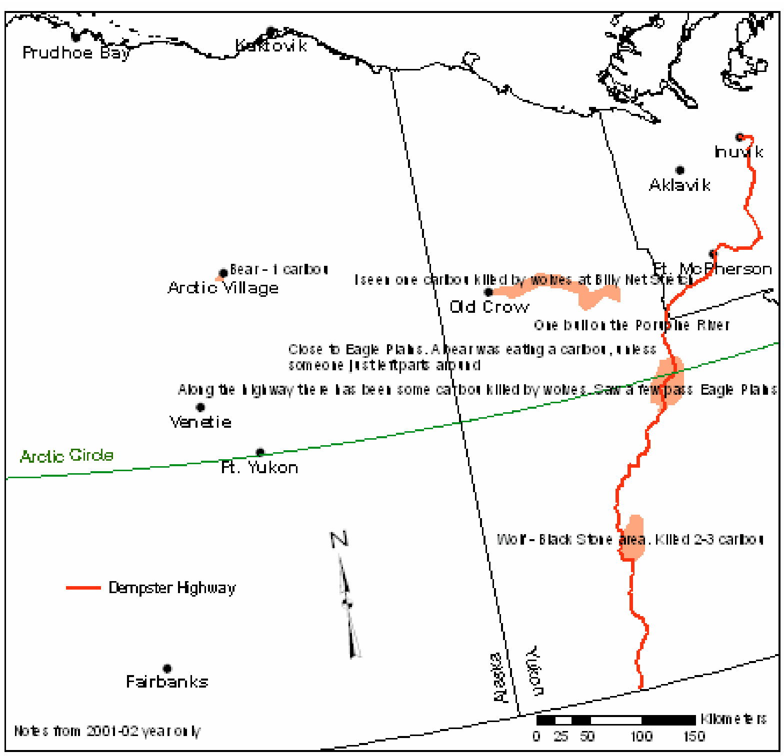
Attributes of 2001_2002_PREDATION_region

PREDATOR	NOTES
Bear	Close to Eagle Plains. A bear was eating a caribou, unless someone just left parts around
Wolf	I seen one caribou killed by wolves at Billy Net Stretch
Wolf	One bull up on the Porcupine River
Wolf	Black Stone area. Killed 2-3 caribou
Bear	Along the highway there has been some caribou killed by wolves. Saw a few pass Eagle Plair
Bear	1 caribou

Record: 5 Show: All Selected Records (0 out of 13 Selected.) Optior

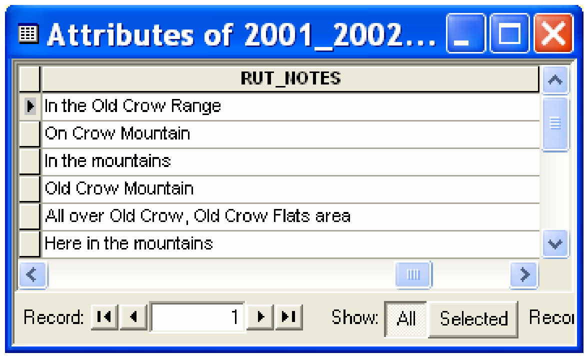
These notes can also be used be mapped (Figure 6.22). While spatial data are available for 1999-00, 2000-01, 2002-03 and 2003-04, no notes were digitally recorded for these years.

Figure 6.22 Predatory Kills of Caribou 2001-2002 with Notes



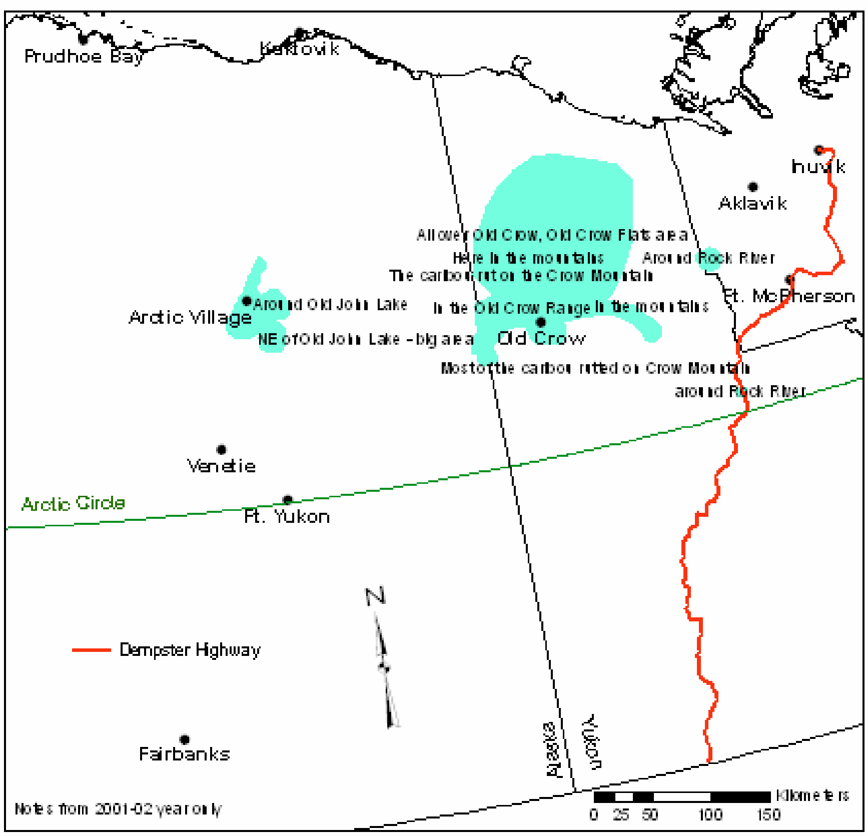
The Notes variable in Figure 6.23 was used to describe the rutting observations contained in the shapefile. These notes were then placed on the map to describe observations (Figure 6.24). While spatial data for caribou rutting areas are available for 2002-03, no notes were digitally recorded.

Figure 6.23 Attributes of 2001_2002_RUT_region.shp



RUT_NOTES
In the Old Crow Range
On Crow Mountain
In the mountains
Old Crow Mountain
All over Old Crow, Old Crow Flats area
Here in the mountains

Figure 6.24 Caribou Rutting Areas 2001-2002 with Notes



Notes made in the 2001-2002 spring calving season ask for the caribou seen during spring migration and if cows have calves. Community experts were also asked to describe the terrain (e.g., lakes, ridge tops, water crossings, valley bottoms, boulder fields). Some experts also went into greater detail and described which lake or water crossing. Some of the notes regarding calving terrain include observations such as “in the Eagle Plains area”, “near Trail River”, “crossing the Porcupine River”, “Caribou Look-out”, and “on mountains” (ABEKC Questionnaire 2001-02).

For both fall and spring migration in 2001-02 notes are made regarding the date that the caribou were seen, the direction the caribou were traveling (e.g., moving south, southwest), the number of caribou seen (choice between just a few, 50 to 100, 100-500, and more than 500), the composition of the group (e.g., bulls, cows, or mixed groups), terrain, if they were feeding, and other general comments about the herd. Some of the comments referring to the fall migration of the PCH include (with home community in brackets): “[moving] towards the south to Old Crow, moving really fast” (Fort McPherson); “they were moving south, crossing the Porcupine River” (Old Crow); “rutting and running around, chased by hunters” (Old Crow); “the caribou are always changing routes” (Aklavik Gwich’in); “moving through the Rock River area, bulls and cows…caribou usually came in big herds, [but] for the past few years there [have been] hardly any caribou (heading south) migrating” (Aklavik Gwich’in); “feeding right until rut…” (Old Crow); and “crossing the Porcupine River at Rampart House” (Old Crow) (ABEKC Questionnaire, 2001-02). Referring to body condition, the comment was made by an expert from the community of Old Crow that the caribou were in “very good shape” (ABEKC Questionnaire, 2001-02).

Observations of caribou during spring migration included the following comments: “…traveling late” (Old Crow); “towards Old Crow, traveled very fast” (Fort McPherson);

they were traveling “through Ogilvie River towards Old Crow” (Fort McPherson); “saw some around Rock River, heading south to Olgilvie” (Fort McPherson); “not moving because of the ice” (Old Crow); “heading North to calving grounds” (Old Crow); “moving to Blackstone area, through and over ridge tops” (Fort McPherson); and regarding body condition, “very poor…” (Old Crow) and “it was in poor shape” (Old Crow) (ABEKC Questionnaire, 2001-02).

Caribou observations in the 2001-2002 winter season include similar comments, for example (with experts’ home community in brackets): “between James Creek and Eagle Plains” (Fort McPherson); “towards Old Crow, same route they traveled last year” (Fort McPherson); “within the last 2 years noticed that they travel towards Old Crow” (Fort McPherson); “good shape, fat 1”-2” (Old Crow); “wintering in Crow Flat” (Old Crow); “many caribou stay out at Crow Flat because of good food” (Old Crow); and “above Arctic Village, Martin Stand” (Arctic Village) (ABEKC Questionnaire, 2001-02).

Additional descriptive data contained in the Access database can be used to yield more information from the current ABEKC data. More descriptive data is available for 2001-02 than any other year. It is recommended that all information from the questionnaires be transferred into tables in Access so that more data is available to depict observations and perform general queries such as locations where wolves have been a predatory threat to caribou or areas where unhealthy caribou have been reported.

This chapter has provided approaches for depicting spatial information in the ABEKC database. The accuracy of the data has not been quantified and the data may not be ready for critical time-series analyses. However, using methods described in this chapter to identify high priority areas for conservation, supplementing radio-collar data with ABEKC caribou data and depicting unmapped information in the database all assist in obtaining more useful information from the ABEKC database than in its current format.

CHAPTER 7: CONCLUSION

This chapter summarizes the findings of the research, provides recommendations to improve the data collection process and subsequent data depiction, describes the limitations of the project and suggests points for further investigation.

7.1 Summary of Findings

The two research questions that have been addressed are whether the Arctic Borderlands Ecological Knowledge Co-op data gathering and mapping process can be improved, and whether more useful information can be obtained from the data. These questions have been explored through a review of relevant research, meetings with key players involved in TEK-based initiatives in the Yukon and in ABEKC database development, and a critical analysis of the Access database, spatial database, and how the two relate.

Analysis of the way in which information flows from initial interviews to map production has indicated that this process can be improved. The questionnaires should be designed to better meet the local and traditional knowledge data needs and address specific concerns. The same map reference codes should be used every year, which translates to the same questions being asked every year since the codes are derived from the questions. Attribute data are included in tables in Access and should be updated with information for all subsequent years. It is recommended that during the interviews, when a respondent makes reference to an exact location this observation should be recorded on the hard copy maps so that the technician digitizes all spatial observations. It is also important to check for data that are not being used that would usefully lend itself to GIS.

In order to increase the efficiency of the production of knowledge, make the GIS component more user-friendly and potentially yield more useful information from the ABEKC data, the following recommendations are provided:

7.1.1 Recommendations for Improving the Production of Knowledge by ABEKC

1. In order for the data to be easily translated into GIS format, the same questions should be asked every year.
2. Provide community experts with a copy of the questionnaire beforehand so they are better prepared for the interview.
3. Get younger people involved with the interviews to help them gain knowledge of what is happening with the land and animals.
4. Determine what the data are going to be used for before the interviews are conducted. This way the focus of the interviews should be the questions that relate specifically to the desired output.
5. Provide community experts with a small calendar harvest book to record weather observations, harvest information, animals that are caught, and to note specific locations and dates.
6. The data should be checked for accuracy using a quantifiable means of measurement. For example, the thickness of the marker used to draw polygons on the map sheets and the scale of the map can be used to calculate the level of precision when marking an observation on a map sheet during an interview.

7.1.2 Recommendations for Improving Visualization of the Data

1. The tables in the ABEKC_Community database should be updated every year.
2. ABEKC_Community should be used as the main, updateable database. This would allow for fast data retrieval and depiction and also ensure that all the data are in the same format and are easily accessible.
3. The mtPolygons table in ABEKC_Community should be updated every year and should be modified to include an Autointerview ID field. The Autointerview ID can in turn be used to assign a Polygon ID to each observation in the attribute tables from information recorded on the questionnaires and can be saved in this one database, ABEKC_Community, with the Polygon ID as the common field linking the attribute tables, the mtPolygons table, and the shapefiles.
4. It is important to check for information that is not currently spatially referenced but would usefully lend itself to GIS. There would be a lot more location-based responses and more analyses could be performed if point-based sightings were recorded on the map sheets and subsequently, digitized. It is recommended that during the interviews, when a respondent makes a reference to an exact location that this observation be recorded on the hard copy maps so that the technician digitizes all spatial observations.
5. Use the same map reference codes every year so that the data can be easily translated into GIS format. Categorical map references (as opposed to colour codes) make rendering into a GIS more feasible and would improve the mapping process. The 2001-02 interview year should be used as a model for

map reference codes (as these codes include many different types of observations).

6. In order to identify areas of potentially high significance to a community, the ability to depict and aggregate overlapping polygons should be a standard feature of the system. The best approach to determining areas with concentration of observations is to convert polygons to rasters using the Count field created by the dissect algorithm.
7. Every type of observation, for each year of data, should be created as separate raster layers. Raster data allow for various overlays and queries to be performed and can be used alongside conventional scientific data that are also in raster format.
8. The base maps used during the interviews should be structured as a grid with cell sizes that respondents feel comfortable with. This would help eliminate the fear of revealing a secret hunting or fishing location and also standardize the mapping process.

The overlapping areas of caribou observations have been displayed for several years of data to determine if more information can be obtained from the ABEKC data. These overlapping areas should be regarded as hotspots for conservations strategies. The best approach for determining areas with concentration of observations is to convert polygons to rasters and map the Count field created from the “Dissect Overlaps” script. The data needs to be assessed for accuracy and precisions before in-depth time-series analyses can be performed. The current time-series maps can be used as starting points for investigations into possible abnormal changes or trends in the landscape therefore the data can yield more information than in its current format. Respondents' observations of migrating, calving, and wintering caribou have also been depicted alongside satellite data obtained from radio-collared caribou in the PCH. While the satellite data are invaluable as they provide information in areas on the land where community experts are not active, where they coincide with ABECK information, attribute information contained in the ABEKC database (such as the abundance of caribou and the number, sex, month observed and age group of sick caribou sightings) can be used to tease out new information about ecosystem health and local conditions where observations are made.

7.2 Limitations to this Study

There are a few, specific limitations in this research which should be addressed as a means for improvement or potential strategies for further study. Although there were limits to the amount of analysis that could be done since the sample size for each year is small (due to the number of interviews conducted but primarily due to different map reference coding systems being used for different years), there are additional fields within the attribute tables in the Access database that contain qualitative descriptions that complement each map reference (for example, the health and composition of the herd and feeding characteristics). These additional variables could have been quantified to permit a thematic mapping exercise.

Additional science-based monitoring and record data (such as precipitation, ice and snow records, etc.) could have been obtained. The indicators developed by the Co-op range from basic environmental measurements (e.g., temperature) to measurements of potential stress (e.g., number of airplane flights) and effects on communities (e.g., time spent on land) (Eamer, 2002). This type of information could possibly have been obtained and its relationship with the community monitoring data could have been investigated. The community monitoring data were only able to be compared alongside satellite data collected from radio-collared caribou because this data were readily available from the CWS.

There are also several issues encountered during this research relating to the problems associated with the use of TEK. First, no methodology has been established for measuring the level of accuracy of the data. If the size of the tip of the marker used to draw polygons on the map sheets and the scale of the maps are known then a level of error could be calculated. This helps to calculate the precision of the data but the amount of subjectivity surrounding the observations sometimes cannot be quantified. For example, the pride of a respondent may result in the reporting of observations that are not true and the desire to protect the secrecy of fishing and hunting locations may result in false observations. In addition, there is no standard polygon size and therefore if a respondent drew a small polygon to depict seasonal caribou observations and another respondent was less attentive to detail and drew a large polygon to depict the same type of observation, discrepancies in the use of the land would be present. A possible option for resolving the latter issue is to have respondents record observations on a grid. Each cell should be large enough so that respondents' secret locations are not unveiled.

It is also important to note that an area that is adjacent to a respondent's hunting, harvesting or fishing area is equally important for sustaining these activities as ecosystems are intricate, interdependent systems and outside stresses can have a ripple effect throughout an entire ecosystem. Depicting areas with concentration of observations is useful for providing a focus for conservation efforts however areas used by only one respondent are also important and should be managed with respect and care.

7.3 Conclusions

The Co-op has a valuable source of collected data which offer an opportunity for First Nations, Inupiat and Inuvialuit knowledge to be used for long-term monitoring. The ABEKC database has the potential to be used as an important source of information that can be overlayed and integrated with other spatially explicit datasets for land-use planning. It is also anticipated that ABEKC's digital data will provide an important base-layer of information from which to build a larger regional database of communities' areas of importance. Future analyses using the Co-op's data may include a comparison and correlation between data collected during the 1996-97 interview year up to the most recent questionnaires completed in 2004-5 to paint a picture of what is changing in northern landscapes. This research has determined that the mapping process can be improved and more useful data can be obtained from the Co-op's community monitoring database. The Co-op's database helps fill the void of information that exists in the north and has the potential to make a significant contribution to resource management and monitoring.

[D] Caribou / Vutzui / Tuktu

□ Now I'd like to ask you questions about Porcupine Caribou, season by season.

[D-1] Last Spring's Caribou Migration and Caribou Hunt (April 1 – June 30)

[D-1-1] AVAILABILITY TO COMMUNITY-SPRING

□ How available were caribou to this community for hunting last spring?

□ Close by and easily found them

□ Not close, required lots of effort to get

□ Not at all available

□ If it was difficult for people in the community to get caribou, what made it hard?

[D-1-2] HUNTING-SPRING

□ Did you go caribou hunting or see any caribou last spring?

□□□ Yes

□ No

□ When there are caribou available, do you usually hunt for caribou in the spring?

□ Yes □ No

[Do not ask any more questions in this section. Go to PAGE 4]

□ What was the main reason that you didn't go caribou hunting last spring?

- □ Caribou were too far away to try hunting them.
- □ Weather or snow conditions were too bad for hunting.
- □ Other reasons

□ Describe these conditions

[Do not ask any more questions in this section. Go to PAGE 4]

[D-1-3] MEETING NEEDS-SPRING

□ Did you get enough caribou last spring to meet your needs?

□ Yes □ No

[D-1-4] SPRING MIGRATION

☐ Describe the migration of caribou last spring.

[D-1-6] SPRING SNOW AND CARIBOU

☐ Would you describe the snow last spring as?

☐ Sugar snow ☐ Hard, icy snow ☐ Other (describe)

☐ Did the snow last spring make it easy or hard for the caribou to travel?

☐ Easy ☐ Hard

☐ In what way?

☐ Did the snow this spring make it easy or hard for the caribou to dig in the snow and feed?

☐ Easy ☐ Hard

[D-1-7] SPRING BODY CONDITION

☐ Compared to other spring seasons, were the caribou last spring:

- ☐ in good shape (had lots of rump fat)?
- ☐ in fair condition (some back fat, but less than one inch)?
- ☐ in poor/skinny shape (little or no rump fat or gut fat)?
- ☐ or was there a mix of some fat caribou and some skinny caribou?
- ☐ don't know

☐ Was there anything unusual to report about these animals' body condition this past spring?

☐ No ☐ ☐ Yes *[if yes, ask]* → ☐ Please explain.

[D-1-5] SPRING MIGRATION TABLE

☐ Show me on the map where you saw caribou <u>last spring</u>.

[Label the map with a reference number from the chart and ask all the questions in the row for that reference number on the chart. If an observation is for a location not on the map, or is not related to one location, use the last row.]

Ref # on map	**Date seen**	**Moving?** (yes or no; if yes, direction moving)	**Number seen**	**Group composition**	**Type of land** (ridge tops, valley bottoms, boulder fields, shorelines, frozen lakes, water crossings, other?)	**Were the caribou feeding?**	**General comments about conditions observed**
SM-#1			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
SM #-2			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
SM #-3			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
NOT ON MAP							

[D-2] Calving (last June)

[D-2-1] Calving Locations

☐ Did you see any caribou with new calves last June?

☐ Yes ☐ No → ***[Go on to the next page, Fall Caribou]***

↓

☐ Show me on the map where you saw caribou with new calves last June

[Label the map with a reference number from the chart and ask all the questions in the row for that reference number on the chart. If an observation is for a location not on the map, or is not related to one location, use the last row.]

Ref # on map	**Date seen**	**Numbers of cows with calves?**	**Type of land where caribou were seen** (Were they on ridge tops, valley bottoms, boulder fields, shorelines, frozen lakes, water crossings, other?)
Calv #1			
Calv #2			
Calv #3			
Not on map			

[D-2-2] What Affects Calving Location

☐ Did anything in particular affect where caribou calved last spring?

☐ Yes ☐ No *[Write notes here]*

↓ ↓

☐ Which of the following affected where they calved? [Check **all** that apply]

- ☐ snow conditions
- ☐ too much snow
- ☐ not much snow
- ☐ wind
- ☐ ice conditions
- ☐ other weather conditions *[ask for details]*
- ☐ poor feed areas
- ☐ good feed areas
- ☐ wolves or other predators
- ☐ human activity *[ask for details]*
- ☐ other *[ask for details]*

[D-3] Fall Caribou Migration and Caribou Hunt (July 1 to Nov. 1)

[D-3-1] AVAILABILITY TO COMMUNITY-FALL

☐ How available were caribou to this community for hunting this past fall?

☐ Close by and easily found them

☐ Not close, required lots of effort to get

☐ Not at all available

☐ If it was difficult for people in the community to get caribou, what made it hard?

[D-3-2] HUNTING-FALL

☐ Did you go caribou hunting or see caribou this fall?

☐ Yes ☐ No

☐ When there are caribou available, do you usually hunt for caribou in the fall?

☐ Yes ☐ No

[Do not ask any more questions in this section. Go to PAGE 8]

☐ What was the main reason that you didn't go caribou hunting this fall?

☐ Caribou were too far away to try hunting them.

☐ Weather or snow conditions were too bad for hunting.

☐ Other reasons

☐ Describe these conditions

[Do not ask any more questions in this section. Go to PAGE 8]

[D-3-3] MEETING NEEDS-FALL

☐ Did you get enough caribou this fall to meet your needs?

☐ Yes ☐ No

[D-3-4] FALL MIGRATION

☐ Describe the migration of caribou this fall.

[D-3-5] FALL MIGRATION TABLE

☐ Show me on the map where you saw caribou <u>in the fall</u>.

[Label the map with a reference number from the chart and ask all the questions in the row for that reference number on the chart. If an observation is for a location not on the map, or is not related to one location, use the last row.]

Ref # on map	**Date seen**	**Moving?** (yes or no; if yes, direction moving)	**Number seen**	**Group composition**	**Type of land** (ridge tops, valley bottoms, boulder fields, shorelines, frozen lakes, water crossings, other?)	**Were the caribou feeding?**	**General comments about conditions observed**
FM-#1			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
FM #-2			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
FM #3			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding Don't know	
Not on Map			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	

[D-3-6] FALL BODY CONDITION

□ Compared to other fall hunts, were the caribou this fall:

- □ in good shape (had lots of rump fat)?
- □ in fair condition (some back fat, but less than one inch)?
- □ in poor/skinny shape (little or no rump fat or gut fat)?
- □ or was there a mix of some fat caribou and some skinny caribou?
- □ don't know

□ Was there anything unusual to report about these animals' body condition this fall?

□ No □ Yes *[if yes, ask]* → □ Please explain.

[D-4] Winter Caribou Observations (November 1 to now)

[D-4-1] AVAILABILITY TO COMMUNITY-WINTER

□ How available have caribou been to this community since the beginning of the rut?

□ Close by and easily found them

□ Not close, required lots of effort to get them

□ Not at all available

↓

□ If it was difficult for people in the community to get caribou, what made it hard?

[D-4-2] HUNTING-WINTER

□ Have you been caribou hunting or have you seen caribou this winter?

□ Yes □ No

□ When there are caribou available, do you usually hunt for caribou in the winter?

□ Yes □ No

[Do not ask any more questions in this section. Go to PAGE 11]

□ What was the main reason that you didn't go caribou hunting this winter?

- □ Caribou were too far away to try hunting them.
- □ Weather or snow conditions were too bad for hunting.
- □ Other reasons

□ Describe these conditions

[Do not ask any more questions in this section. Go to PAGE 11]

[D-4-5] WINTER TABLE

☐ Show me on the map where you have seen caribou <u>this winter</u>.

[Label the map with a reference number from the chart and ask all the questions in the row for that reference number on the chart. If an observation is for a location not on the map, or is not related to one location, use the last row.]

Ref # on map	**Date seen**	**Moving?** (yes or no; if yes, direction moving)	**Number seen**	**Group composition**	**Type of land** (ridge tops, valley bottoms, boulder fields, shorelines, frozen lakes, water crossings, other?)	**Were the caribou feeding?**	**General comments about conditions observed**
WC-#1			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
WC #-2			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	
WC #3			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding Don't know	
Not on Map			☐ Just a few caribou ☐ Lots (50 to 100) ☐ LOTS (100- 500) ☐ REALLY LOTS (more than 500)	☐ Bulls ☐ Cows ☐ Cows w/ calves ☐ Mixed groups		☐ Feeding ☐ Not feeding ☐ Don't know	

[D-4-3] MEETING NEEDS-WINTER

 Did you get enough caribou this winter to meet your needs?

 Yes No

[D-4-4] WINTER MOVEMENTS

 Describe the movements of caribou <u>this winter</u>.

[D-4-6] WHAT AFFECTS WINTERING LOCATION

 Did anything in particular affect <u>where the caribou have been this winter</u>?

 Yes No *[Write notes here]*

↓ ↓

 Which of the following affected where they have been since the beginning of the rut? [Check **all** that apply]

- snow conditions
- too much snow
- not much snow
- wind
- ice conditions
- other weather conditions *[ask for details]*
- poor feed areas
- good feed areas
- wolves or other predators
- human activity *[ask for details]*
- other *[ask for details]*

[D-4-7] WINTER BODY CONDITION

 Based on your harvest <u>since the beginning of the rut</u>, were the caribou:

- in good shape (had lots of rump fat)?
- in fair condition (some back fat, but less than one inch)?
- in poor/skinny shape (little or no rump fat or gut fat)?
- or was there a mix of some fat caribou and some skinny caribou?
- don't know

 Was there <u>anything unusual</u> to report about these animals' body condition from this winter, since the beginning of the rut?

 No Yes *[if yes, ask]* → Please explain.

[D-5] <u>General Questions about Caribou</u>

[D-5-1] HEALTH OF HERD

 Do you think the Porcupine Caribou Herd is healthy? Yes No

↓

 Why not?

[D-5-2] PREDATORS

□ Have you seen any kills of caribou by predators this past year? (Such as bears, wolves, eagles, wolverines)? *[If yes]* □ Where?

Ref # on map	Type of predator	Number of caribou and other details
Kill #1	□ Wolf □ Bear □ Wolverine □ Other_______	
Kill #2	□ Wolf □ Bear □ Wolverine □ Other_______	
Not on map	□ Wolf □ Bear □ Wolverine □ Other_______	

[D-6] Questions for People who Harvested Caribou

[D-6-1] Unhealthy Caribou

□ How many caribou did you harvest from last April until now? __________

□ Of those caribou that you harvested, how many of them looked like they were sick or unhealthy? _________________

[If some were unhealthy]

□ Describe these unhealthy caribou and mark where you found them on the map, if possible.

Ref # on map	Number of animals	Month of year seen	Sex *(circle)*	Age class *(circle)*	What was wrong with them?
UC #1			male female	Adult Yearling Calf	
UC #2			male female	Adult Yearling Calf	
Not on Map			male female	Adult Yearling Calf	

APPENDIX B – CARIBOU DATA

Year	Name of Shapefiles (.shp)	Description	Rasters
99-00	1999_2000_caribou	- All observations	car_99_00
00-01	2000_2001_caribo 2000_2001_car_fw 2000_2001_car_sp	- All observations - Fall/winter observations - Spring migration	car_00_01 car_fw_00_01 car_sp_00_01
01-02	2001_2002_calves 2001_2002_caribou_fall_migration 2001_2002_caribou_spring_migration 2001_2002_first_fall_caribou 2001_2002_caribou_winter 2001_2002_rut 2001_2002_predation 2003_2003_sick_caribou	- Calves in spring - Fall migration - Spring migration - First fall arrivals - Winter observations - Rutting areas - Predator kill sights - Unhealthy/sick caribou	calves_01_02 car_fm_01_02 car_sp_01_02 car_fc_01_02 car_w_01_02 car_rut_01_02 pred_01_02 car_sck_01_02
02-03	2002_2003_calves 2001_2002_caribou_fall_migration 2001_2002_caribou_spring_migration 2001_2002_first_fall_caribou 2002_2003_caribou_winter 2002_2003_rut 2002_2003_predation 2003_2003_sick_caribou	- Calves in spring - Fall migration - Spring migration - First fall arrivals - Winter observations - Rutting areas - Predator kill sights - Unhealthy/sick caribou	calves_02_03 car_fm_02_03 car_sp_02_03 car_fc_02_03 car_w_02_03 car_rut_02_03 pred_02_03 car_sck_02_03
03-04	2003_2004_caribou_fall_migration 2003_2004_caribou_spring_migration 2003_2004_caribou_winter 2003_2004_predation 2003_2003_sick_caribou	- Fall migration - Spring migration - Winter observations - Predator kill sights - Unhealthy/sick caribou	car_fm_03_04 car_sp_03_04 car_w_03_04 pred_03_04 car_sck_03_04

APPENDIX C – ALL SHAPEFILES

Year	Name of Shapefile (.shp)	Description
99-00	1999_2000_caribou 1999_2000_fish 1999_2000_misc	- All caribou observations - Fish locations - Miscellaneous observations (e.g., fish, berries, etc.)
00-01	2000_2001_car_sp 2000_2001_car_fw 2000_2001_misc	- Spring caribou migration - Fall/winter caribou observations - Miscellaneous observations (e.g. fish, berries, etc.)
01-02	2001_2002_bears 2001_2002_birds_prey 2001_2002_calves 2001_2002_caribou_fall_migration 2001_2002_caribou_spring_migration 2001_2002_caribou_winter 2001_2002_cranberries 2001_2002_first_caribou_fall 2001_2002_ha_airplane 2001_2002_ha_atvs 2001_2002_ha_snowmobile 2001_2002_ha_subsisthunt 2001_2002_ha_tourism 2001_2002_human_activity 2001_2002_lifetime 2001_2002_loche_liver 2001_2002_moose 2001_2002_muskoxen 2001_2002_predation 2001_2002_rut 2001_2002_salmonberries 2001_2002_sick_caribou 2001_2002_small_birds 2001_2002_water_level 2001_2002_waterfowl 2001_2002_wolves	- Bear observations - Birds of prey observations - Caribou calves in spring - Fall caribou migration - Spring caribou migration - Winter caribou observations - Cranberry locations - First caribou fall arrivals - Human activity (airplanes and helicopters) - Human activity (ATVs) - Human activity (snowmobiles) - Human activity (subsistence hunting) - Human activity (tourism) - All human activity - Lifetime use area - Loche liver abnormalities - Moose observations - Muskoxen observations - Caribou predator kill sights - Caribou rutting areas - Salmonberry locations - Unhealthy or sick caribou - Small bird observations - Water level observations - Waterfowl migration observations - Wolf observations
02-03	2002_2003_bear_cubs 2002_2003_bears 2002_2003_birds_prey 2002_2003_calves 2002_2003_caribou_fall_migration 2002_2003_caribou_spring_migration 2002_2003_caribou_winter 2002_2003_freeze 2002_2003_human_activity 2002_2003_lifetime 2002_2003_loche_liver 2002_2003_lynx 2002_2003_moose 2002_2003_muskoxen 2002_2003_predation 2002_2003_rut 2002_2003_sick_caribou 2002_2003_small_birds 2002_2003_waterfowl	- Bear cub observations - Bear observations - Birds of prey observations - Caribou calves in spring - Fall caribou migration - Spring caribou migration - Winter caribou observations - Freeze-up locations - All human activity - Lifetime use area - Loche liver abnormalities - Lynx observations - Moose observations - Muskoxen observations - Caribou predator kill sights - Caribou rutting areas - Unhealthy or sick caribou - Small bird observations - Waterfowl migration observations

	2002_2003_wolves	- Wolf observations
03-04	2003_2004_bear_cubs 2003_2003_bears 2003_2004_berries 2003_2004_birds_prey 2003_2004_caribou_fall_migration 2003_2004_caribou_spring_migration 2003_2004_caribou_winter 2003_2004_fish 2003_2004_ha_airplane 2003_2004_ha_atvs 2003_2004_ha_gasoil 2003_2004_ha_other 2003_2004_ha_researchers 2003_2004_ha_snowmobile 2003_2004_ha_sporthunt 2003_2004_ha_subsisthunt 2003_2004_human_activity 2003_2004_lifetime 2003_2004_loche_liver 2003_2004_moose 2003_2004_muskoxen 2003_2004_polar_bear_predation 2003_204_predation 2003_2004_salmon 2003_2004_sick_caribou 2003_2004_small_birds 2003_2004_trap 2003_2004_waterfowl 2003_2004_wolves	- Bear cub observations - Bear observations - Berry locations - Birds of prey observations - Fall caribou migration - Spring caribou migration - Winter caribou observations - Fish locations - Human activity (airplanes and helicopters) - Human activity (ATVs) - Human activity (gas and oil) - Human activity (other) - Human activity (researchers and scientists) - Human activity (snowmobiles) - Human activity (sport hunting) - Human activity (subsistence hunting) - All human activity - Lifetime use area - Loche liver abnormalities - Moose observations - Muskoxen observations - Polar bear observations - Caribou predator kill sights - Salmon locations - Unhealthy or sick caribou - Small bird observations - Trapping line - Waterfowl migration observations - Wolf observations

APPENDIX D: RELATING TABLES IN ARCVIEW 3.2 AND ARCMAP 9

Relating Tables in ArcMap 9

1. Open both the shapefile and the external Access table by clicking the *add data* button in ArcMap;
2. In the table of contents, right click on the shapefile,point to *joins and relates*, and click *relate*;
3. In the relate box, click the first dropdown arrow and select the appropriate field (i.e., *Poly_ID*) in the shapefile that the relate will be based upon;
4. Click the second dropdown arrow and select the table to relate the shapefile to;
5. Click the third dropdown arrow and select the field (*PolygonID*) in the related table to base the relate on;
6. Type a name for the relate as you will use this name to access the related data;
7. Click *OK* in the relate box;
8. To display related records in the access table, open the attribute table for the shapefile, right click on the shapefile in the table of contents and choose *open attribute table*;
9. Select the records in the attribute table for which you want to display related records in the access table;
10. Select *options*, point to *related tables*, and select the name of the relate you want to access and this will highlight all records (and therefore map reference codes) in the access database that are associated with this polygon. If you relate to a table that does not have an ObjectID column (i.e., Delimited text files or OLEDB tables), you will not be able to apply selections using the relate. The related tables command from the table window's options menu will list the relate, but it will be dimmed out. The identify tool, however, can still be used to find related records. To apply selections using the relate you must export the access table by right clicking on the access table and selecting Data > Export (this will assign an ObjectID column to the table);
11. To manage the relate, select a table or layer in the table of contents and click *properties*. Select the *joins and relates* tab. All relates for the selected layer or table are listed on the right side of the dialog. You can add new relates or remove existing ones;
12. To remove the relate between the tables, choose *remove relate(s)* and *remove all relates* from the *joins and relates* menu (Gartner Lee Ltd., 2003).

Relating Tables in ArcView 3.2

1. Open the source table (access mdb) that you wish to link to the destination table (shapefile). If the source table is not in your project, add it to your project first.
2. Click on the name of the field in the source table that will be used as the common field for the link.
3. Open the destination table that you wish to link the source table to.
4. Click on the name of the field in the destination table that will be used as the common field for the link. This field does not need to have the same name as the one you choose in the source table, but it must contain the same data so that the link can be established.

5. Choose Link from the Table menu.
6. The table that is active when you choose Link is the destination table. The last table that was active is the source table (Gartner Lee Ltd., 2003).

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