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Commercial use of caribou (*Rangifer tarandus*) in the Canadian Arctic

by

Joseph Ignace David Dragon ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

Wildlife Ecology and Management

Department of Renewable Resources

Edmonton, Alberta

Fall 2002

0-612-81183-2

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled ***Commercial use of caribou (Rangifer tarandus) in the Canadian Arctic*** submitted by ***Joseph Ignace David Dragon*** in partial fulfillment of the requirements for the degree of ***Doctor of Philosophy*** in ***Wildlife Ecology and Management***.

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ABSTRACT

This thesis on commercial use of caribou (*Rangifer tarandus*) in the Canadian Arctic provides insight into the development of the commercial hunting industry and analyzes specific case studies of market hunting and large-scale commercial hunting activities in an attempt to ascertain the biological and economic sustainability of commercial harvesting.

An evaluation of market hunting in the South Slave region of the Northwest Territories was based on personal interviews with Aboriginal hunters. Data from 1989 to 2001 provided approximately 60 market hunts involving 1 312 caribou. Over 70 percent of the hunts occurred during February and March. Caribou herds comprised of cow and bull herds accounted for 43 percent of the overall market hunts, whereas groups of bulls accounted for 32 percent and cow groups accounted for the remaining 25 percent. Prices for caribou, attained through market hunting activities, averaged Can$2.05 to $2.56 per kilogram.

A dynamic deterministic simulation model using STELLA software was used to evaluate the ecological impact and economic viability of a large-scale commercial harvesting on Southampton Island, Nunavut. A biological and economic analysis of this Arctic ecosystem and the effect of current subsistence hunting, historic large-scale commercial harvests, possible re-introduction of wolf (*Canis lupis*), and future large commercial hunts were evaluated through simulation. Extremely high fecundity (0.99 for yearlings and adults) and low mortality (0.01 for calves, yearling, and adults) were required to fit the observed rate of increase from 1967-

1997. Simulations indicated initial peak densities of 3.6 caribou/km^2 before collapse. Using high wolf predation efficiencies, the model suggested that wolves may be able to regulate the caribou herd to 0.4 caribou/km^2. Approximately 7 373 caribou or 400 000 lbs. dressed carcass meat had to be harvested to stabilize the herd at 0.58 caribou/km^2. Using Net Present Value analysis, harvest operations showed minimum sensitivity to discount rate manipulation but were very sensitivity to price variation. Break-even prices of Can$2.56, $2.49, $2.45, and $2.43/lb were realized at 120 000, 160 000, 200 000, and 240 000 pounds, respectively.

Commercial hunting of caribou in the Canadian Arctic provides Aboriginal people with the opportunity for ecosystem management and offers sustained economic development opportunities in remote communities in the form of wage employment that is similar to their traditional hunting activities. By adapting to the ever-changing demands of both the resource and northern communities, commercial hunting of caribou should remain a viable option in the Canadian Arctic.

ACKNOWLEDGEMENTS

To my wife, Leslie and our son, Max, thank you for your love and support during this entire thesis process. I could not have completed this without your constant commitment and encouragement Leslie Rae and you are the love of my life.

I extend my sincere thanks to my supervisory committee: Bob Hudson, Ross Wein, Vic Adamowicz, and Cormack Gates. In particular, I would like to thank my supervisor, Bob Hudson, for his continual support, fantastic enthusiasm, and uncanny ability for knowing just about everything there is to know about wildlife production systems and ecosystem management - Bob, you are a wonderful teacher. I would also like to thank Scott Jeffrey and Ron Graf for providing supervisory roles during my project.

Financial support was provided by the Government of the Northwest Territories Department's of Resources, Wildlife and Economic Development and Education, Culture and Employment. In addition, I thank TransCanada Pipelines, the Beverly and Qaminirjuaq Caribou Management Board Scholarship, and the Fort Smith Metis Association for providing additional financial support.

I would like to acknowledge the guidance of Susan Fleck, John Colford, Lloyd Binder, Brian Threadkill, Dave Pelling, Earl Evans, and Ken Hudson - your commitment to providing insightful, intellectual comments during the dissertation process was very much appreciated and will provide an excellent reference for additional research.

During my research, I was able to interact with many great people who helped me with logistical support, document retrieval, research assistance, or general advice with respect to commercial hunting in the North. I would like to thank the following people: Norm Mair, Ian Ellsworth, Tim Divine, Ron Morrison, John Nishi, Sandy Buchann, John Best, Jeff Watt, Kevin Smart, Kevin Lloyd, Calvin

Schindell, Brett Elkin, Alison Welch, Luke Cody, Richard Olsen, Bob Sturm, Milton Freeman, Bernie Bergman, Nick Kaeser, Dan Westman, Gerry LePrieur, Julie Barnett, John F. Olson, and the Aiviit Hunter's and Trapper's Organization. I would also like to thank the following people for graciously allowing me to stay with them for extended periods of time while studying in Edmonton: Lee Bourassa (deceased), Darcy Draper, Megan and John Stock, and Shelley Pruss and Garry Scrimgeour.

To my sister Sabrina, thank you for being such an inspiring role model. To my sisters, Brenda, Connie, and Joy - thanks for all the encouragement. To my mom and dad, I cannot begin to express my appreciation for all your support and for allowing me to follow my dreams - I only hope I can be as good of a parent as you have been to all of us. To Bob and Lynne (mom) Russell, thanks for making my transition to the South so easy and I'm so grateful to you both for letting me be a part of your family.

Finally, I would like to thank Mr. Bob McLeod. Bob, you have been a excellent mentor for me and I am truly thankful for your guidance, encouragement, advice, and support during my career. I hope that I can one day fill this role in a young Northerner's dream.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Aboriginal people (Dene, Inuit, and Metis) in the Canadian Arctic have depended for centuries on the hunting of caribou (*Rangifer tarandus*) for subsistence, cultural values, and social interactions with adjacent bands (Freeman, 1986; Freese, 2000). The early sharing and trading of caribou meat for other forms of wildlife products (meat, fish, furs, etc.) or manufactured clothing items (moccasins, parkas, mitts, etc.) between Aboriginal groups was commonplace before contact with non-Aboriginal people (Crowe, 1991; Freeman, 1986). These dealings can be described as the earliest form of commercial hunting for caribou in the Canadian Arctic.

With the onset of European exploration to the Canadian Arctic, explorers, whalers, and later fur traders further developed this practice with the trading of material goods for caribou carcasses (Gordon, 1996; Oswalt, 1979; Riches, 1982). This trading relationship between Aboriginal hunters and non-Aboriginal buyers of caribou meat eventually developed into monetary exchange with the extension of credit to the Aboriginal people (Ray, 1996). The Aboriginal people were able to bridge to the cash economy through the fur trade but with its collapse, they had few alternatives (Ray, 1996; Smith and Burch, 1979).

The federal government's social policy of developing permanent rural communities throughout the Canadian Arctic in the 1950s and 1960s meant Aboriginal people had fewer chances to harvest from the migratory caribou herds (Smith and Burch, 1979). The challenge of government was to develop economic development programs that allowed Aboriginal harvesters to use traditional harvesting/cultural practices to participate in the newly introduced cash economy.

To meet this challenge, the government helped initiate, over the last century, four commercial resource related programs in collaboration with local Aboriginal resource users:

1) A reindeer herding industry was initiated in the early 1900s. However, this program had many setbacks and faced many challenges, including acceptance of the herding lifestyle (Hill, 1967; Nasogaluak and Billingsley, 1981; Scotter, 1972, 1982, 1989; Treude, 1979; and Stager and Denike, 1972).

2) Community organized caribou hunts were introduced in the late 1960s. These hunts were subsidized by the federal and territorial governments and were developed by government and Aboriginal organizations to provide meat supplies to the small, remote, predominately Aboriginal communities of the Canadian Arctic who had difficulty accessing migratory caribou herds (Bisset, 1974).

3) Market hunting which saw local Aboriginal harvesters hunting caribou for commercial sale within their respective communities (late 1980s) (Dragon, 1999).

4) Large-scale commercial caribou and muskoxen (*Ovibos moschatus*) hunts were developed in the mid 1990s to supply federally approved meat product for export sales (Dragon, 1999; Gunn et al. 1981).

This thesis evaluates the latter two examples of these commercial resource related programs; specifically market hunting and large-scale commercial caribou hunts.

Market hunting of caribou satisfies the Aboriginal community needs by providing wild caribou meat supplies to Aboriginals in the Canadian Arctic. This activity has been a long-standing practice in the Canadian Arctic and continues to provide Aboriginal hunters with opportunities to participate in a hunting activity that allows for additional recreation and cultural opportunities, supplemental revenue generation, as well as fulfilling personal and community-based needs. Due to the extensive logistical requirements of obtaining caribou meat supplies in the South Slave Region of the Canadian Arctic, this area was chosen to analyze market hunting activities by Aboriginal hunters. Hunters were interviewed and a full description and interpretation of market hunting activities are presented.

It is difficult to understand the impacts of large-scale commercial hunting on free roaming wild caribou populations due, in large part, to the immense size of herds within the Canadian Arctic, their geographic ranges, and the lack of precise population data required to monitor herd effects. However, a caribou herd located on an island in the eastern Arctic, Southampton Island (SHI), Nunavut, provided an excellent opportunity to study the effects of large-scale commercial hunting on the caribou herd and the local economy in a relatively controlled environment.

In 1967, approximately 48 caribou were captured and transported from nearby Coats Island to SHI (Parker, 1975). Free of predators, fully protected from hunting, and abundant vegetation allowed the herd to increase exponentially since introduction (Ouellet, 1992). Arctic re-introductions of *Rangifer* to islands have historically culminated in a dramatic rise in population numbers followed by a subsequent crash (Klein, 1968; Nishi, 1993; Scheffer, 1951). Heard and Ouellet (1994) predicted that without intervention, the SHI herd would potentially increase beyond the island's carrying capacity and subsequently crash similar to other insular populations. Commercial harvesting was initiated primarily as a herd management initiative to control herd growth but was also intended to generate economic development within the community (Threadkill and Associates, 1995-2001). With over 30 years of collected data, the SHI system provides an excellent opportunity to study the effects of subsistence and commercial hunting on this herd of caribou. The resource dilemma faced by government officials and Aboriginal groups in the Canadian Arctic is that harvesting of any wild species for profit tends to either open up the species to overharvesting or subject the parties carrying out the activities to potential financial uncertainty (Caughley and Gunn, 1995; Conrad, 1989; Mackenzie, 1995).

My research on commercial harvesting of caribou in the Canadian Arctic provides greater insight into the development of this industry, the rationale for commercial harvesting, current policy and legislation surrounding commercial harvesting, and analyzes specific case studies of commercial hunting activities in an attempt to ascertain the biological and economic sustainability of commercial harvesting of caribou in the Canadian Arctic. Accordingly, my research approach was to provide papers that are included in chapters 2 through 7 that address these key issues. Each chapter is intended to discuss the findings in relation to commercial harvesting of caribou in the Canadian Arctic.

Chapter 2 documents a historical perspective of the emergence of commercial hunting of caribou in the Canadian Arctic. Chapter 3 reviews and analyzes present day commercial hunting activities (market hunting, organized community hunts, and large-scale commercial hunts) by describing the role of government as well as private industry and community involvement in these operations. Chapter 4 reviews and evaluates current government policies and legislation pertaining to commercial harvesting of caribou in the Canadian Arctic. Chapters 5-7 consider specific case examples where market hunting and large-scale commercial hunting projects are taking place in the Canadian Arctic. Chapter 5 documents caribou market hunting activities in the South Slave region of the NWT. Chapter 6 and 7 uses a simulation model using STELLA simulation software to evaluate the population and economic viability of commercial harvesting on SHI. Chapter 6 provides a biological analysis of SHI and the effect of subsistence hunting and past large-scale commercial harvests. Chapter 7 builds upon the previous chapter by including a commercial hunting component to the SHI ecosystem. This simulation replicates several harvesting scenarios in order to evaluate the economic and biological sustainability of large-scale commercial harvesting on the island.

The purpose of this study is to provide insight into the historical and present day variables and effects of commercial harvesting of caribou in the Canadian Arctic so that managers can make more informed decisions with regards to future commercial harvesting activities. Specifically, my study addresses the following questions relating to the commercial use of caribou in the Canadian Arctic:

- What has been the impetus for the development of commercial harvesting?
- Do government policies and legislation address current commercial utilization of caribou?
- Under what conditions is commercial hunting economically viable?
- Should government continue to provide financial assistance to commercial harvesting activities?
- In the case of Southampton Island, can commercial harvesting control the exponential growth of a caribou herd within the carrying capacity of its habitat?

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CHAPTER TWO

EMERGENCE OF COMMERCIAL HUNTING OF CARIBOU IN THE CANADIAN ARCTIC

INTRODUCTION

The history of commercial use of ungulates in the Canadian Arctic[1] can be traced to a series of social and marketplace adaptations by Aboriginal people. Trade of wildlife resources between Aboriginal groups has been occurring for thousands of years (Freese, 2000). However, in the last 500 years, contact with explorers, whalers, and fur traders transformed the hunting traditions and barter exchanges of the Aboriginal people (Krech, 1974; Oswalt, 1979; Purich, 1992). Aboriginal hunting practices were further altered by the appearance of government programs and the development of alternative wage based employment in the Canadian Arctic.

This chapter presents a brief overview of events and ecological and socio-economic changes that have affected the commercial hunting of caribou in the Canadian Arctic. Each development was analyzed with the goal of presenting the reader with a historical perspective of commercial hunting of caribou (*Rangifer tarandus*).

Hunting traditions and the barter economy

Before contact with European explorers, Aboriginal people were a nomadic group of opportunistic hunters with a well-established transitory lifestyle (Spies, 1979).

[1] For the purposes of this work: The Canadian Arctic includes the Northwest Territories and Nunavut Territory. At the onset of this work, both the Nunavut Territory and the Northwest Territories were termed the Northwest Territories before the Nunavut Territory division on April 1,1999.

Aboriginal peoples' hunting and trapping patterns followed seasonal and resource availability patterns (Ray, 1996). Both Inuit and Dene depended on the migratory caribou herds for subsistence. When caribou herds were not available due to migrations, hunters would rely on provisions from earlier hunts or alternative species for food (Pike, 1892).

The erratic nature of caribou migrations meant that regional bands would sometimes cross an adjacent band area in search of caribou. Social isolation could result in starvation for people depending on caribou and consequently, Aboriginal hunters would occasionally participate in hunting activities with members of different regional bands (Arnold, 1989). This form of hunting was practised among related hunting parties (i.e. blood and marriage ties) but was established with unrelated or distantly related individuals as well. Arnold (1989:21) notes:

> "Unrelated hunters could camp and hunt together at a caribou crossing and would share their game on the basis of these partnerships. A hunter would also share the caribou which he had killed with relatives in the camp."

I contend that this early form of sharing and trading of game by Aboriginal people within their respective bands and among regional bands, was in fact an early form of commercial use of resources. The hunted or trapped resources that were shared/traded did not involve monetary compensation but were traded based on value and need. Aboriginal hunters were rewarded by the trade of other goods which they could not acquire themselves such as other meat supplies (dried meat, pemmican, etc.), fish supplies, clothing, tools, and metals (Crowe, 1991). Crowe (1991:25) commented on barter among Aboriginal groups:

> "Depending on the region, a variety of other things were made for sale - blankets of woven strips of rabbit skin, nets of hide or willow bark, ochre powder for paint, bags of seal

> oil, dried meat, wooden bowls, sled-runners, mats of rush and willow, canoes, snowshoes, lamps, bowls, moccasins, and sealskin boots."

Each person belonging to a band or group had his or her own role (i.e. hunting, fishing, sewing, etc.), which would ensure the sustainability of the whole group. This form of trading resources within and amongst Aboriginal people allowed for a high level of interdependence among groups. Ray (1996:6) explains:

> "the 10-12,000 year history of settlement and cultural development in Native Canada meant that Europeans encountered a very diverse and well-rooted peoples when they arrived on the scene".

The Aboriginal nomadic hunter of the past has been gradually transformed by the interaction of rural society into their culture. This transformation has had its costs on Aboriginal societies throughout the Canadian Arctic. An in-depth study of these key developments is beyond the scope of this work but a brief synopsis of each event is presented.

APPEARANCE OF NEW MARKET FOLLOWING EUROPEAN CONTACT

Explorers

Aboriginal people were quick to respond to new market opportunities following European contact. Contact with European explorers in the late 1500s initiated the first trading activities between Aboriginal people and non-Aboriginal people. Skins, pelts, and meat harvested from caribou and muskoxen (*Ovibos moschatus*) were exchanged for iron tools and utensils. Aboriginal peoples' nomadic rounds did not change as a result of trading and they continued to live their transitory lifestyle that allowed them to periodically trade with European traders. The Inuit acquired European goods that increased the efficiency of their hunting and working tools. Trading, although an opportunistic event, was highly valued by the Inuit because it would ease the life of these nomadic hunters (Purich, 1992).

Early exploration in the Arctic began with the voyages of Martin Frobisher in 1576, who led an expedition in search of a Northwest Passage to Asia (Gordon, 1996; Hantzsch, 1977; Purich, 1992). Further expeditions in the search of a Northwest Passage from the late 1500s to the early 1600s included John Davis in (1585), Henry Hudson (1610), William Baffin and Robert Bylot (1615 and 1616) (Neatby, 1958). British Arctic exploration peaked in the thirty-year period following the end of the Napoleonic Wars in 1815 (Purich, 1992). In the early nineteenth century, England had an abundance of under-utilized ships and unemployed sailors. As a result, the search for a Northwest Passage came in vogue again (Purich, 1992). The second wave of explorers had John Ross rediscovering Lancaster Sound in 1818 followed by his second in command, Lieutenant William Edward Parry, who travelled a similar route in 1819. John Franklin made three trips to the Arctic in 1819, 1825, and the famed lost voyage of 1845. Franklin, commanding a large expedition of two ships in search of a Northwest Passage, sailed into Lancaster Sound and never returned. His failure to return from his expedition spawned a new era of Arctic exploration termed the "Franklin searches". The searches, consisting of a total of eight ships and several land expeditions, lasted until 1880 (Purich, 1992).

Sporadic contact with European explorers after this time had little effect on the Inuit culture. During this period, Inuit providied explorer crews with fish and caribou. Aboriginal hunters and trappers began to trade pelts and hides for European iron objects such as axes, knives, and other steel implements (Purich, 1992). Aboriginal people, who were more of a subsistence or provisioner people (Kenyon, 1997), depended primarily on the animals that they harvested for food and tools that they used in everyday life (Gordon, 1996). With the newly acquired trade goods from the explorers, the Inuit found it a lot easier to manufacture their tools made of bone and ivory with the iron-bladed tools obtained from the explorers (Oswalt, 1979).

The initial trading practices between explorers and Inuit for caribou meat occurred without monetary compensation. A reciprocal value relationship was practiced during this period as meat supplies and clothing was actively traded for metal tools. Both parties mutually benefited from these transactions. Trade was limited to the goods the explorers carried with their ship. Dependence on these 'foreign' goods did not occur in Aboriginal societies during this period (Riches, 1982) but a civil relationship between the distinct cultures was formed. This relationship would later facilitate trading practices among them.

Whaling

The second transformation of northern Aboriginal life began with the development of the whaling industry in the Arctic (Purich, 1992). Whaling ships from England, the United States, and later Scotland arrived off the coast of northern Canada to take advantage of the abundant bowhead whales (*Balaena mysticetus*) (Hantzsch, 1977). There was a high European demand for whale oil and baleen. Baleen was used in corset stays for women, buggy whips, and other products requiring elasticity and flexibility (Oswalt, 1979). Along with this infiltration of non-Aboriginal people to the Canadian Arctic, over-exploitation of the resident renewable resources occurred most notably of the bowhead whale (Conrad, 1989; Purich, 1992), caribou (Kelsall, 1968; Nasogaluak and Billingsley, 1981; Parker, 1972) and muskoxen (Barr, 1991; Gunn et al. 1991), the later being were killed by whalers for food and sport (Rutherford et al. 1922). Although the whalers brought many provisions from Europe, such as preserved beef and pork, these often spoiled. The whalers sought fresh meat and the important vitamin C that it provided, to deter the disease scurvy (Kenyon, 1997).

Kenyon (1997:19) commented on the use of Aboriginal labour sources for acquiring caribou carcasses:

> "Evidence for discrete sites assigned for provisioning purposes is rare (if non-existent), but whaling ships' logs are available which describe the volume of meat resources - predominantly caribou - that were brought in by trade with independent natives as well as through contract with predominately native labour (see Cassell, 1989)"

Oswalt (1979:293) remarked on whalers wintering on the western shore of Southampton Island:

> "Eskimos were hired as hunters to provide fresh meat, and whaleboat crews consisting of Eskimos hunted whales for different vessels"

Whalers began wintering and set up "whaling posts" at the edge of the sea to get a jump on whaling activities in the spring. Whalers hired Aboriginal people to help with post hunt activities as well as secure game for the crews (Kenyon, 1997; Scotter, 1989). Inuit were used for hunting caribou during the summer and fall months and seals in the winter (Hantzsch, 1977). However, with the whalers high demand for caribou and muskoxen as food in combination with the ability to trade for goods such as rifles, ammunition, tobacco, alcohol, tea, and clothing, Inuit began to change their hunting practices by remaining at these posts and hunting for the whaling crews. Living among the whaling posts, Inuit became dependent on European goods. Ross (1977) commented on the acquired dependency upon foreign goods by Inuit:

> "A self-reliant people accustomed to supporting themselves in one of the world's severest environments grew steadily more dependent upon external sources of food and clothing".

Living near the whaling stations provided the Inuit with convenient trade goods, which made life easier, but also introduced infectious diseases such as measles and smallpox to which the Inuit had no immunity. For the first time, this nomadic culture became sedentary. Ross (1977) described this transition:

> "For the Eskimos, whaling provided a means of obtaining a variety of useful imported goods, either as wages or in trade. But the price was high. Nomadism was to an extent replaced by concentration at whaling harbours; hunting declined and diets changed; diseases took their toll; population diminished".

After a half century of whaling, the demand for whale products decreased abruptly, as had the whale population (Hobart, 1981). British whaling companies now had an abundance of ships with many unemployed whalers (Purich, 1992). However, the fur trade in Europe was growing and this led to the influx of European ships into the coastal and inland areas of the Canadian Arctic in search of furs. From 1900 to 1926, whaling developed into what was termed free trading. Small trading companies, all British, bartered with Inuit from shore stations or ships that came to the area in the summer. Inuit once again tradied their labour or caribou meat for whalers' trade goods (Purich, 1992).

The decline of muskoxen and caribou was drastically affected by the introduction of firearms and the onset of Inuit hunting to feed whaling crews (Barr, 1991; Kenyon, 1997; Scotter, 1989). The shortage of meat forced many Inuit into trapping furbearers in order to obtain money to buy food and other necessities from the whaling posts. This period of time witnessed the beginning of a money based market economy for the Aboriginal society in the Canadian Arctic. Non-Aboriginals dictated values associated with meat supplies, fur harvests, and labour. Trading was based on supply and demand in the local market and back in Europe. However, fur from Northern Canada began to fetch high prices on European markets (Ray, 1974).

Fur trade

The fur trade in Canada traces its origins to the incorporation of the Hudson's Bay Company (HBC) in 1670 (Gordon, 1996). In 1717, the HBC established a fur trading post at Churchill to open trade with the Indians farther west (Ray, 1974). The subsequent travels of HBC explorers into the Subarctic regions of Canada were the beginnings of trade with the Dene of the Canadian Arctic (Cranstonsmith, 1995). One of the first explorers into the barrenlands was an HBC officer named Samuel Hearne. Hearne was in search of the Coppermine River in the years 1769 to 1772 (Harper, 1964). With the aid of a famous Chipewyan chief named Matonabbee, Hearne was finally able to complete his journey (Vandiveer, 1929). Hearne (cited in Yerbury (1986:130) stated that in 1771 the Chipewyan still:

> "live generally in a state of plenty, without trouble of risk; and consequently must be most happy, and, in truth, the independent also" and are seldom "exposed to the gripping hand of famine, so frequently felt by those who are called the annual traders" (Hearne, 1971:82-83).

By setting up posts or Forts in many areas across the north, explorers continued to expand the HBC's role in the fur trade in northern Canada. At the peak of the fur trade, the HBC ran over 100 posts in nearly 80 locations (Yerbury, 1986).

The interactions between Inuit (Arctic regions) and Dene (Subarctic regions) with fur traders had similar detrimental effects on both cultures (Ray, 1996). Increased dependence on trade goods which included hatchets, knives, firearms, ammunitions, trapping tools, net lines, twine, liquor, and tobacco (Ray, 1996) and food supplies including flour, tea, and sugar (Cranstonsmith, 1995) was observed in Aboriginal populations. Arthur Ray (1996) postulates that modern Native welfare societies are of recent origin and traces the causes to the early fur trade. Ray looked at the evidence of over two and one-half centuries of historical data to suggest that:

> "faunal depletions, scarce resources, the establishment of posts in marginal areas, the existence of low-paying seasonal employment, and the extension of trade goods on credit combined to produce dependent welfare societies in the late nineteenth and early twentieth centuries" (Yerbury, 1986:7).

With the increased dependency on European goods, northern Aboriginal peoples' nomadic cycles, which flowed with the seasons and availability of food, became reversed (Ray, 1996; Riches, 1982; Yerbury, 1986). Instead of remaining near coastal borders to harvest and store seal meat, Inuit trappers headed inland to trap white fox (*Alopex lagopus*) to trade for European goods (Gordon, 1996). Rutherford et al. (1922) describes an instance of a trader, from the HBC (Kent Peninsula), who had induced most of the Natives to quit sealing in order to catch more foxes. The trader's desire to obtain larger quantities of fur led to hiring Inuit to hunt seals to feed those who were trapping (Rutherford et al., 1922). With the introduction of firearms, some Inuit trappers were seen:

> "shooting as many caribou as possible, often to lure foxes" (Rutherford et al., 1922:74).

Aboriginal trappers were changing trapping patterns in response to the emergence of new market opportunities (Smith and Burch, 1979). The white fox was not a furbearer that was traditionally trapped by the Inuit. However, the increased dependence on European goods drove the Inuit farther inland in search for this furbearer (Harper, 1964; Purich, 1992). This occurred at approximately the same period when the Dene and Metis were moving from the edge of the treeline farther into the boreal forest to trap the beaver (*Castor canadensis*) sought so actively by the HBC (Ray, 1996). The consequence of moving to better-suited habitat for trapping and closer proximity to the posts for trading made life for the Aboriginal harvester more sedentary than nomadic. By setting traplines, Aboriginal trappers would now be spatially restricted in order to check traps and to trade with fur traders. Reliance on the various Forts for metal goods and food became commonplace (Ray, 1974). Material goods switched from being a luxury item to a necessity for Aboriginal trappers (Van Stone, 1974).

Harsh environmental factors in the Canadian Arctic and Subarctic regions dictate that any act(s) or device(s) that could make nomadic life easier were quickly adapted into the Aboriginal lifestyle. This adaptation within Aboriginal society was first witnessed by early trading practices with Europeans. Trading resulted in Aboriginal people acquiring metal tools such as knives, axes, and other steel implements that led to easier manufacturing of tools for hunting. Later, trading practices centered on the acquisition of rifles that dramatically increased success rates of hunting caribou and other game. The use of rifles in warfare and hunting practices also dramatically changed traditional demographic alignments throughout the Athapaskan territories (Van Stone, 1974). Although these adaptations or tools modernized and eased Aboriginal lifestyles, their trade value began to shift from a single valued transaction (i.e. one beaver pelt to one metal implement) to a multiple ratio (i.e. 10 beaver pelts to one firearm) depending on the trader (Crowe, 1991). Relying on modernised tools and accessible food supplies soon left the Aboriginal people dependent on Forts and traders for most goods.

Credit became an integral part of the HBC's plan to "lure" Inuit, Dene, and Metis into the fur trade (Cranstonsmith, 1995; Gordon, 1996; Ray, 1974; Van Stone, 1974; Yerbury, 1986). Ray (1996) elaborates that credit trading was very compatible with the Aboriginal tradition of sharing food. The varying paths of caribou migrations over generations would lead these people to share their food with other groups of their bands when they were in need of food (Pike, 1892). When the trader developed social and economic bonds with a particular Aboriginal group, the Aboriginals would expect the trader to provide what they required at time of need as well (Yerbury, 1986). Aboriginal trappers saw their credits as a personal debt to the individual trader and not to the HBC. Credit became a means of indenturing Aboriginal people to company stores in the fur trade. From a trader's standpoint, the more credit he could extend to a Aboriginal trapper meant the trapper would not fall into the hands of competitors. The trader could then oversee that the trapper would have the equipment necessary to harvest more furs. Van Stone (1974:97) commented on this credit relationship with Aboriginals:

> "It was essential that the trader give credit in order to receive fur; a trapper not working his trapline because he could not obtain credit was certainly of no value to the trader".

In some instances, Fort managers depended on some Aboriginal hunters to harvest meat for the Fort employees at individual Forts. In the 1840's, Kutchin men in Fort McPherson were hired to hunt for caribou to supply the Fort (Krech, 1974). Cranstonsmith (1995:1) elaborated further on the dependency of caribou in the fur trade:

> "Caribou, exploited freely, was indispensable to the success of the early fur trade both as a domestic meat supply for Indian trappers and as a trade commodity to provision fur trading posts".

Missionaries, who arrived in the Subarctic regions in the mid 1800s, also depended on Aboriginal hunters. Hunters would provide the missionaries with fresh meat, dry meat, fat, and pemmican in trade for powder, ball, shot, files, knives, axes, thread, needles, calico, and flannel (Cranstonsmith, 1995).

Increased trading activities brought new technologies to Aboriginal people. The acquisition of the repeating rifle, steel trap, western clothing, and the use of dog teams increased dramatically during this time period (Crowe, 1991). The increase in dog team use put a strain on caribou populations, as trappers now had to hunt more caribou to feed their dog teams. Although the repeating rifle enabled the procurement of more animals for trapping activities, it drastically reduced the caribou herds in the close proximity of the Forts (Kelsall, 1968). This meant that Aboriginal hunters would have to travel great lengths to acquire caribou and would often decline to do this, as they were now dependent on the Fort for their provisions. Fort credit would be used for their food provisions. It was estimated that the Chipewyan were spending as much as 39 percent of their credit on food (Yerbury, 1986).

The demise of the fur trade began with the onset of World War I between the years 1914 and 1919 (Ray, 1974). Fur prices were low and credit was cut off to Aboriginal trappers who were unable to buy the bare necessities of life. Relief was needed in the Aboriginal population because the resources they traded, such as meat, skins, and pelts, no longer had the same value associated with them as in the past. Wages earned through hunting and trapping could no longer keep up with the prices of food and other necessities from the posts. In order to address this predicament, the Canadian government proceeded to encouraged Aboriginal people to move into settlements.

Earlier hunting practices of both traders and Aboriginals resulted in a decline in caribou populations and thus a lack of meat supplies in many communities. The lack of meat in these northern locations, combined with the reduced availability of meat in Canada during World War I, prompted the investigation of alternative sources of meat production. The Canadian government investigated reindeer ranching and commercial utilization of caribou and muskoxen in the Canadian Arctic.

GOVERNMENT INVOLVEMENT

Early investigations into commercial use of reindeer and muskoxen

In 1917, the reduced availability of meat during World War I prompted the Canadian government to look into the possibilities of using caribou to supplement the wartime supply of meat. Cranstonsmith (1995:83) comments:

> "A scheme to use caribou on a massive scale to supplement dwindling wartime meat supplies was investigated in depth by the Advisory Board of Wild Life Protection in the interest of National Service. Plans to export caribou meat continued well into the spring of 1918. Only the difficult logistics of storing and shipping the meat delayed putting the project into operation before the war ended on November 11, 1918 (NAC RG 85, Vol. 665. File 3914, correspondence between Dominion Parks Branch, Royal North West Mounted Police, Department of Agriculture, Department of Mines, and Office of the Deputy Minister of the Interior).

On the heels of this wartime exploration into the commercial use of caribou, a Royal Commission was appointed to investigate possibilities for reindeer and muskoxen industries in the Arctic and Subarctic regions of Canada on 20 May 1919 (Rutherford et al. 1922). Along with hearings and written submissions, the committee accessed information on the potential of these regions for grazing from personal interviews with explorers, missionaries, and scientists. Led by Arctic explorer, Vilhjalmur Stefansson, the committee was convinced that muskoxen and reindeer could be readily domesticated and steps should be taken to develop herds for commercial purposes. Stefansson, believing his assumptions to be correct, resigned from the committee on 12 March 1919. He then applied for a large land lease on southern Baffin Island, approximately 260 000 square kilometres, for grazing purposes (Rutherford et al., 1922; Scotter, 1989).

The motivation for conducting research on the commercial harvesting of muskoxen and reindeer was driven by four main components (Rutherford et al., 1922). First, with the onset of starvation among Aboriginal people, the Dominion wanted to develop large herds of reindeer and muskoxen for reliable and economical meat and clothing supplies for Inuit and Dene of the Canadian Arctic. Second, the Dominion felt there was a need to protect the wild populations from possible extermination. Third, the Dominion hoped to:

> "provide for future food supplies for white men who may go into the north to develop or exploit, as the case may be, the mineral and other natural resources" (Rutherford et al., 1922:21).

Finally, the Dominion wanted to lay the foundations for a possible future commercial meat industry that would resemble the success of Norway and Alaska (Rutherford et al. 1922).

REINDEER HUSBANDRY

The integration of wild caribou with the domesticated reindeer was a potential problem area but was overshadowed by the possibility of securing an industry that would potentially benefit the local Aboriginal people. Other areas of concern included the past failure of introduced herds in some areas of Alaska, Lobster Bay, Newfoundland, and Fort Smith, Northwest Territories. Failure in these areas was attributed to the lack of herding skills, which inevitably led to a number of animals escaping to join the wild population (Rutherford et al. 1922).

The Royal Commission concluded that a group of islands located at the northern end of Hudson's Bay, Southampton Island, Coats Island, and Mansell Island, should be reserved for subsequent reindeer and muskoxen grazing ground (Figure 2-1). Grazing grounds were granted by Order in Council on 10 March 1920 (P.C. 522) (Rutherford et al. 1922). The commission agreed that the Inuit would be better suited to become herders with proper training from Lapp herders and with missionary help to persuade them to leave their traditional hunting practices for the herder lifestyle (Rutherford et al. 1922). However, Ethnologist Diamond Jenness noted that:

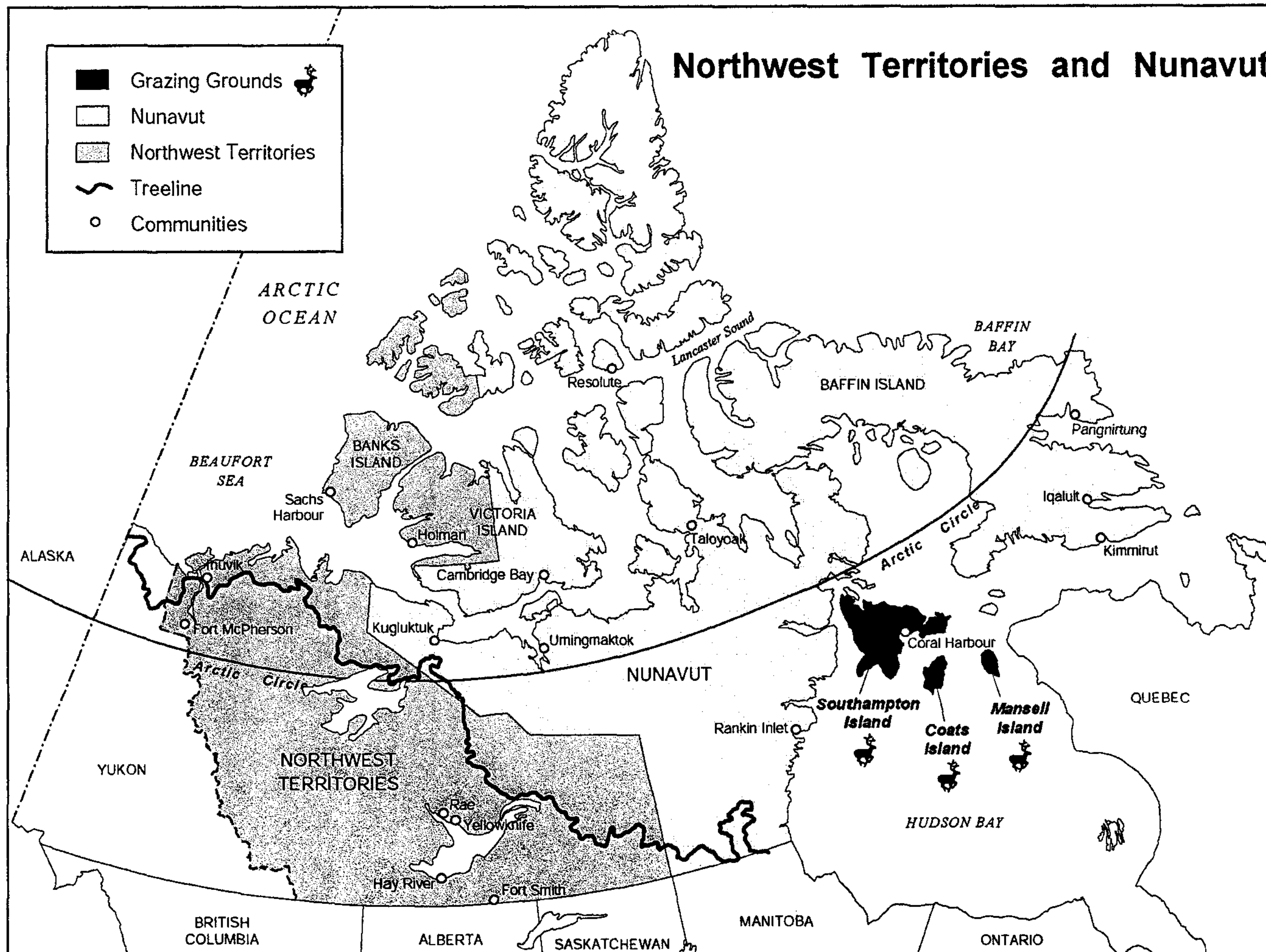

Figure 2-1 Areas recommended to be reserved for reindeer and muskoxen grazing grounds by the Royal Commission of 1919.

> "While intelligent and trustworthy, they (Inuit) have been for generations hunters and fisherman, and as long as game, fish, and seal are plentiful they will not in his opinion, turn away from that life for the more humdrum life of herding" (Rutherford et al., 1922:33).

In 1921, V. Stefansson convinced the Hudson's Bay Company to set up a subsidiary, Hudson's Bay Reindeer Company. Stefansson, who had acquired grazing privileges on southern Baffin Island, then purchased 627 reindeer from Norway and contracted six Sami herders to manage this initial commercial enterprise (Scotter, 1989). Two years later, the reindeer herd had declined to 181 animals and the last of the hired Sami herders left the Baffin Island area. The project was officially concluded on 27 May 1927 due to inefficient herding, poor management, and a lack of feeding grounds needed to herd reindeer cited as the major sources of failure (Scotter, 1989).

Dr. Sheldon Jackson, a missionary from Alaska, was the first person to bring reindeer to North America in 1891 (Rutherford et al., 1922; Scotter, 1989; Stern et al., 1980). While inspecting mission schools in 1890, Jackson stopped on the Siberian side of the Bering Strait (Rinaldo, 1997). Jackson marvelled at the reindeer herds that supported thousands of natives with meat, clothing, and labour. With countless cases of starvation occurring among Aboriginal peoples in Alaska, Jackson secured funding from the United States government to purchase reindeer from Siberia in hopes of alleviating starvation among the Alaskan Aboriginal people (Tower, 1988).

From 1891 to 1903, the United States government spent approximately \$183 000 for a herd of 6 500 reindeer (Rutherford et al. 1922:33). In 1919, a revenue of \$42 000 was observed when approximately 1 000 reindeer carcasses were shipped from Nome to Seattle and sold for \$0.28 per pound freight on board (f.o.b.) Seattle (Rutherford et al. 1922). Stern et al. (1980) published a comprehensive study on the Alaskan herding period from 1891 to 1977. Initial indications from the Alaska herding project were positive, which led Canadian government officials to believe that similar success could be achieved in the Canadian Arctic. The aim of the Canadian reindeer industry in the Western Arctic was to mimic the Alaskan reindeer industry by providing jobs and meat to the Aboriginal people.

A number of factors played a role in bringing reindeer to the Mackenzie region. Although the caribou population in the Western Arctic was stable, changing migration patterns were forcing Aboriginal hunters to travel over 100 miles to hunt caribou (L. Binder, pers. comm. 1999). At this time, the Government of Canada was concerned with the lack of meat supplies in eastern Canada and with the Alaskan reindeer experiment deemed a success, it was believed that reindeer herding could serve as a long-term supply of protein and employment to the region (L. Binder, pers. comm. 1999; Rutherford et al., 1922).

With the 1922 Royal Commission report and A.E. Porsild's 1926 field evaluations on the proposed Mackenzie reindeer grazing area, the Government of Canada decided to experiment with reindeer herding. Porsild's report concluded that there appeared to be adequate vegetation to support a large herd, possibly in the order of 250 000 reindeer in the Mackenzie region and 300 000 in the Great Bear Lake Basin (Nasogaluak and Billingsley, 1981; Scotter, 1989). The Canadian government purchased 3 000 reindeer from the Alaskan herd at Kotzebue in 1929 (Nasogaluak and Billingsley, 1981; Scotter, 1989; Stager and Denike, 1972). The Lomen Reindeer Company of Alaska agreed to deliver the herd to the Mackenzie River Delta Reindeer Preserve. The delivery of these animals took six winters and five summers (Scotter, 1982; Scotter, 1989; Stager and Denike, 1972). There are a number of papers and articles describing the Mackenzie reindeer operations including: Hill (1967), Nasogaluak and Billingsley (1981), Scotter (1972), Scotter (1982), Scotter (1989), Treude (1979), and Stager and Denike (1972). The events and details of this project will be briefly summarized in this work.

Mackenzie region reindeer operations

The aim of the Canadian government, with regards to reindeer herding, was to allow local Inuit to work at an occupation that was similar to their traditional lifestyles (Dragon, 1999; Scotter and Telfer, 1975). Local Aboriginals were to be encouraged to draw their livelihood from the land and reindeer herding represented a slight modification of a land-supported living (Stager and Denike, 1972). Poole (1982:22) described the term for reindeer husbandry as:

> "intermediate or transitional, in the anthropological sense of hunting and gathering".

Once the herd grew an appropriate size, the plan of the government was to set up a government owned herd from which smaller herds would be formed with Inuit ownership (Scotter, 1989). Local Inuit herders had to complete an apprenticeship before they were given their own herd for management. A critical concern was the attainment of a secure supply of meat that was in close proximity to the Inuit community. Whaling crews in the Beaufort Sea area had drastically reduced local caribou resources and the reindeer project had the intention of providing meat and employment to the area (Stager and Denike, 1972).

Although, the reindeer project saw early success with increased herd numbers, setbacks did occur. The first Inuit owned herd was created in 1938 and five other Inuit owned herds were developed until 1954. However, the reindeer herds were relinquished back to government supervision by 1964 (Nasogaluak and Billingsley, 1981; Scotter, 1989). The government herds were then contracted out to private managers from 1960 to 1968. The managers were hired to increase herd sizes and raise money from the sale of reindeer meat. Animals were under minimal supervision and actually decreased from 8 400 to about 2800 during this time period (Scotter, 1989).

The next phase of this experiment had the government ask the Canadian Wildlife Service to take charge of the operation and perform biological studies while options for the future of the herd were contemplated. Stager and Denike (1972) were contracted to study the effects of Native ownership and the economic viability of the reindeer herd. Their findings reflected that a herd could be economically viable without government assistance. In 1974, consistent with the goal of Aboriginal ownership, the government sold the entire reindeer herd, made up of 5 200 animals, to an Inuit herder named Silas Kanagegana for Can$ 50 000 (Nasogaluak and Billingsley, 1981). Kanagegana's company, Canadian Reindeer Ltd., operated essentially without government financial assistance while under his ownership (Scotter, 1989). However, due to health problems, Kanagegana was forced to sell the herd to William Nasogaluak for Can$ 250 000 in 1978 (Scotter, 1989).

Obstacles faced by this herding operation included the presence of predators, reindeer mixing with wild caribou, poaching, diseases, unfavourable herding practices, the availability of more rewarding wage labour, and finally, Inuit resisting the reindeer herding lifestyle (Scotter, 1989). Stager and Denike (1972) noted that the reindeer industry has not always been a welcome entity among people in the region and that trapping was the first love of the people. Scotter (1989:233) remarked on the possible reasons for Inuit resistance to reindeer herding:

> "To change a hunter into a herder would mean changing not only his life style but also his whole psychology. At that time, most Inuit were unwilling to turn from hunting and trapping and a settled community life to become mere followers of reindeer"

The cultural background of Inuit played a significant role in the early setbacks of the Mackenzie reindeer project. The Inuit perception of wildlife resources did not correspond to the herding lifestyle. Inuit believed that when animals present themselves to a hunter, the spirits are consenting to their eventual death. Arnold (1989:21) further elaborated on the Inuit belief system:

> “the traditional belief system of the Inuit included the concept that animals have souls, and those of caribou in particular were considered to be quick to take offence. Therefore, the animals had to be treated in strict accordance with a system of taboos if continued hunting success were to be ensured. Furthermore, the souls of caribou could be dangerous if any of the taboos connected with them were violated.”

Local Inuit did not accept the idea that the animals were now personal property and that Inuit had to exert strict controls over the animals.

Another issue facing Canadian Reindeer Ltd. was conflict with local hunters (Poole, 1982). Bad feelings arose as a result of newly established laws and regulations that were imposed by the territorial government officials to protect the herd from hunters (J. Colford, pers. comm. 1999). Caribou interspersion with reindeer herds would occur and local hunters would, knowingly or unknowingly, shoot a mix of caribou and reindeer (L. Binder, pers. comm. 1999). These legal instruments gave these animals a preferential right and then assigned this right to specific individuals. This made no sense to local Inuit, who were used to dealing with transgressions through their own traditional means (J. Colford, pers. comm. 1999).

In the early years, the lack of sufficient cash flow and federal meat inspection requirements negatively affected the reindeer operation. The market for Canadian Reindeer Ltd. meat was limited to domestic sales because of the inability of the company to send meat across the Northwest Territories border. Agriculture Canada required Canadian Reindeer Ltd. to satisfy strict meat inspection criteria before exporting meat supplies. A portable slaughter facility was developed, with the help of Agriculture Canada officials, to satisfy this requirement. This system would be later modified to process federally inspected muskoxen and caribou hunts throughout the Canadian Arctic.

The company did prosper when meat sales increased due to selling across territorial borders. However, the main proceeds during the 1970s and 1980s were derived from the development of an export market for velvet antlers to eastern countries for medicinal purposes (Poole, 1982). Meat sales increased due to selling across territorial borders but were not significant and were primarily used as an acceptable means of culling the herd (J. Colford, pers. comm. 1999).

Kunnek Resource Development Corporation is currently in the process of buying the reindeer herd from Canadian Reindeer Ltd. (L. Binder, pers. comm. 2001). In the past, legal issues with the Inuvialuit of the Western Arctic have caused many concerns for the company. The 1984 land claims agreement signed between the Inuvialuit of the Western Arctic and the Canadian government limited grazing rights on the Reindeer Preserve. The Reindeer preserve was first established in 1933, and later enlarged three-fold in 1955 (Scotter, 1989). However, with the land claims agreement, significant portions of preserve became private lands owned by the Inuvialuit. As a result, agreement could not be reached between the Inuvialuit and Canadian Reindeer Ltd. about either grazing fees or the sale of the herd.

Consultations with the Inuvialuit have resulted in a multi-level governmental advisory group that make recommendations to Kunnek Resource Development Corporation (L. Binder, pers. comm. 2001). The advisory group will review the current management plan developed by Kunnek Resource Development Corporation and make recommendations on herd movements, relationships with hunters, and interactions with local caribou herds. The herd was recently moved from the Tuktoyaktuk Peninsula to a new summer range area (Richards Island) for ease of herding and better forage. The herd was estimated to number between 4 500-4 800 (L. Binder, pers. comm. 2001). It is predicted that after calving, the herd could reach as high as 6 000 animals.

The challenges of herd management also include a relatively high incidence of brucellosis (*Brucella suis biovar 4*), which is endemic to reindeer and barren-ground caribou (J. Colford, pers. comm. 1999; Witter, 1981). It is speculated that this strain of brucellosis originated from the Russian reindeer herds (Meyer, 1964). In all likelihood, the transfer of reindeer from Siberia to Alaska in 1891 introduced this strain of brucellosis to North America. In order to satisfy Agriculture Canada's meat inspection guidelines, significant investment to eradicate this disease from the herd, will have to be actualized by Canadian Reindeer Ltd.

Reindeer herding was an experiment imposed on Inuit by the Canadian government to help alleviate meat shortages and provide employment opportunities. The Canadian government's concept of allowing Aboriginal people to work in an environment similar to their traditional lifestyles was very insightful. However, reindeer herding projects, for the most part, have failed due to the fact that Aboriginal people of the Canadian Arctic were not herders; they were hunters. Traditionally, the Aboriginal people of the North have subsisted on migrating caribou herds for meat, clothing, and tools. Archaeological evidence has uncovered an established relationship between Chipewyan and barren-ground caribou during the Arctic Small Tool tradition after 1500 B.C. (Cranstonsmith, 1995). Gordon (1996) remarks that radio carbon dating of tools indicates barrenlands hunting bands existing 8,000 years ago. The progression from hunter to herder in the Canadian Arctic, which was:

> "simply that more absolute control was exerted over the daily movements of animals" (Hudson, 1989:20),

was never accepted by Aboriginal people. McLean (1849: citied in Osgood (1932) and Spiess (1979:115)) commented on an early version of caribou herding in the Arctic:

> "I have been informed that the Yellowknives, and some other tribes inhabiting these desert tracks, have the art of taming the fawns, which they take in great numbers while swimming after their dams so that they (the fawns) follow them (the men) like dogs till (the men) see fit to kill (the fawns)".

Speiss (1979:116) postulated the reasoning for non-herding behaviour by the Yellowknives:

> "Previously, small herds were kept for meat in case of famine, but were primarily kept as decoys to aid in hunting. For the first historic step to occur in the process of the domestication of caribou for an insurance food supply, it would only have been necessary for the Yellowknives to have exerted a bit of herding labour, and to have kept the fawns near their camp into adulthood. Then North America might have had an aboriginal domestic-caribou-keeping people. Either the idea never occurred to them, or it was unnecessary. Or perhaps it was too much bother to keep the calves alive."

From these excerpts, it is evident that the possibility to herd caribou was present for the Yellowknives. However, the Yellowknives and other Aboriginal groups in the Canadian Arctic determined that they would utilize caribou for hunting rather than herding. Seasonal rounds, cultural beliefs, and hunting practices may have determined that raising caribou calves would have been too labour intensive and/or not beneficial for the group. If sufficient provisions could be attained through seasonal hunting and fishing activities, herding caribou could have been seen as a burden or just unnecessary for these nomadic hunters. Although herding is one of the oldest forms of livelihoods for many Arctic and Subarctic peoples, it did not evolve among Aboriginal peoples in the Canadian Arctic where cultural traditions have centered on the hunter/gatherer lifestyle.

ASSIMILATION OF ABORIGINAL SOCIETY INTO THE RURAL ECONOMY

After the Second World War, the fur industry collapsed and dependence on government assistance spread rapidly throughout remote communities of the Canadian Arctic (Bone et al. 1973). Smith and Burch (1979:90) commented on this period:

> "During the depression and war years fur prices dropped steadily, and the number of trading posts declined accordingly. By the fall of 1950 the only ones left were situated in locations close to mission stations and/or government outposts of various kinds. During the decade that followed, famine conditions north of the tree line led the Canadian government to relocate many of the Caribou Inuit to those centers, and virtually all of the rest eventually moved in voluntarily. The result was a series of nucleated settlements inhabited by Inuit and Whites distributed along the eastern and northern margins of the study area, and a similar group of Chipewyan-White communities (with some Cree) located along the southern and western margins."

With the Canadian government's ensuing school and housing development projects of the late 1950s and 1960s, Aboriginal people were encouraged to move into settlements (Smith and Burch, 1979). Consequently, the final transition phase of assimilation of the Aboriginal hunter/gatherer society into the rural economy took place with this development.

During this period, Aboriginal hunters were no longer primarily dependent on wild meat resources. Monies obtained through introduced wage employment and the infusion of government subsidization programs, most noticeably the family allowance program established in 1945 (Cranstonsmith, 1995), allowed residents to purchase food items from local grocery stores. The dependence on wild herds of caribou diminished as Aboriginal hunters began to stay within the confines of the community. Once again, the easier lifestyle was quickly adapted into Aboriginal society throughout the Canadian Arctic.

Territorial government programs were implemented in the late 1960s to help Aboriginal groups access caribou herds. These organized community hunts were initially developed to provide meat distribution back into the Aboriginal population (J. Colford, pers. comm. 1999). However, some Aboriginal community groups have utilized hunts of this nature to develop business ventures using a renewable resource (Bissett, 1974).

The transition from hunter/gatherer to the wage economy has been an extensive process for the Aboriginal people of the Canadian Arctic. However, caribou still serve as an integral part of Aboriginal society. Wages earned through employment are used to purchase modern hunting equipment such as snowmobiles, boats and motors, and rifles with telescopic sights which all increase the likelihood of success for hunters. Hunting caribou serves as an important source of country food for northern Aboriginal people in that it is cheaper to obtain, more nutritious and better tasting than store bought food (Arnold, 1989; Wein et al., 1996). Hunting is not only utilized for subsistence purposes but also used as a form of recreation by Aboriginal hunters when not participating in wage labour activities. This form of subsistence use is at the root of the present day market hunting activities of wild, free roaming caribou.

CONCLUSION

European exploration and exploitation of the Canadian Arctic has had a diversity of effects on Aboriginal culture and indigenous wildlife. Essentially, however, the impetus of commercial caribou hunting has remained constant i.e. the provision of caribou meat for trade or sale.

Initially, trade with European explorers had little effect on the Inuit culture, as commerce was not based on a monetary system. However, this relationship set the stage for increased trade reliance with whalers and the later onset of fur traders in the Canadian Arctic. The whaling era saw a switch to increased dependence on European goods, which came to be seen as necessities and not luxuries for the local Inuit. Introduction of full-time hunting jobs and rifles encouraged dependence on whaling stations and also resulted in the transmission of new and often fatal diseases to the Aboriginal people. Hunting with rifles also resulted in the depletion of local populations of caribou and muskoxen. The Inuit began to congregate for longer periods of time around trading locations and subsequently, hunters were forced into trapping furs in order to obtain money to buy supplies from the small trading posts. Inuit hunters were hired by posts to provide meat supplies for European traders but commercial hunting of caribou was minimal as more attention was given to the trapping of fur.

The onset of the fur trade era in the Subarctic regions of the Canada began in the early 1700s by the Hudson's Bay Company (HBC) with analogous results to the coastal Inuit's experience. Nomadic cycles were reversed for the Dene and Metis and credit was introduced to the Aboriginal trappers as a way of indenturing them to company stores. However, decreased fur prices dictated that Aboriginal trappers in the Canadian Arctic would have no means of attaining essential items from the Forts. Relief was needed in these areas, as the Aboriginal communities were heavily dependent upon foreign resources to subsist. Relief was provided through programs executed by the Canadian government.

In order to alleviate the food shortage problem, the Canadian government investigated the commercial use of reindeer. However, reindeer herding had many setbacks as the Inuit of the Western Arctic and Baffin regions never accepted reindeer herding. Reindeer herding has been isolated to the Western Arctic of the NWT and political issues continue to surround the viability of the operation.

Increased government assistance was brought into the many remote communities of the Canadian Arctic, including the initiation of schools, housing developments, and community infrastructure from 1950 to 1960. Increased wage labour and subsidization programs continued the decreased dependence by Aboriginal hunters on wildlife resources. However, the desire for caribou meat within Canadian Arctic communities and government programs aimed at continuing Aboriginal hunting traditions, provided supplemental wild meat resources to Aboriginal people through organized community hunts.

Presently, most Aboriginals harvest caribou for subsistence/recreational purposes. Caribou are hunted for additional meat supplies but most domesticated meat supplies can be obtained from the local grocery store with monies earned through wage labour employment. The desire for caribou meat within the Aboriginal and non-Aboriginal population is high. Such demand for caribou meat has prompted the development of market hunting by local hunters and organized community hunts by local Aboriginal organizations. The increased demand for exotic game meats in the domestic and international markets has also spawned the emergence of large-scale commercial hunts. These hunts have been developed in collaboration by Aboriginal organizations, territorial government, and the private sector. These commercial hunting activities will be discussed in more detail in the following chapters.

The adaptable nature of Aboriginal people has been their key to survival in the harsh environment of the Canadian Arctic. The history of commercial use of caribou in the Canadian Arctic is one of adaptations through contact with non-Aboriginal cultures and the local responses to new market opportunities.

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PERSONAL COMMUNICATIONS

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CHAPTER THREE

COMMERCIAL HUNTING OF CARIBOU IN THE CANADIAN ARCTIC AND SUBARCTIC

INTRODUCTION

The hunting of caribou (*Rangifer tarandus*) by Aboriginal people of the Canadian Arctic[2] changed dramatically from pre-explorer contact. For thousands of years, the Dene and Inuit, hunted caribou for subsistence purposes with a minimum assemblage of tools made of bone, antler, sinew, wood and stone (Gordon, 1996). The Inuit primarily occupied the Arctic regions whereas the Dene, and later Metis, occupied the Subarctic (Figure 3-1). Caribou were hunted using a variety of techniques including stalking, drives into water, snares, running down, decoying, and mass traps (Arnold, 1989; Gordon, 1996; Spiess, 1979). A successful hunter would provide game for his immediate family, for elders and other band/group members who were not able to acquire their own meat during the caribou migrations (Dragon, 1999). This practice followed social structure directives most often associated with the maintenance of kin groups and interpersonal relations within the community (Wenzel, 1986). There was no compensation expected with this activity and the success of one hunter was shared among many. However, there was a reciprocal relationship of harvest sharing between band members and regional bands during seasonal rounds that provided a consistent source of food during the year (Freeman, 1986).

The succession of trading activities with explorers, whalers, and fur traders, allowed for the acquisition of foreign goods that greatly affected Aboriginal

[2] For the purposes of this work: The Canadian Arctic refers to the Northwest Territories (NWT) and Nunavut Territory (NU). At the onset of this work, both Nunavut and the Northwest Territories were termed the Northwest Territories before the Nunavut Territory division on April 1,1999.

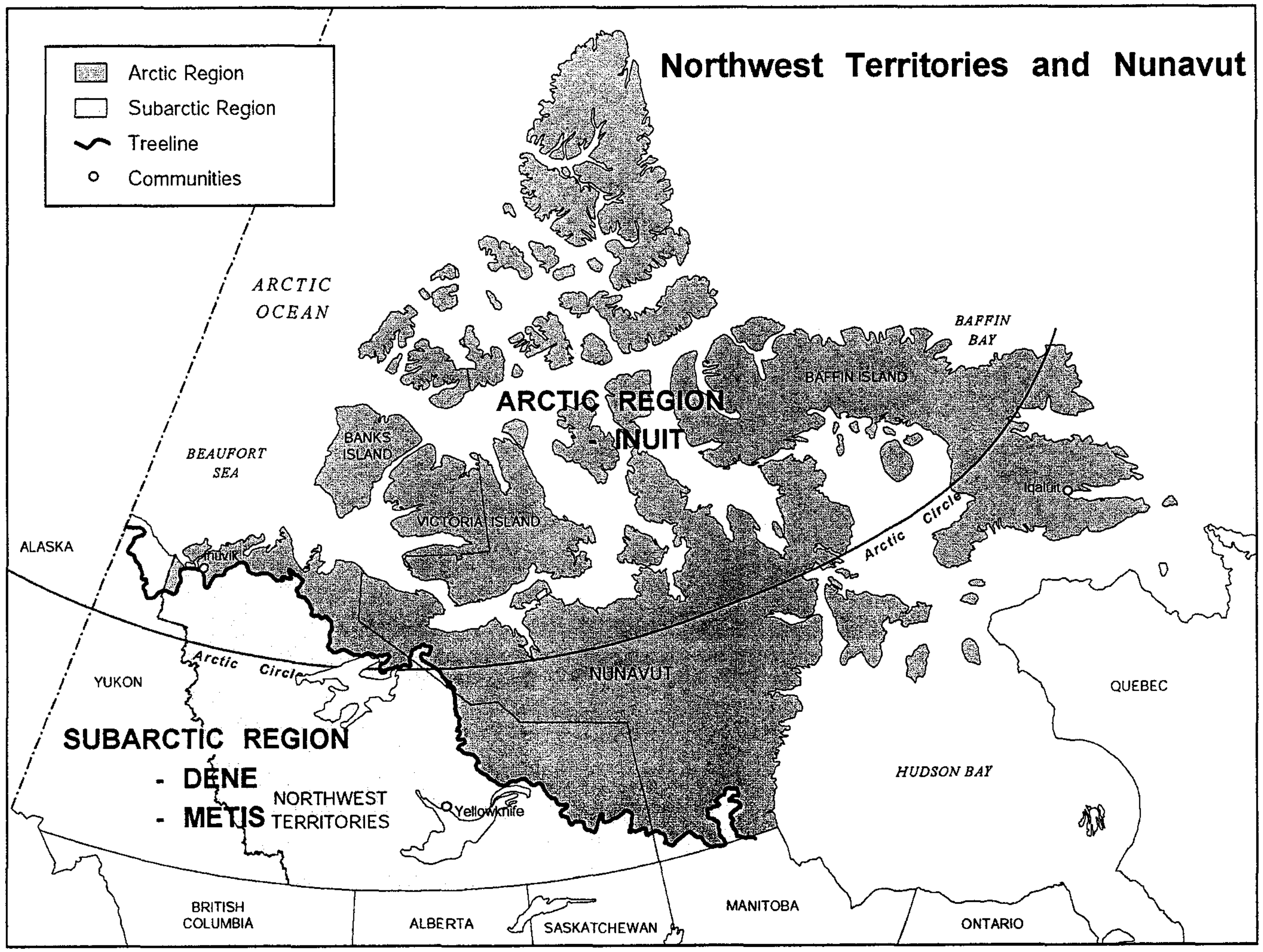

Figure 3-1 Regional distribution of Inuit, Dene, and Metis people in the Canadian Arctic.

hunting practices. Initial trading practices with explorers in the Arctic regions provided the Inuit with metal implements (Oswalt, 1979). By using these metal objects, such as knives and axes, hunters could manufacture their tools, made of bone and ivory, with greater ease.

With the introduction of European firearms and other trade goods from whalers, the traditional act of hunting by Aboriginals was forever changed. Bows, arrows, harpoons, spears and skinboats were traded or upgraded for firearms, fishing nets, wooden boats, and eventually motors (Riches, 1982). Great numbers of caribou were easily harvested with firearms acquired through trading (Gordon, 1996). Aboriginal people, who were accustomed to great periods of time without any sightings of the migrating caribou herds and possible starvation, would kill caribou as if they were hunting with their traditional methods of spears and bows and arrows. Consequently, there was considerable concern by explorers and scientists alike, for the possibility of over-exploitation of caribou herds. Rutherford et al. (1922:32) noted:

> "Captain Bernard states that if the slaughter which has taken place in the last four years, since the natives have been armed with rifles as a result of the establishment of trading posts on Coronation Gulf, continues, there will be no caribou left in that region within 10 years".

By increasing trading activities, Aboriginal hunters added a new component into their hunting lifestyles that inevitably led to the change in hunting practices of the Aboriginal people. The explorers, whalers, and fur traders who were in need of fresh meat and hides from the Inuit and Dene hunters, traded firearms and other goods which resulted in a new incentive for hunting caribou. As trade goods increased in value (i.e. rifle), the emergence of monetary exchange was introduced into Aboriginal society and the progression of market hunting in the Canadian Arctic continued with the introduction of the wage economy.

In the following chapter, I will review market hunting, organized community hunts, and large-scale commercial hunts within the Canadian Arctic. For the purposes of this chapter, market hunting refers to hunting by an Aboriginal hunter for cash exchange within the Canadian Arctic. Organized community hunting refers to hunting by an Aboriginal organization for resale and/or communal distribution to its members or community members within the Canadian Arctic. Large-scale commercial hunts will be defined as hunting by an Aboriginal community organization, which complies with federal meat inspection guidelines determined by Agriculture Canada, for sale in either domestic or export markets.

MARKET HUNTING

In this section, I will discuss original forms of subsistence hunting, the emergence of market hunting, current market hunting activities, legislative requirements, benefits associated with market hunting, description of a typical market hunt, and issues relevant to market hunting activities in the Canadian Arctic.

Hudson (1989) classified hunting practices as either subsistence or commercial systems. Subsistence hunting includes traditional hunting and rural market hunting, whereas commercial hunting involves reduction cropping (culling) and sustained cropping (Hudson, 1989). All forms of these wildlife production systems currently exist in the Canadian Arctic. However, as previously stated in chapter two, I contend that Aboriginal rural market hunting in the Canadian Arctic can be considered an early form of commercial use in that it serves formal Aboriginal markets. Although rural market hunting in Aboriginal society did not include monetary exchange, the value that the harvests provided were quantifiable in the Aboriginal society and can be considered a commercial activity. In terms of meat distribution, however, I do agree that rural market hunting in the Canadian Arctic does indeed supplement the subsistence hunting niche by providing meat to those Aboriginal people, for whatever reason who are unable to attain wild meat.

Subsistence hunting

Market hunting has been a long-standing practice in the Canadian Arctic. The foundation of market hunting lies within the act of obtaining game in excess of subsistence needs. As Hudson (1989) noted, the original hunting production system consisted of subsistence hunting. The yearly subsistence activity cycle for an Aboriginal harvester from the Canadian Arctic is based on seasonal harvesting activities (Table 3-1). Subsistence hunting revolved around the harvesting of fish and game for food and clothing.

Aboriginal hunters needed to meet current subsistence demands as well as predict future needs due to the variable nature of future harvests. Subsistence harvesting is a fulltime job requiring the individual to be diligent in terms of time management, meeting current needs and projecting future demands. Aboriginal harvesters maintained their bargaining power among their own people or regional bands by providing extra services/goods that were acquired during subsistence hunting activities.

In pre-contact times, if an Aboriginal hunter secured an abundance of game, the excess was distributed along kinship lines (Freeman, 1986; Wenzel, 1986). Klein (1989:103) commented on the system of reciprocity between Chipewyan hunters in the Subarctic regions:

> "Although successful caribou hunting by the Chipewyan has depended on dispersal of social groups, the subsistence system required a well-defined reciprocity system to distribute meat between those groups that were in the path of the migrating caribou and those that were not."

Table 3-1 Subsistence seasonal rounds of Aboriginal peoples in the Canadian Arctic.

Season	Activity	Output	Needs Served	Future Needs Addressed
Summer/Fall	Hunting	Meat/hides	Food for own use and family & barter	Stored food (Dry Meat)
			Clothing for present needs	Barter goods for Future (cash)
				Clothing for future needs
Note: Barter may be used for fuel or purchase of traps				
Fall/Winter	Trapping	Fur/Meat	Fur for own use and sale or barter	Cash for future needs
			Food to supplement stored food	
Note: Cash or barter may be used for hunting equipment				
Spring	Hunting	Meat/hides	Food for own use and family	Stored food (Dry Meat)
			Clothing for present needs	Bartered goods for future cash
				Clothing for future needs
Note: Cash and barter may be used for fishing nets				
Spring/ Summer	Fishing	Fish	Food for own use and sale or barter	Stored fish (Dry Fish)
				Cash for future use

Weiler (1992:37) discussed a similar display within the Naskapi Aboriginal society in Labrador:

> "In traditional Naskapi society, free distribution along kinship lines of the yields of subsistence harvesting among the members of the community was expected social behaviour and a characteristic cultural trait"

The act of sharing meat was customary among the Inuit and Dene when subsisting on the migratory caribou (Usher, 1986). Although still present today among close family members, the custom of meat sharing in northern Aboriginal societies has undergone significant changes in the last century.

The emergence of market hunting

Meat sharing continued amongst Aboriginal bands and regional groups but the emergence of European explorers spawned the first exchanges with non-Aboriginals. European explorers began to trade with Inuit hunters for iron implements in exchange for meat and hides (Purich, 1992). A formal system of market hunting, with the exchange of money, emerged when whaling posts and fur trading Forts (Krech, 1974; Oswalt, 1979; Usher, 1986), began hiring Aboriginal hunters to supply crews with local meat and hides fostering a dependence on traded goods. Aboriginal hunters were also recognized for their contribution to northern explorers. Mary-Rousseliere (1984:598) noted:

> "The Metis, combining the attributes and sometimes the defects of two races, were particularly skilled at hunting bison from horseback – they managed to recharge their guns by spitting the bullets into the barrels while at full gallop in pursuit of their prey! For a long period, they were the suppliers of bison meat, the source of pemmican, the staple diet of the voyagers and the northern explorers."

Market hunting activity has remained relatively the same for hundreds of years; the attainment of wild game for sale. The market hunter, who distributed meat among community members, was initially compensated by payment in bartered goods. Such bartered goods might include gasoline, ammunition or other game animal products attained at different times during the year by the receiving party (such as ducks, geese, fish, vegetables, or processed items such as drymeat or dryfish). Although the distribution and sharing of meat between Aboriginal groups has taken place for centuries, the development of wage labour and the high costs of equipment has dictated that money exchange replace bartering. The desire for game meat is still prevalent in Aboriginal societies and market hunters continue to fill this niche by supplying wild meat to community members.

With the establishment of a wage economy within the Aboriginal society, hunters were no longer as dependent on migrating caribou for their primary food supply. Wage employment meant Aboriginal hunters were permanently located in communities and had less time for hunting activities due to the time commitments of wage labour activities. If a hunt was unsuccessful, they could buy food from the local store or from a market hunter with monies earned in wage activities or, if unemployed, with their government subsidy.

During this period, the use of expensive, modern equipment to harvest game became commonplace among Aboriginal hunters. Technological advances of hunting equipment and modes of transportation, allowed wage earners to participate efficiently in hunting activities for short periods of time, such as weekends and/or while on vacation from their wage occupation. Old methods of accessing game, such as using dog-teams, were very time consuming and labour intensive. However, in order to afford modern equipment, hunters needed to spend more time at wage labour activities and subsequently had less time for hunting activities.

With limited time and the high cost equipment needed to conduct a hunt, unless game is in close proximity to the hunter, the hunt becomes too costly for the individual hunter. Hunters must decide whether they are hunting for recreational activity, for food provisions, or a combination of these activities. If hunting for food provisions, the hunter must decide whether it would be less expensive to buy wild meat from individuals selling meat in the community or purchase domestic meat products from the local grocery store. Consequently, the demand for wild meat within the community has encouraged some Aboriginal hunters to sell their surplus meat to other Aboriginals.

Market hunting for supplemental income involves many factors for the Aboriginal hunter. Above all, hunters must be certain that caribou are available where the hunting activity is going to occur. This is achieved by contacting other hunters for their most recent sightings. Without a guarantee of animals to hunt, market hunters risk losing money by travelling great distances and being unable to locate caribou. For example, in the South Slave region of the Northwest Territories some hunters, who have wage earning employment, travel (in some cases at least 1700 - 2000 km--round trip) to shoot caribou for sale in the local market and for personal use (discussed in Chapter Five).

Aboriginal people in the Canadian Arctic have displayed great adaptability over the last century, shifting from a traditional hunter/gatherer lifestyle to participating in an economy that integrates wage earning and harvesting activities (Gunn et al., 1991; Usher and Weihs, 1990). Informal selling of meat in rural markets has been reported in several hunter-gatherer societies for many species of wild ungulates (Asibey, 1977; Bissett, 1974; Caldecott, 1986; de Vos, 1973; Gunn et al., 1991; Hawley et al., 1983; Hudson, 1989; N. Magnus, pers. comm. 2001; Novikov, 1983; Sale, 1983; and Usher, 1976).

Current market hunting activities and legislative requirements

In the Canadian Arctic, market hunters consist of Aboriginal people (Inuit, Dene, and Metis) who are entitled to hold a General Hunting License (GHL). As long as the species is not subject to a restrictive quota by the territorial government, GHL holders are permitted to harvest as many animals as required for subsistence purposes (Bennett, 1982). However, there is an upper limit to this type of hunting as hunters who waste harvested animals are subject to fines (NU Wildlife Act, 1989; NWT Wildlife Act, 1988). The purpose of the GHL is to authorize subsistence hunting by Aboriginal people. The GHL originates from the former Northwest Territories (NWT) Game Ordinance sections, was granted for hunting specifically designated to meet the needs of Aboriginal harvesters and their families. In 1968, changes to the NWT Game Ordinance allowed GHL holders to sell meat (Cranstonsmith, 1995). Presently, the Department of Resources, Wildlife, and Economic Development (RWED) and the Department of Sustainable Development in the Nunavut Territory have legislated mandates for regulating the sustainable use and commercial use of wildlife.

Market hunters in the Canadian Arctic can sell their meat either to local GHL residents directly or to institutions/meat processing facilities (Table 3-2). When selling their meat to other GHL holders, market hunters are not required to obtain commercial meat tags. Commercial tags allow the GHL market hunter to sell their meat to non-GHL holders and institutions such as hospitals, correctional facilities, homes for the elderly, and meat processing facilities. Currently, there are three, small-scale meat-processing facilities in the eastern Arctic that produce meat for retail purposes located in Cambridge Bay, Rankin Inlet, and Pangnirtung (Figure 3-2).

Meat sales by market hunters can only take place within territorial borders. Without meeting Agriculture Canada's meat inspection requirements, wild meat cannot legally cross provincial borders for retail purposes. Colford (1998:7) explained the legislation requirements of domestic meat production in the NWT:

> "Meat from wildlife and domestic animals slaughtered and consumed in the Northwest Territories is not required to be inspected to ensure the animal, carcass or meat products meet acceptable health standards. There is no territorial legislation or delivery system for implementing an inspection system."

Market hunting sales in the Canadian Arctic vary by location. For instance, in the Arctic regions, Inuit market hunters primarily sell meat to the local processing plants or co-operatives (C. Schindell, pers. comm. 1997). These retail outlets then sell meat directly to non-Aboriginals and thus satisfy another market desire for wild meat. Usually, sales between GHL holders in the Arctic regions are minimal because of the ease of acquiring caribou for personal use (I. Ellsworth, pers. comm. 1997).

In the Subarctic regions, GHL holders are the main source of caribou meat for Aboriginal buyers with minimal sales to retail outlets (B. Bergman, pers. comm. 1999). This type of sale predominates because the long travel distances to access a caribou herd is usually a deterrent to hunters that only want to harvest a few caribou (E. Evans, pers. comm. 1999). By the time the hunter takes into account the wear and tear on their vehicle, fuel costs, and equipment required to complete a hunt of this nature, it becomes more cost effective to buy caribou from a local market hunter. Another reason that market hunting is more prevalent in the south slave region is the lack of established meat processing plants near these communities. Local institutions are generally unwilling to buy meat from market hunters due to inconsistent supply schedules and they must obtain additional insurance for selling meat obtained without federal meat inspection approval. For many institutions, the risk does not warrant the effort needed to get involved in selling non-inspected meat products. However, the

Table 3-2 Commercial hunting guidelines in the Canadian Arctic.

Type of Commercial Use	Consumer	Commercial Tag Required?	Limit on Harvest?	Domestic or Export Sales?	Required to Follow Federal Harvesting Regulations?
Market Hunting					
GHL to GHL	GHL holders	NO	NO	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions or meat processing plants	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
Organized Community Hunts					
GHL to GHL	GHL holders	NO	NO	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions or meat processing plants	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
Large-scale Commercial Hunts					
GHL to GHL	GHL holders	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions, meat processing plants, or international export	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic or Export	YES

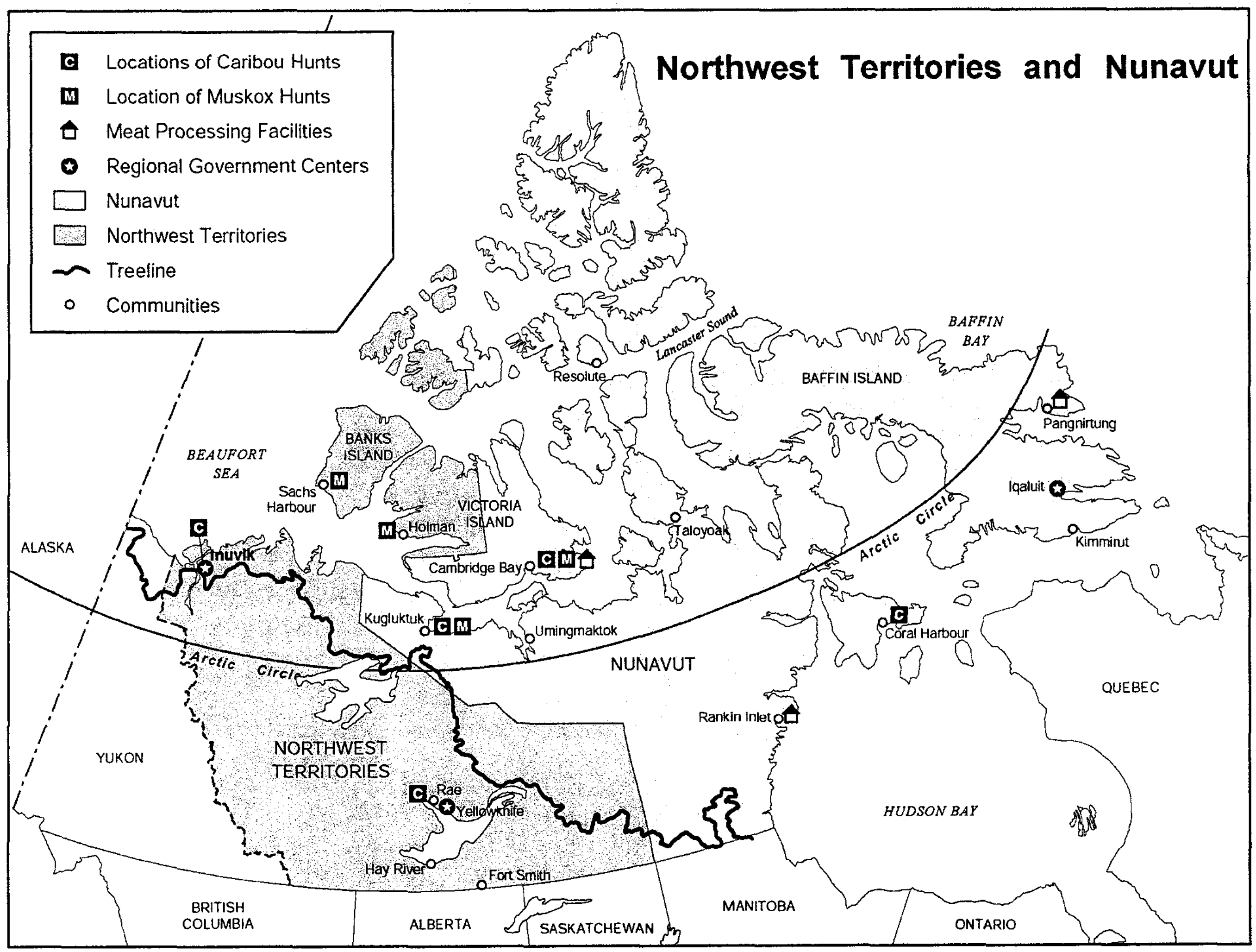

Figure 3-2 Locations of caribou and muskoxen commercial hunts and meat processing facilities in the Canadian Arctic.

demand for wild meat from consumers is very high in some communities (N. Kaeser, pers. comm. 2001).

Benefits associated with market hunting

With cash from caribou sales, market hunters are able to offset the cost of purchasing better hunting equipment such as new rifles, better ammunitions, sleighs for hauling caribou, snowmobiles, vehicles, and camping equipment. The acquisition of trade goods by Aboriginal hunters has motivated much of the early Aboriginal trading practices (Purich, 1992), trapping activities (Ray, 1974), and wage economy employment (Freeman, 1986). Freeman (1986:31) remarked on the dependency on cash for participating in Aboriginal harvesting activities:

> "It is quite true today that cash is an important part of everyday life, and that people need to obtain cash in order to sustain the hunting, trapping and fishing that they want to carry out".

Gunn et al. (1991:197) further elaborated on the necessity of wage employment to pay for the costs of hunting muskoxen:

> "Wage earning is a necessary part of the domestic economy as a means to offset annual cash costs for the hunter (rifles, snow machines, gas, etc.) range from US $ 4000 to US $ 8000 (Usher and Weihs, 1990)".

Caribou carcasses sold by market hunters range in price from Can$ 80 to Can$ 100 depending on the purchaser of the meat (i.e. GHL holder, non-GHL holder, or institution/meat processing plant) and geographic location (Arctic vs. Subarctic regions). Market hunting has also turned into a recreational side occupation for some hunters. Market hunting has developed not only to supplement a hunter's income but for many community and personal reasons as well.

Market hunting fills a void that allows Aboriginal people in the community to have access to caribou meat. Time constraints relating to wage earning employment, remoteness of hunting areas from settlements, and equipment costs limit some Aboriginal hunters' ability to hunt caribou for themselves or their family. Market hunting provides a valued service to Aboriginal communities because Aboriginal people have maintained a preference for game meat (Bissett, 1974; Calef, 1980; Wein et al., 1996). Elderly Aboriginal people often utilize market hunters as much as possible to have access to wild meat (K. Hudson, pers. comm. 1999). In addition, market hunting allows Aboriginal hunters to enjoy the benefits of getting out on the land to conduct hunting activities for recreational reasons. Being paid to hunt is regarded as an additional benefit to the market hunter. Some market hunters use the opportunity to pass their knowledge of hunting to younger Aboriginal hunters.

Typical market hunt

Market hunters must be proficient hunters and processors of meat to attain and maintain clients (discussed in Chapter Five). The commercial hunting of caribou, which demands great skill in terms of shot location, is made easier with modern-day equipment such as high-powered rifles with telescopic scopes and snowmobiles. However, the work involved in processing and producing clean caribou meat is very strenuous and labour intensive. Presenting meat that is not wind/sun burnt, badly shot and free of hair is critical for maintaining customer loyalty.

Methods of transportation for market hunting activities have changed over the years and include: dog team, vehicles (snowmobile, all-terrain vehicle, bombardier, truck or a combination of the vehicles), and single engine aircraft. Modes of travel have changed due to the changing migratory routes of caribou, increased mobility due to road infrastructure development, and increased costs and time involved in hunting caribou. For example, in the early 1970s, market hunters were using single engine aircraft to access caribou. This practice fell out of favour once the cost of renting a plane became too expensive. Today, most market hunters use snowmobiles and/or trucks for market hunting transportation.

Market hunting of caribou in some Subarctic regions of the NWT is dependent on road access, whereas in Arctic regions, where extensive road systems are absent, hunters can usually access caribou from their community by snowmobile or all-terrain vehicle. Market hunters can harvest from 1-60 caribou during an excursion. The number depends on the number of animals available, the number of hunters participating, distance from kill site to community, method of transportation, and market of distribution. High demand and lack of storage facilities dictate that caribou carcasses are usually sold within a day of arriving in the community. It should be noted that consistent market hunters are a select group of individuals. Reasons for some hunters failing to be proficient at this activity include the inability to sell meat, higher costs than anticipated to participate in this type of activity, and underestimation of workload required to complete a hunt.

As mentioned previously, commercial tags are required for market hunters to sell caribou meat to either non-GHL holders or institutions. Territorial government legislation stipulates that these commercial tags must be acquired prior to the actual hunt (Nunavut Wildlife Act, 1989; NWT Wildlife Act, 1988). In 1998, approximately 50 percent of the commercial quota of caribou, 8300, was harvested (Colford, 1998). This figure is misleading in that the majority of the market hunters in the Subarctic regions of the NWT do not apply for commercial tags because they are hunting for sales to GHL holders. The majority of commercial meat tags used by Arctic communities are for market hunting, organized community hunts, or large-scale commercial hunts (J. Colford, pers. comm. 1999).

Market hunting issues

Records for market hunting activities to individual GHL holders are limited due to the lack of systematic record keeping. Currently, territorial governments do not require the market hunter to submit records for the sale of wildlife to other GHL holders. Consequently, volume estimates for this activity are non-existent. However, it should be noted that this type of activity does exist in many communities in the NWT. In recent years, production from market hunting has increased because of the decline in community organized hunts for caribou and increased demand from local Aboriginal people. As Hudson (1989) noted, rural market hunting can be considered a segment of subsistence hunting that fills the subsistence needs for caribou meat in the larger Aboriginal population. Thus, subsistence needs of the community are being met through market hunting. Therefore, market hunting in the Canadian Arctic should remain a sustainable hunting activity in order for Aboriginal people to attain caribou meat without jeopardising the respective caribou population.

Past studies on Aboriginal hunters' success have been misleading (Miller, 1987). In the mid 1900s, Cranstonsmith (1995) stated that restrictive hunting policies had the Aboriginals:

> "underestimating of take (deliberately) for fear of restrictive action or regulation on the part of the government (Usher, 1976:22)".

Conversely, some studies have had the problem of hunters and trappers exaggerating their harvest (Bissett, 1974). The reason being that the hunter(s) wanted to portray their hunting skills as far superior than was actually the case. Lack of hunter participation is another problem faced when trying to accumulate voluntary data on individual Aboriginal harvests (Usher et al. 1985). However, this scenario has changed in recent years in areas of comprehensive land claims throughout the Canadian Arctic.

Land claimants are actively reporting harvests for the benefit of their people rather than a government initiative. Termed, "Basic Needs Levels", by most comprehensive land claims agreements, the Renewable Resource Board must be able to ascertain the total allowable harvest levels in their respective claim areas. For example, in the Sahtu Dene and Metis Comprehensive Land Claim Agreement (1993:13.5.6), harvest levels are determined by a settlement area harvest study. This study provides the necessary information for the Board and government officials to sustainably manage wildlife resources.

ORGANIZED COMMUNITY HUNTS

Organized community hunts have occurred in the Canadian Arctic since the late 1960s. In 1968, legislation was introduced which allowed GHL holders to sell caribou meat within the NWT (Cranstonsmith, 1995). Predominately conducted by local Hunters' and Trappers' Organizations/Associations (HTO/HTA) or Aboriginal band councils, community hunts provide caribou meat for the respective group's members while trying to transition the Aboriginal population into the rural wage economy. For the context of this paper, organized community hunts refers to hunting by an Aboriginal organization for resale and/or distribution to its members or other community members within the Canadian Arctic.

1960-1970

Organized community hunts in the Canadian Arctic were developed by the federal government to secure wild meat for the Aboriginal people and to provide the opportunity for business ventures using a renewable resource (Bissett, 1974). The ever-changing migratory patterns of caribou, the transition of the Aboriginal population to a wage economy, and the high costs associated with hunting caribou, limited the ability of Aboriginal people to hunt caribou. Relocated to rural communities by the federal government in the 1950s, many Aboriginal people were unemployed and without the resources to conduct hunting activities (Freeman, 1986). Community organized hunts were developed to blend wage economy jobs with the traditional act of harvesting caribou by Aboriginal people (J. Colford, pers. comm. 1999) and provide meat for the newly formed rural communities.

Schools were being built in most of these communities with the help of government departments and missionaries (Hobart, 1981). Mandatory school participation meant Aboriginal families were confined to community limits. Thus, either the Aboriginal family member sought work in the labour force or collected government assistance. Increased cases of disease and malnutrition were observed in these predominately Aboriginal communities (Bone et al., 1973; Hobart, 1981). Increased dependence by Aboriginal people on government subsidy programs brought about the need for greater meat resources for the communities. To alleviate these problems, the federal government decided to supply these remote communities with caribou meat.

1971-1980

Documentation from this era of organized community hunts is limited by insufficient record keeping and written accounts are contradictory (J. Colford, pers. comm. 1999). The federal government offered financial assistance to local HTAs for conducting hunts. The amount of assistance varied for each hunt and included logistical and market advice, as well as organizational assistance (Bissett, 1974). At best, hunts would break-even with respect to the costs of procuring and flying meat into small isolated communities. Bissett (1974) documented that from 1969 to 1972, caribou meat from organized community hunts sold for between $ 0.25 and $ 0.75 per pound. Meat was either given to welfare recipients, sold cheaply to GHL holders, or was sold to local institutions, such as newly formed hostels. These hunts continued sporadically through the 1970s and 1980s.

1980-2000

Community hunts were required to follow the same regulations that the market hunter must follow (Table 3-2). These meat-sale regulations are sale of meat between GHL holders does not require a commercial meat tag, sale of meat to non-GHL holder and/or institution(s) requires a commercial meat tag issued by RWED, meat sales cannot occur across territorial or provincial borders unless the hunt complies with federal meat inspection regulations (Gunn et al. 1991; Dragon, 1999), and wastage is punishable by law which is enforced by the territorial government (Nunavut Wildlife Act, 1989; NWT Wildlife Act, 1988). However, it should be noted that there are currently three types of organized community hunts completed by three separate groups of Aboriginal people in the Canadian Arctic.

The Inuit, in the Arctic regions of the Canadian Arctic, conduct organized hunts to sell meat back to community members or to local meat outlets (C. Schindell, pers. comm. 1999). The Dogrib and the Chipewyan people near Great Slave Lake conduct harvests, which are subsidized by the territorial government, for distribution back to their community without monetary compensation (J. Sangris, pers. comm. 2001). These hunts have been completed on an annual basis since the late 1970s. Finally, in the South Slave region, the Dene and Metis people have conducted hunts for either free distribution to GHL members or for sale back to their members and other GHL holders in the community (E. Evans, pers. comm. 1999).

Typical organized community hunt

Typically, a group of Aboriginal hunters volunteer or are contracted/hired by the HTA or Band Council to hunt a specific number of animals. Because of limited storage facilities, hunts of this nature typically do not exceed 100 animals. If the organizers are anticipating the sale of meat to the entire community and not exclusively to GHL holders, then commercial meat tags must be acquired before the hunt takes place (B. Bergman, pers. comm. 1999). Hunts of this nature have been completed using a number of alternative sources of transportation including plane, truck, and komatik (K. Hudson, pers. comm. 1999; C. Schindell, pers. comm. 1997).

In the community of Fort Smith, NWT, if caribou are relatively close to the community (<150 km) and are accessible by snowmobiles, then hunts are conducted in this manner. Sleighs are attached to the snowmobile for transportation of the caribou. The number of animals that can be transported is determined by the number of hunters with sleighs (E. Evans, pers. comm. 1999). If caribou are not accessible by snowmobile, local hunters may utilize chartered aircraft on skis. These aircraft will land on the ice on inland lakes where caribou are concentrated and local chartered aircraft companies typically require a 60 kilometre minimum flight (K. Hudson, pers. comm. 1999). The hunters will then shoot the caribou on the lakes, butcher the animals, load up the plane, and return to the community carcasses are sold or distributed.

The most common hunting method in the Subarctic regions of the Canadian Arctic involves travelling by truck on maintained roads or highways and then by snowmobile to areas where caribou are present. The actual hunt usually takes two to five days, which includes travel to locate caribou, camp set-up, killing and butchering of caribou and return trip to community. The hunters are reimbursed for their travel expenses (meals, gas, ammunition, etc.) and paid for the number of caribou they kill/butcher (Dragon, 1999). Typically, hunters both use and sell this meat.

In Arctic locations, Inuit hunters typically leave their communities on sleds or komatiks to conduct organized community hunts because there is little road infrastructure. Caribou are typically close to the communities, which allow for easy access to animals.

Government involvement in community organized hunts

Subsidy grants to perform organized community hunts have been obtained through federal and territorial government sources or sponsored by the community's HTA or Aboriginal band organizations (J. Colford, pers. comm. 1999). Government may pay for costs associated with aerial surveys for caribou, groceries/supplies, and transportation of hunters and meat (Bissett, 1974). Any money received from the sale of carcasses was used to pay any outstanding hunt expenses. The goals of these hunting activities were to either break-even or realize a small profit. In the latter case, funds would be used for other traditional harvesting activities or programs within the community.

Government funded hunts for caribou have been conducted by other Aboriginal peoples in Canada such as the Naskapi Indian of Northern Quebec/Labrador (Weiler, 1992). Naskapi hunting camps are set up for a period of several weeks to approximately two months. Large teams of hunters (5-15 persons) will carry out the caribou hunt for the benefit of the community. Depending on the geographic location and time of year, family groups are encouraged to participate as well. Additionally, hunters are also allowed to trap for furs for their own profit while still receiving a salary from the Naskapi band. Like some organized community hunts in the NWT, Naskapi harvests of meat and skins are free for the equal distribution between community members (Weiler, 1992). Value of the meat harvested at these hunts was estimated to represent a return of over 700 percent of the initial investment (Weiler, 1992). Interestingly, Bissett (1974:183) noted that organized community hunts conducted in 1971-72 in the Western Arctic had similar value to expense ratios:

> "approximately $ 7 value for every $ 1 spent".

Government departments established organized community hunts in the Canadian Arctic for three reasons. The first objective was to provide needed meat supplies into newly established communities throughout the Canadian Arctic. Secondly, the hunts were an attempt to re-kindle the traditional practice of securing game for people unable to secure caribou for themselves. Finally, hunts were an early attempt by the government to employ the Aboriginal population in an occupation that was similar to their traditional lifestyles before the wage economy was introduced. Territorial government programs continue to provide funds for Aboriginal groups to participate in community hunts (D. Stewart, pers. comm. 1999). However, due to a lack of organization, improper handling of meat, poor marketing of sales and in some cases, low harvest success, hunts of this nature have been slowly replaced by market hunting in certain communities throughout the Canadian Arctic.

LARGE-SCALE COMMERCIAL HUNTS

For the purposes of this paper, large scale commercial hunts will be defined as hunting by an Aboriginal community organization, which complies with federal meat inspection guidelines determined by Agriculture Canada, for sale in either domestic or export markets.

Large-scale commercial hunts resulted from experienced gained during organized community hunts in the Canadian Arctic and Sub-Arctic as well as the increased demand for wild meats in the international markets. Aimed at supplying meat across territorial and provincial borders, large-scale commercial hunting of caribou has been investigated and designed to create economic opportunities in remote communities in the Canadian Arctic (see Figure 3-3 for locations of large-scale commercial hunts for caribou). The remoteness and small population base of these communities usually dictates that wage labour jobs are limited once all the service sector jobs are filled. Since 1985/86, large-scale commercial hunts have taken place in Inuvik, Kugluktuk, Holman, Rae-Edzo, Cambridge Bay, and Coral Harbour (Table 3-3, Figure 3-3). With the exception of Inuvik, all communities participating in these commercial hunts have a very limited wage economy base. Also, it should be noted that all the communities, with the exception of Rae-Edzo, are all remote Inuit communities.

> "It is highly unlikely that commercial game development would exist in a community that had a strong economic base as other options would exist" (J. Colford, pers. comm. 1999).

With abundant caribou populations near these remote communities, these hunts were undertaken to generate economic activity in an occupation that was similar to the Aboriginal traditional harvesting systems. Consequently, the primary goal of these operations was to employ Aboriginal hunters and inject cash incomes into the community. Profit maximization was not the objective of these economic development projects but rather the objectives were to cover the costs of the project(s), provide meat to the local community, and determine whether there was a market for caribou meat exported from the Canadian Arctic (J. Colford, pers. comm. 1999).

The driving force behind large-scale hunts has been the collaboration between the territorial government, the private sector, Aboriginal organizations (i.e. HTAs/HTCs/HTOs), and local communities (Dragon, 1999). Although executed by the local HTA organizations, the territorial government provided economic development grants for the capital infrastructure required to complete hunts of

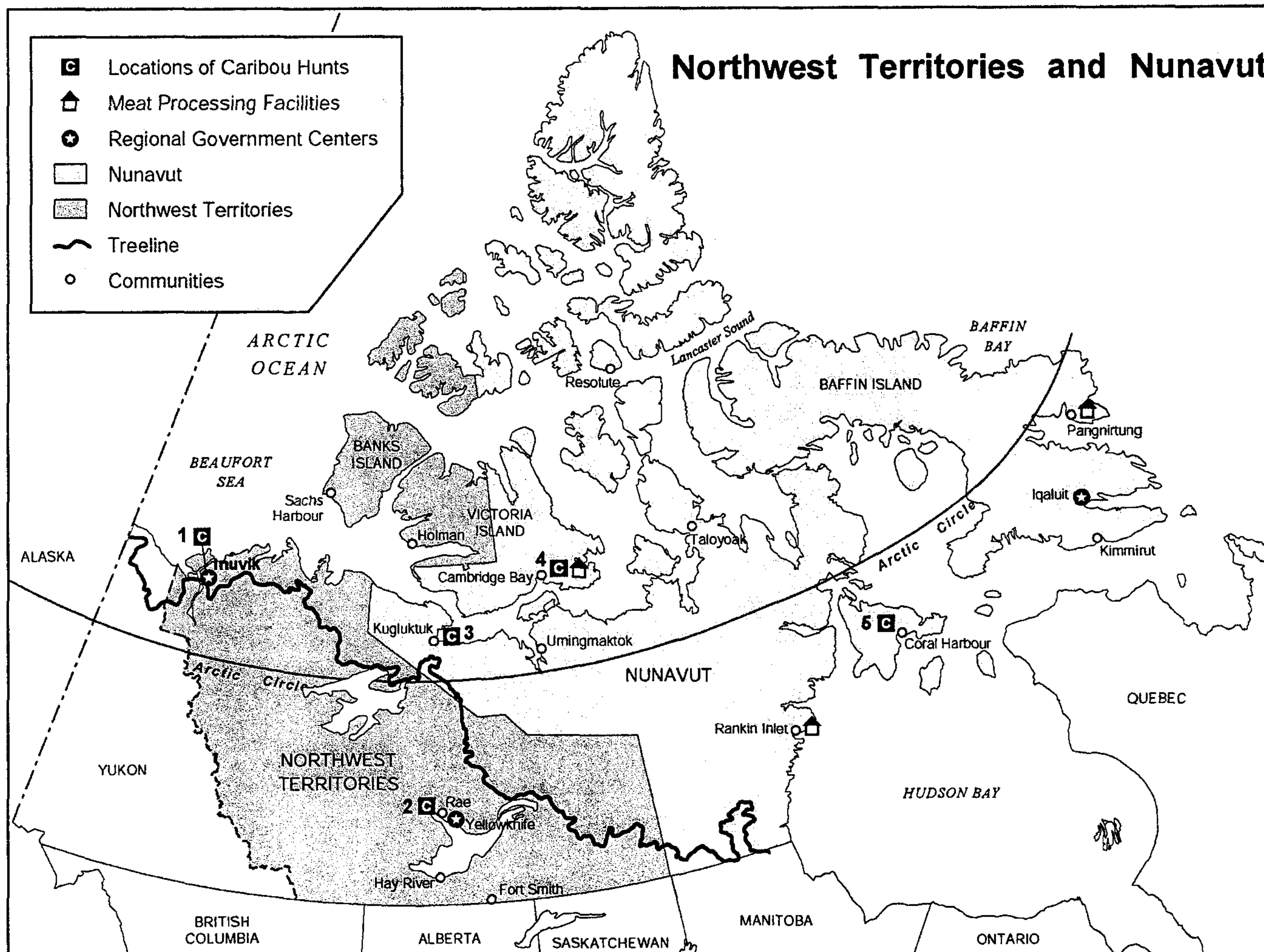

Figure 3-3 Locations of commercial caribou hunts in the Canadian Arctic since 1985/1986.

this nature. The territorial government also assisted in the marketing and business operations of these hunts. Hunting skills and knowledge acquired by local Aboriginal people during subsistence hunting is critical for the success of operations such as commercial harvests (Gunn et al. 1991).

The early success of organized community hunts and the increase in wild meat sales in southern Canada, the United States, the Far East, and Europe, encouraged the evolution of large-scale hunting of caribou for export purposes. Since 1985/86, approximately 16 federally approved caribou hunts have taken place across the NWT (Figure 3-3 and Table 3-3). For the most part, these hunts have been experimental ventures to assess the marketability of northern meats and the feasibility of completing hunts of this nature in the respective communities. Commercial hunting in the Canadian Arctic has produced approximately 18 773 caribou carcasses approved for commercial export sales (Table 3-4).

The majority of commercial harvests for caribou have occurred on an island population of caribou in the eastern Arctic, Southampton Island (SHI) (Figure 3-3). With the exception of SHI, commercial hunting operations in the Canadian Arctic can be classified as sustained cropping. SHI is a very unique situation in that the commercial hunts began as a sustained cropping exercise but quickly turned into a reduction cropping or culling operation because of large increases of caribou numbers (Heard and Ouellet, 1994). Since 1993/94 when an experimental harvest of 194 caribou was completed on SHI, approximately seven large-scale hunts have produced approximately 16 151 caribou carcasses that have been federally approved for export sale.

Similar hunting projects involving culling exercises have occurred on wild reindeer populations in Russia (Matyushkin, 1984; Novikov, 1983; Pavlov, 1996; Roslyakov, 1984; Sokolov and Lebedeva, 1989; Yakushkin et al., 1984). In 1968 and 1969, approximately 15 000 and 36 000 respectively, wild reindeer were

Table 3-3 Locations of large scale commercial hunts in the Canadian Arctic and corresponding community population numbers.

Community	Population
Inuvik	3 296
Kugluktuk	1 201
Holman	423
Cambridge Bay	1 351
Rae-Edzo	1 662
Coral Harbour	669

Source: Bureau of Statistics (1996).

killed in Taimyr and Evenkia National regions (Yakushkin et al., 1984). However, increased commercial exploitation of wild reindeer in Russia has had its negative effects as well. By the end of the 1960s, the Murmansk Olbast population was decimated and:

> "In less than thirteen years of commercial exploitation, the number of Murmansk reindeer was so undermined that their hunting was completely prohibited (Novikov, 1984:3).

Commercial operations can put excessive pressure on a population unless they are monitored and managed. The Aiviit HTO in Coral Harbour, Nunavut, in conjunction with territorial and federal government and local organizations, is demonstrating that commercial harvesting of caribou can be realized in the Canadian Arctic. Since the majority of meat production from large-scale commercial caribou harvesting comes from SHI, I review this operation in more detail.

SOUTHAMPTON ISLAND LARGE-SCALE COMMERCIAL CARIBOU HARVESTS

SHI is approximately 43 000 km² and is located off the northeastern shore of Hudson's Bay (Figure 3-4). The predominately Inuit community of Coral Harbour is located on the southern shore of SHI and has a population of 669 (Bureau of Statistics, 1996). Caribou populations were abundant until the 1900s but were depleted when local Inuit hunters acquired firearms through trading practices with European whalers (Ouellet, 1992). Not being a migratory caribou herd, the SHI herd was quickly decimated by intense hunting practices by both whalers and Inuit. Heard and Ouellet (1994:88) commented:

> "caribou were rare by 1935...and the last caribou died in 1953 (Parker, 1975; B. Mikitok, pers. comm. 1989)".

Table 3-4 Large-scale commercial hunting of caribou in the Canadian Arctic for export meat production (1986-2001).

Year	Harvest Production*	Number of Hunts	Carcass Weight (lb.)**	Carcass Weight (kg.)**
1986	100	1	7 700	3 500
1991	521	2	40 117	18 235
1992	53	2	4 081	1 855
1993	312	2	25 122	11 419
1994	643	2	51 000	23 182
1995	2 307	1	133 806	60 821
1996	1 924	1	111 592	50 724
1997	3 165	1	175 341	79 700
1998	2 888	1	159 995	72 725
1999	1 187	1	78 699	35 772
2000	2 099	1	121 595	55 270
2001	3 574	1	196 570	89 350
TOTALS	**18 773**	**15**	**787 120**	**357 933**

* If harvest carcass weight not included in records, then total harvested number used to estimate value

** If weight was not recorded, then 77 lb. was used to estimate average finished carcass.

In 1967, approximately 48 caribou were captured and transported from nearby Coats Island to SHI (Ouellet, 1992). Free of predators, fully protected from hunting, and abundant vegetation allowed the herd to increase dramatically. Heard and Ouellet (1994:94) noted this rapid increase:

> "At the present rate of increase, the number of caribou on Southampton Island is doubling every three years. If the herd continues to increase geometrically, it will reach the island's predicted carrying capacity (Parker, 1975) of 40 000 within 5 years".

Looking to control the herd dynamics, the Aiviit HTO, in conjunction with the territorial government, implemented a reduction cropping or culling operation. Working with territorial biologists and other department officials, the Aiviit HTO has been successfully harvesting caribou since 1993/94 and has averaged approximately 2 450 caribou per year since 1994/95. Interestingly, a 1929 exploratory report by the Canadian government on the potential of commercial use of caribou designated SHI, nearby Coats Island, and Mansell Island (Figure 3-4) as the premier locations to begin commercial operations of caribou (Rutherford et al. 1929). Commercial hunts in the Canadian Arctic have been extensively funded by government sources but have be co-operatively developed by Aboriginal organizations and territorial and federal government departments, through experimentation and trial and error.

Through an economic agreement between the federal and territorial governments, 1991-1996, funding was allocated to develop commercial wildlife harvesting operations. Grants were provided to subsidize costs associated with shipping, support infrastructure development, and conduct population inventories. By conducting trial hunts, expertise in commercial meat processing was developed by locals using Agriculture Canada veterinarians and project managers, who had prior experience in southern commercial meat operations.

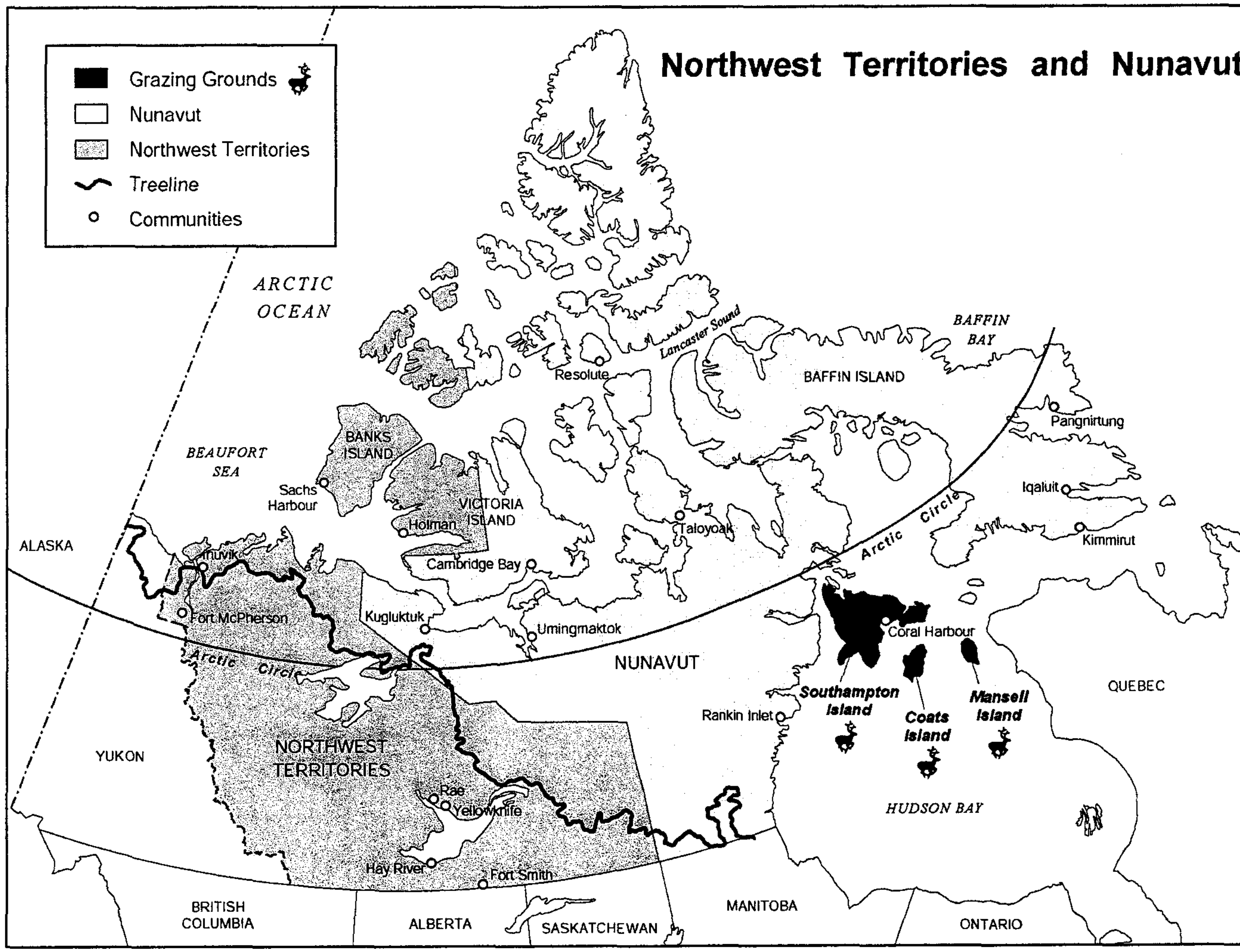

Figure 3-4 Areas recommended to be reserved for reindeer and muskoxen grazing grounds by the Royal Commission of 1919.

Corporate operations

As the complexities of the hunt's business affairs increased, the Aiviit HTO formed a new corporate entity. In 1995, the HTO, with the aid of the territorial government, established a corporate entity, the Tunnuq Harvest Company Ltd. (Tunneq). Tunneq was created in order to distinguish business affairs from the HTO and the commercial caribou operation (Threadkill & Associates Ltd., 1999). A local Inuit man, Mr. Leonard Netser, who has been successfully managing the operation since 1996, presently manages the harvest operation year round.

In 1998, Tunneq and the Aiviit HTO decided to privatize the harvest operation and the Southampton Meat Company (SMC) was established. A Memorandum of Agreement was signed between the Aiviit HTO and SMC sets out the responsibilities and understandings respecting the harvest operation (Threadkill & Associates Ltd., 1999). This commercial hunting venture was formally established in 1996 with a four year sales and project management contract between Tunnuq Harvest Company Ltd. and a southern firm, Thornbury Grandview Farms Ltd., which is based in Proton Station, Ontario. However, Thornbury Grandview Farms Ltd. effectively breached their agreement and removed itself from further involvement in the harvest (Threadkill & Associates Ltd., 1999). An alternative market, Keewatin Meat and Fish Ltd., located in Cambridge Bay, was secured as a buyer for SMC product.

Large-scale commercial hunt dynamics

Critical components required to begin a large-scale commercial harvest are cold weather, a good ice platform, and animals. Hard freezing of carcasses requires temperatures of minus 20 degrees Celsius to minus 25 degrees Celsius. Abattoirs are always built on frozen lakes or close to accessible sources of water (J. Colford, pers. comm. 1999). Clean water supplies are required to satisfy

Agriculture Canada meat processing regulations. Time of year plays an integral role in the dynamics of a hunt. Daylight, temperature and general weather conditions affect all facets of these operations. There are two annual windows of opportunity to commercially harvest caribou in the Canadian Arctic, the fall and spring seasons.

On SHI, the fall hunting window could begin in early November and last until early December. The spring hunt window can begin in March and continue until the end of April (Appendix 3-1). After trial hunts during both seasons, consensus has favoured spring hunts because of: higher average day-length; warmer temperatures; and in general, better weather conditions in terms of amount of snowfall and fewer periods of extreme temperatures (D. Pelling, pers. comm. 1997).

Concerns that surround large-scale commercial hunts include high costs of transporting meat and the lack of infrastructure, accurate information on herd population numbers, available workforce, and trained local people (B. Threadkill, pers. comm. 1998). It should be noted that the SHI large-scale commercial hunting project has always been subsidized by territorial government agencies. However, the level of assistance has decreased as the harvest operation became more efficient and local expertise developed (Threadkill & Associates Ltd., 1999).

Caribou harvesting on SHI has reached many of its goals such as: increased self reliance in the local community; injection of cash into the local economy through employment opportunities and job training; refinement of the large-scale hunting process through the use of portable abattoir systems; and maintenance of populations. However, there are both economic and population dynamics that continually threaten the viability of this operation. Ideally, the ultimate goal is a balance between keeping the caribou population in check and remaining economically viable through sustained cropping. The balance of harvesting the appropriate number of animals to permit sustainable harvesting from an insular population and also remain economically sound, is a dilemma which SMC faces each year. Gunn et al. (1991:202) noted:

> "the dilemma is that the most appropriate economic harvesting strategy may not be the most appropriate ecologically".

The inverse of this statement is also appropriate when discussing commercial hunting activities of a wild species. However, a compromise can be reached if parties mutually agree to pursue this. This ecological versus economical predicament has been faced by many commercial operations for wild resources in the past with detrimental consequences on the common resource stock. Examples of this phenomenon can been seen in the collapse of the Atlantic cod fishery (Mackenzie, 1995), the downfall of the bowhead whale fishery in the Western Arctic (Conrad, 1989), and the exploitation and demise of the bluefin tuna (Caughley and Gunn, 1995), to name a few. However, large-scale commercial harvesting has been limited to a reduction or culling exercise on SHI. Documentation of commercial harvesting and its effects are limited in the Canadian Arctic.

With the exception of a paper by Gunn et al. (1991) on muskoxen and this author's review of commercial hunting in the Canadian Arctic (Dragon, 1999), documentation on the prospects of commercial harvesting is limited to internal government reports and commercial harvest business plans. Limited information and unreliable census data apply to all levels of hunting in the Canadian Arctic (Miller, 1987). Jingfors (1986:168) commented on the historical documentation of Aboriginal wildlife harvesting over the past 40 years:

> "the records are only of limited value due to incomplete, or sporadic, coverage in space and time, lack of systematic sampling techniques and inconsistent, or unknown, reporting dates".

Berger (1977), Kelsall (1968), Miller (1975), Smith and Taylor (1977), and Usher et al. (1985) have discussed the basis and limitations of this predicament in the Canadian Arctic. However, numerous habitat and population studies have been conducted on SHI (Heard and Ouellet, 1994; Ouellet, 1992; Ouellet et al., 1993; Ouellet et al., 1994; Parker, 1975;) and the nearby Coats Island, (Adamczewski et al., 1987a,b; Adamczewski et al., 1988; Gates et al., 1986a,b). These studies and others will provide the basis for simulation modelling chapters on the population and economic dynamics of large-scale commercial hunts on SHI (Chapter 6 and 7). Determining the population and economic sustainability of this commercial enterprise can give considerable insight into the dynamics of this operation.

CONCLUSION

The federal government, and later territorial government's rationale for the introduction of commercial hunting into small, remote Canadian Arctic communities has been to: increase Aboriginal self reliance at the local level; increase employment opportunities for the resident labour force through education, training and job creation; maximize opportunities for local retention and investment in profits; and influence the pace of development to promote long term benefits from the use of wildlife resources (Department of Renewable Resources, 1994). The current commercial hunting activities in the NWT include market hunting, organized community hunts, and large-scale commercial hunts. Overall, my research indicates that these types of hunting activities have achieved the stated goals.

The three types of commercial hunting systems in the NWT have different origins. For example, market hunting, which has been practised since the time of early European explorers, has developed into a supplemental source of income, a recreational activity, and a forum for hunting knowledge transference in

Aboriginal communities. For generations, Aboriginal hunters supplied meat to others to attain goods that would increase their success at hunting and provide for their families. This trading activity in the Canadian Arctic still exists with the market hunter of today and has been integrated with the imposed wage economy. On the basis of time limitations, market demand, and population numbers, the market hunter supplies meat when the demand is present.

Conversely, organized community hunts initially developed as federal, and later territorial government aid programs to support employment initiatives or provide meat supplies in Aboriginal communities. These programs were designed to provide access to caribou meat as well as the opportunity to conduct business ventures involving a renewable resource. Aboriginal hunters, in some cases, were paid to practice the traditional hunting activity of securing game for those in need. The goal of the government was to blend wage economy jobs with the traditional act of harvesting caribou. Hunts of this nature brought a real sense of "community" to the Aboriginal harvesters and continue to provide meat supplies in certain Aboriginal communities. However, organized hunts in other regions have declined in recent years but Aboriginal market hunters have replaced this market niche. Reasons associated with the demise of this activity include: lack of organization; improper handling of meat; poor marketing of sales; and in some cases, the amount of caribou meat attained did not equate to the monies spent on harvesting them.

Large-scale commercial hunts for caribou in the Canadian Arctic have developed as an extension from earlier organized community hunts. Aboriginal organizations, in collaboration with the private sector and territorial government agencies have investigated and developed a commercial hunting operation that sells meat to local domestic and export markets. Working co-operatively with Agriculture Canada to meet federal meat inspection guidelines, caribou meat is current being exported from Canadian Arctic borders to the rest of Canada, the United States, the Far East, and Europe.

With the arrival of the wage economy into the Aboriginal peoples' lifestyles, reliance shifted from subsistence harvesting to dependence on government directed programs and government transfer payments. Through commercial hunting activities, government programs hope to link caribou harvesting and Aboriginal people to wage employment. With the exception of market hunting, which was an internally imposed hunting activity; these externally imposed hunting systems (organized community hunts and large-scale commercial hunts) have taken some time to be accepted by some northern cultures. These activities utilize a resource that has significant cultural value for the Aboriginal people of the Canadian Arctic. However, the commercial viability of these operations is questionable when government subsidization is eliminated (see Chapter 7).

The territorial government, as a means of creating economic opportunities where none would otherwise exist, developed large-scale commercial hunts. Most activity has taken place in small, remote communities where wage labour activities were minimal. These economic development programs were not expected to realize a profit but were operated with the objective that they would attempt to cover the costs of the operation and inject money into the local economy. These communities have the luxury of abundant wildlife resources within a reasonable proximity of their respective communities. The evolution of experimental hunting projects to large-scale commercial hunts, with a formal contractual basis for commercial caribou meat, has changed the basis of this hunting activity. On SHI, caribou are required to be harvested on a continual basis to supply contracts with northern and southern based meat plants.

The question now remains, are large-scale commercial hunts sustainable from an economic standpoint and if so, can they remain biologically sustainable in the Canadian Arctic? In the past, commercial utilization of wild animals has generated either a disastrous result for the population utilized or for the business entity conducting these operations. Without proper safeguards on population management and capital expenditures required to complete these exercises, market demand could lead to over-exploitation of the resource.

APPENDIX 3-1 Harvest and processing methods for large scale commercial caribou harvest in Coral Harbour, NU - March-April, 1997.

In the next section, I will describe the Southampton Island harvest and processing methods that I witnessed in 1997.

Harvesting activities begin with the mobilization of a base camp, which is usually located within a radius of 65-100 km of the community and centrally located to the caribou herd. The camp location is determined by community members to be optimal for access to the potential caribou that will be harvested. The camp is equipped with a large kitchen tent, accommodation tents for workers, generator tents, and washroom facilities adequate to service 40-50 people. A portable abattoir facility, which is equipped with a railing system for easy movement of carcasses, is located in the camp to process these animals. This camp must also be located within an area that has a clean water supply to satisfy federal meat processing specifications.

The group anticipated obtaining an average of 90 animals per day. The hunters leave base camp on snowmobile, towing an empty komatik or Inuit sled. The hunters shoot the caribou in the head or neck area to reduce wastage of meat. Upon being shot, the caribou is immediately bled by cutting the carotid artery. The throat or esophagus is also cut to reduce bloating. The hunter then puts the caribou on his komatik and continues to hunt. The hunter has approximately one hour, from time the first caribou is shot, to transport the game back to the portable abattoir. This time limit was set by meat inspectors with the Canadian Food Inspection Agency to reduce bacterial contamination of the meat.

Typically, hunters arrive back at camp with two to seven caribou for processing. As the hunt progresses, the hunters generally have to travel farther from the base camp to hunt caribou and consequently have less time to hunt. Managers acknowledge that hunting success typically declines after approximately 2 200 to 2 500 animals have been harvested.

Once caribou are delivered to the abattoir, they are hooked onto a railing system where they are skinned, gutted, examined by federal officials, cut into halves, and trimmed for excess fat and haemorrhaging. However, if an animal is not shot in the head or neck, all traumatized tissue will be removed during the meat cutting process. Federal officials condemn any animals that are shot in the stomach area, any meat that has come into contact with other non-sanitary surfaces, and any meat that does not meet Agriculture Canada's meat inspection standards due to arthritis, emaciation, parasites, infections, and/or pneumonia. Over the years, the territorial government has worked with Agriculture Canada to refer to carcasses that are removed from the line as "downgraded for community use" if the problem is very isolated and/or cosmetic in nature. Animals are defined, as "condemned" when there is significant involvement of parasites, infections, etc. (J. Colford, pers. comm. 1999).

The carcasses are wrapped with cheesecloth and sent outside the abattoir on the railing system to freeze in the ambient temperature. The frozen meat is put into a combo bin that is located on a skid or barge system. This skid system is loaded with combo bins and transported back to Coral Harbour with a D-6 Cat. The combo bins are delivered to the airport where they are set on wooden pallets for ease of movement. Pallets are loaded onto an aircraft and transported to Thompson, Manitoba where they are loaded onto refrigerated trucks and delivered to meat processing facilities in Proton Station, Ontario where they are delivered to final end users. Carcasses are then cut into desirable meat cuts and distributed for sale.

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CHAPTER FOUR

POLICY AND LEGISLATION FOR COMMERCIAL HUNTING IN THE CANADIAN ARCTIC

INTRODUCTION

The commercial hunting industry in the Canadian Arctic[3] has evolved to its present form from the traditional practice of subsistence hunting by Aboriginal peoples in the Arctic and Subarctic regions. From bartering for foreign goods with early explorers, to the present day activities of accepting cash for wild caribou carcasses, Aboriginal hunters have transitioned from a traditional nomadic existence to the intermixing of wage labour and harvesting activities (Gunn et al. 1991; Usher and Weihs, 1990). Wild ungulates utilized in this hunting industry include caribou (*Rangifer tarandus*) and muskoxen (*Ovibos moschatus*). For the purposes of this work, commercial hunting of caribou will imply the organized hunting of caribou in the Canadian Arctic for sale in local or export economies.

Policy and legislation for commercial hunting came with the emergence of government in the Canadian Arctic. The main impetus for harvesting legislation has been the protection of the species hunted. Federal and later territorial agencies, in collaboration with land claims groups, would determine appropriate harvesting levels. Policy for hunting caribou has continually focussed on identifying the appropriate harvesting levels based on maintaining community harvesting requirements (Urquhart, 1989). Present day legislation and the policy surrounding meat harvesting activities in the Canadian Arctic has evolved with the industry (Appendix 4-1).

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[3] For the purposes of this work: The Canadian Arctic includes the Northwest Territories (NWT) and Nunavut Territory (NU). At the onset of this work, both the Nunavut Territory and the Northwest Territories were termed the Northwest Territories before the Nunavut Territory division on April 1,1999.

In the Canadian Arctic, there are different processing requirements for wild meat sales to domestic and export consumers. Federal meat inspection regulations determine commercial export harvesting requirements. However, domestic use is only regulated by guidelines that were established as a practical means of meeting consumer needs, while still being able to promote domestic sales. The main source of commercial hunting meat sales in the Canadian Arctic is large-scale hunting. Government programs, with community and private industry involvement, have played key roles in the development of this segment of the wild meat industry. Land claim agreements, Aboriginal participation, and government support will form the basis for the future of commercial hunting in the Canadian Arctic.

EARLY DEVELOPMENT OF CARIBOU HUNTING POLICY AND LEGISLATION

The importance of generating economic activity from renewable resources was common in the Canadian Arctic economy as far back as the 1940s. The Dominion Wildlife Service branch of the federal government was responsible for managing wildlife resources in the Canadian Arctic in the 1940s. Their mandate was to:

> "manage wildlife resources according to "scientific" principles for the benefit of national economic development" (Cranstonsmith, 1995: 64 from Abel, 1993: 204-214).

However, even with a depressed economy on the forefront of the government's agenda, caribou utilization would decrease due to an increased awareness of the decline of caribou populations. The Dominion Wildlife Service would be replaced by the formation of the Canadian Wildlife Service (CWS) in 1947. CWS biologists, specifically A.W.F. Banfield (1947-1950) and later John Kelsall (1950-1959), conducted research on the caribou populations in the Canadian Arctic (Polar Record, 1951; Urquhart, 1989). Their studies pointed to a drastic decline in caribou numbers from the turn of the century. In 1949, management of wildlife resources in the Canadian Arctic was transferred from the federal to territorial government and subsequently NWT Council assumed responsibility for enforcement of wildlife regulations. In 1950, with concerns surrounding the declining caribou populations, the NWT Council ruled that missions and hospitals must cease using caribou and import other kinds of meat for patients (Cranstonsmith, 1995).

The 1950s saw further evidence from CWS biologists regarding the apparent decline of caribou numbers (Polar Record, 1951) and officials argued that caribou used for sale to whites was not in the spirit of conservation (Cranstonsmith, 1995). Government officials afraid of the demise of the caribou herds decided that the best policy action should be to protect the caribou at all costs. In 1960, caribou were declared an endangered species by a federal order-in-council (Urquhart, 1989). Urquhart (1989:100) commented:

> "The crisis was blamed mainly on hunters. During the following decade, however, there was some indication that the downward trend in caribou numbers had been reversed, and regulations, which had been tightened up somewhat during the 1950s, were relaxed."

In 1968, the NWT Game Ordinance was created and by the early 1970s the territorial Game Management Division (now the Department of Resources Wildlife and Economic Development (RWED) had taken over the lead role in caribou studies from the Canadian Wildlife Service (Urquhart, 1989).

PRESENT DAY COMMERCIAL HUNTING DEVELOPMENT

The legalization of commercial use of caribou in the Canadian Arctic occurred in 1968 when the NWT Game Ordinance was revised to liberalise the use of caribou (Cranstonsmith, 1995). Government programs aimed at improving the economy of Aboriginal communities, required changes to the NWT Game

Ordinance (which would become the NWT Wildlife Act in 1979). Under the NWT Wildlife Act, the GNWT has legislative authority to manage wildlife (NWT WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4). Wildlife is defined as all vertebrates except fish that are naturally occurring in the Territories (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4). The Wildlife Act and regulations establish wildlife management units, wildlife management zones, wildlife preserves, wildlife management areas, critical wildlife areas or special management areas, set harvest quotas, sex, age and size limitations, determine seasons, and develop habitat preservation regulations. The NWT Game Ordinance revision permitted the holders of a General Hunting License (GHL) to sell caribou meat within the Canadian Arctic as long as it was to other GHL holders.

In the Canadian Arctic, Aboriginal people (Inuit, Dene, and Metis) are entitled to hold a GHL, which permits them to harvest as many animals as required for subsistence (i.e. to meet the needs of that person and their families) (Bennett, 1982). However, there is an upper limit to this type of hunting in that hunters that harvest animals and waste or do not utilize all harvested game are subject to fines (NWT WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4). Only GHL holders, whether individuals or groups of GHL holders, may hunt caribou for meat sale in the Canadian Arctic (NWT WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4). Miller (1987:527) noted:

> "From 1948 until 1978, natives in the NWT obtained GHLs on an annual basis, and were required to provide oral accounts of yearly game kills to the licensing authority at renewal time. In 1978, the GHL became a permanent (life-long) issue to eligible hunters."

WILDLIFE MANAGEMENT IN THE NORTHWEST TERRITORIES AND NUNAVUT

The government department assigned duties pertaining to the sustainable use, commercial use, and regulatory supervision of wildlife in the Northwest Territories and Nunavut is the Department of Resources, Wildlife and Economic Development (RWED) and the Department of Sustainable Development (SD) respectively. These departments manage wildlife throughout the Canadian Arctic and work co-operatively with resources users and Aboriginal land claim groups on settlement areas.

Land claim agreements

Four land claims agreements have been signed in the Northwest Territories (NWT) and Nunavut (NU) since 1984: the Inuvialuit Final Agreement (1984); the Gwich'in Comprehensive Land Claim Agreement (1992); the Sahtu Dene and Metis Comprehensive Land Claim agreement (1993); and the Nunavut Comprehensive Land Claim (1993). In August 1999, the Dogrib Land Claim and Self-Government Agreement-In-Principle was initialled by the chief negotiators for the Dogrib Treaty 11 Council, the federal government, and the GNWT. The completion of land claim agreements has retained some powers to Aboriginal people with respect to resource management. The importance of land claim areas to wildlife management is evident by their power to override current wildlife legislation. Under land claims agreements, GNWT retains ultimate authority to enact wildlife legislation. However, land claim agreements may provide advice on what legislation is needed. Colford noted (1998: Appendices):

> "Federal legislation enacting the Inuvialuit, Nunavut, Gwich'in and Sahtu land claim agreements also affects wildlife management. Where the NWT Act, Canada Wildlife Act, NWT Wildlife Act or any other legislation are inconsistent with the land claim agreements, the land claim

> agreements prevail. Under these agreements, harvesting by beneficiaries can be regulated through the use of by-laws established by community and regional hunters' and trappers' organizations. This could not be done under previous legislation. The agreements also establish co-management boards with certain approval and policy powers and advisory powers to which government Ministers must give full consideration".

Territorial wildlife departments work cooperatively with each land claim group but maintain the authority to manage wildlife under land claims agreements. A result of land claim agreements has been the ability of Aboriginal people to establish polices, propose regulations, and make decisions regarding wildlife management issues in their respective land claim areas. The agreements establish specific rights with respect to wildlife management for Aboriginal people. The aim of the GNWT has been to involve Northerners in all aspects of wildlife management that include: setting priorities for management and research; reviewing research proposals; participating in field studies; evaluating the significance of research results; and deciding on management actions (Colford, 1998).

Co-management boards have developed in land claim areas and non-claim areas with local HTAs and regional wildlife organizations. Co-management boards in land claim areas are comprised of 50 percent members nominated by the beneficiary group and 50 percent nominated by territorial governments. This is a provision of all land claims agreements to ensure informed decision making towards wildlife. Land claim agreements essentially allow beneficiaries to elaborate their policies towards managing wildlife, which includes developing policy and proposing regulations. There are currently four co-management boards in the NWT and NU, which include the Wildlife Management Advisory Council in the Inuvialuit Settlement Region (ISR); the Gwich'in Renewable Resource Board in the Gwich'in Settlement Area (GSA); the Sahtu Renewable Resources Board in the Sahtu Settlement Area (SSA); and the Nunavut Wildlife Management Board in the newly established Nunavut Settlement Area (NSA).

Co-management boards have also been developed to manage specific wildlife resources in local or inter-jurisdictional areas (Treseder and Honda-McNeil, 1999). Such co-management boards involving caribou populations in the Northern Canada include the Beverly Qamanirjuaq Caribou Management Board (Beverly and Qamanirjuaq Caribou Management Board, 1996: Scotter, 1991; Thomas and Schaefer, 1991) and the Canadian Porcupine Caribou Management Board (Therrien, 1987). These boards have been implemented to discover an alternative way of managing a resource that is of benefit to all parties.

In areas of comprehensive claim agreements throughout the Canadian Arctic, co-management renewable resource boards (RRB), consisting of beneficiaries and wildlife managers, determine quotas for the resource utilized. These advisory boards send their recommendations or decisions to the appropriate Minister for consideration and action (Sahtu Dene and Metis Comprehensive Land Claim Agreement, 1993:13.8.25). In most settlement areas, a Renewable Resource Council (RRC) is established to provide advisory roles for the RRB. RRC's consist of not more than seven persons who reside in the respective community (Gwich'in Comprehensive Land Claim Agreement, 1992). Aboriginal members of the co-management Boards and Councils are chosen from the local and regional Hunters' and Trappers' Associations (HTA). Dragon (1999:31) noted:

> "Hunters' and Trappers' Associations (HTAs) exist in most communities in the Canadian Arctic. Under terms of comprehensive claim settlements, HTAs may have legislative responsibilities for some aspects of wildlife management. HTAs may also be known by different names under different claim settlements."

Some of the different names for HTAs include HTCs (Hunters' and Trappers' Committees) and HTOs (Hunters' and Trappers' Organizations). As quoted from the NWT Wildlife Act (1988):

> "Hunters' and Trappers' Association means the Hunters' and Trappers' Association or, if there is no Hunter's and Trappers' Association, the council of a band, as defined in the Indian Act (Canada)".

The wildlife co-management boards recommend the total allowable harvests (TAH) for a particular species. Quotas are based on TAH and reflect the number of animals that can be sustainably harvested out of the population (Sahtu Dene and Metis Land Claim Agreement, 1993). Quotas for commercial meat use may be established after the needs of the land claimant beneficiaries are met. The local HTA generally distributes caribou tags to individual members for market hunting purposes or may decide to use the tags for either a community hunt or large-scale commercial hunt. Different land claim agreements have different processes for controlling the issuance of commercial and trophy tags (Sahtu Dene and Metis Land Claim Agreement, Volume 1, 1993:13.7). However, all land claims agreements clearly identify that traditional users have top priority in terms of allocation of resources (Hall and Lloyd, 1989).

Meat harvesting

Meat sales in the Canadian Arctic for caribou are best described as a three-tiered marketing system (Table 4-1). GHL holders may harvest caribou for either local meat sales to other GHL holders, non-GHL holders, or institutions/meat processing plants within the territory harvested or meat sales destined for commercial export outside territorial borders. Presently, Aboriginal hunters in the Canadian Arctic use three types of commercial meat harvesting systems: market hunting, organized community hunts, and large-scale commercial hunts. The regulations pertaining to the processing of caribou carcasses depend on the final destination of the product.

In the Canadian Arctic, wild meat can be harvested for either domestic or export use. Domestic use involves the sale of meat within territorial borders and does

Table 4-1 Commercial hunting guidelines in the Canadian Arctic.

Type of Commercial Use	Consumer	Commercial Tag Required?	Limit on Harvest?	Domestic or Export Sales?	Required to Follow Federal Harvesting Regulations?
Market Hunting					
GHL to GHL	GHL holders	NO	NO	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions or meat processing plants	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
Organized Community Hunts					
GHL to GHL	GHL holders	NO	NO	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions or meat processing plants	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
Large-scale Commercial Hunts					
GHL to GHL	GHL holders	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic	NO
GHL to non-GHL	Non-GHL holders, institutions, meat processing plants, or international export	YES	YES, based on number of commercial tags obtained prior to hunt	Domestic or Export	YES

not require inspection whereas meat used for export purposes is destined to cross territorial borders and is required to meet Canadian federal meat inspection guidelines. With the creation of the Nunavut Territory in 1999, meat export guidelines apply to both territories. For example, meat harvested in Nunavut (Southampton Island, NU) and destined for markets in Yellowknife, NT would be required to meet Canadian federal meat inspection guidelines and visa-versa.

Domestic meat use

Market hunters can sell caribou meat, within territorial borders, to other GHL holders, hotels, restaurants, or institutions such as hospitals, corrections facilities, homes for the elderly, and meat processing facilities (Table 4-1). Meat can be sold to these end users without inspections to ensure the animal, carcass or meat products meet acceptable health standards (Colford, 1998). As well, there is no territorial legislation that requires the GHL hunter to report any of the animals for inspection purposes as long as the meat is sold within territorial borders (Dragon, 1999). When meat is sold directly to another GHL holder, there is no limit on the number of animals that can be harvested for these purposes. There are currently no government recording procedures for animals harvested for market hunting purposes. However, any GHL hunter that does not utilize the animals that they have killed, can be charged and subject to a fine.

If the market hunter or HTA organized hunting party plans to sell meat to non-GHL holders such hotels, restaurants, an institution, or a meat processing plant within territorial borders, they are required to obtain commercial meat tags from RWED/SD before the actual hunt takes place. RWED/SD and local wildlife management boards develop commercial meat tag quotas for specific caribou herds.

Enforcement

Market hunting in the Canadian Arctic has increased in recent years due to increased wild meat demand by local residents, the establishment of processing facilities in some Canadian Arctic communities, and the decline of organized community hunts by HTAs (E. Evans, pers. comm. 1999). Monitoring of these hunting activities is extremely difficult for RWED wildlife officers due to the logistics of travel required to oversee small projects of this nature and the non-registering of animals sold to other GHL holders (B. Bergman, pers. comm. 1999). The exact number of animals sold to other GHL holders is unknown by wildlife departments due to the lack of imposed limits or control on the number of caribou obtained and the non-existence of a reporting system. However, it can be assumed that GHL market hunters are only fulfilling the subsistence needs of other GHL holders that for whatever reason, are unable to attain wild meat resources for themselves.

ISSUES NOT ADDRESSED UNDER CURRENT LEGISLATION OR POLICY

An area of concern to the consumer associated with this type of commercial meat sale is that any GHL holder, regardless of hunting ability, is allowed to pursue caribou for meat sale. There are no criteria or conditions for accrediting a GHL hunter when they are trying to pursue an animal for sale to other individuals. Wounding of animals, because of a lack of hunting ability, is commonplace for an unseasoned hunter. Lack of shooting accuracy and firearm and ammunition selection contribute to the wounding of caribou.

Meat processing techniques vary with each individual hunter based on either what they have learned from their relatives (who were caribou hunters themselves), or from experimenting on their own. Animals that are harassed while in pursuit are known to show meat deterioration (Wiklund et al. 1997) and thus would present the consumer with inferior meat quality. Detecting disease also depends on the market hunter's experience because they butcher the animal in the field and typically present the final end users with a butchered carcass or parts of carcasses.

Criteria should be established for a market hunting licence and should be legislated to ensure the safety of these operations, as well as the quality of the meat delivered to the consumer. This program could involve a certification process for each market hunter that would cover appropriate firearms and ammunition used to hunt caribou, shooting skills, processing techniques that increase the quality of meat presented for sale, and disease identification. Market hunting is an occupation that has developed from the traditional act of harvesting caribou for subsistence purposes. However, rules and regulations for this activity need to be developed to ensure the safety of the meat presented to the consumer and the protection of caribou populations utilized for this hunting activity. Domestic meat sales of wild caribou are predominately satisfied by market hunters and organised community hunts whereas, large-scale commercial hunts have been designed to meet export demands with minor sales in the domestic market.

Export meat use

In Canada, any fish or meat products that cross provincial borders and/or are destined for international trade are subject to federal food inspection legislation (Colford, 1998). An Agriculture Canada veterinary inspector or accredited veterinarian must inspect meat intended for export. The Canadian Food Inspection Agency (CFIA) was formed in April 1997 to oversee the federally mandated food inspection and quarantine services of Agriculture Canada. Since 1985, Agriculture Canada veterinary inspectors have worked with territorial departments and local HTAs/HTOs to inspect meat and develop a protocol specifically for Canadian Arctic harvests for the export market. Colford (1998:7) noted:

> "At the request of Northerners, Muskoxen (*Ovibos moschatus*), reindeer (*Rangifer tarandus*), and caribou (*Rangifer tarandus*) have been added to a provisional list to allow federal inspectors the authority to provide inspection services for these species. It has been provided on a needs basis, and only for meat intended for export from the Canadian Arctic."

Meat destined for export can be obtained through large-scale commercial hunting projects utilizing federally approved portable abattoir facilities. These projects are initiated and developed with the co-ordination of the GNWT and the respective community's HTA. Large-scale hunting of wild free-roaming ungulates for meat production has been occurring in remote Aboriginal communities for over two decades (Figure 4-1). However, current territorial government regulations surrounding commercial use of caribou, which were implemented in the early 1970s, require revision to reflect today's hunting practices (Colford, 1998). Large-scale hunting has developed in the Canadian Arctic in response to territorial departments trying to generating economic activity in small remote communities, creating an alternative source for wild meat and, in the case of Southampton Island, a herd reduction exercise.

LARGE-SCALE HUNTING DEVELOPMENT

In 1917, the Canadian government looked to supplement wartime meat supplies with wild caribou meat (Cranstonsmith, 1995). Interestingly, difficulty in the logistics of storing and shipping the meat, which still affect present day commercial operations, delayed the project. This project did not proceed as the First World War ended on November 11, 1918 before the project could take place.

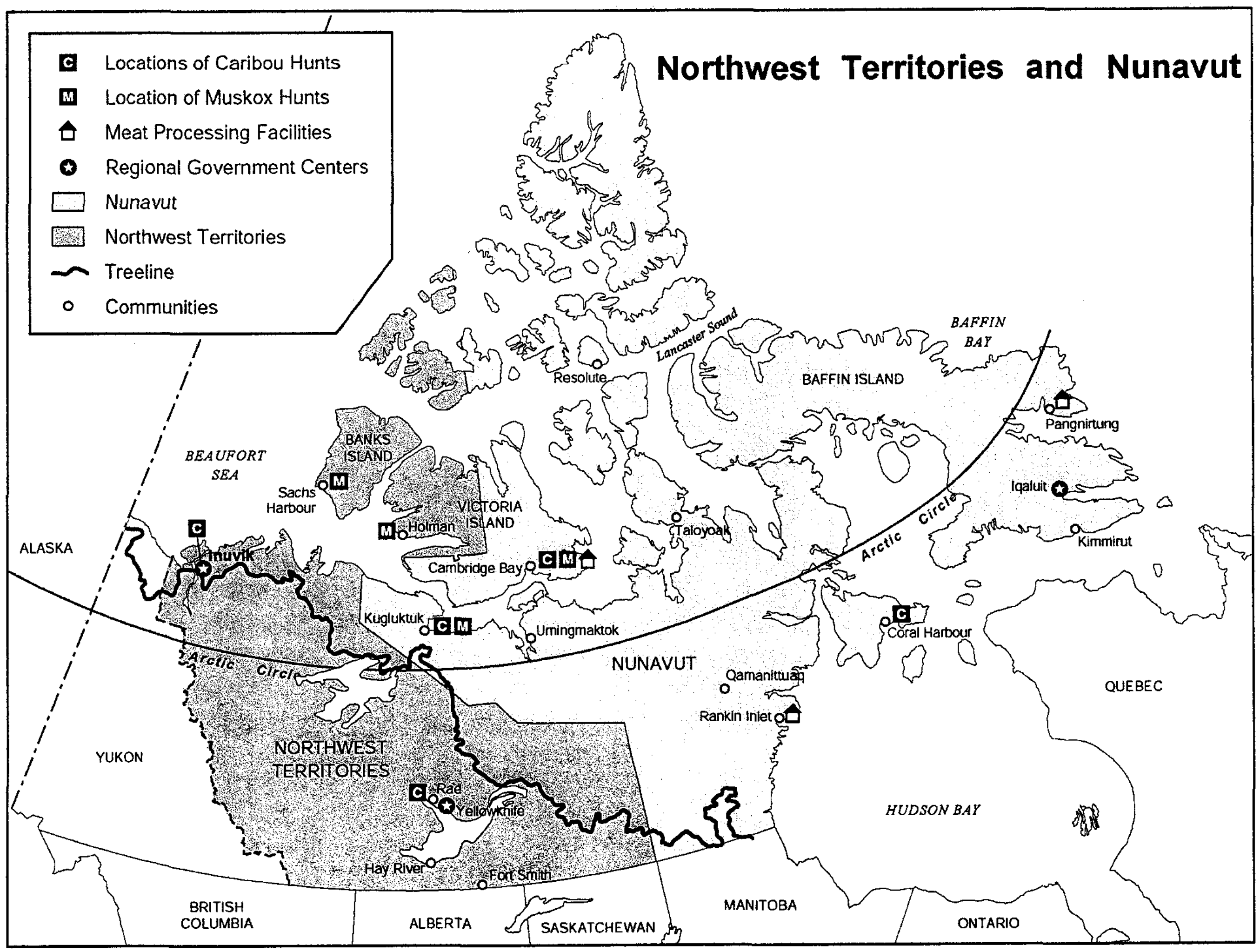

Figure 4-1 Locations of caribou and muskoxen commercial hunts and meat processing facilities in the Canadian Arctic.

In 1929, a Royal Commission was appointed by an Order in Council to research the possibilities of reindeer and muskoxen use in the Canadian Arctic (Rutherford et al. 1922). This report suggested that these species could be utilized for commercial purposes but further research of the habitat and population numbers should be conducted. Initial reindeer projects failed due to various problems associated with herding practices (Scotter, 1972).

With the 1968 legislation allowing the sale of caribou between GHL holders, commercial hunting in the Canadian Arctic was realized. Commercial hunting began as government sponsored hunts, which will be referred to as organized community hunts. Organized community hunts were developed to encourage wage labour in a form similar to the Aboriginal traditional act of harvesting and to deliver small supplies of meat to the local communities. In the 1970s, early success of these types of operations and the development of reindeer meat sales from the western Arctic reindeer operations, prompted government officials to initiate the development of small processing facilities. These facilities were once located in the communities of Inuvik, Yellowknife, Rankin Inlet, Kugluktuk, Cambridge Bay, Fort Smith, Baker Lake, and Iqaluit (Figure 4.1). Colford (1998:2) noted:

> "The facilities, typically small scale, were set up to allow meat processing for community needs and local sales. The expense of operating these facilities, and the limited management expertise and markets available to them, rendered virtually all operations economically non-viable. Operations were either supported with sporadic government assistance or were closed down due to management and financial difficulties."

Success with community hunts, the development of meat processing facilities, and the rise in demand for wild meat in Asia and Europe induced the government to investigate the commercial hunting of caribou and muskoxen for export purposes. The failure of these small meat processing facilities did little to deter the investment in large-scale hunting projects.

Government funding shifted directly to the promotion of meat products for export (J. Colford, pers. comm. 1999). To obtain government grants to participate in large-scale harvests, HTAs were required to complete hunts that complied with meat inspection guidelines enforced by Agriculture Canada. Community hunts for domestic usage continued in local communities but was virtually non-existent without government subsidization.

Initially starting in 1982, the first experimental hunt on muskoxen was completed near Sachs Harbour in the western Arctic (Figure 4-1). The Department of Renewable Resources and the Department of Economic Development and Tourism (now merged and referred to as Resources, Wildlife and Economic Development, (RWED)) worked in conjunction with the local HTA and advice from Agriculture Canada veterinarians to process approximately 96 muskoxen carcasses. Numerous problems plagued these initial hunts. Colford (1998:2) explained:

> "While the use of "country food", as a dietary staple is still widespread, acceptance of wild meat, fish, and agricultural products into the commercial marketplace remains tentative. There are a number of reasons for this including an inadequate distribution network, limited processing capability, lack of information, an imperfect track record with regards to product quality and price, inconsistency of supply, and the lack of an effective inspection system which has left a less than perfect impression among discerning consumers".

Capital infrastructure for these operations has been subsidized through government investment programs. Government funding continued to support these projects in the hopes that international exposure would establish whether or not commercial projects of this nature should continue. Lessons from these experiences were applied to the first ever large-scale commercial export harvests for caribou in 1985/86 in Inuvik, NWT. Caribou meat from this hunt was exported to EXPO '86 in Vancouver, British Columbia. The meat products were very well received by the international audience and thus prompted food producers and politicians alike, to endorse large scale commercial hunting (Colford, 1998).

In the early 1990s, focus on the commercial hunting operations turned towards eliminating some common stumbling blocks in government policy and legislation for communities completing these hunts. With the aid of government personnel and funding, more efficient field technology was developed, pulse harvesting was created to increase production, and inspection guidelines were developed and tested to ensure quality Northern meat supplies (Colford, 1998). Other areas of improvement during this period included the development of mobile and fixed abattoirs and larger processing plants to increase the usage of under-utilized commercial quotas. Pilot projects to determine domestic markets in the Canadian Arctic and export markets in Japan were initiated by the territorial government as well. Key issues surrounding the management and financial components were also reviewed. With all these areas addressed, new federally approved meat processing facilities were developed in Cambridge Bay and Rankin Inlet (Figure 4-1). For the first time, large-scale federally inspected pulse harvests for export were conducted.

It should be noted that these economic development projects were initiated in small, remote communities where wage labour was minimal. Abundant local wildlife resources were utilized to promote an industry that was economically non-viable without government subsidization.

GOVERNMENT AND PRIVATE SECTOR INVOLVEMENT IN COMMERCIAL HUNTING

Two territorial government departments and a federal government department currently monitor large-scale commercial and some market harvesting in the Northwest Territories as follows:

A) Department of Resources, Wildlife and Economic Development (RWED) has the mandate and legislation to make regulations pertaining to the use and sale of wildlife and its products (NWT WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4.). RWED has implemented various regulations for harvesting, processing, sale, and serving of game and game products, as well as environmental requirements for commercial hunting operations.

B) The Department of Health and Social Services has mandate and legislation governing the sanitary conditions for preparing and serving food under the Public Health Act. HSS has the authority to make regulations and in 1997 implemented domestic meat inspection regulations that apply to fixed abattoirs.

C) Agriculture and Agrifood Canada through the Canadian Food Inspection Agency (CFIA) has the mandate and legislation to ensure food safety when agricultural products are produced for inter-provincial and international trade. CFIA inspects meat imports and federally registered establishments that produce processed meats and ready to eat products to verify compliance with food safety regulations.

In 1989, a Special Committee on the Northern Economy (SCONE) reviewed areas that could support the domestic economy in the NWT (NWT Legislative Assembly, 1989). The mandate of SCONE was to create a single, long-term economic development strategy for the Northwest Territories and resulted in 30 recommendations that concentrated on people development, policy, and program development and organizational development economy (NWT Legislative Assembly, 1989). Within the report, the tourism and economic development sectors were reviewed and recommendations looked at focusing on exports and import substitution of renewable resource products/foods. Key areas of priority included an emphasis on import replacement, creation of primary industry and value added potential, investment in developing communities, and a call for a meat inspection system (Colford, 1998). A section of this report noted (NWT Legislative Assembly, 1989:58):

> "The program should be administered jointly by the Department of Renewable Resources and local HTAs. Besides providing direct assistance to hunters and trappers the program should have a research and development component (looking into product development, processing and sale of country foods, craft production, public relations and education) along with programs for conservation, management, enhancement, environmental protection, and regular program evaluation and monitoring".

The SCONE report in 1989 was the driving force behind the creation of NWT Development Corporation (DevCorp) and formed the basis for the current direction of the commercial meat industry in the Canadian Arctic (Colford, 1998). The DevCorp is a government agency that has the responsibility for the marketing of meat within and outside the Canadian Arctic. Arctic Canada Trading Company, formerly Canadian Arctic Foods, a subsidiary of DevCorp, is specifically mandated to market northern food products.

Along with community participation, commercial meat production in the Canadian Arctic has many participants in the private sectors as well. In the private sector, the dominant players are the local HTA's who have become exporters and marketers of game meat. Local HTA's are now initiating commercial hunts as well as setting up small-scale meat processing facilities that are mainly used for domestic sales. Small-scale meat processing facilities are presently in place in the Kitikmeot (central Arctic), Keewatin (eastern Arctic), and Baffin (eastern Arctic) regions. The processing facilities in the central Arctic and eastern Arctic are located in Cambridge Bay and Rankin Inlet respectively, and both are federally approved processing plants. An area of concern with these plants and their ability to process meat from commercial hunts is the lack of freezing space required for processing the large-scale hunts.

Exporters of game meat have included the Umayot Corporation (Banks Island, NWT discontinued 1994), Southampton Island Meat Company, formerly Tunneq Harvests (Coral Harbor, Nunavut) and the Dogrib Game Corporation (Fort Rae, NWT). These operations have primarily focused on caribou and muskoxen sales as well as the marketing aspects of selling wild meat. Export sales for 'exotic' wild meat from the Canadian Arctic has been marketed by private businesses in the past but is currently assigned to the Keewatin Fish and Meat Plant in Rankin Inlet.

FUTURE POLICY FOR COMMERCIAL HUNTING

Wildlife Act

The NWT Wildlife Act (Wildlife Act) governs the management of wildlife throughout the NWT. The Wildlife Act is now over 20 years old and is presently under review and will be revised following extensive consultations with user groups. The drafting of a new Wildlife Act is required to fully integrate land claims provisions, be adaptable to incorporating new land claim agreements, and remain compatible with the Canadian constitution and other federal and territorial legislation. Some of the topics that are being addressed include: integration of land claim agreements, compatibility with the Charter or Rights and Freedoms and other legislation, how can people hunt, wildlife harassment, export of live wildlife; export permits for game meat; feeding game meat to domesticated animals, gifts of game meat, wasting of wildlife, and penalties and enforcement (RWED, 2001).

Issues that must be addressed

Over the past few years, considerable strides have been made to develop territorial guidelines for domestic meat harvesting. No legislation exists for the governance of this activity but the territorial government enforces these guidelines by including them in the issuance of a wildlife license to the organization completing the hunt. Commercial wildlife licenses were initiated for large-scale commercial hunts by the territorial government in 1992. Through a commercial program funded by GNWT, meat inspection regulations were passed by the Department of Health and Social Services and implemented in the fall of 1996. However, these regulations are applicable for abattoir facilities only.

Currently, there is no territorial legislation or delivery system for implementing a meat inspection system; however legislation may need to be put in place in the next few years as the commercial use of wildlife increases. As a part of the commercial wildlife license, the territorial government can dictate harvesting guidelines to a commercial harvesting operation. A system that emulates CFIA inspection guidelines and incorporates northern harvesting circumstances is more desirable.

Territorial government programs

Government participation in the development of policy and legislation and fundamental program support are vital components in the success or failure of commercial hunting programs in the Canadian Arctic. RWED's mandate for blending renewable resources with economic prosperity is as follows:

> "The mandate of the Minister and the Department of Resources, Wildlife and Economic Development is to promote economic self-sufficiency and growth through the sustainable development of natural resources and enhance the creation of new, sustainable opportunities in the traditional and wage economies. Through the promotion of sustainable development, the Department manages and protects the integrity, quality, diversity, and abundance of natural resources and the environment". (RWED, 1999)

Current RWED programs for commercial hunting are guided by legislation and policy and are as follows:

> Renewable Resource Use Policy (1984) – The GNWT will foster development of renewable resource potentials in the Northwest Territories by encouraging and supporting domestic, subsistence, commercial, and outdoor recreational uses of renewable (RWED Policy 52.08, 1991).
>
> Commercial Renewable Resource Use Policy (1986) - The GNWT supports and encourages the development of the NWT economy in a manner compatible with Northern lifestyles and aspirations. To that end, the GNWT shall encourage and support the development of a commercial renewable resource sector that is consistent with acceptable resource management and business management practices (RWED Policy 52.08, 1991).
>
> Sustainable Development Policy (1990) - The GNWT recognizes that environmental conservation is essential to long-term economic prosperity while at the same time economic development can contribute significantly to the achievement of conservation goals. The interdependence between conservation and development will be officially recognized by the Government of the Northwest Territories through the application of the concept of sustainable development to all its decisions and actions related to natural and heritage resources in the Northwest Territories (NWT Policy 52.05, 1993).

Commercial hunting development in the Canadian Arctic depends heavily on government policy in regards to employment initiatives, the environment, Aboriginal employment, and to all areas revolving around the Northern lifestyle. Renewable resources currently form the subsistence and economic base for many Aboriginal people of the Canadian Arctic (Renecker et al. 1989). The

GNWT sustainable development strategy (Department of Renewable Resources, 1994) described the rationale for the introduction of commercial hunting systems in the Canadian Arctic:

> "to promote economic self reliance at the local level; to increase employment opportunities for the resident labour force through education, training, and job creation; to maximize opportunities for local retention and investment of profits; and to influence the pace of development to promote long term benefits from the use of wildlife resources."

The direction of government policy with respect to commercial hunting has been to establish a link between the economy and environment that was not previous there before. The overall objective of the government was to increase business opportunities with regards to renewable resources but still maintain a balance between the sustainability of this type of activity on the resources utilized.

The issue of property rights and resource objectives with respect to wildlife resources and the association of government agencies and Aboriginal land claim groups must be clarified. Although the NWT Wildlife Act governs the management of wildlife, and as such the Minister responsible for wildlife utilization is ultimately responsible for the resource, land claim agreements dictate that Aboriginal resource groups have authority to manage the wildlife resources in their specific claim area. As discussed, the Ministry's overall objectives revolve around the interdependence of conservation and economic development of wildlife resources. In the future, Aboriginal groups will be responsible for not only the monitoring of these objectives but as well, the enforcement of these objectives. Community based monitoring has presented positive results in other Aboriginal cultures (Child, 1996). However, the social, economic, political and environmental aspects of Aboriginal and territorial governments must all be fulfilled in order to address wildlife management agendas in the Canadian Arctic (Caughley and Sinclair, 1999).

Investment in the commercial hunting industry through program and financial support has been substantial for the territorial government (J. Colford, pers. comm. 1999). However, successful large scale commercial hunts for caribou are only being witnessed in one community in the eastern Arctic, Coral Harbour, NU. Depending on herd dynamics and harvesting scenarios, this population could face drastic declines (Heard and Ouellet, 1994) and with it, the ultimate decline of large-scale commercial hunting of caribou in the Canadian Arctic.

CONCLUSION

Legislation for commercial harvesting was initially established for conservation purposes. As commercial harvesting became linked to the wage economy, policy and legislation were revised to overcome barriers to meet economic development, employment, and conservation agendas. Development of meat processing techniques and determination of markets for wild caribou meat increased the visibility and viability of commercial hunting operations in the Canadian Arctic. Policy formulation for the commercial harvesting of caribou has developed over the years as a function of the sustainable use of the resource while continuing to focus on economic development in small, remote communities in the Canadian Arctic. Government officials were well aware of the difficulties and complexities of these operations but the focus of these exercises was to generate economic activity in activities that were consistent with Aboriginal lifestyles. Policy surrounding commercial hunting has evolved with the commercial hunting activity whereas legislation has lagged behind.

With the upcoming review of the NWT Wildlife Act, legislation needs to be developed to address current commercial hunting activities. Wildlife regulations must be able to incorporate land claim agreements while maintaining a strong hold on conservation practices. Current practices of commercial hunting in the Canadian Arctic look to satisfy both the domestic and export meat markets.

Legislation will have to address both aspects of commercial hunting to continue to maintain sustainable caribou populations.

In the future, policy will evolve as the Aboriginal land claim groups exert further control over resources. If further control over resources means that harvesting more caribou will enable Northern Aboriginal people to overcome the economic hardships of living in the Canadian Arctic, then most likely this type of activity will be pursued. Key factors for the success of commercial hunting in the Canadian Arctic revolves around the maintenance of government and Aboriginal group co-operation, sustainable use of the caribou populations, and finally, the scale of harvesting operations.

APPENDIX 4-1: History of policy and legislative events surrounding commercial hunting in the Canadian Arctic (1947-1993).

Year	Policy	Legislation	Land Claims	Type of Commercial Hunting Enabled/Disabled
1947		Dominion Wildlife Service – mandate was to manage wildlife resources according to scientific principles for the benefit of national economic development		
1950		NWT Council amended ordinance to control use of caribou meat as dog food when alternative dog food available and with a prohibition against the sale of meat to whites in settlements.		Commercial use of caribou was deemed not in the spirit of conservation.
1960		Caribou were declared in danger of extinction by the Order in Council.		Application of quotas and seasonal restrictions on caribou; applicable to Indians in the NWT, but not to Indians in the provinces.
1968		NWT Game Ordinance liberalized the regulations pertaining to the hunting of caribou.		Allowed GHL holders to sell caribou meat within the NWT.
1979		NWT Wildlife Act – last amended 1988.		Revisions allowed for the commercial sale of wildlife with export permits
1984			Inuvialuit Final Agreement	Exclusive right to beneficiaries for harvesting of muskox throughout the Western Arctic Region.
1984	RWED Renewable Resource Use Policy (51.02) --effective on 23 Aug. /84 and last revised 10 Jan. /89			Locally based efforts initiated and GNWT to take an active role in developing renewable resource use activities.
1986	RWED Commercial Renewable Resource Use Policy (61.05) --effective Dec./86 and last revised on 01 Apr./91			GNWT encourages and supports the development of a commercial renewable resource sector that is consistent with acceptable resource management and business management practices.
1989	SCONE Report Released			Focused on harvesting, country foods, and import replacement.
1990	RWED Sustainable Development Policy (51.05) --effective 28 May/90 and last revised 19 Mar./93			GNWT recognizes that environmental conservation is essential to long term prosperity while at the same time economic development can contribute significantly to the achievement of conservation goals.
1992		Chapter P-12 of the NWT Public Health Act – Camp Sanitation Regulations		Stipulated that camps (more than ten people), must be located not less than 30 meters from any water supply, lake, stream or other water course. Implications for large-scale commercial harvest operations.
1992			Gwich'in Comprehensive Land Claim Agreement	Gwich'in Tribal Council shall have the right of first refusal for any commercial harvesting of wildlife and Gwich'in RRB requires the RRC to consent to commercial harvesting.

1993			Sahtu Dene and Metis Comprehensive Land Claim Agreement	Sahtu Tribal Council shall have the right of first refusal for any commercial harvesting of wildlife and Sahtu RRB requires the RRC to consent to commercial harvesting.
1993			Nunavut Land Claim Agreement	Nunavut Wildlife Management Board can allocate a portion of the allocation for commercial harvest operations once all claimants needs are filled.
1993		Section 22: Commercial Wildlife License		Allows GNWT to maintain conditions surrounding commercial harvesting of caribou through the issuance of a license.

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CHAPTER FIVE

MARKET HUNTING OF CARIBOU IN THE SOUTH SLAVE REGION OF THE NORTHWEST TERRITORIES

INTRODUCTION

Market hunting of caribou (*Rangifer tarandus*) has been a long-standing practice of Aboriginal people in the Northwest Territories (NWT). Initially, game acquired by Aboriginal hunters through their nomadic cycles was traded within their own band, and at times, neighboring bands (Arnold, 1989; Crowe, 1991; Freeman, 1986; Klein, 1989; Spiess, 1979). As explorers (Purich, 1992), whalers (Oswalt, 1979), and later fur traders (Krech, 1974) arrived in the Canadian Arctic, trading escalated between the Aboriginal people and these foreign parties. Caribou meat and skins were traded for metal goods such as knives, axes, metal pots, and later rifles and ammunition (Purich, 1992). With the arrival of the wage economy in the Canadian Arctic, market hunting of caribou has continued but is presently performed by a small assemblage of Aboriginal hunters who maintain full-time wage employment and participate in market hunting activities as a source of recreation and a secondary source of income.

BACKGROUND

This chapter identifies aspects of market hunting that are specific for the NWT such as market hunting regulations and the options for selling caribou meat in the NWT. However, most of this chapter reviews activities that are specific to South Slave market hunters which includes: development of market hunting in the South Slave region; market hunting description; selling of caribou meat in the community; modes of transportation for market hunting; specific dates and overall market hunting statistics; reasoning for market hunting activities for these Aboriginal hunters; and finally, observations by the author.

Market hunting regulations in the NWT

In the NWT, market hunters consist of Aboriginal people (Inuit, Dene, and Metis) who are entitled to hold a General Hunting License (GHL). As long as the species hunted is not in danger of extinction or does not require special consideration for wildlife management, the Government of the Northwest Territories (GNWT) can permit GHL holders to harvest as many animals as required for subsistence purposes (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4). However, there is an upper limit to this type of hunting in that hunters that harvest animals and waste or do not utilize carcasses are subject to fines under Section 58.1 of the NWT Wildlife Act (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4).

The use and purpose of the GHL is to authorize subsistence hunting by Aboriginal people. This hunting right, which originates from the former NWT Game Ordinance sections, was granted for hunting purposes specifically designated to meet the needs of that person and their families (Bennett, 1982). In 1968, changes to the NWT Game Ordinance allowed GHL holders to sell meat according to GNWT rules and regulations (Cranstonsmith, 1995). The Ordinance of the Northwest Territories (1978: Part V (55): 5) stated:

> "A person who holds or is eligible to hold a general hunting license may buy, sell, barter, gift or receive as a gift the meat of game from or to another person who holds or is eligible to hold such a license."

Additionally, the Ordinance and later the NWT Wildlife Act, stipulated that a person who does not hold a GHL may receive meat as a gift from a GHL holder but only limited quantities are available for this type of activity. The NWT Wildlife Act: Consolidation of Sale of Wildlife Regulations (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4) specified that:

> "A person may receive a gift of meat from the holder of a GHL if (a) the person does not receive more than 10 kg over a period of 60 days."

Meat sales by market hunters can only take place within territorial borders. Without meeting Agriculture Canada's meat inspection requirements, wild processed meat cannot legally cross provincial or territorial borders for retail purposes. Colford (1998:7) explained the policy regarding domestic meat production in the NWT:

> "Meat from wildlife and domestic animals slaughtered and consumed in the Northwest Territories is not required to be inspected to ensure the animal, carcass or meat products meet acceptable health standards. There is no territorial legislation or delivery system for implementing an inspection system."

The territorial government department assigned the mandate for the sustainable use, commercial use, and regulatory supervision of wildlife in the NWT is the Department of Resources, Wildlife and Economic Development (RWED).

Options for selling caribou meat in the NWT

Market hunters in the NWT have two options for selling their meat, either to local GHL holders or to institutions/meat processing facilities. When selling their meat to other GHL holders, market hunters are not required to obtain commercial meat tags (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4.). However, when the GHL market hunter wishes to sell to non-GHL holders and institutions such as hospitals, correctional facilities, homes for the elderly, or meat processing facilities, commercial tags are required before the actual hunt takes place (WILDLIFE ACT. 1988. R.S.N.W.T. 1988, c. W-4.). Currently, there are no meat-processing facilities in the NWT, only in Nunavut. As well, local institutions are generally unwilling to buy meat from market hunters because the product is harvested without federal approval and/or the inconsistent supply schedules (J. Colford, pers. comm. 1999). Consequently, the majority of meat sales are limited to other GHL holders or Aboriginal organizations.

Market hunting sales are most prevalent in the South Slave region because of the long distances residents must travel to access caribou herds. The time requirement, costs associated with caribou hunting, and type of equipment necessary to complete hunts of this nature are usually deterrents to hunters that only want to harvest a few caribou for personal consumption. Sales by the market hunters' averaged two to four caribou carcasses per household.

STUDY AREA AND METHODS

Interviews were conducted with Aboriginal hunters in the community of Fort Smith, NWT (Figure 5-1). Fort Smith is home of approximately 2 728 residents, of which 59 percent are Aboriginal ancestry (predominately Dene or Metis) (NWT Bureau of Statistics, 1999). Fort Smith is located at 60θ00 'N and 111θ53'W and is approximately 322 air km SW of Yellowknife. The average wind speed from December to April is 11.2 km/hr, the average snowfall ranges from 3 to 51 cm from December to April, and mean temperature range is –1.4 to –25.4θC (Table 5-1).

Select hunters in the community, as well as wildlife officials from the Government of the NWT (Department of Resources, Wildlife and Economic Development), were questioned on their knowledge of Aboriginal hunters selling caribou meat within the community. Hunters interviewed were selected based on their reputation for providing caribou meat to people in the community and were contacted either by telephone or personal visitation.

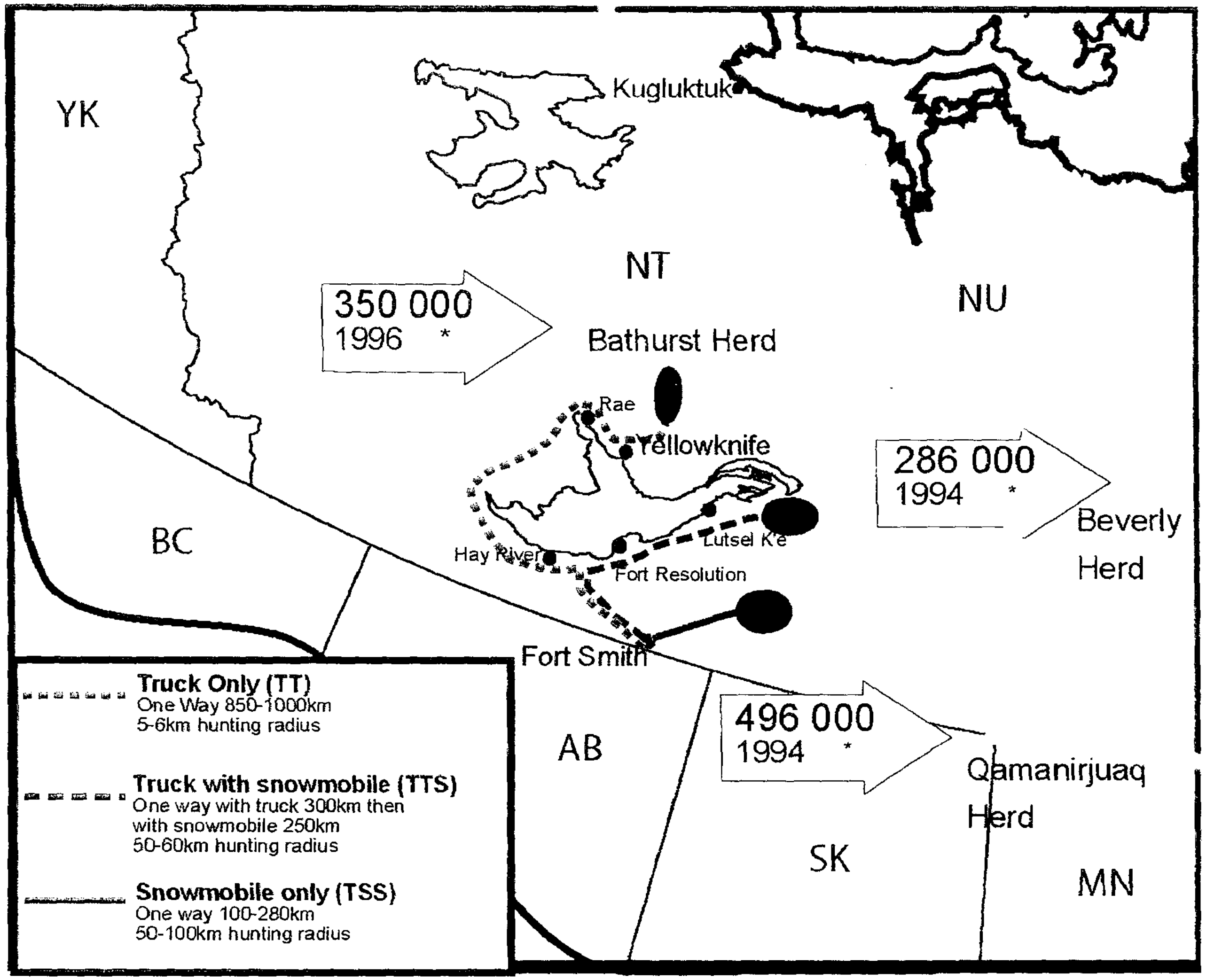

Figure 5-1 Travelling routes for South Slave caribou market hunters.

* Population estimates provided by Government of the Northwest Territories

Table 5-1 Weather statistics for Fort Smith, NT by month (1961-1990).

Month of Market Hunt	Average Mean Wind Speed (km/hr)	Mean High Temperature (°C)	Mean Low Temperature (°C)	Mean Temperature (°C)	Average Snowfall (cm)
December	10	-17.2	-26.3	-21.7	35
January	11	-20.3	-30.5	-25.4	48
February	11	-15.2	-27.4	-21.2	51
March	11	-6.9	-21.3	-14.0	43
April	13	5.0	-7.9	-1.4	3
Total					180

* Weather information from Environment Canada – Canadian Climate Normals 1961-1990.

Approximately eight hunters were identified and approached for comments on their caribou market hunting activities in the South Slave Region. Initial feedback demonstrated that only two hunters had continually participated in caribou market hunting activities while the remaining hunters had either discontinued their participation in this activity or only completed hunts on an *ad hoc* basis. Three hunters had participated in three hunts or less and discontinued pursuing market hunting altogether. Three other hunters had been conducting random market hunts (4 to 7 hunts) for the past 7 years with marginal success. These two groups of hunters were questioned on their market hunting activities but sufficient information was not obtained due to lack of response, declining of interviews, or vague recollections of past hunts (in terms of number of animals harvested, dates, sex ratio, etc.). However, two hunters were identified that had participated in market hunting of caribou for more than 13 years and conducted hunts on an annual basis.

The research effort focused on these two hunters as they clearly represented the majority of market hunting for caribou in this community. Both hunters had excellent reputations within the community for providing consistent supplies of caribou meat. Each hunter consented to the use of their information on market hunting activities under the provision that permission for further use of raw data must be obtained from each informant and that they review final copy of this document.

Interview protocol

The market hunters were interviewed using structured interviews on market hunt dynamics, hunt logistics, processing techniques, and marketing/selling of meat. Personal interviews with the hunters averaged three to four hours as well as five to six additional phone interviews with each hunter to corroborate the information recorded during the initial interviews. Detailed records of market hunting activities were collected from the market hunters from 1989 to 2001. During this period, the hunters participated in approximately 60 market hunts which accounted for 1 312 harvested caribou. Hunter records of market hunting activities included the date, methods of transportation, number of caribou harvested, sex ratio, and location of kill sites. This research is the first documentation of market hunting activities in the Canadian Arctic.

RESULTS

The market hunters cited traditional hunting activities, along with participation in community-organized hunts, and contractual hunting for Canadian Wildlife Service collections, as the origins for their market hunting endeavors. Community-organized hunts in the South Slave region took place from the early 1970s to late 1980s while contractual hunting for research purposes was conducted for the Canadian Wildlife Service in 1980, 1981, and 1983-1987 (Thomas and Hervieux, 1986; Thomas and Barry, 1991).

Community organized hunts were undertaken by local organizations and funded by federal and territorial governments. The objective of these hunts was to provide meat for Aboriginal elders in their respective communities. However, due to lack of organization, improper handling of meat, poor marketing of sales, and in some cases, lack of caribou for money spent, hunts of this nature in the South Slave Region have slowly been replaced by market hunts.

From 1980-1987, the market hunters, along with other Aboriginal workers, harvested and processed approximately 1 285 caribou for federal government research purposes (Figure 5.2) (D. Thomas, pers. comm. 2001). Meat from this project was donated to the local Metis of Fort Smith (R. Mercredi, pers. comm. 2001). However, after the completion of this project, the market hunters recognized that the desire for caribou meat was high within the Aboriginal community and began to establish market hunts for caribou in 1989. The market

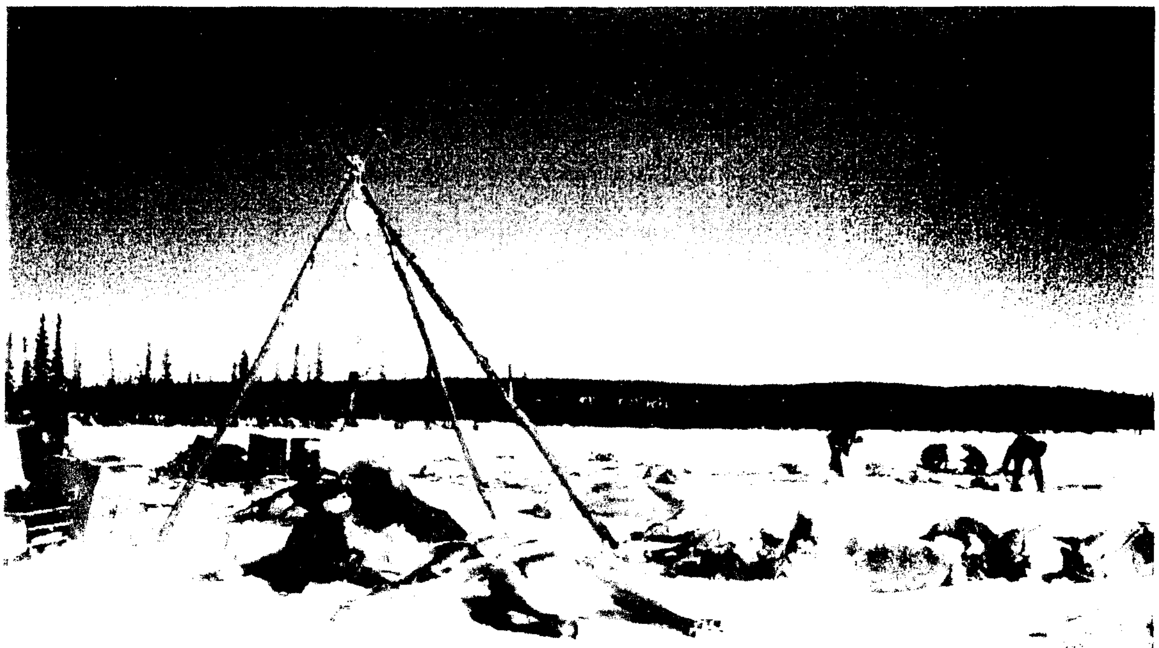

Figure 5-2 Research study conducted on caribou by Canadian Wildlife Service -- Tent Lake, Northwest Territories.

hunters provided clean, good quality meat thus ensuring repeat customers (D. Dragon, pers. comm. 2001).

Market hunts

During the winter, the market hunters would encounter caribou herds that were grouped together in small numbers (25-50) but would number in the thousands in a very small area as well. Once the caribou are located, the market hunter drives the snowmobile within shooting distance of the herd. Using telescopic sights, the typical shooting distance averaged around 125 meters but the market hunters reported shooting caribou from distances of 400 meters. Optimal distance for accuracy for the market hunters was between 200 and 350 meters.

Approachability of caribou herds depended on number of caribou in the herd and the ambient temperature. Market hunters reported skittish animals when the temperature was colder than normal (-35°C to -55°C) and also with herds of small sizes. In large numbers, caribou were described as being easier to approach. Animals that are harvested have a healthy coat and "look in good shape" to the market hunters. Most animals harvested are in good condition (fat) but sometimes looks can be deceiving and the odd skinny animal is harvested. Clients preferred to buy fat caribou from the market hunters. However, all the meat that is harvested is later mixed together by the market hunters in order for clients to get a random share of the meat quality. The market hunters noted that they would always put aside four or five fat carcasses for elders in the community.

Shot placement was of the utmost importance to the market hunters in order to maintain high meat quality and reduce wastage of meat. Once the market hunter reached an appropriate shooting location, animals were typically shot in the neck or head. The chances of obtaining a head or neck shot was increased by intentionally waiting for the caribou to get into an open area (clear from other caribou) where a clear shot could be made. Shooting precision was influenced by factors such as wind speed, whether the animals were skittish, and the number of shooters (disturbance of herd). The market hunters noted that at 180 to 230 meters, if two caribou are lined up, one in front of the other, that a single shot through the neck of the first caribou would often kill the second animal as well. Instances of caribou shot in the thoracic cavity or body were very rare, as this would damage meat and make skinning and processing inefficient. However, the market hunters reported that occasionally a bullet would accidentally hit an animal in the herd that was in close proximity to the target animal. In these instances, damaged meat was trimmed at the time of processing. The market hunters preferred to use rifles with telescopic sights for improved accuracy. The most utilized firearm for harvesting caribou was a 270-caliber rifle with 130-grain ammunition but market hunters also used a 30-06-caliber rifle with 150-grain ammunition as well.

The number of animals harvested at one time depended on ambient temperature, distance from camp, time of day, and number of hunters. Hunters preferred to have one shooter and two processors (one skinner and one butcher) for a market hunt. The maximum number of people used for market hunting was three and the minimum was a market hunter working alone. In the past, the market hunters would either hunt alone or with each other. More recently, the son of one of the market hunters has been taking part in the market hunts.

Cold temperatures dictated that, depending on the number of hunters, smaller groups of caribou would be harvested to prevent freezing of the carcasses. The general rule was that 10 caribou could be harvested and processed before the last one would start to freeze or become "stiff". Caribou that are located close to camp allow the hunter to harvest more animals (in optimal conditions) because of access and ease of hauling carcasses to processing location.

The number of daylight hours is an important hunting factor during the winter months in the Canadian Arctic and Sub-Arctic. The market hunters would shoot only the number of animals that could be processed before darkness. The ability to see the caribou carcasses in daylight allows for safer butchering, cleaner meat, and more efficient skinning. If processing does continue into the night, the market hunters used a headlamp, attached with a 4-D battery pack. At different occasions, the hunters would also use the headlamps of the truck. In the winter, the daylight hours average between 9:30-10:00 a.m. to 3:30-4:00 p.m. and increase in length when approaching the spring months.

Once harvested, the shooter then ties, on average, two or three caribou at a time (by the head) to the back of their snowmobile for transport to the processing location. It is important that the caribou be tied as close as possible to the hitch of the snowmobile as this allows for the caribou carcass to be easily towed without dragging into the snow. The market hunters noted that when animals are pulled behind the snowmobile in late March, they must be aware of snow forming a hard crust. With the springtime ambient temperature rising and falling, a crust could form on the top of the snow. When towing the animal on this surface, the hide and some of the meat could be damaged when dragged along this surface. Therefore, the market hunters would either have to wait to harvest caribou until the snow begins to thaw with the daytime temperature, or use a sleigh to transport the caribou carcasses to the processing location.

The processing location is carefully selected to provide shelter from wind. The hunters try to locate their camps in lake bays near forested areas that have flat, clean snow. During camp set up, the snowmobile is driven in horizontal lines approximately 10 feet apart. These trails harden very quickly in the cold temperatures and provide a firm surface to lay butchered meat. Upon arriving at the processing location, the caribou are positioned in a horizontal line between the snowmobile trails on the fresh snow and equally spaced for ease of processing (Figure 5-3). The market hunters use the snow to position the

Figure 5-3 Caribou carcasses lined up for market hunting processing – Drybone Lake, Northwest Territories.

caribou for ease of skinning, butchering, and hauling. Kneeling in the snow was the preferred method of processing the caribou, as this would eliminate some of the stress on the hunter's lower back.

The processing of caribou during a market hunting trip depends on a number of interrelated factors. A lone market hunter can skin and butcher a caribou in 15 minutes. However, a hunt that has one shooter, one skinner, and one butcher typically processes six caribou per hour. It is critical for the shooter to assess the hunting conditions (mentioned previously) in order to maintain a steady pace in the operation. Availability of caribou ultimately determines harvesting scenarios. For example, scarce caribou herds dictate that as many animals as possible are harvested once located (in this scenario, shooter might become skinner as well). However, if caribou herds are abundant, easily accessible, and in close proximity to camp location, the shooter would have greater flexibility in determining the appropriate hunting schedule. It was noted that in one hunt, the market hunters harvested and processed 32 caribou in one day. However, under optimal conditions, the market hunters preferred to process approximately 20 caribou per day.

Caribou harvested for market hunting sales are skinned and butchered to maximize transport load capacity and to provide clean meat for the end user (i.e. free of hair follicles, free of damaged meat, and not wind burnt). Customers preferred that caribou meat purchased from market hunters was clean, quartered, and had the hair removed. Quartering of the caribou also allows for easy and efficient storage in either a sleigh or truck bed. In cold temperatures, surgical gloves are worn over a thin pair of cotton gloves to maintain hand warmth for the skinners and butchers. Warm carcasses are preferred for the ease of pulling off the hide and warmth on hands. The market hunters noted that the hide pulls off a female caribou with ease but with bull caribou, the animal must be completely skinned off with a knife. This would be presumably from the females having more fat stored on their bodies than the males during this time period. The tasks involved in market hunting are divided between the hunters as to allow for a productive sequence of hunting, skinning, and butchering for the market hunters while eliminating overcrowding in the processing area.

The market hunters perfected, over time, a method for butchering the caribou carcasses once the animal was skinned. One of the market hunters commented:

> "with the caribou laying on one side, you begin by cutting the shoulder and thigh off the side facing up and laying these in a row on clean snow away from the processing area; then cutting the belly skin on that side and flipping caribou over; next step would have the butcher cutting off the other shoulder and thigh and remove rest of belly skin; brisket would then be cut, snapped and then cut off; the stomach contents were then removed from the body cavity; the rump was cleaned and then cut off; body cavity was cleaned with snow; next, one rib was cut off with an axe and the whole back was left intact for cutting into steaks or roasts; the cut-off rib was laid inside the uncut rib and then the neck was cut off; neck was de-boned; heart, kidneys, and brisket were placed into the ribs, and the liver (after freezing) was put into a bag; the head was flipped over in the snow and slits are cut on either side of the jaw bone and the tongue is cut off and kept; all meat was placed neatly on the snow to freeze and all waste materials were placed in one pile. In order to keep the knife from freezing, the butcher's knife is usually kept in the embryonic sack (which would contain the unborn caribou calves). A knife that becomes dirty from frozen blood and hardened snow takes only 20 seconds in the embryonic sack to be fully cleaned."

The handling of the butchered meat is critical for maintaining appearance and quality. Once meat is butchered, it is laid out on the snowmobile trails for three to four hours in order for the outside of the meat to become partially frozen. The reason being that the meat is then still flexible enough to pile in either a truck box or sleigh for transport. The meat can remain outside for a maximum of 24 hours to permit freezing. However, to avoid sun and/or wind damage, meat must be either stored under a tarp or placed in the truck bed under a tarp after this period of time. In addition, if it starts to snow, the market hunters must quickly collect all meat to avoid snow cover on meat and possible obscuring of the meat location. Once transported back to the community, clients are notified of availability of caribou meat.

Selling caribou meat in the community

In the community of Fort Smith, clients visit the market hunter's residence to buy meat or the market hunter delivers the meat (typically to elders in the community). Finished carcass weights for adult cows and bulls ranged from 39 to 41 kg and 45 to 54 kg respectively (Table 5-2). From the late 1970s until 1998, the market hunters would charge Can$75 per caribou carcass or $1.39 to $1.92 per kilogram (Table 5-2). Since 1998, the average price of a caribou carcass has increased to Can$80 or $1.46 to $2.05 per kilogram while Can$100 or $1.85 to $2.56 per kilogram is charged for the carcass, head, and edible internal organs (referred to as "goodies" by the elders). Goodies, in the Aboriginal community, consist of the heart, liver, kidneys, omasum (bible), reticulum (hair net), caecum (thimble), and greater omentum (lace around stomach). Elders in the community are typically the buyers of goodies and would request their order prior to the hunt. The market hunters estimated that 25 percent of their overall market hunt clients would purchase goodies. It was noted that the bible, hair net, thimble, and lace would only be taken from fat animals. If the market hunters used a truck for market hunting, they would also collect caribou heads for customers as well. In addition, if large bulls were harvested, the neck hair or bell would be cut off and given to local Aboriginal craftspeople for caribou tufting.

During the winter season, clients repeatedly called the market hunters requesting caribou meat. Consequently, the market hunters did not have a problem selling all their harvested caribou and were never faced with excess meat. Hunts were

Table 5-2 Meat price per kilogram for caribou hunted for market hunting purposes in South Slave Region, Northwest Territories.

	Female Carcass Weight (kg)		Male Carcass Weight (kg)	
	Low	High	Low	High
	39	41	45	54
Price/Carcass				
($ CAN)				
$ 75	$ 1.92 /kg	$ 1.83 /kg	$ 1.67 /kg	$ 1.39 /kg
$ 80	$ 2.05 /kg	$ 1.95 /kg	$ 1.78 /kg	$ 1.48 /kg
$ 100	$ 2.56 /kg	$ 2.44 /kg	$ 2.22 /kg	$ 1.85 /kg

also completed for institutions but the market hunters preferred selling caribou meat to families in the community because the sale was more of a personal nature. The market hunters felt that they served a valuable service to the Aboriginal community and were proud that they were able to provide clean, good quality meat supplies. The majority of sales was intended for other GHL holders and consisted of 50 percent Metis and 50 percent Dene clients. Caribou meat was sold within one day after arriving into Fort Smith, and delivery never exceeded two days.

The caribou meat obtained from market hunting activities generally sold to families that were repeat customers. The market hunters commented that one elderly lady had purchased meat from the hunters since the late 1960s. Heads of families buying meat were in the age range of 35 to 55 years but many elders in the community were also loyal customers. The market hunters estimated that 25 percent of the overall sales were used for drymeat purposes. However, it was noted that one client would annually buy 8-10 caribou carcasses per year, of which, 50 percent would be made into drymeat.

TYPES OF MARKET HUNTS FOR CARIBOU IN THE SOUTH SLAVE REGION

Four modes of transportation are used from the town of Fort Smith to the actual market hunt locations; travel by truck (TT); combination of travel by truck then by snowmobile (TTS); travel by snowmobile and sleigh (TSS); and finally, travel by airplane (TA). The type of transportation used is determined by the location of barren-ground caribou at particular times of the year (near road systems or off road).

A short description and hunting statistics of each market hunting activity will be presented. Detailed records of the method of transportation, year in which hunt took place, specific dates of each market hunt, caribou groups used for market hunts, and exact locations of market hunts were documented by the market hunters. The caribou groups encountered on each hunt will be listed into one of three categories: cows, bulls, and mixed groups (cows and bulls mixed).

Mode of transportation

A) Travel by truck

Travel by truck (TT) market hunts require the market hunter to travel from 850 to 1 000 kilometers (one-way) with a full size, heavy duty, half- ton pickup truck (4 X 4 is an option) from Fort Smith, NT to Yellowknife, NT area. A small snowmobile (Elan –Skidoo model) is stored in the back of the truck to be used to bring carcasses back to the truck. TT hunts access barren-ground caribou herds that accumulate near winter roads that are built to access outlying communities and mining locations (Jingfors and Gunn, 1981).

Due to the long distances traveled by the market hunters for TT hunts, generally the hunters will set up a camp near an area where a large concentration of caribou have been sighted. The market hunters hunt for several days in the area until they have harvested the number of animals they desire. Caribou are located by travelling on winter ice roads that connect lakes in the Rae Lakes/Yellowknife/Gordon Lake region (Figure 5-1). This area is characteristic of dense boreal forest habitat with many interspersed lakes and rock outcrops (Jingfors and Gunn, 1981). Kelsall (1968), Rowe (1972), Kelsall et al. (1977), and Jacobson (1979) provide detailed descriptions of this biome. The hunters try to locate their camps in lake bays near forested areas as to shelter themselves from the prevailing wind.

Canvas tents are used for market hunts of this nature and depending on the number of hunters, either a 3.7 m X 4.3 m (three people) or 3 m X 3.7 m (two people) tent will be set up by the hunters. These tents have a 2.7 m peak at the center and 1.5 m walls on the sides. Although the tents used take more time to set up, the hunters preferred the ability to stand up straight after completing a full days hunt in which they are bending over carcasses most of the day. The market hunters equip the camp with an air-tight heater, portable propane stove for cooking, kerosene lamp, cooking utensils, and food supplies. Hunters would sometimes sleep outdoors with only a tarpaulin and sleeping bag in the springtime where outside temperatures could reach minus 20°C.

When caribou are located, the camp is set up, and the shooter takes the Elan to scout for animals. The caribou are then harvested as described previously. The skinning and processing of the caribou takes place near the camp for convenience of processing and later transportation to the truck.

Once the caribou meat is ready to load into the truck, thighs and bodies are located at the front of the truck box and are protected with cardboard backing. Goodies are put into the holes and all meat is interlocked to maximize space. All meat is covered with a tarpaulin and the equipment (camp gear) is put on top. Typically, a truck box can hold 20-25 caribou that are strategically placed. However, due to the size difference between males and females, this would change depending on whether the caribou harvested were bulls, cows, or mixed animals (25 cows or 20 bulls). The market hunters typically used two vehicles for hunts of this nature.

The preferred TT market hunt would involve three market hunters and would begin on Friday by driving eight hours to the general area and setting up camp. The goal for Saturday would be scouting the area for caribou and processing 10 caribou that day. The goals for Sunday and Monday would be to harvest 20 caribou per day. Tuesday, the hunters would break down camp and drive to Yellowknife and overnight in a local hotel. The hunters would then return to Fort Smith on Wednesday.

When two market hunters (one truck) used the TT method, the hunt would typically only take three days to complete. This was only done when large caribou herds were close to the all-weather roads. The hunters would leave Fort Smith after work on Friday, sleep in their vehicle overnight, hunt and process the animals all day Saturday, and return back to Fort Smith on Saturday night/early Sunday morning.

TT hunts for market hunting accounted for approximately 25 percent of the total hunts performed by the market hunter (15 out of a total 60 hunts) and accounted for 38 percent of the total harvest amount (517 out of a total 1 312 total animals harvested) (Appendix 5-1). The average harvest per hunt using this mode of transportation was 34 caribou, with the highest harvest being 56 animals and the lowest being 18. Approximate expenses for conducting TT hunts averaged Can$500 to $900 depending on number of trucks used (Appendix 5-2).

TT market hunts averaged around four days in length while the longest recorded hunt lasted seven days and the shortest hunt lasted two days. TT hunts were conducted during the winter road season (January 28-30 through March 22-28), with the majority occurring in February and March. Consequently, TT hunts mainly harvested mixed groups (80 percent) and cow groups (20 percent) (Appendix 5-1).

B) Travel by truck and snowmobile with sleigh

Market hunting with truck and snowmobile with sleigh (TTS) require the market hunter to travel by truck approximately 300 kilometers (one-way) from Fort Smith to Fort Resolution, followed by a 8 hour or 255 kilometer ride on snowmobile to the Lutselk'e area (Figure 5-1). A long-track snowmobile (Skandic 500) with either a 2.7 m sleigh (can hold 12 butchered caribou plus camp materials) or a 3 m sleigh (can hold 15 butchered caribou plus camp materials) is used for this type of activity. The larger snowmobile has an extended track that allows for good suspension and has the increased power that is required to pull a sleigh loaded with caribou meat. The market hunters set up a camp, as described in (A) previously, once arriving at an area where caribou are present. The habitat is boreal forest and market hunters access this area via trapline trails and connecting lakes.

A typical TTS market hunts begisn on Friday by driving to Fort Resolution, NT and snowmobiling to hunt location. Once at desired location, camp would be set up and scouting/hunting would be done all day Saturday. On Sunday, the camp would be taken down and the market hunters would return to Fort Smith.

TTS market hunts accounted for approximately 27 percent of the total hunts performed by the market hunter (16 of 60 hunts) and accounted for 31 percent of the total harvest amount (376 of 1 312 total animals harvested) (Appendix 5-1). The average caribou harvest using TTS was 27 animals. The highest harvest using this method of transportation was 80 caribou and the lowest was eight. Expenses for conducting a TTS market hunt averaged Can$300 to $550 (Appendix 5-2).

TTS hunts averaged three days in length with the longest recorded hunt lasting seven days while the shortest hunt lasting only two days (Appendix 5-1). This mode of travel would be used once Great Slave Lake was frozen over and until caribou left these wintering grounds. Specific hunt dates ranged from December 7 to April 20. The majority of TTS hunts occurred at the end of March and beginning of April (Appendix 5-1). TTS market hunts predominately encountered mixed groups (56 percent) and groups composed of cows (31 percent). Bull groups accounted for only 13 percent of total hunts using the TTS method (Appendix 5-1).

C) Travel by snowmobile with sleigh

Travel by snowmobile and sleigh (TSS) require the market hunter to travel from 150 to 575 kilometers (round trip) with a long-track snowmobile (Skandic 500 - Skidoo model) directly from Fort Smith, NT east to the long lakes region of the South Slave (Figure 5-1). The market hunter would tow either a 2.7 m sleigh (can hold 12 butchered caribou plus camp supplies) or a 3 m sleigh (can hold 15 butchered caribou with camp supplies) behind the snowmobile.

Hunts using the TSS method would be mainly undertaken during weekends. Up to three market hunters would get their hunting equipment and snowmobiles ready on Thursday night and plan on leaving Friday after work or early Saturday morning (around 6 a.m.). If leaving in the morning, the hunters would leave Fort Smith and arrive in the area around 1 or 2 p.m. Upon arriving in this area, the market hunters would typically camp in either their own cabin (which is used for trapping purposes), another trapper's cabin, or set up a canvas tent as mentioned previously. Occasionally, TSS market hunts can require the market hunter to travel in the general vicinity of the camp location, from 50 to 100 kilometers, in search of caribou herds. The hunters access this area via trapline trails and frozen lakes. The market hunters would typically start to hunt caribou around 2 p.m. but were conscious that darkness arrived around 3:30 p.m. – 4:00 p.m.

TSS hunts averaged three days in length with the longest recorded hunt lasting five days and the shortest hunt lasting one day. TSS market hunts occurred from December 26to April 5. The majority of these hunts were conducted from mid-February to the end of March (Appendix 5-1). TSS hunts predominantly encountered groups of caribou composed of bulls (65 percent). Cows and mixed groups made up 20 and 15 percent of the hunts respectively (Appendix 5-1).

TSS accounted for approximately 43 percent of the total hunts conducted by the market hunter (26 out of total 60 hunts) and accounted for 27 percent of the overall harvest (363 out of a total 1312 total animals harvested) (Appendix 5-1). The average caribou harvest using this mode of transportation was 14 animals with the highest harvest being 23 caribou while the lowest hunt was five. Approximate expenses for conducting a TSS hunt average Can$200 to $350 (Appendix 5-2).

D) Travel by airplane

Market hunts using airplanes (TA) accounted for only five percent of the total market hunts documented. The practice of using airplanes began in the late 1960s with organized community hunts. However this type of market hunting for caribou has been minimal since that time. The main reason for not using airplanes has been the high cost of flying to the hunt location and the small number of caribou that can be loaded into an airplane. In the instances where the market hunters have used airplanes, caribou were known to be relatively close to Fort Smith, demand for meat in the community was high, and costs for chartering a plane were reasonable. The market hunters noted that they would typically keep one or two caribou for themselves and sell the rest of the animals to cover the cost of the airplane charter.

TA market hunts would typically occur in one day. The pilot and market hunter would fly to a location where there were known concentrations of caribou and land on the frozen lakes near the caribou herd. The market hunter would deplane and proceed to harvest the caribou. In some cases, the plane would taxi out to the dead animals, and by attaching a rope to the skis; the pilot could then drag the animals to a central location for processing. Because of the fluctuating cost of the charters, a profit was rarely actualized from TA market hunts.

However, in past years, due to the leniency of aircraft companies weight restrictions and the reduced cost of aircraft charters, a small profit could be realized from these types of hunts. Currently, a Cessna 185 can transport 5 or 6 caribou per load, which includes a pilot and one market hunter. If a Beaver aircraft was used, 11 caribou could be loaded with a pilot and two market hunters. Market hunters are charged per air kilometer traveled and a minimum flight requirement of 80 air kilometers is dictated by the local aircraft charter company (I. Ross, pers. comm. 2001). In order for TA market hunts to be cost effective, animals need to be within a 113 to 129 kilometer radius from the community.

The highest hunt total documented using TA market hunts was 38 caribou (repeated hauling trips for airplane) while the lowest hunt total was six (Appendix 5-1). TA hunts accounted for approximately five percent of the total hunts performed by the market hunters (three out of 60 hunts) and accounted for four percent of the overall total caribou harvest (56 out of 1 312 total animals harvested)(Appendix 5-1). TA market hunts were conducted from the end of March until the beginning of April. Market hunts using TA encountered mainly cow herds (66 percent) as well as mixed herds (34 percent) (Appendix 5-1).

Average expenses for conducting TA market were Can$425 for a Cessna 185 charter and Can$650 for a Beaver charter (Appendix 5-2). However, these costs can vary with the fluctuating costs of aviation fuel.

MARKET HUNTING DATES AND STATISTICS

Market hunts in the South Slave region were undertaken from late-December to mid-April but the majority of the market hunting activity (70 percent of the hunts recorded) was completed during February and March (Figure 5-4.). Limiting factors were good ice conditions, proximate location of the caribou herds, and physical condition of harvested animals. The market hunters acknowledged that

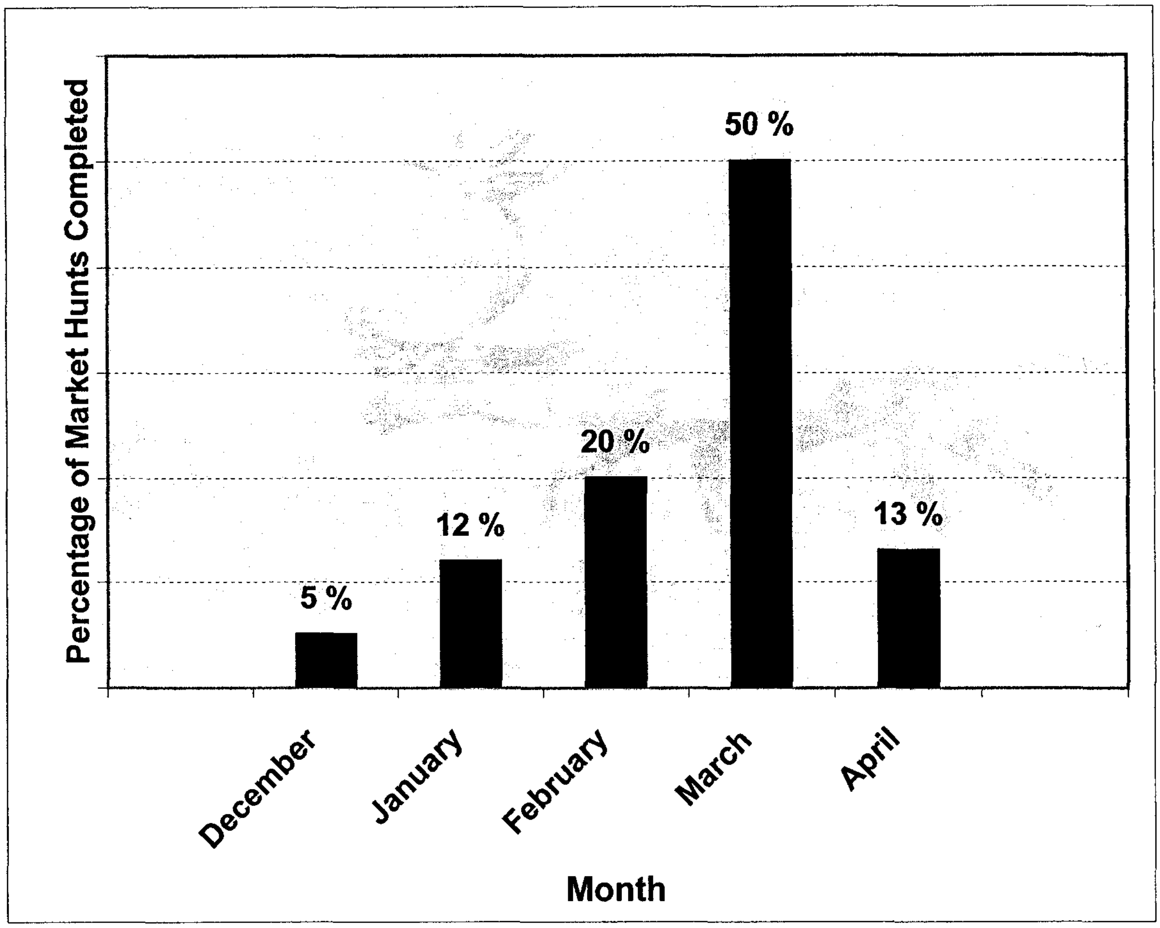

Figure 5-4 Percentage of total market hunts for caribou in the South Slave Region of the Northwest Territories by month (1989-2001).

they could travel to areas earlier in the hunting season, as evidenced by 17 percent of the hunts occurring in December and January, but preferred to market hunt in late February, March, and early April (83 percent of the hunts recorded). The market hunters noted that the caribou were noticeably in better physical condition during these time periods and the hunters preferred to provide good quality meat to their customers.

Overall, mixed groups (or social units) accounted for 43 percent of the overall individual market hunts (26 out of total 60 hunts) whereas groups of bulls accounted for approximately 32 percent of the overall hunts (19 out of total 60 hunts) (Table 5-3). Cow groups only accounted for 25 percent of the overall market hunts (15 out of 60 hunts). Mixed groups composed the largest percentage of actual caribou harvested by the market hunters (57 percent or 748 out of 1312 total animals harvested)(Table 5-3). Cows and bull groups only accounted for 23 percent (307 out of 1312 total animals harvested) and 20 percent (257 out of 1312 total animals harvested) of the actual caribou harvested respectively. The average success per market hunt for each group category was as follows: mixed-29 per hunt, cows-24 per hunt, and bulls- 14 per hunt.

The market hunters used travel by snowmobile and sleigh (TSS) 43 percent of the time while travel by truck and snowmobile and sleigh (TTS), travel by truck and snowmobile (TT), and airplane (TA) accounted for 27, 25, and five percent respectively (Appendix 5-1). However, in terms of total harvest amount per mode of transportation, TT accounted for 38 percent of the overall harvests from market hunts and TTS, TSS, TA accounted for 31, 27, and four percent respectively (Appendix 5-1).

FINANCIAL ASPECTS OF MARKET HUNTING IN THE SOUTH SLAVE REGION

Table 5-3 Group types encountered per market hunt and overall percentage of caribou harvested per group for caribou market hunts in the South Slave Region of the NWT (1989-2001).

Group Composition	Average Number of Caribou Harvested per Hunt	Group Types Encountered Per Market Hunt	Overall Percentage of Caribou Harvested Per Group
Mixed	29	43 % (26 of 60 hunts)	57 % (748 of 1 312)
Cows	24	25 % (15 of 60 hunts)	23 % (307 of 1 312)
Bulls	14	32 % (19 of 60 hunts)	20 % (257 of 1 312)
Total		100 % (60 total hunts)	100 % (1 312 total animals harvested)

Note: Data pooled for two hunters in the South Slave Region.

Financial aspects include capital outlay, depreciation on the hunter's equipment, and compensation for the time required for each market hunt activity. Market hunting is a strenuous activity that takes time and financial resources to complete. For example, the capital outlay required to begin market hunting would be approximately Can$ 58 015 to be properly set up with all the necessary equipment (Appendix 5-3). The hunters noted that not having the properly maintained equipment, in such a harsh climate as the Canadian Sub-Arctic, could not only be life threatening but very costly if mechanical failures occur. The market hunters travel long distances with their vehicles and snowmobiles during market hunts and consequently the wear and tear on the equipment would eventually require either repair or replacement. Heavy loads due to hauling caribou carcasses increase the chances of causing damage to equipment as well. Repairs to equipment could end up costing the market hunter rather then compensating the hunter for conducting market hunts. The additional weight incurred while transporting carcasses puts added stress on vehicles suspension and motors. One market hunter commented that a motor ruined during a TSS hunt in 2002/01 cost approximately Can$ 3 500 to repair. Because the market hunters use their market hunting equipment for other recreational activities as well, it is very important that care and maintenance of equipment is strictly followed.

In the South Slave region, the market hunters would typically hunt on weekends. However, because of the long distances traveled, weekend hunts dictate that the hunter(s) are constantly working (i.e. preparing for hunt, driving truck or snowmobile to hunt location, setting up camp, hunting, skinning and butchering, camp maintenance (i.e. chopping wood, hauling water, keeping fire going, and preparing meals), piling and covering meat, packing meat, camp take-down, driving back home, and finally selling the meat). Although the hunts only average a few days in length, the activity is strenuous and time consuming. The market hunters estimated that they handled the meat approximately eight separate times from when the animal is first harvested to when it finally delivered to the client.

The compensation for this activity is minimal when you consider all these activities and that, depending on how many hunters are conducting the hunt; proceeds are divided equally (Appendix 5-2). Hunt success is not guaranteed and, consequently, neither is profit from a market hunt.

TT hunts averaged four days and 34 carcasses (Appendix 5-1). To complete this hunt, three hunters would be the standard and therefore would each receive approximately Can$ 670 or around $ 223 per day for their efforts (assuming 9 caribou were sold with goodies)(Appendix 5-2). TTS hunts averaged three days and 27 carcasses. Three hunters would participate in this hunt with each receiving Can$ 583 or around $ 186 per day (assuming 7 caribou were sold with goodies). TSS hunts averaged three days and 14 carcasses. Two hunters would conduct TSS hunts and would receive Can$ 500 or $183 per day (assuming 4 caribou were sold with goodies). TA market hunts usually lasted one day and the hunter would either make Can$ 175 per day (Cessna 185 airplane charter) or Can$ 225 per day (Beaver airplane charter—two hunters).

As presented, the average wage that market hunters potentially receive is minimal. So why do these Aboriginal hunters, who have full-time wage employment, participate in these hunting activities?

REASONS FOR MARKET HUNTING

The market hunters had recreational, monetary, as well as personal and community-based reasons for their market hunting activities but the main reason for these hunting activities was recreational. These Aboriginal hunters grew up hunting in the South Slave region and enjoy the chance to get out on the land with good equipment and good hunting partners. Caribou hunts also presented the opportunity for the market hunters to occasionally hunt wolves (*Canis lupis*) and wolverines (*Gulo gulo*) during the market hunt. The market hunters would sell the pelts and would average Can$300 per wolf pelt and Can$250 per wolverine pelt.

Extra income from market hunting sales allowed the hunters to buy new equipment that could be used for other personal hunting purposes as well as market hunting activities (i.e. firearms, snowmobiles, binoculars, extra gear, etc.). In addition, the extra income allowed the market hunters to have money for their household budgets. The market hunters noted that having the opportunity to pass their hunting knowledge to younger generations was also a motivator for the market hunts. Additionally, the market hunters expressed a great sense of accomplishment and pride from providing wild meat to the community and especially the elders in the community.

OBSERVATIONS

Interestingly, weather was not a factor in determining whether or not the market hunters would embark on a market hunt. Typically, the equipment and camp supplies were packed and ready to go on the word that caribou had been sighted in a specific hunting area. In one instance, the hunters estimated the ambient temperature to be -60°C because the dial had completely wrapped around on the thermometer (Figure 5-5). Snowmobiles had to be covered with a tarp and the exhaust was used to warm up and un-thaw the snowmobile track for over 30 minutes before the hunters could begin traveling.

On most market hunts, the hunters would keep the tongues of the caribou. The tongues were seen as "trophies" and only long standing customers or elders would have an opportunity to obtain this delicacy from the market hunters. The hunters also noted that a fat caribou would have a richer tasting tongue and the tongue would be a lot thicker compared to a skinny caribou. Skinny caribou would have a smaller tongue with more visible veins. Interestingly, in the late

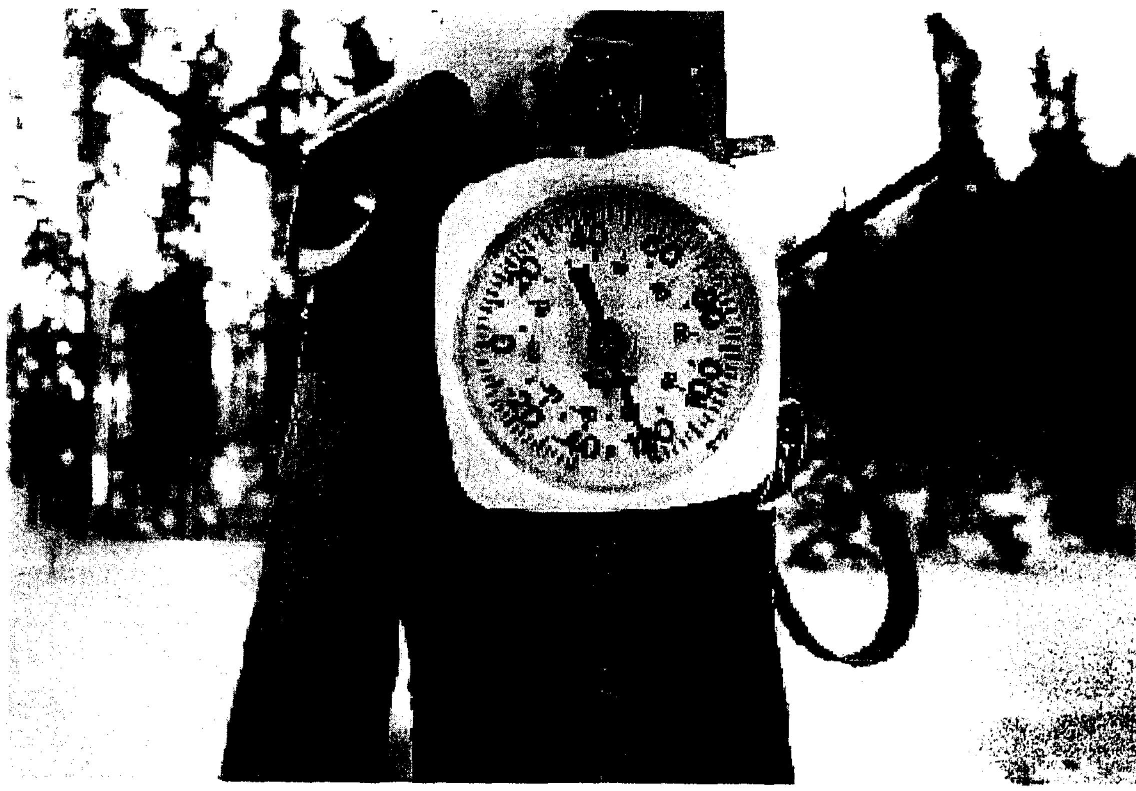

Figure 5-5 Thermometer displaying severe cold temperatures during market hunt for caribou -- South Slave Region, 27 December 1995.

1800s, Pike (1892:50) also remarked of this preference for caribou tongues by Aboriginal hunters during his travels in the Canadian Arctic:

> "It is a point of etiquette that when two or more Indians are hunting in company, the depouille (backfat) and tongue belong to the man who did the killing, while the rest of the meat is shared in common."

The market hunters also described while hunting in the Rae Lakes/ Yellowknife /Gordon Lake areas (travel by truck), that the Dogrib Dene would prize any unborn caribou fetuses for eating. The Dogrib Dene would ask the market hunters, as well as resident hunters, if they could be permitted to take any caribou fetuses that were left over from the caribou hunts. Pike (1892:51) noted:

> "the favorite dish of all, the young unborn caribou cut from its dead mother...it is considered a delicacy among the Indians (Dog-Ribs and Yellow Knives) throughout the northern part of Canada."

Another interesting observation was the amount of ammunition used to harvest caribou. The market hunter estimated that to harvest 30 caribou, approximately 50 shells would be used. The market hunter could have easily shot one caribou per shell but accuracy and shot location was of the utmost importance to the market hunters. Shooting on lakes meant that the hunter must either shoot up wind or down wind from the caribou groups. The hunters remarked that shooting crosswind could move the shot location by 0.6 m under windy conditions. Consequently, it was noted that the shooting tasks were delegated to the most accurate shooter and the other market hunters either skinned the animals or butchered the animals while maintaining the campfire and providing meals for the hunting party.

Product presentation to the client is an important aspect of market hunting and is a matter of pride for the market hunters. Market hunters view the end product as a representation of their integrity as a hunter and a provider. Every aspect of hunt is undertaken to present the best quality meat available. To this end, the market hunters would even use cooking oil as a substitute for chain oil when using a chainsaw to cut off the legs of the carcasses (i.e. 15 cm from the ankle). The saw would minimize time required to remove the legs and provided a clean cut. If a power saw was not available, legs would be cut with an axe.

I observed that time required to complete these hunting activities was not a deciding factor for participation by the market hunters. Hunters would travel long distances by vehicle and snowmobile to hunt caribou. They completed hunts mainly as a form of recreation. However, weather conditions in the Canadian Sub-Arctic are variable and sometimes changes in weather patterns would result in more strenuous activities for the hunters. For example, one market hunter recalled a hunt when blowing snow buried the snowmobile trail. One of the hunters had to walk on foot to create a trail while the other followed with both snowmobiles along the trail. This section of the trail, which would have normally taken four hours to complete, took the market hunters nearly 18 hours to complete. In another example, three market hunters had to cut the overgrowth of the snowmobile trail when trying to access an area for market hunting. The hunt took 29 hours to complete from start to finish (non-stop) and only produced seven caribou. It is cases such as these, which deter other hunters from participating in market hunting.

ISSUES SURROUNDING MARKET HUNTING IN THE SOUTH SLAVE REGION

The market hunters cited cases of inexperienced hunters attempting to conduct market hunting activities as one of the main issues surrounding market hunting in the South Slave region. The wounding of animals and wastage of meat due to improper shooting, processing, and shipping techniques were characteristic of these new market hunters. The market hunters noted that poor meat quality and appearance ultimately created a negative image for anyone, including the market hunters interviewed, conducting caribou market hunts. The market hunters considered themselves professional hunters and took great pride in the quality and presentation of their caribou meat.

The market hunters estimated that over 70 percent of the meat harvested by the inexperienced hunters is in poor condition and that wounding accounts for an additional 35 to 40 percent of wastage. Carelessly handled meat or poorly shot meat would be sold for considerably less (Can$50) or would eventually end up not being sold and was wasted. Clients are unhappy with this type of meat quality and will switch to store bought meat once they have had a bad experience with purchasing caribou from a market hunter. The demand for caribou meat, along with the decline in hunting by GHL holders continues to encourage inexperienced hunters to pursue this type of hunting activity. Training of hunters to provide much needed experience in meat handling and processing should be explored. This could be implemented by developing a license for market hunting and making the license holder attend classes on the land (i.e. hunter safety, shooting skills, rifle selection, camp skills, butchering and processing techniques, hunting ethics, etc.) to develop these skills. In addition, legislation could be enacted that would provide for a standardized protocol for meat inspection of game meat attained by market hunters. The basis and limitations of not adhering to a standardized set of inspection guidelines has been discussed with other wild species utilized for market hunting purposes (Brodowski and Beutling, 1998). Without the attention to detail in meat quality and hunting ethics, new market hunters will not be successful in this type of hunting activity.

CONCLUSION

At first glance, it appeared that market hunters were compensated well for conducting hunts over a relatively short period of time (usually weekends). However, it should be noted that although the market hunting mode using travel by truck was by far the most lucrative and most consistent in terms of production

(Can$ 223 per day average; only 25 percent of the overall hunts but accounted for 38 percent of the overall carcass production), market hunters preferred snowmobile with sleighs over other methods. This was evident in the fact that snowmobile with sleigh market hunts accounted for 43 percent of the overall hunts but only produced 27 percent of the overall carcass production. This reinforces the market hunter's priority of recreational value as the main reason for market hunting. Although travel by truck was the most economical hunting method, it was also the most labour intensive for the hunters because of the number of animals harvested and travel requirements. However, workloads depended on weather conditions and availability of animals.

The amount of work and care that must be taken to assure good, clean quality meat was evident from the market hunter's interviews. They took pride and gained a great sense of accomplishment by providing the best quality meat in the community. The market hunters tended to harvest more cows and mixed groups as clients preferred this type of meat. The cow and mixed groups were also preferred because the smaller bodied animals could be packed more efficiently and allow the hunters to obtain more animals for resale. This selective hunting technique was evident by the fact that the majority of the meat harvested was from mixed and cow groups (43 and 25 percent respectively) and accounted for approximately 80 percent of the overall harvest. Price did not very with the size or sex of the animals harvested. Bull groups accounted for only 32 percent of the overall market hunts and only 20 percent of the overall harvest production. Bull groups were primarily harvested by the travel by snowmobile and sleigh mode and were located on the fringe of the caribou migrations. For the most part, the market hunters hunted bull groups because that was the only caribou available at that particular time of the year.

The market hunters continually scrutinized meat quality. Meat would be swept to remove snow when the meat was packed in the truck or sleigh for transport to Fort Smith and would be swept again when taken out of the truck or sleigh upon arriving in Fort Smith. This care taken in handling meat is just one small aspect that contributed to successful market hunting. The market hunter's quality assurance measures guaranteed repeat customers.

Market hunting for caribou in the South Slave region fills a specialized niche in providing wild meat to GHL holders. Without this type of hunting, many Aboriginal people in the community of Fort Smith, especially elders, would not have access to caribou meat. However, it has been clearly demonstrated that market hunting of caribou can only be an economically sustainable activity if a number of interrelated conditions are satisfied. These include the availability of capital equipment necessary to complete hunts of this nature, the costs of the hunt being covered by meat sales, the hunt providing recreational benefits to the market hunters, high quality meat products delivered to clients, continued sales in the community, and ultimately, the availability of caribou. However, the presentation of substandard meat products and lack of success by other inexperienced hunters, could be the only negative aspect foreseeing market hunting in the South Slave region. The high demand for quality caribou meat in the community, the proficiency of skilled hunters, and their culturally-based interest in the enterprise are the main factors contributing to the viability of the industry.

ACKNOWLEDGEMENTS

I am most grateful to the two anonymous market hunters who provided the basis for this document. By trusting me with their knowledge and records, I was able to document, the first account of market hunting for caribou in the Canadian Sub-Arctic.

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APPENDIX 5-1: Overall statistics of market hunting of caribou in the South Slave Region, Northwest Territories (1989-2001).

Mode of Transportation	Average Harvest Per Mode of Transportation			Percentage of Total Hunts Performed Per Mode of Transportation	Percentage of Total Harvest Per Mode of Transportation	Typical Months Hunts were Completed	Number of Days Market Hunting			Groups Types Encountered Per Market Hunt		
	Hi	**Low**	**Avg.**				**Hi**	**Low**	**Avg.**	**Cows**	**Bulls**	**Mixed**
Truck (TT)	56	18	34	25 % (15 out of 60)	38 % (517 out of 1312)	February/ March	7	2	4	20 %	0 %	80 %
Truck and Snowmobile and Sleigh (TTS)	80	8	27	27 % (16 out of 60)	31 % (376 out of 1312)	End of March/ Beginning of April	7	2	3	31 %	13 %	56 %
Snowmobile and Sleigh (TSS)	23	5	14	43 % (26 out of 60)	27 % (363 out of 1312)	Mid-Feb./ End of March	5	1	3	20 %	65 %	15 %
Airplane (TA)	38	6	*	5 % (3 out of 60)	4 % (56 out of 1312)	End of March/ Beginning of April	5	1	1	66 %	0 %	34 %
Total				100 %	100 %							

* Depends on type of airplane used (Cessna 185 charter – 5-6 caribou/load with hunters and Beaver charter -11 caribou/load with hunters).
Note: Data pooled for two hunters in the South Slave Region.

APPENDIX 5-2: Overall costs and revenues associated with optimal success in market hunting of caribou in the South Slave Region, Northwest Territories.

Mode of Transportation	Number of Caribou Harvested Per Mode of Transportation *	Average Sales Per Trip (CDN) **		Average Cost Per Trip (CDN)	Estimated Profit Per Mode of Transportation
		Carcass only ($ 80)	Carcass with Goodies ($ 100)		
Truck (one truck)	25	$ 1 520	$ 600	$ 500	$ 1 620
Truck (two trucks)	50	$ 3 040	$ 1 200	$ 900	$ 3 340
Truck and Snowmobile and Sleigh (one truck and 9 foot sleigh)	12	$ 720	$ 300	$ 300	$ 720
Truck and Snowmobile and Sleigh (one truck and 10 foot sleigh)	15	$ 880	$ 400	$ 300	$ 980
Truck and Snowmobile and Sleigh (two trucks, two 10 foot sleighs)	30	$ 1 760	$ 800	$ 550	$ 2 010
Snowmobile and Sleigh (one snowmobile and 9 foot sleigh)	12	$ 720	$ 300	$ 200	$ 820
Snowmobile and Sleigh (one snowmobile and 10 foot sleigh)	15	$ 880	$ 400	$ 200	$ 1 080
Snowmobile and Sleigh (two snowmobiles and two 9 foot sleighs)	24	$ 1 440	$ 600	$ 350	$1 290
Airplane ***(Cessna 185)	6		$ 600	$ 425*	$ 175
Airplane (Beaver)	11		$ 1 100	$ 650	$ 450

* Note: 1) Number of caribou harvested per mode of transportation is assuming cow groups are hunted and loads are filled to capacity.
2) Data pooled for two hunters in the South Slave Region.

** Assumes $ 80 (CDN) for carcass and $ 100 (CDN) for carcass with goodies.

*** *Market hunters using aircraft usually sell all animals for $100 (CDN) per carcass.*

**** Prices are quoted for a 60 air mile trip from Fort Smith, NT and return (Big River Air Ltd., Fort Smith, NT).

APPENDIX 5-3: Capital requirements and associated costs for market hunting activities in the South Slave Region, Northwest Territories.

Market Hunting Item	Estimated Cost** ($ CDN)	Life Expectancy (Yrs)
Camp Supplies		
4 X 4 Extended Cab Truck	$ 40 000	10
Truck Trailer	$ 1 000	10
Snowmobile (Elan)	$ 2 000	2-3
Snowmobile (Skandic)	$ 6 500	2-3
Sleigh (wooden)	$ 1 000	15
Sleigh (plastic)	$ 1 400	15
Canvas Tents	$ 600	6-7
Air-tight Wood Stove	$ 100	10-15
Air-tight Gas Stove	$ 120	10-15
Gas Lamp	$ 75	10-15
Pots and Pans	$ 100	lifetime
Supplies Box (Grub Box)	$ 200	lifetime
Hunting Supplies		
Rifle	$ 520	lifetime
Telescopic Device for Rifle	$ 750	lifetime
Ammunition	$ 25/box	**
Binoculars	$ 700	lifetime
Knives for skinning/butchering (6)	$ 600	lifetime
Skinning Gloves	$ 50	
Clothing		
Snowmobile Suit	$ 500	5
Winter Parka	$ 400	5
Snowmobile Pants	$ 400	5
Winter Boots	$ 250	2
Fur Hat	$ 350	10
Fur Mittens	$ 250	10
TOTAL	$ 58 015	

* 1996 Estimated Costs

** Market hunter estimated that 50 shells were used to harvest 30 caribou.

Note: Data pooled for two hunters in the South Slave Region.

CHAPTER SIX

THE MODELING OF A RE-INTRODUCTION OF CARIBOU TO AN ARCTIC ISLAND ECOSYSTEM

INTRODUCTION

In the early 1900s, caribou (*Rangifer tarandus*) and tundra wolves (*Canis lupus hudsonicus*) were plentiful on Southampton Island (SHI), Nunavut[4] (Heard and Ouellet, 1994; Parker, 1975). However, the initiation of trading practices between Inuit and Europeans for firearms quickly decimated the caribou population and subsequently the wolf population declined as well. Manning (1942:28 from Parker, 1975) noted:

> "Soon after the establishment of the Hudson's Bay Company post in 1924, caribou numbers rapidly declined, probably a result of an unlimited supply of cartridges to the Aivilingmuit".

Parker (1975) from Manning (1942) commented that caribou were rare on the island in 1935 and wolves were extinct on SHI by 1937. The last caribou on SHI reportedly died in 1953 (Heard and Ouellet, 1994).

In 1967, the Northwest Territories Game Management Service and the Canadian Wildlife Service cooperatively transported 48 caribou to SHI from nearby Coats Island (Manning, 1967; Parker, 1975, Ouellet, 1992). The re-introduction was initiated to supplement the diet of the local Inuit community (Ouellet (1992) from Manning (1967)). The local Inuit adopted strict no hunting guidelines in order to let the herd grow to a harvestable level (Parker, 1975). Free of predators, fully protected from hunting, and with abundant sources of vegetation in both the summer and winter, the herd increased dramatically (Table 6-1).

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[4] At the onset of this dissertation, both the Nunavut Territory and the Northwest Territories were termed the Northwest Territories before the Nunavut Territory was created on April 1,1999.

Heard and Ouellet (1994) estimated the annual rate of growth, based on historical population surveys of the SHI herd to be 27.6 percent. Parker (1975) estimated the carrying capacity for SHI to be 40 000 caribou but he did not visit the island in the winter to document snow conditions with respect to availability of lichens (Ouellet et al., 1993). As caribou on SHI are restricted to mainly windswept areas that were free of snow cover and Parker's predictions did not include habitat use based on seasonal changes in distribution of caribou (Heard and Ouellet, 1994), Ouellet et al. (1993) proposed that Parker's estimate could be an overestimate of the island's carrying capacity. Ouellet et al. (1993:140) noted:

> "Contrary to this prediction, pellet group counts, aerial survey data (Ouellet, 1992), and signs of grazing, suggest that the lichen-heath felsenmeer range type was not heavily used by caribou in winter, but the raised lichen-Dryas sedge was favored".

The historical reasoning for the re-introduction of Rangifer to Arctic islands has been to provide meat for human consumption (Klein, 1968; Knightley and Lewis-Smith, 1976; Nishi, 1993; Ouellet, 1992; Scheffer, 1951). The success or failure of these introductions tends to revolve around the abundance and quality of forage and the response of plants to herbivory by the introduced caribou population. However, Arctic re-introductions of Rangifer to islands have historically culminated in a dramatic rise in population numbers followed by a subsequent crash (Klein, 1968; Nishi, 1993; Scheffer, 1951)(Appendix 6-1). Heard and Ouellet (1994) predicted that without intervention, the SHI herd would potentially increase beyond the island's carrying capacity and subsequently crash similar to other insular populations.

In this chapter, the re-introduction of caribou to SHI is examined to evaluate the plant herbivore dynamics surrounding the re-introduction. Historically, caribou existed on the island but it is unclear whether or not the caribou were in a fairly stable equilibrium with their habitat before their extirpation by local hunters. With little to no grazing pressure on SHI since the 1930s, the lichen biomass had an opportunity to accumulate before the caribou re-introduction (Ouellet et al., 1993). This accumulation of lichen could create an unstable situation by predisposing the island to a sudden increase in caribou numbers and subsequent crash once lichen biomass was reduced (Klein, 1968; Scheffer, 1951). However, some biologists believe that the SHI population could persist at low levels on the island by utilizing vascular plants (sedges and grass and willows) once the initial crash occurs (A. Gunn, A. pers. comm., 2001). Replacement of lichens by vascular plants in diet has been described in other Rangifer populations (Bergerud, 1974, Gauthier and Theberge, 1986; Leader-Williams, 1988; Reimers, 1982,1983; Skoog, 1968) and on nearby Coats Island (Adamczeski et al., 1988, 1993). Gates et al. (1986a:359) commented:

> "As the density increases on SHI we predict that grazing will reduce lichen availability (a density dependent process), leading to an ecological state similar to Coats Island".

Ouellet (1992) commented that SHI caribou rely heavily on lichens for their winter diet. Considering the exponential population increase since introduction (Heard and Ouellet, 1994) and the history of re-introductions on other Arctic islands (Appendix 6-1), the critical management problem to address in this work is what is the carrying capacity for this system and how can this population persist for many years to follow.

The purpose of this study, using a modelling approach, was to evaluate whether or not the winter caribou/lichen system on SHI is a self-stabilizing system. Additionally, I assess whether the caribou population can rely on natural processes for regulation (i.e. introduction of wolves) and/or community subsistence harvests to stabilize this rapidly growing population.

The specific objectives of the modelling exercise were to re-create the SHI caribou population from past studies and try to understand the dynamics of this re-introduction by determining the following:

- Whether SHI is a self-stabilizing system;
- If wolf introduction can stabilize the SHI system;
- Whether local community subsistence needs can stabilize the SHI system;
- Address future population implications of SHI system.

STUDY AREA

SHI is located on the north end of Hudson Bay (Figure 6.1) and is approximately 43 000 km² in area (Ouellet, 1992; Parker, 1975). The largest island in Hudson Bay, SHI has been classified by Parker (1975) into two physiographic regions that are described as Canadian Shield and Hudson Bay Lowlands. The island is divided by an abrupt escarpment which has low flat limestone plains dominated by Dryas barrens and sedge meadows on one side and steep to rolling Precambrian shield dominated by *Alectoria spp* and *Cetraria spp* lichens and heaths on the other (Heard and Ouellet, 1994).

SHI is completely surrounded by open water year-round, which creates a climate as harsh as that found on most of the High Arctic islands (Parker, 1975). The snow cover period generally lasts from mid-September or early October until mid-June. Snowmelt occurs rapidly in mid-June and the growing season typically lasts from July to the beginning of September. The mean daily temperature recorded at Coral Harbour was -11°C and the annual precipitation for rain and snow is 13 cm and 113 cm respectively (Heard and Ouellet, 1994). Coral Harbour recorded double the amount of snowfall as Baker Lake, which is located at the same latitude as Coral Harbour on the mainland (Parker, 1975). The average wind speed at Coral Harbour is 20 km/hr. Fog and low overcast conditions are often present during the snow-free months.

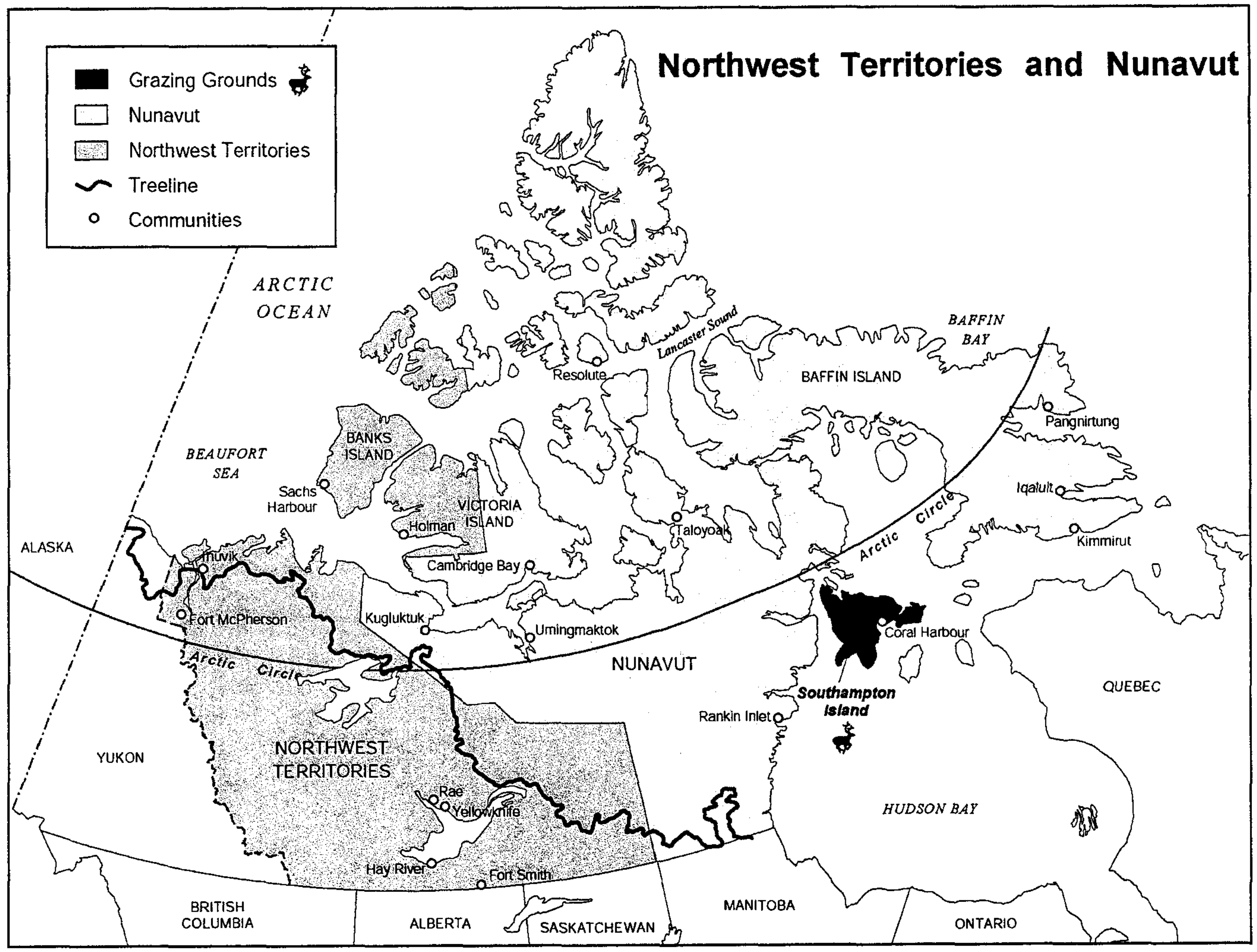


Figure 6-1 Location of large-scale commercial caribou hunt-Southampton Island, Nunavut.

MODEL STRUCTURE

The model is a dynamic deterministic simulation programmed using STELLA simulation software by High Performance Systems. STELLA was selected for its simplicity, graphic object orientation, and strict adherence to systems dynamics conventions. Versions beginning with 5.0 Research allow for subscripted variables, offering new scope for dealing with distributed systems.

The operating environment within STELLA is composed of a multi-level, hierarchical environment that includes a high-level map (Figure 6-2), a model construction layer (Appendix 6-2), and an index of terms for the model (Appendix 6-3). The high level map provides the relationship of the model's structure. The model construction layer provides a more detailed view into the model and allows relationships to be linked and equations defined. The equation view provides a view of the entities in a list format. Costanza et al. (1998) provide an introduction to ecological modeling using STELLA software.

The goal of this exercise is to get the model to be a faithful representation of the SHI system by compiling as much data as possible from empirical studies and processes. Numerous habitat and population studies have been conducted on Southampton Island (Parker (1975), Ouellet (1992), Ouellet et al., (1993), Heard and Ouellet (1994), Ouellet et al., (1994)) and a nearby island, Coats Island, (Adamczewski et al., (1987a,b), Adamczewski et al., (1988) Gates et al. (1986a,b). These studies and others provided the basis for this chapter on the population dynamics of the re-introduction of caribou to SHI, Nunavut.

In the following sections, I review the model construction layer based upon key sources of information and assumptions I used. It is generally understood that lack of suitable field data is a major issue when trying to model ungulate populations (Bunnell et al., 1975; Doerr, 1980; Eberhardt, 1991; Euler and

Morris, 1984; Milner-Gulland, 1997; Walters et al., 1975; Walsh et al., 1995; Stocker, 1983; Stocker and Walters, 1984).

POPULATION PARAMETERS

The initial population variables used to evaluate the dynamics on SHI were developed by creating model sectors for caribou, lichen, winter severity, wolves, hunting, and the community population of Coral Harbour (Figure 6-2). The model was developed with components that allowed me to turn off the winter severity, wolves, and hunting sectors, in order to test the model.

For this model, I chose a time scale of 180 years to gain an impression of the frequency, amplitude, and focus of the population cycles. Interactions between caribou and vegetation have strong delayed density-dependent attributes that can promote population fluctuations (Messier et al., 1988). Rangifer population fluctuations have been reported to vary from 20-40 years to 130 years (Caughley and Gunn, 1993; Couturier et al., 1990; Gaare, 1997; Haber and Walters, 1980; Hemming, 1975; Klein, 1968; Melgaard, 1986; Palmer and Rouse, 1945; Scheffer, 1951; White et al., 1981). Lichen regeneration rates range from 30-50 years to as long as 120 years, depending on severity of depletion (Helle and Aspi, 1983; Henry and Gunn, 1991; Hudson and Bunnell, 1980; Klein, 1968; Reimers, 1977; Scotter, 1967). Caughley and Gunn (1993:52) noted:

> "Meldgaard (1986) traces a similar picture of wide fluctuations in the number of caribou over many decades on Greenland: the sequence of peak and trough tended to repeat over 30-50 years and were asynchronous among areas".

Gaare (1997:7) commented:

> "But it is everywhere true that reindeer management should be range oriented, and on a 100 year perspective rather than a 10 year one".

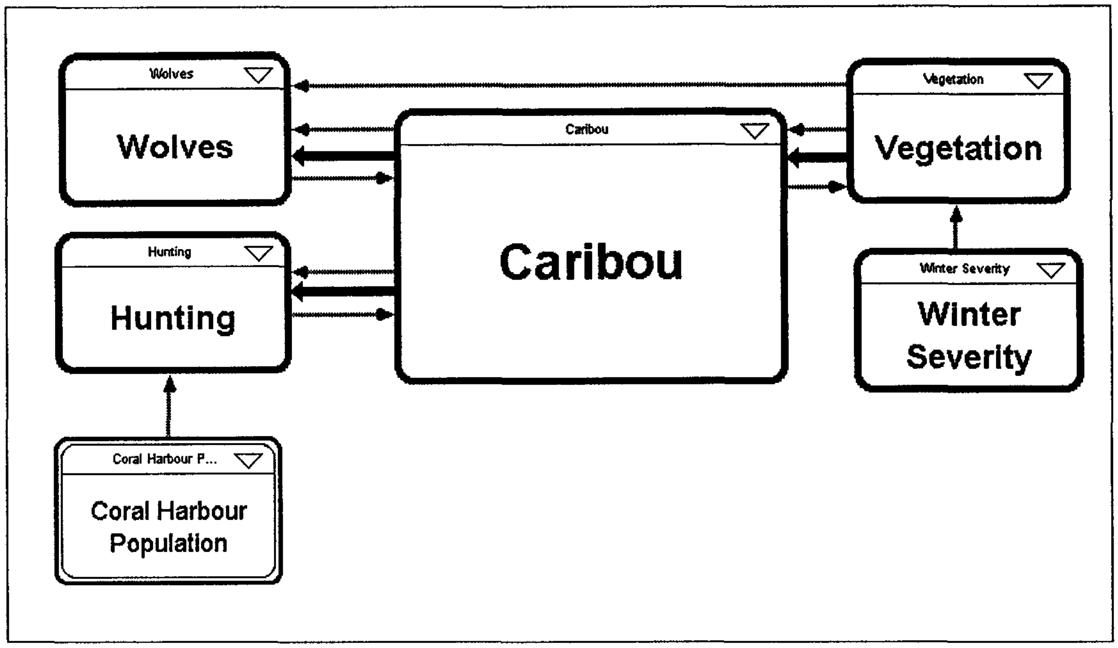


Figure 6-2 High-level map level for SHI caribou re-introduction model.

Note: The large arrows represent a bundled flow that corresponds to the material flows between processes in the model. The small arrows represent bundled connectors that correspond to any sector-to-sector connectors that exist in the model.

CARIBOU SECTOR

The caribou sector was developed using a gender and age structured model that utilized calf, yearling, and adult pools to depict the SHI caribou population (Figure 6-3). This age structure matched available life history schedules and complemented population survey information used for model verification. Although the caribou sector was initially developed using the simplified approach of a single pool, the resulting prediction in population numbers did not correspond to the reported population surveys (Ouellet, 1992; Heard and Ouellet, 1994) and recent population estimates (Table 6-1). The initial values for each pool consisted of the original transfer of 48 caribou (19 cows, 7 yearling females, 2 female calves, 6 bulls, 6 yearling males, and 8 male calves) to SHI from nearby Coats Island in 1967 (Manning, 1967; Parker, 1975; Ouellet, 1992). Gender specific variables were encapsulated in a single array variable that allowed simplification of the model while permitting a generic model structure to be repeated several times. This gender structure was followed throughout the population model parameters.

Fecundity

The modeling exercise using age/gender structure predicted very high fecundity values for yearling and adults on SHI to reach initial population estimates. This conclusion was verified by the findings of Ouellet (1992), where all yearlings in the four-year sample were pregnant and collection data indicated that 97 percent of all adult females sampled were pregnant (sample size 93).

Table 6-1 Population surveys of caribou (Rangifer tarandus groenlandicus) on Southampton Island, Nunavut (1967-1997).

Year	Population Estimate	Adults Males	Adults Females	Yearlings Males	Yearlings Females	Calves Males	Calves Females	Notes and Sources
1967	48	6	19	6	7	8	2	--Initial introduction (Ouellet, 1992)
Nov-78	1 200 +/- 340							-- Including calves (Ouellet, 1992)
Jun-87	5400 +/- 1130							-- 4000 +/- 660 1 yr or older (Ouellet, 1992)
Mar-90	9 000 +/- 3200							-- Including calves (Heard and Ouellet, 1994)
Jun-91	13 700 +/- 1600							-- 1 yr or older (Heard and Ouellet, 1994)
Jul-95	18 275 +/- 1 390	cv 0.076						-- 1 yr or older (R. Mulders, pers. comm. 2001)
Jul-97	29 146 +/- 1 767	cv 0.06						-- 1 yr or older (R. Mulders, pers. comm. 2001)

Additional Notes:

1. Heard and Ouellet (1994) remarked that the 1987 survey was the best estimate of the population composition because it was conducted from a helicopter that resulted in broader coverage than earlier surveys.
2. Please see Ouellet (1992) for complete review of survey techniques.
3. June 1987 - 93 calves per 100 females, 69 yearlings per 100 females therefore, 73 percent of calves survive to become recruited in adult pop at one year (Williams and Mulders, 1994).
4. July 1995 - estimate was regarded by regional biologist as an under estimate -- more in the range of 20,000 (uncontrollable problems with survey) (R. Mulders, pers. comm. 2001).

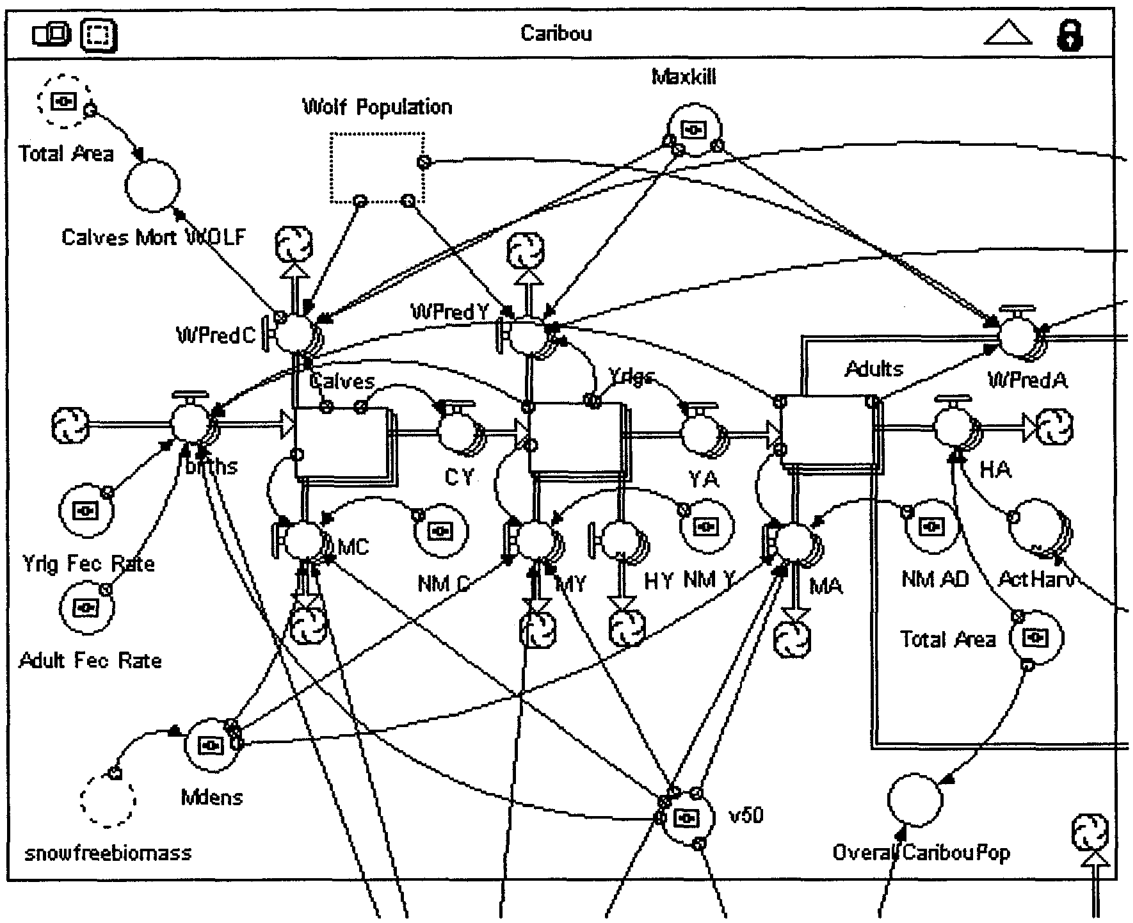


Figure 6-3 Model construction level for caribou sector.

Ouellet (1992:42) commented:

> "Exceptionally high pregnancy rate in yearlings on SHI suggests that age at first reproduction might be influenced by forage availability. Further, results clearly indicate that being pregnant as a yearling did not prevent reproduction in the following years ... because pregnancy rate was 100% in these females".

It is generally accepted that caribou fecundity is high, especially when range conditions are excellent (Dauphine, 1976; Reimers, 1983; Skogland, 1985). Gaare and Skogland (1980) suggest that the body size and reproductive performance of reindeer relate to lichen biomass of the winter pastures. Klein (1987) noted that upon re-introduction to St. Matthews Island, 83 percent of the yearling females were pregnant during the first year. Klein (1968:352) further remarked:

> "Under optimal range conditions, reindeer has been known to conceive during their first year and have their first fawns when they are one year of age (Palmer, 1934; Davey, 1963; Skuncke, 1969)".

Godkin (1986) reported a 99.5 percent average pregnancy rate in the Mackenzie Delta reindeer herd, with an additional 24.7 percent of the animals carrying twins (sample occurred from 1976 to 1981 and sample size was 4 050).

Mortality

The model assumed very low rates of mortality for calves, yearlings, and adults on SHI. SHI population models derived by government biologists reported similar results (Williams and Mulders, 1994). Heard and Ouellet (1994:93) noted mortality rates on SHI based on a population balance model (sensu Walters, 1986) keeping mortality rates constant over time with no density dependent effects:

> "Assuming 100% survival of individuals older than calves, the survival rate of calves must have been at least 72% to achieve the observed rate of growth. This survival rate must have been greater than that because natural mortalities of individuals other than calves were reported. Conversely, if calf survival was 100%, then adult survival must have been at least 92%."

Helle and Aspi (1983:338) commented:

> "Winter survival of most reindeer and caribou populations living in the sub-arctic or northern taiga is highly dependent upon the availability of reindeer lichens (Cladonia spp)".

Because the vegetation on SHI was of high quality and quantity (Parker, 1975; Ouellet, 1992), I assumed that food limitation was not a factor in the mortality on SHI at low population densities. Ouellet (1992) noted that natural mortality on SHI was low (only 17 deaths from 1973 to 1991 were recorded) thus indicating that survival should remain relatively high for this caribou population with no natural predators and abundant sources of winter and summer vegetation.

To evaluate the effect of hunting activities to date on SHI caribou, a converter (ActHarv) represented actual hunting losses to the caribou population from either local hunters or research use between 1978 and 2001 (Ouellet, 1992; Threadkill and Associates, 1995-2001).

Mortality in the caribou sector was also linked to the vegetation sector by overall vegetation available per unit time, Mdens, and V50 parameters (see Linkages of Trophic Levels below). To evaluate the effects of the possible re-introduction of wolves to SHI, mortality rates of each population pool were correlated to a wolf sector (see Wolf Sector below). Within the model, mortality rates due to harvesting, either for subsistence, commercial, or research use was applied only to the adult pool.

VEGETATION SECTOR

The information used for the vegetation sector was taken from Parker's (1975) extensive studies from 1970 to 1972 of the standing crop of lichens and annual production of vascular plants (sedges, grasses, and willows) on SHI (Figure 6-4). I assumed that the caribou re-introduction of 1967 had little effect in 1970 to 1972 when the population of caribou had only grown to an estimated 250 animals. Range types were divided according to moisture regimes and physiographic features (Parker, 1975). Maximum values reported for vegetation biomass ranged from 3000 kg/ha (lichen), 400 kg/ha (sedges), and 200 kg/ha (willows). However, total weighted mean biomass values were calculated from coverage of respective range on SHI (Table 6-2).

Within the vegetation sector, both the lichen and vascular plant information was encapsulated in a single array variable that allowed for the simplification of the model while permitting a generic model structure to be repeated several times. This structure was followed throughout the vegetation model parameters. The vegetation growth and consumption variables were calculated based on a difference equation version of a plant-herbivore model described by Caughley (1977:126-132).

Lichen

Lichens are the preferred winter diet of caribou in the Canadian Arctic whereas abundant forage, in the form of shrubs, sedges, heaths, grasses, and lichens, are used during the summer months (Adamczewski et al., 1988; Gaare, 1997; Holleman et al., 1980; Ouellet, 1992; Heard and Ouellet, 1994). Resilience of forage to winter grazing by *Rangifer* has been directly linked to food quantity on Arctic islands (Klein, 1968; Leader-Williams, 1982; Nishi, 1993; Ouellet, 1992; Scheffer, 1951; Thomas and Hervieux, 1986).

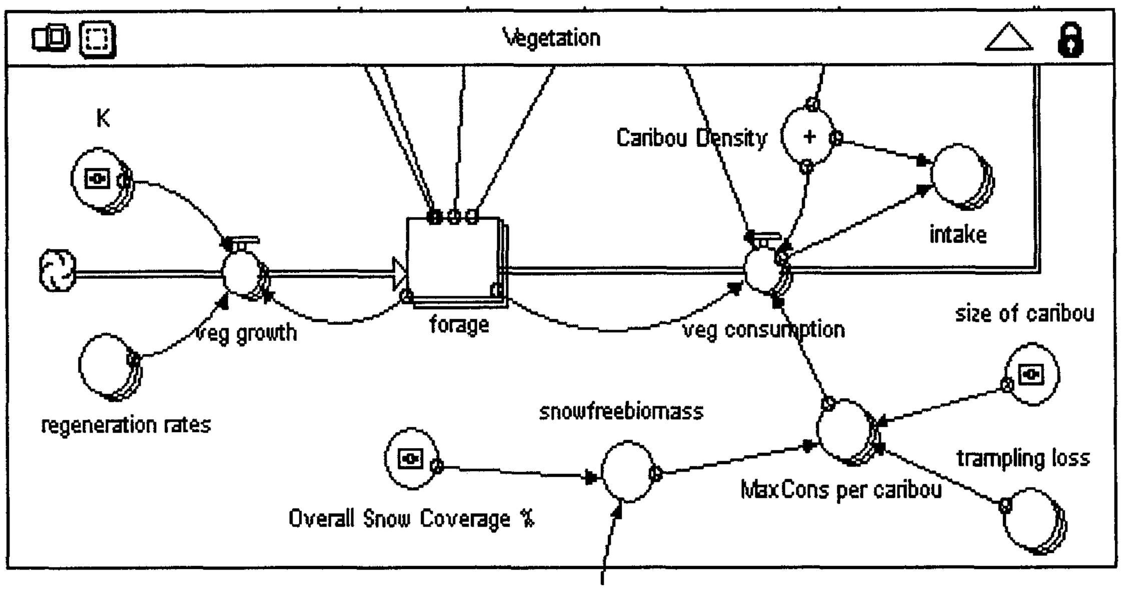


Figure 6-4 Model construction level for vegetation sector.

Table 6-2 Calculations of lichen and vascular biomass on Southampton Island, Nunavut.

Range Type	Total Area (km²)	Lichen Biomass (kg/ha)	% Cover	Sedge/Grass Biomass (kg/ha)	% Cover	Willow Biomass (kg/ha) (creep)	(acsend)	(avg.)	% Cover
Hudson Bay Lowlands									
Dryas barrens	2,967		13.9	175	17.2	10	60	35	0.9
* Raised lichen-Dryas sedge	5,745	490.1	32.9	205	25.3	12	62	37	1.1
Patterned Ground Tundra (polygons)	4,840	203.9	9.5	402	63.6	200	160	180	19.7
Sedge-heath transition	5,353		5.2	320	47.9	60	90	75	6
Sedge-willow meadow	5,957		1.1	400	57.2	200			21.3
Sedge-willow bog	327		<0.1	370	56.7	50	80	65	4.9
Canadian Shield									
Lichen-heath felsenmeer Plateau	7,344	755.3	38.3	120	7.5	21	65	43	2.1
Lichen-heath felsenmeer Lowland	3,789	823.9	88.4	30	27.9	10			6.6
Plateau Meadow	938		16.8	220	26.1	140	130	135	13.8
Total	**37,258**	weighted		weighted				weighted	
Water	5,750	mean		mean				mean	
	43,008	**342**		**197**				**77**	
**lichen heath alluvial shingle	430	2912.6	87.5		9.4				1.1

*Parker (1975) predicted that caribou should use the lichen-heath felsenmeer as winter range, and his carrying capacity estimate was based on the lichen biomass found in this range type. Contrary to this prediction, pellet group counts, aerial survey data (Ouellet, 1992), and signs of grazing, suggest that lichen-heath felsenmeer range type was not heavily used by caribou in winter, but the raised lichen-Dryas sedge range was favored (LHF range type was located in valley bottoms therefore could not be available in winter.) Ouellet et al.1993.

**Estimated to be one percent of SHI (Ouellet et al. 1993).

Data gather from Parker (1975): **Total Area** -- pg. 18 Table 1; **% Cover** -- pg. 19 Table 2; **Lichen Biomass** -- pg. 31 Table 3; **Sedge/Grass Biomass** --pg. 33 Figure 25; **Willow Biomass** -- pg. 34/35 Figure 26/27.

The winter diet of SHI caribou consists mainly of lichen (Ouellet, 1992; Ouellet et al., 1996). Although abundant lichen range exists on SHI (Parker, 1975), lichens are not resilient to grazing (Archer and Tieszen, 1980; Gaare, 1977; Henry and Gunn, 1991; Klein, 1969,1987; Ouellet, 1992; Ouellet et al., 1993; Ouellet et al., 1994; Palmer, 1934; Pegau, 1968; Skuncke, 1969). Lichens are often used as an indicator of carrying capacity (Gaare and Skogland, 1980) as availability of lichens often determines winter survival of most *Rangifer* populations (Gaare, 1997; Helle and Aspi, 1983).

However, populations of *Rangifer* do exist on low biomass of lichen by utilizing vascular plant species (Bergerud, 1974, Gauthier and Theberge, 1986; Leader-Williams, 1988; Reimers, 1983; Skoog, 1968). The nearby Coats Island caribou population, adjacent to SHI, exists with a low overall lichen biomass and high vascular biomass but has been regulated in the past years by stochastic fluctuations in climate (Adamczewski et al., 1988, 1993; Gates et al., 1986b). Bergerud (1974: 765) noted:

> "I would argue that caribou can prosper in the complete absence of lichens as long as a good supply of sedges and evergreen shrubs is available."

Long winters, which are characteristic of the Arctic, determine the quantity of forage available for caribou and ultimately determine sustainable populations (Klein, 1968). Klein (1968:363) noted:

> "With regard to ungulate range, it can perhaps be stated that forage quantity acts primarily to govern population size while quality determines the size of the individual. Further, in northern regions, food limitation is most critical during the winter period while qualitative variations in food supply make themselves felt during summer when the physiological demands are highest and growth is most rapid (Klein, 1964). Thus range carrying capacity involves two quite different criteria: the winter component which governs the upper limit

> of the population, and the summer component which determines the physical stature of the individual."

Access to high quality forage has been suggested as a limiting factor for caribou on Coats Island during the winter months (Adamczewski et al., 1988). Ouellet et al. (1993) documented overgrazing of lichen habitat on parts of SHI. Lichen regeneration rates as described by Gaare (1997) were used in the model. Gaare (1997) showed that annual regeneration rates of lichen after disturbance displayed a logistic type of growth with an intrinsic growth rate of about 0.20. Gaare's study implied that at low biomass, growth was around 20 percent, at middle biomass, 10 percent, and at high biomass, 0 percent. For lichen regeneration rates, I assumed that the SHI rate of lichen recovery for the model was 0.20.

Lichen biomass for SHI ranged from 200 kg/ha (South Bay Lowland) to 3000 kg/ha (alluvial shingle range type) (Parker, 1975). Ouellet et al. (1993) noted that lichen biomass ranged from 690 to 2 630 kg/ha for three winter ranges on SHI. Ouellet (1992) and Ouellet et al. (1993) also noted that from 1983 to 1991 lichen biomass on a section of the island declined from 2550 to 550 kg/ha after heavy grazing.

Available lichen range was recorded on SHI as 21 719 km^2 (Raised-lichen-Dryas sedge – 5 745 km^2, Lichen-heath felsenmeer plateau – 7 345 km^2, Lichen-heath felsenmeer lowland – 3 789 km^2, and polygons – 4 840 km^2) (Ouellet et al., 1996).

Published estimates of lichen consumption by *Rangifer* range from 1.23 kg (dry matter)/day to as high 7.03 kg (dry matter)/day (Arsenault et al., 1997; Boerte, 1990; Hanson et al, 1975; Holleman et al., 1979; Holleman et al., 1980; Kelsall, 1968; Klein, 1982; McEwan, 1968; Parker, 1975; Rominger and Robins, 1996; Russell and Martell, 1984; Seip, 1991; Trudell and White, 1981; White and Trudell, 1980a, b; and White et al., 1981). For the purposes of the model, I used an asymptotic or maximum daily intake of 5 % of bodyweight (Arnold, 1989; Holleman et al., 1979; White and Trudell, 1980a, b) for a 95 kg caribou (Ouellet, 1992).

Trampling of the lichen mat has been reported to waste as much as one and a half to ten times the lichen eaten by caribou (Bunnell et al., 1975; Pegau, 1970; White and Trudell, 1980a). Swanson and Barker (1992:41) commented:

> "On most islands, reindeer grazing and trampling are the major factors causing lichen depletion."

In the model, trampling was estimated to waste approximately twice what the caribou on SHI would consume (Bunnell et al. 1975).

Snow cover, in terms of the amount of lichen mat available also affected lichen consumption, which was developed with a winter severity index (see WSI section) within the model (Gunn et al. 1989).

Vascular plants

For the purposes of the model and corresponding data from Parker (1975), I grouped sedges, grasses, and willows as vascular plants. Caribou utilize these plants primarily during the summer months on SHI (Ouellet et al., 1993). Parker (1975) noted that crude protein levels in sedges and willows were high on SHI. Maximum values of sedge biomass were reported at 600 kg/ha on plots where sedge occupied up to 90 to 100 percent ground cover. Ascending willow reached maximum biomass of 500 kg/ha on plots where they occupied 80-90 of ground cover. However, the most productive habitats were found in sedge willow meadow range with 400 and 200 kg/ha for sedges and willow, respectively. Least productive ranges reported values of 30 kg/ha for sedges and 10 kg/ha for willow. Total weighted mean biomass values for vascular plants were calculated from coverage of vascular range on SHI (Parker, 1975)(Table 6-2). Parker noted that the annual production of sedges and grasses per range type is negatively correlated with lichen production values. The relationship was a result of moisture content -- sedges proliferated on poorly drained soils where lichen were located on well drained and sandy soils. Parker (1975:51) commented:

> "These findings explain earlier reports of caribou wintering on the highlands (good lichen production) and summering on the lowlands (good sedge, grass, and willow production)."

Ouellet et al. (1993) noted:

> "Although lichens were locally overgrazed, deciduous shrubs were not affected."

However, within the model, I assumed that approximately 10 percent of the vascular plant biomass would be displaced due to trampling and that the vascular plants would regenerate at a yearly level of 0.73 (Ouellet, 1992). Ouellet et al. (1994) have shown responses to clipping depended on time of year and clipping intensity. Although clippings increased chemical composition in vascular plants during the summer period on SHI, it is not known what effect clipping would have on vascular plant production throughout the whole year.

WINTER SEVERITY SECTOR

Caribou face many uncertainties in the Arctic (Russell and Martell, 1984; White et al., 1981). The Arctic tundra ecosystem presents an extreme climate, described as a polar desert, which is highly unpredictable and variable in duration in terms of temperature, precipitation, and seasonal variation (Caughley and Gunn, 1993; Klein, 1996). Ferguson and Messier (1996) noted that variability and harshness of climates increase with latitude. Geographic variation within the Arctic regions occupied by caribou has been documented (Thomas and Everson, 1982). Severe precipitation, especially the covering of vegetation with snow or ice at critical times in the year, has been attributed to die-offs in the Arctic of both caribou and reindeer (Klein, 1968; Gates et al., 1986b; Gunn et al., 1981; Leader-Williams, 1980, 1982; Miller et al. 1975, 1977; Miller and Gunn, 1986; Reimers, 1982, 1983; Scheffer, 1951; Struzik, 1999) as well as muskoxen (Gunn et al., 1989; Reynolds, 1998). Snow conditions strongly influence availability of winter forage for Rangifer (Henshaw, 1968; Formozov, 1946; Pruitt, 1959; Skogland, 1978). In the Arctic tundra, caribou actively seek out areas free of snow such as ridges and wind-blown areas in the winter periods whereas tundra ponds, wet meadows, and other low lying areas are used throughout the summer (Adamczewski et al., 1988; Klein, 1968; Ouellet, 1992; Punsvick et al., 1980).

The winter severity sector was calculated from Ouellet et al. (1996) and is based on snow accumulations (Gunn et al., 1989) recorded at the Coral Harbour weather station (Figure 6-5). However, Ouellet et al. (1993) did show variation in snow conditions over SHI and Ouellet et al. (1996:21) noted:

> "Further, such index of winter severity is possibly too simplistic to reflect the real nature of the relationship between winter climatic conditions and caribou population dynamics."

However, I used the WSI for predicting further restriction of forage throughout the year. Messier (1991) showed that snow accumulation had no quantifiable effect on moose but rather competition for food had a regulatory impact on Isle Royale, Michigan. However, Skogland (1985) noted that with increased densities, severe weather has consequences affecting reindeer population stability and density dependent effects were manifested through winter food limitation.

The WSI sector is based on parameters that are calculated using the mean cumulative snowfall and three standard deviations from the mean cumulative snowfall reported on SHI (Ouellet et al., 1996). The mean overall snow cover

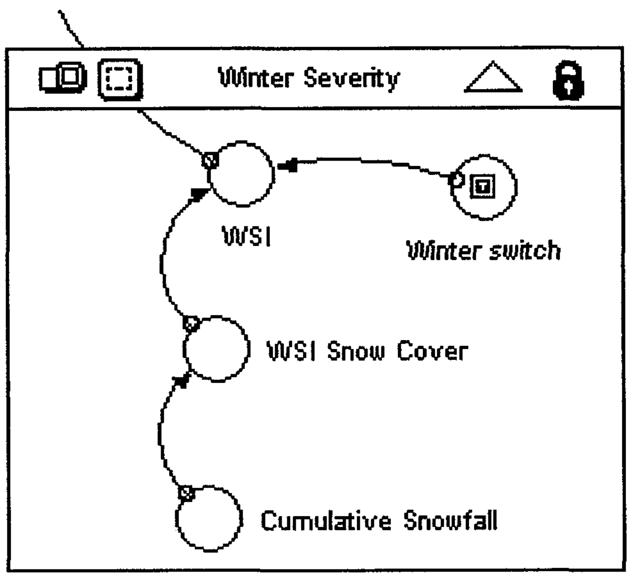


Figure 6-5 Model construction level for winter severity sector.

was estimated to be 50 percent (Parker, 1975). In the model, cumulative snowfall was estimated using a random numerical function within modeling program that generates a series of uniformly distributed random numbers between a minimum and maximum. Values that were generated at the mean and below received 50 percent snow coverage (no effect) then increased an additional 10 percent per standard deviation. I chose 80 percent as the maximum percent coverage to account for summer habitat and areas of SHI (ridges and areas of high relief) that are never covered by snow due to wind.

WOLVES SECTOR

Tundra wolves (*Canis lupis hudsonicus*) remain absent from SHI for a number of reasons. Firstly, the location of SHI with year round open water limits access to the island. However, occasionally ice forms and allows access for wolves onto SHI. Secondly, local Inuit often travel (up to 150 kilometers – one-way) to mainland locations to hunt wolves and subsequently sell the fur (L. Netser, pers. comm. 1997).

Heard and Calef (1986: 164) commented on increased incidences of wolf hunting in the Canadian Arctic:

> "caribou wintered close to Keewatin communities and the introduction of faster snowmobiles made wolf hunting an exciting and desirable sport."

Miller (1975:30) elaborated further on this predator-prey dynamic:

> "Present day Inuit hunters and trappers kill wolves whenever possible. Inuit on the CAA (Canadian Arctic Archipelago) often view the wolf as an unwelcome "successful competitor" for a common food resource, mainly caribou, and also as a destroyer of saleable furs, as wolves destroy foxes in traps (e.g., McEwan, 1955). The hunting of wolves is culturally

prestigious and economically rewarding, so opportunities are rarely missed."

In the late 1990s, a pack of tundra wolves was sighted on Southampton Island. Initial reaction from the local government biologist was to consult with Aiviit Hunters and Trappers Organization (HTO) in Coral Harbour to determine whether this pack of wolves could be protected to assist with addressing the caribou herd growth rate. However, after a community vote (community members on the land were contacted via high frequency radios), it was decided that community members would be allowed to hunt the wolves. The wolves were all harvested the following day by local hunters (R. Mulders. pers. comm. 2001). Consequently, the idea of introducing wolves on SHI is currently not an option to control the increase of the caribou herd.

However, the colonization of wolves to SHI has been proposed as a possible solution to increase the stability of the caribou population on SHI by preventing further irruptions, providing wolf hunting opportunities, and providing income through the sale of hides (Heard and Ouellet, 1994). Messier (1994) suggests that a stable equilibrium between large herbivores and their food plants is unlikely to exist in environments without predators. It was therefore decided to create a wolf sector within the model to try to examine the possible effects of a wolf re-introduction.

The wolf sector (Figure 6-6) was designed within the model so that wolves could be introduced at a particular date (specific year). The maximum density of wolves on SHI was calculated from territorial, behavioral, wolf introduction, and wolf population literature. Wolf territories have been reported from 125 to 3800 km^2 (Hayes and Harestad, 2000a; Kieth, 1983; Mech, 1977; Messier, 1985; Miller, 1975; Stocker, 1981). The number of wolves that could possibly inhabit SHI was predicted based on an average pack territory of 1478 km^2 (Hayes and Harestad, 2000a) and average social pack size of 13 (Gauthier and Theberge, 1986; Haber, 1996; Hayes and Harestad, 2000a; Mech, 1970; Stocker, 1981).

Based on these studies, I concluded that maximum territorial values for wolves on SHI could be about 0.0088 wolves/km². Therefore, I assumed that the wolf density of 0.0065 wolves/km² for caribou/wolf coexistence suggested by Bergerud (1988, 1991) could be representative of the wolf density on SHI. Kuyt (1972) suggested that if the entire diet of wolves consisted of caribou, a minimum predation rate of 23 caribou per wolf per year would be applicable.

Finite rates of increase for wolf populations ranged from $\lambda = 1.01$ to 2.38 in the literature (Bergerud and Ballard, 1988; Boertje et al., 1996; Eberhardt, 1998; Hayes and Harestad, 2000b; Keith, 1983). In the model, I assumed a finite rate of increase value of $\lambda = 1.48$ (Keith, 1983) and a finite rate of decrease of –0.5 (Stocker, 1981). The wolf sector was linked to the caribou sector using a variable termed P50 (see: Linkages of Trophic Levels below).

HUNTING SECTOR / CORAL HARBOUR POPULATION SECTOR

Subsistence hunting on SHI was calculated based on the community population sector (Figure 6-7) and the assumption that the residents would continue to harvest caribou at their present rate of 1.6 caribou per person per year. Subsistence hunting is defined as the harvesting of caribou for food and clothing for personal, family, or community use. Based on historical data, it is assumed that all caribou harvested on SHI are taken from the adult pool. The predominately Inuit community of Coral Harbour has a population of 669 and continues to grow at a rate of 3.2 percent per year (Bureau of Statistics, 1996). The KP variable in the model is the carrying capacity for the community of Coral Harbour. Realistically, without a strong employment base, the community could not continue support a population of over 1500 residents (generous value). This number would stabilize in later years with emigration within Nunavut or to the NWT.

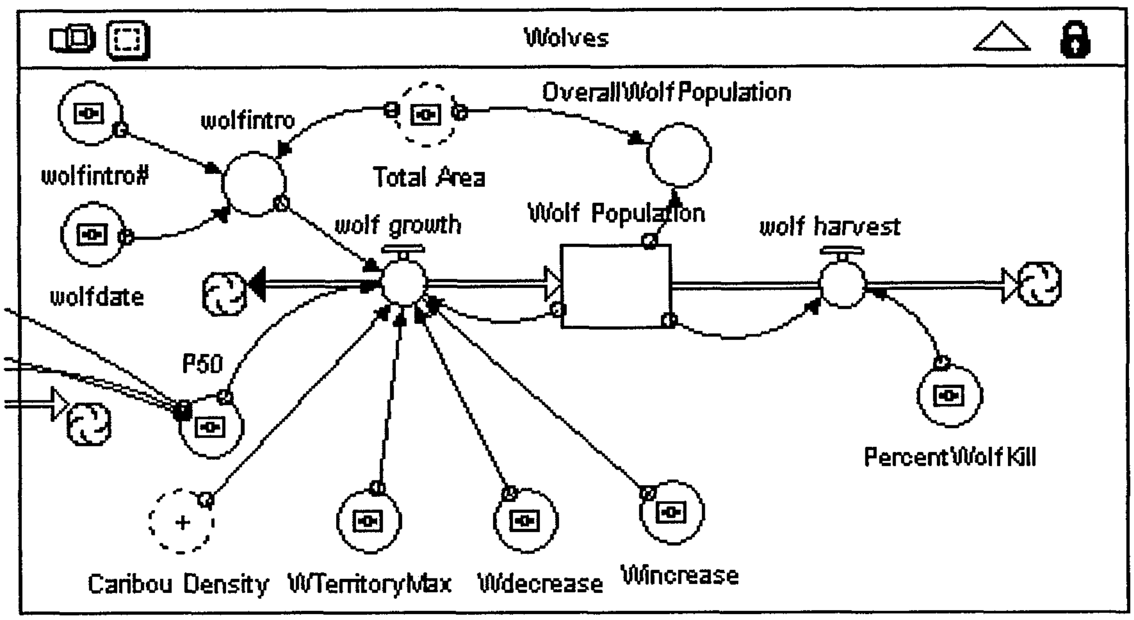


Figure 6-6 Model construction level for wolf sector.

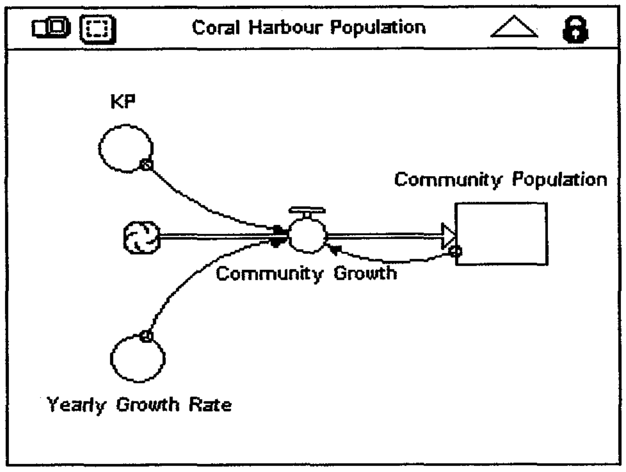


Figure 6-7 Model construction level for Coral Harbour population sector.

The hunting sector (Figure 6-8) was developed within the model to see the effects of subsistence hunting on the SHI caribou herd. In order to allow the herd to grow from re-introduction, the resident Inuit hunters accepted strict no hunting guidelines in 1967 (Parker, 1975). Starting in 1978, when the SHI caribou herd was estimated around 1 200 animals (Table 6-1), Inuit were allowed to hunt approximately 25 caribou per year on SHI (Ouellet, 1992). This quota was increased over the years and is depicted in the model as a separate converter (ActHarv), to distinguish the effects of past community harvests from future subsistence requirements.

The model allows for subsistence hunting when the caribou population of yearling and adults, One Year or Older variable, is greater than the target population. For the purposes of this model, the target population was assumed to be 10 000 females and 5 000 males, well below the carrying capacity of 40 000 suggested by Parker (1975). Government biologists, using spreadsheet analysis, determined that a harvest would have to consist of 70 percent female and 30 percent males from the SHI herd in order to limit population growth (R. Mulders, pers. comm. 2001; Williams and Mulders, 1994) and this was built into the model through the HarvMale% variable.

LINKAGE OF TROPHIC LEVELS

In order to link trophic levels within the model, I used Holling's disk equation that measures the functional response using a constant equation between trophic levels (Eberhardt, 1998). Eberhardt (1998:382) noted:

> "The main form in recent literature of a more elaborate function is the Michaelis-Menton equation used by Holling (1965) and thus widely known as Holling's disk equation."

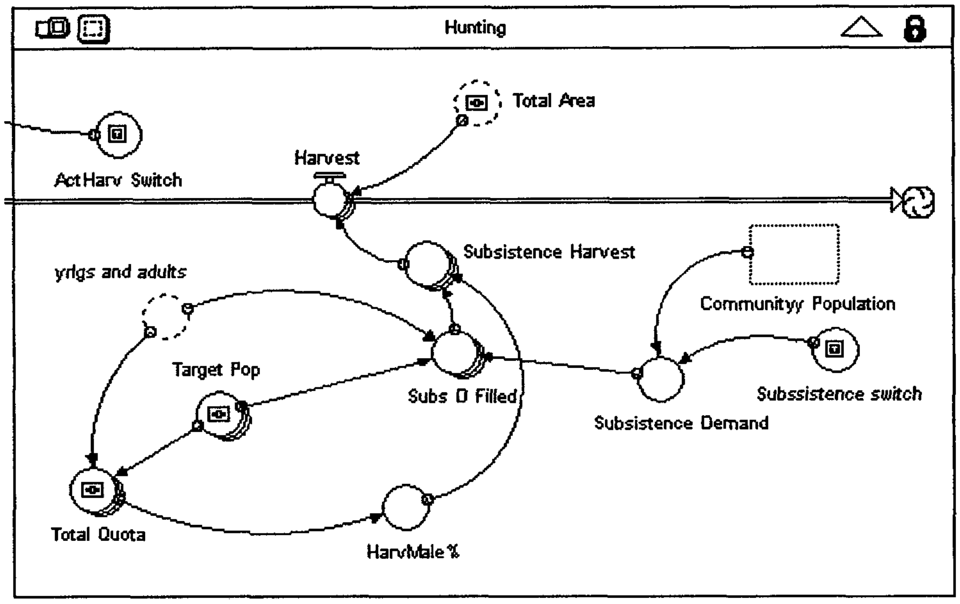


Figure 6-8 Model construction level for hunting sector.

The slope of the functional response was described by V50 or P50 variables in the model using an asymptotic scaler (Marshal and Boutin, 1999). I assumed that population parameters and consumption rates found in the literature have the same scale or about the same slope within model. Messier (1994:482) commented on using Holling's disk equation:

> "The functional response of wolves was determined by the hyperbolic, Michaelis-Menton function, an equation mathematically equivalent to the Holling's disk equation (Real, 1977). The equation takes the form of $y = ax/(b+x)$, where y is the per capita killing rate and x is the moose density. In addition, parameter a represents the asymptotic killing rate when predators are fully satiated, and b is the moose density at half the maximum killing rate. The above formulation describes a Type II functional response."

The V50 variable was developed within the model to identify the measure of caribou's feeding efficiency on the SHI vegetation. A high V50 value would depict an inefficient grazer and subsequent shallow curve whereas a low V50 value is characteristic of an efficient grazer and a subsequent steep curve. The V50 using Holling's disk equation represents the density of caribou that would reduce their feeding efficiency by one half. A feeding efficiency of 500 kg/ha was used within the model (Trudell and White, 1981).

The P50 variable was developed within the model to measure the predation efficiency of wolves on caribou. A high P50 value would indicate an inefficient predator and subsequent shallow curve whereas a low P50 value would be characteristic of an efficient predator and subsequent steep curve. The P50 using Holling's disk equation represents the density of caribou that would reduce the wolves feeding efficiency by one half. The predation efficiency was initially calculated based on the maximum rate of increase for wolves estimated at $\lambda = 1.48$ (Keith, 1983). Dale et al. (1994:644) noted:

> "The functional response for a given prey species is the relationship between kill rate per predator and prey abundance. If individual wolves respond to an increase in prey by killing a higher proportion of that population, this functional response has a regulating influence, even when there is no numerical response."

Using information from Eberhardt (1998), I tried to correct for different body size because his analysis looked at deer and moose interaction with wolves on Isle Royale. However, when looking at overall densities, the apparent slope was not representative of the caribou system on SHI suggesting that wolves on SHI must have been more efficient in their environment. Caribou could be more vulnerable, in the way they live or possibly due to the vast large habitat, and could be preyed upon easier by wolves (increased sightability on SHI). Unfortunately, there are no estimates of wolves' efficiencies in an Arctic ecosystem like SHI. Therefore, I used a graphical representation of the wolves' functional response to determine the projected P50 value on SHI (Figure 6-9).

Bergerud's (1980) suggestion of persistent wolf/caribou populations that require caribou densities of 0.4 to 0.8 caribou/km^2 was used to depict stable population growth but required values of about 0.7 for P50 to make the graph fit the shape correctly. In Canada and Alaska, Seip (1991) proposed medium-density equilibrium for barren-ground caribou herds and wolves to be in the range of 0.6 caribou/km^2. It should be noted that to get the maximum rate of increase up to the values represented by Eberhardt (1998), the theoretical maximum values of 2.0 would have to be used to get asymptotic values to match the appropriate slope. Therefore, I conclude that having caribou in open habitats such as the Arctic would require making the wolves highly efficient in this model.

Heterogeneity Index

One of the greatest challenges was scaling up from food patches to habitats and landscapes (Ford and Krumme, 1979). Mdens was developed within the model

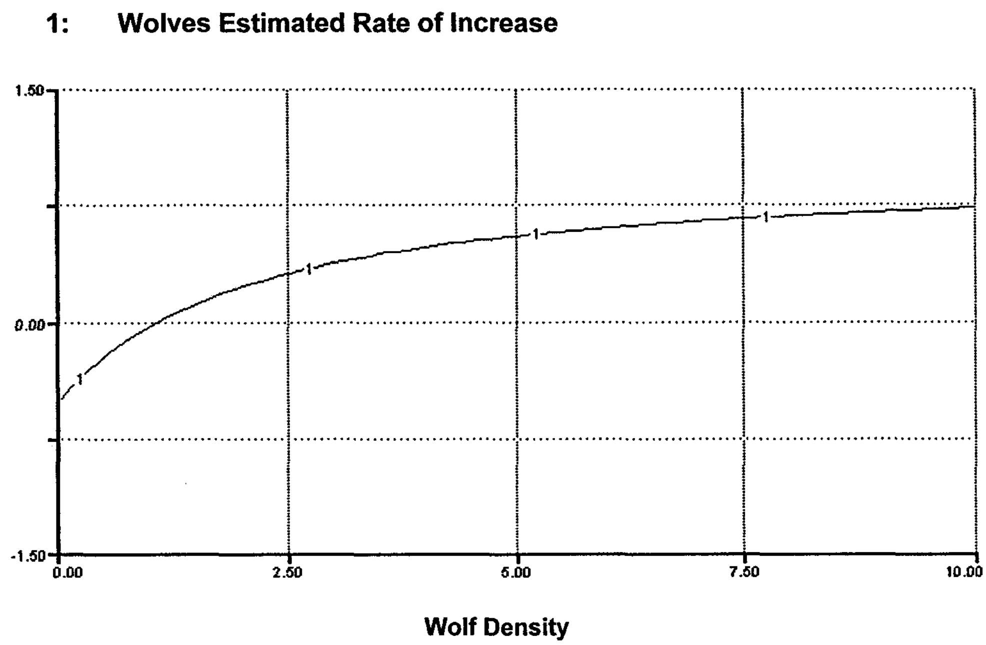


Figure 6-9 Estimated rate of increase for wolves on SHI.

as a correction factor for different grazing responses relative to mean density of vegetation on SHI. Ford and Krumme (1979:25) commented on space use patterns:

> "Individual animals are limited by basic morphological and physiological restrictions to a small sector of the total environment, and within that sector, social, economic, and risk factors further limit their activities."

The great challenge of working with a whole island scale like SHI is that we are assuming that lichen density is even over the entire island. Obviously, this is not the case on SHI based on the information provided on physiographic areas by Parker (1975). Ouellet (1992) described areas or patches of vegetation on SHI. It was assumed that the efficiency of caribou grazing in those areas would be much higher than you could predict based on cases of overgrazing on particular patches of vegetation, namely lichen. However, Mdens was used as a modifier of density that accounts for heterogeneity, which means the caribou feed more efficiently than would be expected on the basis of average density. The reason being that there are areas of clumped vegetation therefore a clumping index was built within the model.

Trudell and White (1981) measured the feeding rate of reindeer, not in the environment, but rather in patches by observing reindeer feeding on a particular vegetation patch per unit time and measuring the biomass of the patch and thus calculating feeding rate. It was therefore necessary to establish a correction variable (Mdens) because any available information on these foraging efficiencies comes from animals feeding on specific sites. Therefore, the model needed to generalize the feeding efficiency based on the SHI vegetation environment.

RESULTS AND DISCUSSION

1) Understanding the past

The model was first calibrated to mimic the initial increase of the SHI caribou herd using population survey data and recorded harvests on SHI from 1967 to 1997 (Table 6-1). As predicted, the SHI population required extremely high fecundity (0.99 for yearlings and adults) and very low mortality (0.01 for calves, yearlings, and adult pools) parameters in order to make the model recreate the initial increase phase. Using a 50 percent snow cover factor it was determined that an Mdens value of 0.0051 was needed to follow the initial increase on SHI (Figure 6-10). The value of 50 percent was chosen based on fact that the modeling exercise calculates values for the entire year and 50 percent was the intermediate value (50 percent value was also used by Parker (1975) for calculations of carrying capacity).

The interesting result of re-creating the initial increase of the caribou herd is that it predicts that the SHI system is very unstable. Without controls on irruptive herd growth, the caribou population is heading for a very unstable future as it experiences a series of overshoot and collapse cycles (Figure 6-11). In fact, based on declining fecundity values from recent commercial harvests (B. Threadkill, pers. comm. 2001), the herd already appears to be experiencing some density dependent effects.

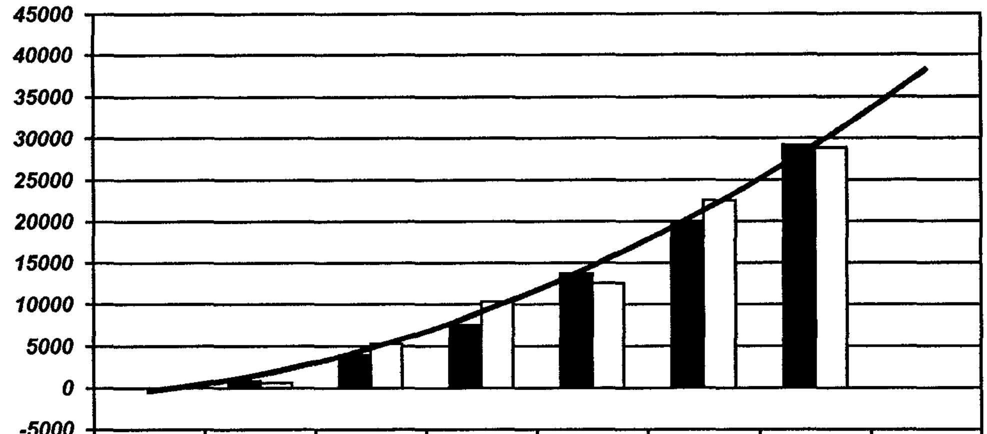
The model tracks the herd through compensatory cycles with lichen and vascular plant biomass. Such behavior has been observed in other studies (Gaare and Skogland, 1980; Klein, 1968; May, 1973). However, the model predicts the eventual collapse of the caribou herd as it experiences irruptive cycles and the herd numbers fall to levels where they may become susceptible to the same stochastic forces that affected other remnant populations in the area (Coats Island). As well, there are no guarantees that the caribou will persist long enough to re-populate the island. Subsequently, the question becomes one of determining a stable population at a level defined by sustainable grazing of lichens.

2) Projecting the future of caribou herd on SHI

The next step was to examine various management scenarios to control the caribou population on SHI. Although occurring over many decades, the modeling exercise (Figure 6-11) suggests that eventually, following re-introduction, the population will work towards some equilibrium after a series of irruptive cycles but it does indeed have a focus. Some type of intervention is required because in the process of working towards the focus, lichen vegetation is drastically reduced. Management must consider possible lichen depletion implications and decide whether this would be considered bad management of the vegetation resource otherwise, the population will continue to experience cyclical patterns of the overshoot and collapse.

The model also suggests harvests that have already occurred on SHI have had some effect on the SHI caribou population. Figure 6-12 reveals that the effect of harvesting activities has basically delayed the cyclical nature of the population but has not changed the character of the system.

Some biologists (A. Gunn, pers. comm. 2002; R. Mulders, pers. comm. 2002) do not believe that the number of caribou estimated by the model could be achieved on SHI (initial peak densities of 3.6 caribou/km^2 before collapse). However, much higher densities have been recorded and observed on smaller island re-introductions of *Rangifer* (Klein, 1968; Leader-Williams, 1988; Scheffer, 1951) as well as many other *Rangifer* herds (see Bergerud (1980) for a list of herds and historical densities). Seip (1991) suggested that in the absence of predators,



	1967	1978	1987	1990	1991	1995	1997
■ Population Surveys	38	864	4000	7600	13700	20000	29146
□ Model Simulation	38	589	5301	10340	12575	22509	28862

Figure 6-10 Comparison of caribou population and model simulation data for SHI.

Note: Figure 6-10 shows a polynomial trendline for Model Simulation data. Data for model simulation is calculated at 50% snow cover and Mdens value of 0.0051.

1. **Forage [Average Lichen Biomass]**
2. **Forage [Average Vascular Biomass]**
3. **Caribou Density**

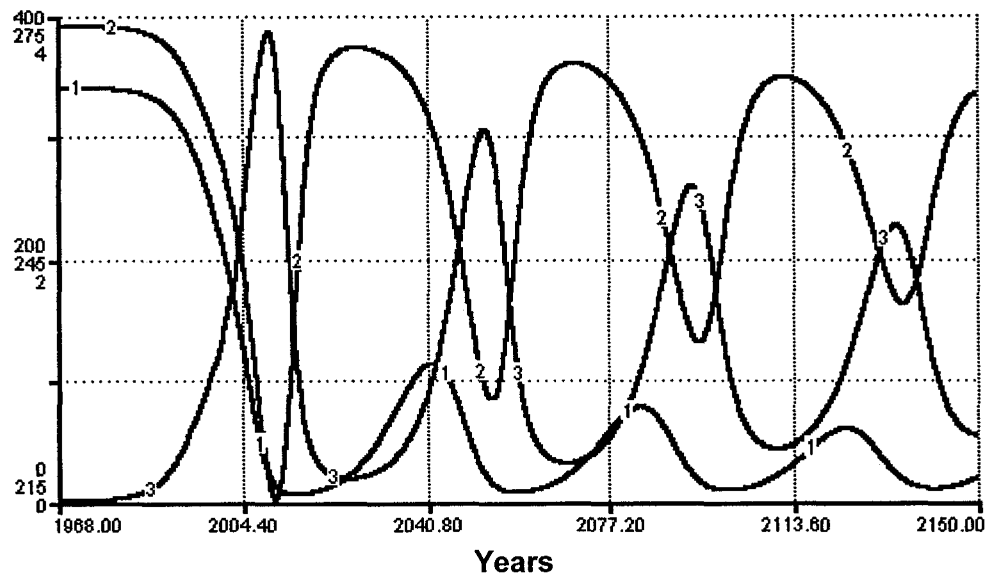


Figure 6-11 Modeled re-introduction of caribou to Southampton Island (1968-2150).

1. **Density of caribou: without any human harvesting.**
2. **Density of caribou: with actual known harvesting values (1977-2001).**

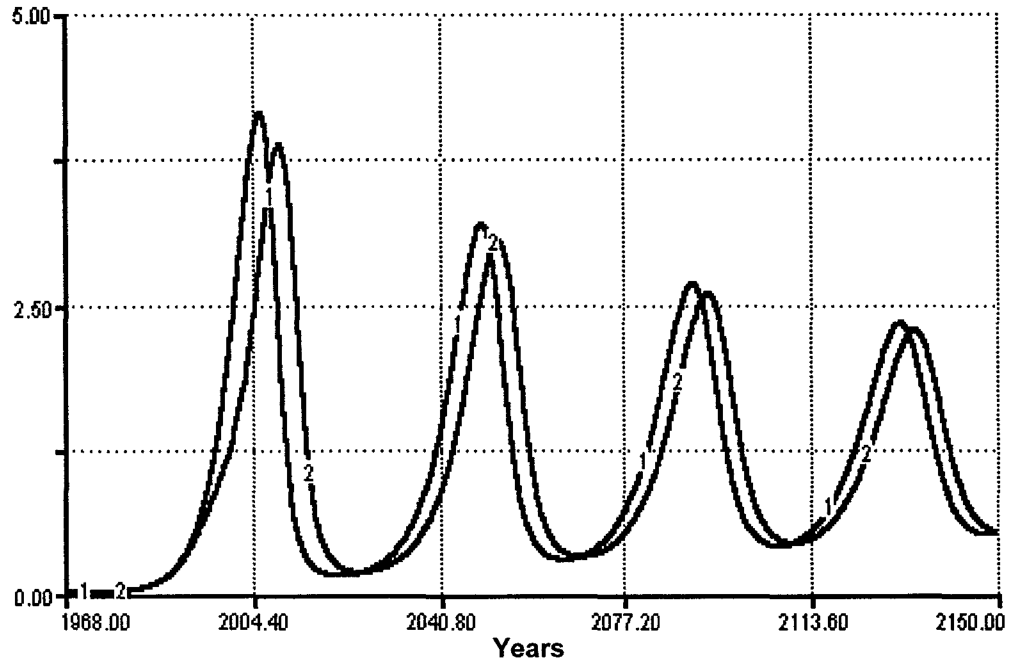


Figure 6-12 Modeled re-introduction of caribou to Southampton Island (1968-2150), with and without human intervention.

caribou can exceed densities of 2.0 caribou/km^2 and can reach numbers as high as 8.9 carbou/km^2. Heard and Ouellet (1994) determined the annual growth rate of caribou on SHI to be 27.6 percent. Therefore, based on this rate of increase and known harvest statistics, I set the parameters of the model to fit these values.

a) Management scenario 1: effect of subsistence harvesting.

For generations, the residents of Coral Harbour have relied upon subsistence hunting for their livelihood. Hunting plays an integral role in their culture but can subsistence harvesting alone control the herd dynamics of SHI? Figure 6-13 depicts an interesting scenario. With the population of Coral Harbour increasing at a rate of 3.2 percent each year, additional harvesting will actually increase the amplitude of the later oscillations. Subsistence harvesting would turn the SHI system from a damped oscillation to a stable limit cycle (Stocker and Walters, 1984). I presume this is the result of being able to keep the caribou population at low densities, which in turn allows for increased productivity of the vegetation, which ultimately predisposes the population to maintain a rapid increase in population numbers in the increase phase of the cycle (previously discussed).

Once again, the SHI system continues to remain unstable as subsistence harvesting actually contributes to a boom and bust cyclical pattern. To keep the model realistic, subsistence hunting continued to remain an integral part of the model as long as animals are available to be hunted on SHI by the local Inuit.

b) Management scenario 2: effect of subsistence harvesting and wolf re-introduction.

It has been suggested that a possible option to control herd numbers on SHI might include the colonization of wolves on SHI (Ouellet et al., 1994). Fritts et al. (1985:459) noted:

1. **Density of caribou: with actual known harvesting values.**
2. **Density of caribou: with actual known harvesting values plus subsistence harvesting.**

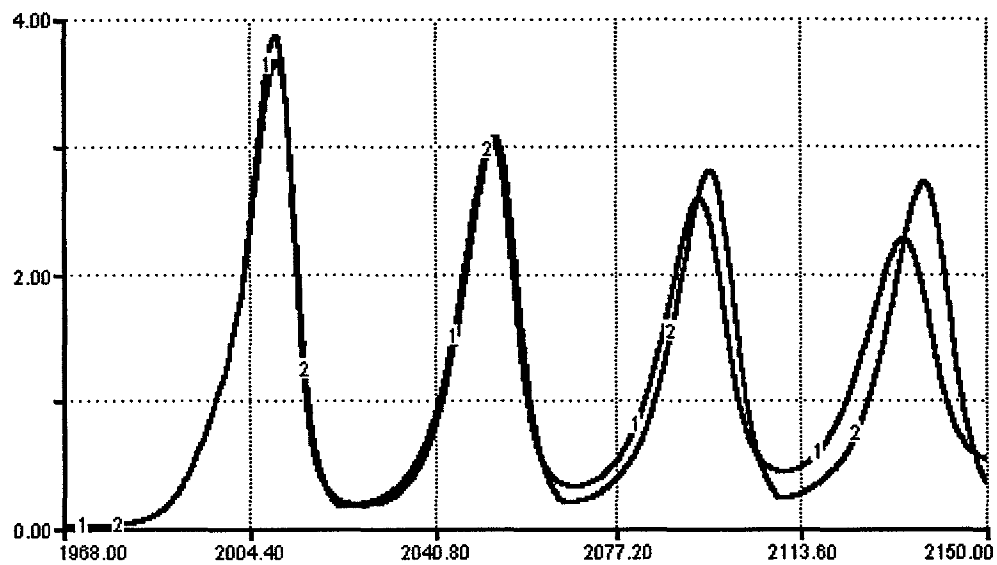


Figure 6-13 Modeled re-introduction of caribou to Southampton Island (1968-2150), with actual harvests and continued subsistence hunting.

> "Wolf reintroductions are expensive, controversial, and attract considerable public attention."

Although it would appear that the community of Coral Harbour would not be very open to the idea of wolf re-introduction, the next section will explore the effects wolves might have on the SHI system.

The re-introduction of wolves to SHI was proposed to help stop the initial increase of caribou on the island. However, the dynamics of such an introduction is highly dependent on a number of assumptions for Arctic island populations of wolves including: maximum rate of increase (Eberhardt, 1998; Keith, 1983), territoriality of wolves (Hayes and Harestad, 2000a; Lewis and Murray, 1993; Mech, 1977; Messier, 1985; Miller, 1979), and social capacity (Hayes and Harestad, 2000a). Using an relatively high efficiency (P50) value of 0.70, the model predicts that wolves would be able to regulate the SHI caribou herd by reducing the amplitude of the initial increase by over half and then regulating the herd based on total pack area to a density of 0.4 caribou/km^2 (Figure 6-14 and 6-15). This supports Bergerud's (1980) predation regulation hypothesis.

However, testing the model was highly sensitive to increasing or decreasing predation efficiency. For example, if predation efficiency was increased by doubling the wolves' efficiency (P50=0.35), the caribou herd displays the classic predator/prey time lag scenario described as a predation pit (Messier, 1994). Increased efficiency also decreased the frequency and amplitude of oscillations (Figure 6-16). Increased efficiency could also lead to further stresses on the caribou population during low density levels which could then be magnified during times of stochastic weather events. At that point, wolves may become efficient enough to take out their prey base, which might lead to a subsequent population crash on SHI.

Using low efficiency rates (P50=2.20), the model suggests that wolves would initially increase with the first caribou oscillation but would subsequently crash

1. Density of caribou: with actual known harvesting values.

2. Density of caribou: with actual known harvesting values and subsistence harvesting.

3. Density of caribou: with actual know harvesting values, subsistence harvesting, and wolf re-introduction.

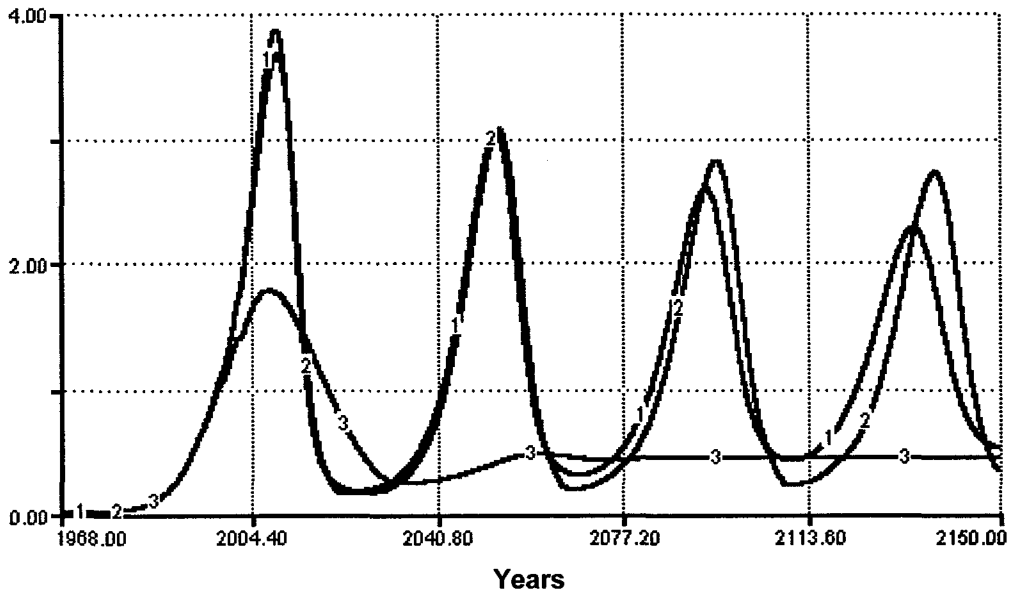


Figure 6-14 Modeled simulations of the re-introduction of caribou to Southampton Island from 1968 to 2150.

*Note: Wolf population numbers are calculated with: introduction date = 1993; number of wolves = 10; P50 Value = 0.70; Rate of Increase = 1.48; Territory Max = 0.0065.

1. Forage [Average Lichen Biomass]

2. Forage [Average Vascular Biomass]

3. Density of caribou: with actual known harvesting values, subsistence hunting, and wolf predation*.

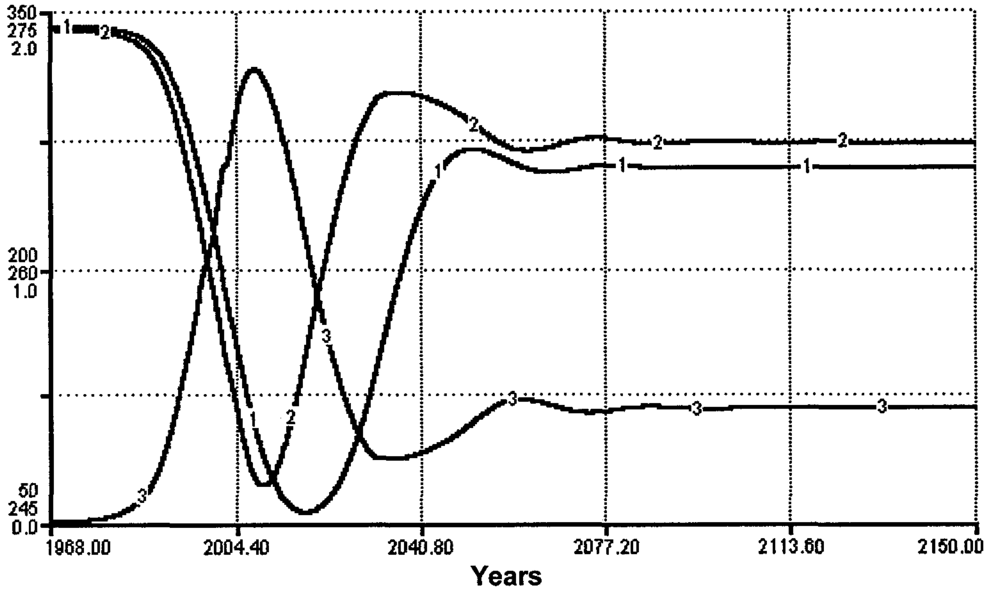


Figure 6-15 Modeled simulations of forage and population interaction of the re-introduction of caribou to Southampton Island from 1968 to 2150.

*Note: Wolf population numbers are calculated with: introduction date = 1993; number of wolves = 10; P50 Value = 0.70; Rate of Increase = 1.48; Territory Max = 0.0065.

and be eliminated from the system (Figure 6-17). At low efficiencies, wolves would have no effect on the caribou population's cyclical overshoot and collapse pattern thus turning the SHI system into a highly unstable system. At moderate efficiencies (P50=1.80), the wolves exhibit a negative damped oscillation for several cycles but continue to remain in the population without any effect on the regulation of the caribou population (Figure 6-18). Predator-prey dynamics showed cyclicity with a period of 41 – 44 years, which is comparable with other model simulations on caribou populations (Weclaw, 2001).

Model simulations of wolf introductions to SHI suggest that wolves could greatly complicate the SHI ecosystem. There is the possibility that wolves could help with regulation of the caribou population but it is critically dependent on predation efficiency. By attempting to assimilate what we know about wolf dynamics, it is possible to introduce wolves to coincide with the caribou population peaks. However, there are many factors that are simply unknown with respect to wolf dynamics (Theberge and Gauthier, 1985), especially in Arctic ecosystems. Using what I thought were the most representative values, the simulation suggests that the introduction of wolves to SHI could possibly help regulate the caribou population but it could also complicate the management of the system. Furthermore, at this point in time it is an unrealistic management option, as the local community does not want wolves introduced on the island.

The tendency of stabilization of the caribou population within the simulation model is very dependent on a number of key parameters. These include the efficiency of the caribou, the lichen and vascular plant biomass (*K*), as well as the initial growth rates for lichen and vascular plants. The model was very sensitive to changes in these parameters. However, using the values from empirical studies on *Rangifer* and plant biomass, as well as local information on SHI (Ouellet, 1992; Parker, 1975), I believe the model to be representative of the SHI ecosytem.

1. **Density of caribou: with actual known harvesting values and wolf predation.**
2. **Wolf Population Numbers*.**

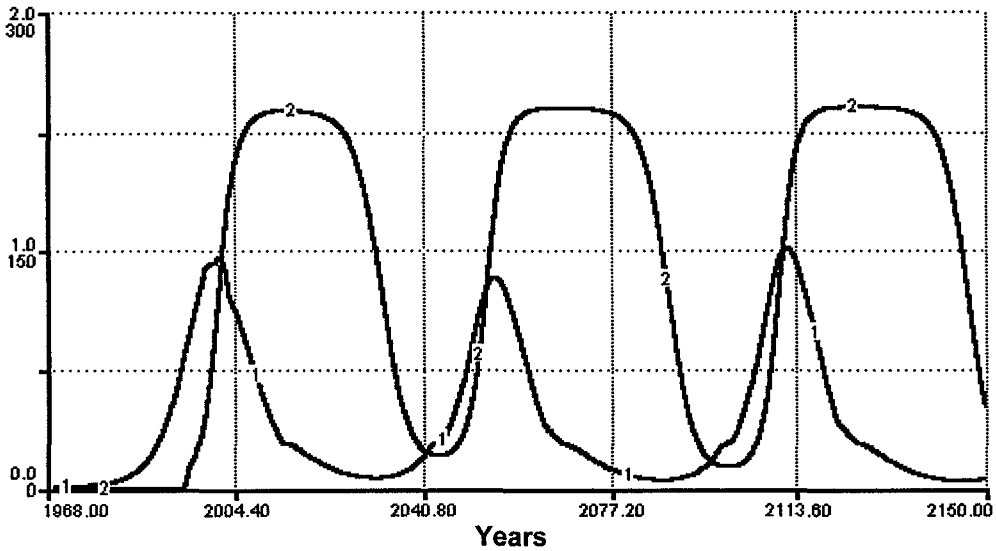


Figure 6-16 Wolf re-introduction on SHI at high wolf efficiency rate.

*Note: Wolf population numbers are calculated with: introduction date = 1993; number of wolves = 10; P50 Value = 0.35; Rate of Increase = 1.48; Territory Max = 0.0065.

1. **Density of caribou: with actual known harvesting values and wolf predation.**
2. **Wolf Population Numbers*.**

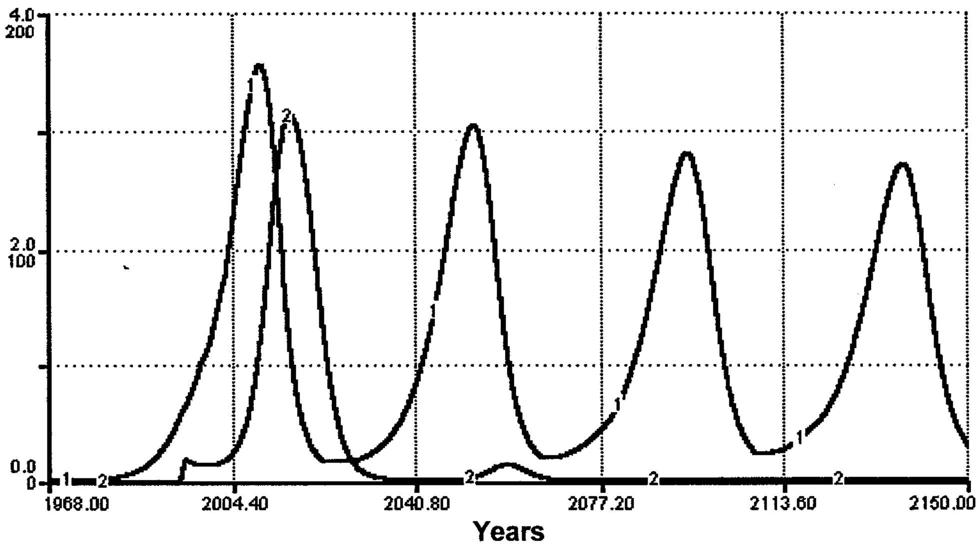


Figure 6-17 Wolf re-Introduction on SHI at low wolf efficiency rate.

*Note: Wolf population numbers are calculated with: introduction date = 1993; number of wolves = 10; P50 Value = 2.20; Rate of Increase = 1.48; Territory Max = 0.0065.

1. **Density of caribou: with actual known harvesting values and wolf predation.**
2. **Wolf Population Numbers*.**

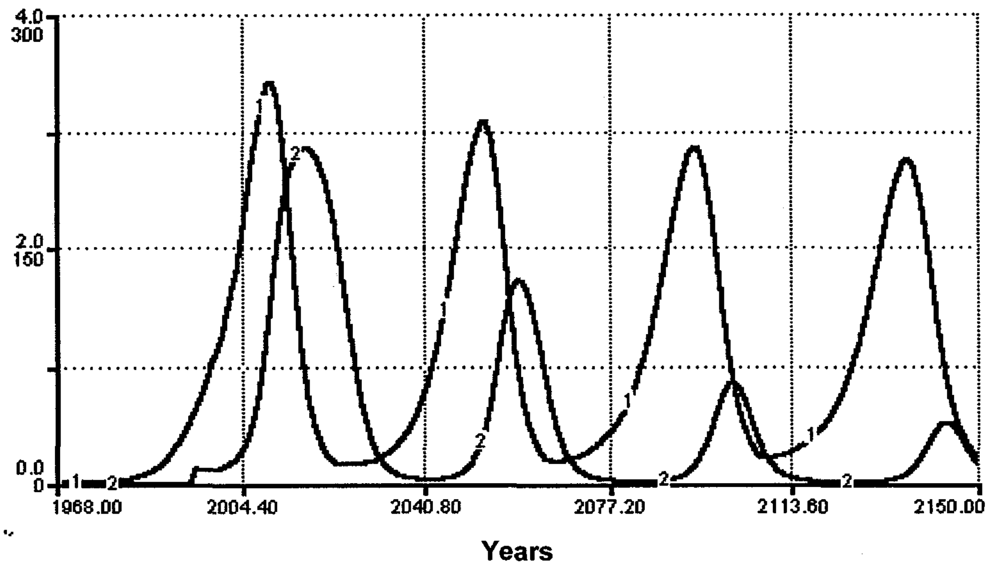


Figure 6-18 Wolf re-introduction on SHI at moderate wolf efficiency rate.

*Note: Wolf population numbers are calculated with: introduction date = 1993; number of wolves = 10; P50 Value = 1.80; Rate of Increase = 1.48; Territory Max = 0.0065.

CONCLUSION

The situation on SHI is reflective of a typical Arctic island ecosystem that is clearly an unstable situation. The rapidly growing caribou population, along with a limited vegetation base, clearly points us in the direction of a biological management crisis with an impending overshoot and collapse scenario. However, the caribou continue to accumulate and the community demands subsistence-harvesting opportunities. Since, SHI is an unstable system and is not likely to be controlled through subsistence hunting or with the re-introduction of wolves or both, alternative methods of regulation have been attempted and proposed to address this ecological problem.

Since 1995, the local HTO has been conducting large-scale commercial hunts in an effort to slow the population growth on SHI and to generate economic development opportunities. Chapter 7 will look at the potential effects of large-scale commercial hunting on the caribou population and the economic sustainability of this type of economic venture in the Canadian Arctic.

APPENDIX 6-1: Re-introduction of *Rangifer* on Arctic islands

The re-introduction of *Rangifer* populations to Arctic islands has been attempted in Alaska (Klein, 1968 and Scheffer, 1951), Antarctica (Leader-Williams, 1988) and Nunavut in Canada (Nishi, 1993 and Ouellet, 1992). Ungulates are known to experience fluctuations in populations (Caughley, 1970). However, the introduction of ungulates generally demonstrates a pattern of an initial irruption followed by a decline in numbers until stabilization occurs (Caughley, 1970; Riney, 1964). Caughley (1970: 57) developed his own four distinct stages following liberation: initial increase, initial stabilization, decline, and postdecline. Re-introductions on St. Matthew Island, Alaska (Klein, 1968, 1987) and St. Paul Island, Alaska (Scheffer, 1951) have resulted in initial irruption followed by dramatic decline and subsequent crash in the animal population. These introductions and subsequent crashes have been attributed to either an overgrazing of habitat, severe climactic conditions, or a combination of these conditions (Swanson and Barker, 1992). Skogland (1985:372) commented:

> "Ground ice in winter, following overgrazing of the lichen, was the most likely cause of the population crashes of several introduced reindeer herds on arctic islands off the coast of Alaska (Scheffer, 1951 and Klein, 1968)"

Introduced Rangifer herds that depended on vascular plants for winter forage, such as graminoids, are generally more successful in terms of population regulation (Leader-Williams, 1988). Heard and Ouellet (1994:94) noted:

> "Range damage is least likely to occur where graminoids are the staple food and most likely where the major food is lichen, as on Southampton Island"

Herds dependent on lichens for winter forage, located on wind-swept areas free of snow cover, had an increased risk of subsequent fluctuations of herd size (Klein, 1968; Nishi, 1988).

Longer regeneration rates of lichen (Gaare, 1997; Klein, 1969, 1987; Palmer, 1934; Pegau, 1968; Scotter, 1967; Skuncke, 1969) versus vascular plants and vulnerability to trampling losses (Evans, 1996; Gaare, 1997; Gaare and Skogland, 1975; Klein, 1969; Pegau, 1970) make lichens more susceptible to overgrazing in arctic ecosystems (Ouellet, 1992; Ouellet et al., 1993). A brief description of arctic re-introductions of Rangifer in predator-free environments follows:

A.) St. Matthews Island, Alaska

St. Matthews Island is located in the north central Bering Sea and is approximately 332 square kilometers in area. In 1944, approximately 29 yearling reindeer (25 females and 5 males) were transported from Nunivak Island to St. Matthews Island by the United States government (Klein, 1968). The majority of the reindeer diet consisted of lichens and the herd was estimated to be increasing at a rate approaching the theoretical maximum (Klein, 1968). By 1963, the herd reached its peak of 6 000 animals. However, the lichen habitat on the island was severely depleted due to overgrazing and trampling. In 1966, the herd was estimated at 42 animals. The population crash was attributed to poor forage quality and severe weather that limited access to vegetation.

B.) St. Paul Island, Alaska

In 1941, the United States government transported 25 reindeer (four males and 21 females) to St. Paul Island (Scheffer, 1951). The following year, approximately 17 calves were born on the island (81 percent fecundity) and the population increased for a period of 27 years. By 1938, the herd peeked at 2 046 animals. Located on 107 square kilometers, St. Paul Island had only 0.04 square kilometers of suitable habitat per reindeer at its peak population (estimated three times its carrying capacity). Weather conditions in the Pribilof Islands made for inadequate winter food supplies due to deep snow conditions. Subsequently, the population drastically decreased to eight animals by 1950. Although vegetation changes were not monitored closely, the decline was associated with the depletion of lichens that were an important food source during winter (see also Klein, 1968).

C.) St. George Island, Alaska

In 1911, along with the St. Paul re-introduction, approximately 15 reindeer (three males and 12 females) were introduced to St. George Island (Scheffer, 1951). St. George Island is approximately 91 square kilometers in area. After an initial increase to 220 animals, the herd fluctuated between 10 and 74 caribou. Scheffer (1951) noted that the only differences in the two island's populations were topography (large cliffs on St. George that could have been the site of accidental deaths) and climactic conditions associated with oceanic weather patterns. St. George was slightly warmer than St. Paul and approximately 22 400 acres and Scheffer noted that the tundra was wetter on St. George as well.

D.) Belcher Islands, Northwest Territories

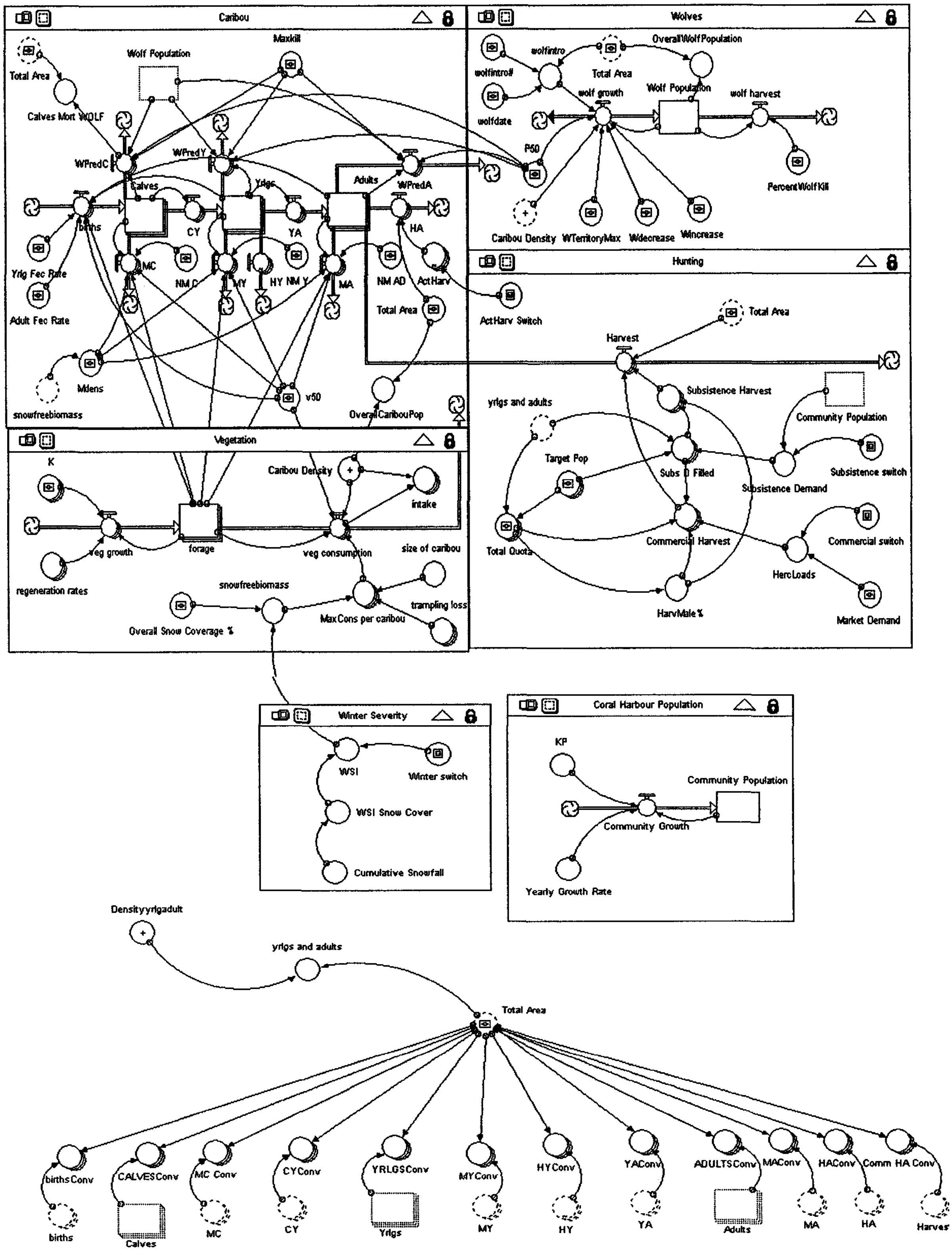
The Belcher Islands are located in the southeast part of the Hudson Bay and consist of four main islands that have a combined area of 4 221 square kilometers. Caribou disappeared from the Belchers around the late 1800s due to severe icing conditions or emigration (Elton, 1965; Flaherty, 1918; Nishi, 1993). In the late 1970s, local Inuit requested the Government of the Northwest Territories (GNWT) to purchase reindeer stock from the Mackenzie River Delta Reindeer Preserve. In 1978, the GNWT purchased 60 reindeer from the herd and released them on the Belcher Islands (Nishi, 1993). Nishi (1993) noted that the summer range was adequate but the winter range was only fair to good.

High densities of reindeer resulted in heavily grazed areas of lichen habitat that saw near complete removal and disturbance of the lichen-moss layer (Nishi, 1983:21). The introduced reindeer followed the series of population successions as described by Caughley (1970) and Riney (1964) and severe degradation of habitat was observed (Nishi, 1993). A limited number of harvests by local Inuit were conducted after January 1983 (Nishi, 1993). However, even with minimal harvests, the reindeer are disappearing entirely from the island, evidently from emigration to the mainland (M.M.R. Freeman, pers. comm. 2001).

E.) South Georgia, Antarctica

Norwegian reindeer (*Rangifer tarandus L.*) were re-introduced to the sub Antarctic islands of South Georgia in 1911 and 1925 (Leader-Williams, 1988) to provide a source of fresh meat for workers at nearby whaling stations (Vogel et al., 1984). The three main herds are located on the Barff Peninsula, Royal Bay area, and the Busen area and each have an area of 131, 58, and 124 square kilometers respectively. The reindeer were dependent on coastal tussock grass Poa flabellata for winter forage rather than lichen (Leader-Williams and Ricketts, 1982). The major winter food (*Poa flabellata*) and the major summer food (*Acaena magellanica*), both tolerant of grazing and trampling, had spread over the previously overgrazed vegetation (Vogel et al., 1984). The introduced herds followed the eruption with subsequent stabilization pattern (Leader-Williams, 1980).

APPENDIX 6-2 Model Construction Level for SHI Caribou Re-introduction Model.



APPENDIX 6-3: Index of terms for SHI caribou re-introduction model.

Caribou

Adults[f](t) = Adult female population.
INIT Adults[f] = Initial introduced population of adult female caribou on SHI.
Adults[m](t) = Adult male population.
INIT Adults[m] = Initial introduced population of adult male caribou on SHI.

INFLOWS:
YA[gender] = Yearly transition from yearling to adult pool.
OUTFLOWS:
HA[gender] = Harvest of adult population.
WPredA[gender] = Wolf predation on adults.
Harvest[f] (IN SECTOR: Hunting)
Harvest[m] (IN SECTOR: Hunting)
MA[gender] = Natural mortality for adult pool.
Calves[f](t) = Female calves population.
INIT Calves[f] = Initial introduced population of female calves.
Calves[m](t) = Male calves population.
INIT Calves[m] = Initial introduced population of male calves.

INFLOWS:
births[gender] = Yearly ratio of caribou calves born on SHI (50/50 ratio)
OUTFLOWS:
CY[gender] = Yearly transition from calves to yearling pool.
MC[gender] = Mortality of calves.
WPredC[gender] = Wolf predation on calves
INIT Yrlgs[f] = Initial introduced population of female yearlings.
Yrlgs[m](t) = Male yearling population.
INIT Yrlgs[m] = Initial introduced population of male yearlings.

INFLOWS:
CY[gender] = Yearly transition from calves to yearling pool.
OUTFLOWS:
MY[gender] = Mortality of yearling population.
HY[gender] = Harvest of yearlings.
YA[gender] = Yearly transition from yearling to adult pool.
WPredY[gender] = Wolf predation on yearling pool.
ActHarv[gender] = Actual historical harvests on SHI.
Adult_Fec_Rate = Adult fecundity rate
Calves_Mort_WOLF = Wolf predation on calves.
Mdens = Correction factor for grazing responses relative to mean density of vegetation.
NM_AD = Natural mortality percentage for adult population.
NM_C = Natural mortality percentage for calf population.
NM_Y = Natural mortality percentage for yearling population.
OverallCaribouPop = Caribou population.
Total_Area = Total available caribou habitat on SHI.
v50 = Measure of caribou feeding efficiency.
Feeding efficiency = 500 kg/ha (Trudell& White, 1981);

Yrlg_Fec_Rate = Yearling fecundity rate.
ActHarv[gender] = Actual harvest of adult caribou population

Coral Harbour Population

Community_Population(t) = Coral Harbour population pool.
INIT Community_Population = Initial value for Coral Harbour population.

INFLOWS:
KP = Carrying capacity for the community of Coral Harbour.
Yearly_Growth_Rate = Estimate growth of community.
Community_Growth = Interaction of yearly growth rate and carrying capacity for the communitiy of Coral Harbour

Hunting

Harvest[f] = Harvest of adult females.

OUTFLOW FROM: Adults[f] (IN SECTOR: Caribou)
Harvest[m] = Harvest of adult males.

OUTFLOW FROM: Adults[m] (IN SECTOR: Caribou)
ActHarv_Switch = Switch used to turn on/off actual harvests.
Commercial_Harvest[f] = Commercial harvest of adult females.
Commercial_Harvest[m] = Commercial harvest of adult males.
Commercial_switch = Switch used to turn on/off commercial harvests.
HarvMale% = Percentage of males harvested.
HercLoads = Determination of Hercules aircraft loads.
Market_Demand = Random determination of market demand.
Randomizer = Variable which randomly calculates market demand.
Subsistence_Demand = Subsistence demand for community harvests.
Subsistence_Harvest[f] = Estimated number of female caribou utilized for subsistence harvesting.
Subsistence_Harvest[m] = Estimated number of male caribou utilized for subsistence harvesting.
Subsistence_switch = Switch used to turn on/off subsistence hunting.
Subs_D_Filled[gender] = Variable to ensure subsistence values are filled before any additional hunting can take place.
Target_Pop[f] = Target population.
Target_Pop[m] = Target population for males.
Total_Quota[gender] = Total quota for caribou harvesting.

Vegetation

forage[lichen](t) = Available lichen habitat.
INIT forage[lichen] = Initial lichen habitat.
forage[vascular](t) = Available vascular plant habitat.
INIT forage[vascular] = Initial vascular plant habitat.

INFLOWS:
veg_growth[plants] = Vegetation growth rates.
Forage Growth rate = regeneration rates of lichen and vascular plants.

OUTFLOWS:
veg_consumption[lichen] = Lichen plant consumption.
veg_consumption[vascular] = Vascular plant consumption.
Caribou_Density = Caribou density.
K[lichen] = Lichen plant biomass.
K[vascular] = Vascular plant biomass.
MaxCons_per_caribou[lichen] = Maximum consumption of lichen per caribou.
MaxCons_per_caribou[vascular] = Maximum consumption of vascular plants per caribou.
Overall_Snow_Coverage_% = Percentage of snow cover.
regeneration_rates[lichen] = Regeneration rate of lichen plants.
regeneration_rates[vascular] = Regeneration rate of vascular plants.
size_of_caribou = Weight of caribou.
snowfreebiomass = Snow –free biomass.
trampling_loss[lichen] = Caribou trampling loss of lichen mat.
trampling_loss[vascular] = Caribou trampling loss of vascular plants.

Winter Severity

Cumulative_Snowfall = Cumulative snowfall.
Winter_switch = Switch used to turn on/off winter varible.
WSI = Relative Winter Severity Index (WSI) is based on snow accumulations recorded at Coral Harbour from 1971-1990. The WSI is calculated according to Gunn et al., (1989) and is based upon percent deviations from the long term mean of accumulated snow depth on the last day of the month, for the periods of early winter (Sept. - Nov.), mid winter (Dec-Feb), and late winter (March-May).
Snow accumulations are taken from Ouellet et al. (1996).

WSI_Snow_Cover = Percentage of snow cover.

Wolves

Wolf_Population(t) = Wolf population pool
INIT Wolf_Population = Initial wolf population.

INFLOWS:
wolf_growth = Wolf growth variable.
OUTFLOWS:
wolf_harvest = Number of wolves harvested by hunters.
bountywolves = Wolf bounty.
OverallWolfPopulation = Overall wolf population.
PercentWolfKill = Percentage of killed by hunters.
Wdecrease = Wolves rate of decrease.
Wincrease = Wolves rate of increase.
wolfdate = 1968
wolfintro = Introduction of wolves to SHI system.
wolfintro# = Number of wolves introduced.
WTerritoryMax = Maximum territory for wolves.
Wolf Pack Size= size of average wolf pack.
social capacity = Social capacity of wolf packs.

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CHAPTER SEVEN

MODELING THE POPULATION GROWTH AND ECONOMIC EFFECTS OF COMMERCIAL HUNTING OF CARIBOU ON SOUTHAMPTON ISLAND, NUNAVUT

INTRODUCTION

In 1967, the Northwest Territories Game Management Service and the Canadian Wildlife Service cooperatively transported 48 caribou (*Rangifer tarandus groenlandicus*) from Coats Island, Nunavut to Southampton Island, Nunavut (SHI) (Manning, 1967; Parker, 1975; Ouellet, 1992)(Figure 7-1). The re-introduction of caribou to SHI was initiated to supplement the diet of the local Inuit community (Ouellet (1992) from Manning (1967)). Strict no hunting guidelines were adopted by the local Inuit in order to let the herd grow to a harvestable level (Parker, 1975). Free of predators, fully protected from hunting, and with abundant sources of vegetation in both the summer and winter, the SHI caribou herd increased dramatically (Ouellet, 1992)(Figure 7-2).

This rapid growth is characteristic of Arctic re-introductions of *Rangifer* to Arctic Islands. However, in almost all the previous introductions, the dramatic rise in population numbers has culminated in a crash (Klein, 1968; Nishi, 1993; Scheffer, 1951) (Chapter 6). Based on these observations, Heard and Ouellet (1994) and Gates et al. (1986a) have predicted that without any intervention, the SHI herd would potentially increase beyond the island's suggested carrying capacity of 40 000 animals (Parker, 1975) and subsequently crash similar to other insular populations.

In the previous chapter, I demonstrated through the use of computer modeling simulation that the SHI system reflects a typical Arctic island ecosystem and is clearly not a self-stabilizing system. Since the objective of the introduction was

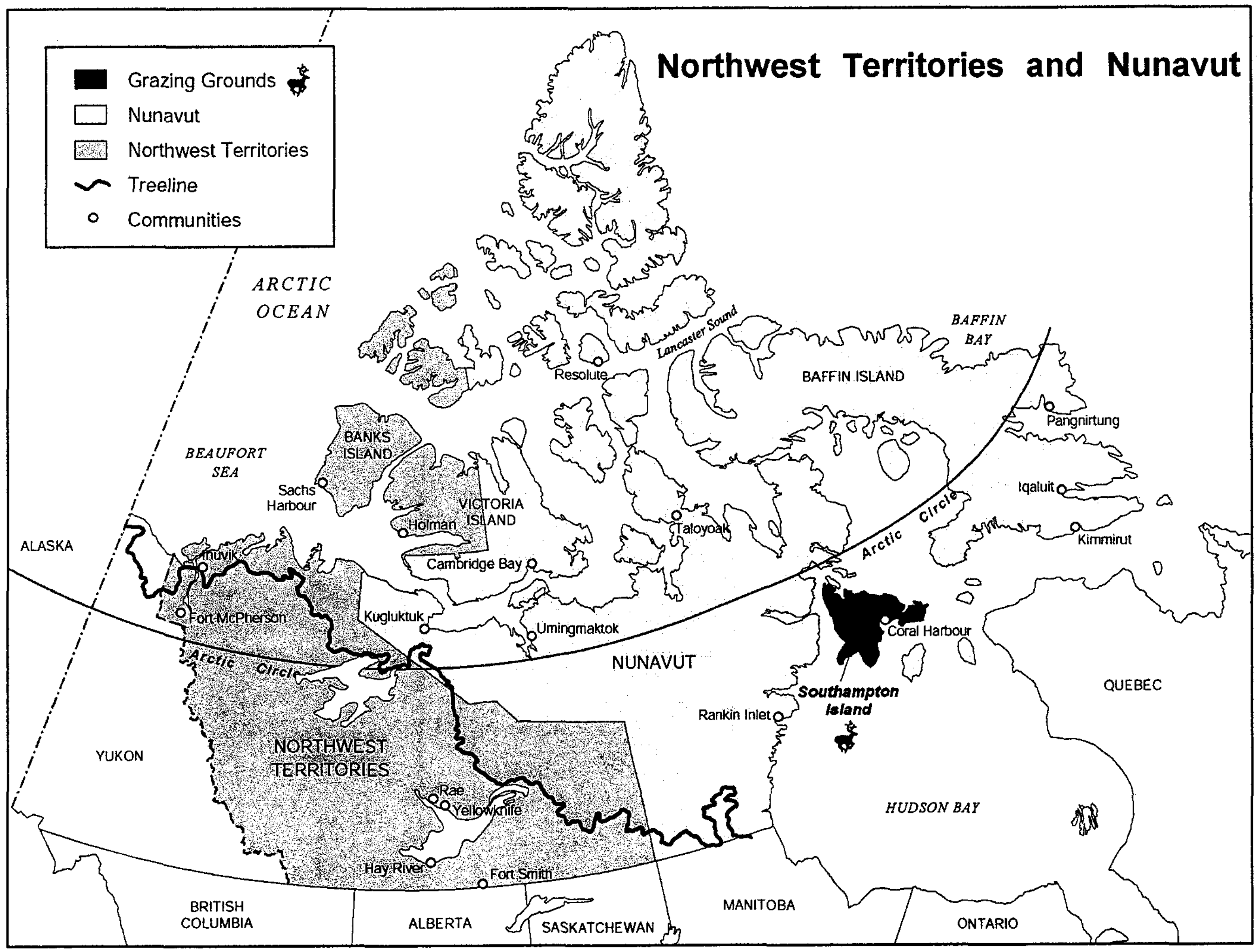


Figure 7-1 Location of large-scale commercial caribou hunt-Southampton Island, Nunavut.

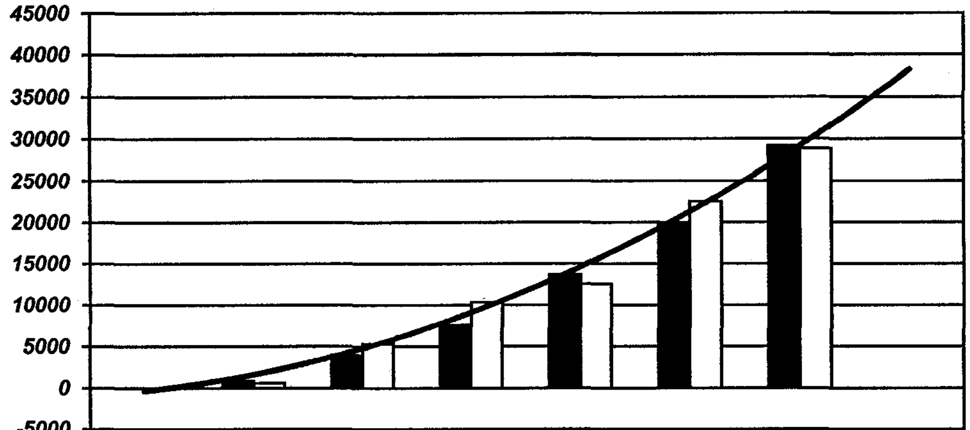
to provide a stable food source for Inuit, the rapidly growing caribou population, along with a limited vegetation base, clearly points to an impending management crisis. As the model demonstrated that neither is likely to be controlled through subsistence harvesting nor the introduction of wolves or both, alternative methods of regulation have been attempted and are proposed to address this potential management crisis.

Looking to control the herd dynamics, the Aiviit Hunters and Trappers Organization (HTO), in conjunction with the territorial government, implemented a cropping operation (Appendix 7-1). Working with territorial biologists and other department officials, the Aiviit HTO initiated commercial harvesting activities for caribou in 1993/94 and has averaged a harvest of approximately 2 450 caribou per year for export since 1994/95 (Table 7-1).

Interestingly, a 1922 exploratory report by the Canadian government on the potential of commercial use of caribou designated Southampton Island, nearby Coats Island, and Mansell Island (Figure 7-3) as the premier locations to begin commercial hunting operations for caribou (Rutherford et al. 1922).

BACKGROUND OF COMMERCIAL HARVEST OPERATIONS

Through an economic agreement between the federal and territorial governments, 1991-1996, funding was allocated to develop commercial wildlife harvesting operations in the Canadian Arctic. Grants were provided to subsidize costs associated with shipping, support infrastructure development, and conduct population inventories. By conducting trial hunts, expertise in commercial meat processing was developed by locals using Agriculture Canada veterinarians and project managers, who had prior experience in southern commercial meat operations.



	1967	1978	1987	1990	1991	1995	1997	
■ Population Surveys	38	864	4000	7600	13700	20000	29146	
□ Model Simulation	38	589	5301	10340	12575	22509	28862	

Figure 7-2 Comparison of caribou population and model simulation data for SHI.

Note: Figure 7-2 shows a polynomial trendline for model simulation data. Data for model simulation is calculated at 50% snow cover and Mdens value of 0.0051.

Table 7-1 Large scale commercial harvesting of caribou for export meat production on Southampton Island, Nunavut (1995-2001).

Year	Harvest Production*	Number of Hunts	Carcass Weight (lb.)**	Carcass Weight (kg.)**
1995	2 307	1	133 806	60 821
1996	1 924	1	111 592	50 724
1997	3 165	1	175 341	79 700
1998	2 888	1	159 995	72 725
1999	1 187	1	78 699	35 772
2000	2 099	1	121 595	55 270
2001	3 574	1	196 570	89 350
TOTALS	**17 144**	**7**	**977 598**	**444 362**

* These values are only for carcasses approved for commercial export. Meat downgraded for domestic use or condemned carcasses are not included.

** Assumes finished carcass weight of 55 lbs per carcass (D. Pelling, pers. comm. 1997).

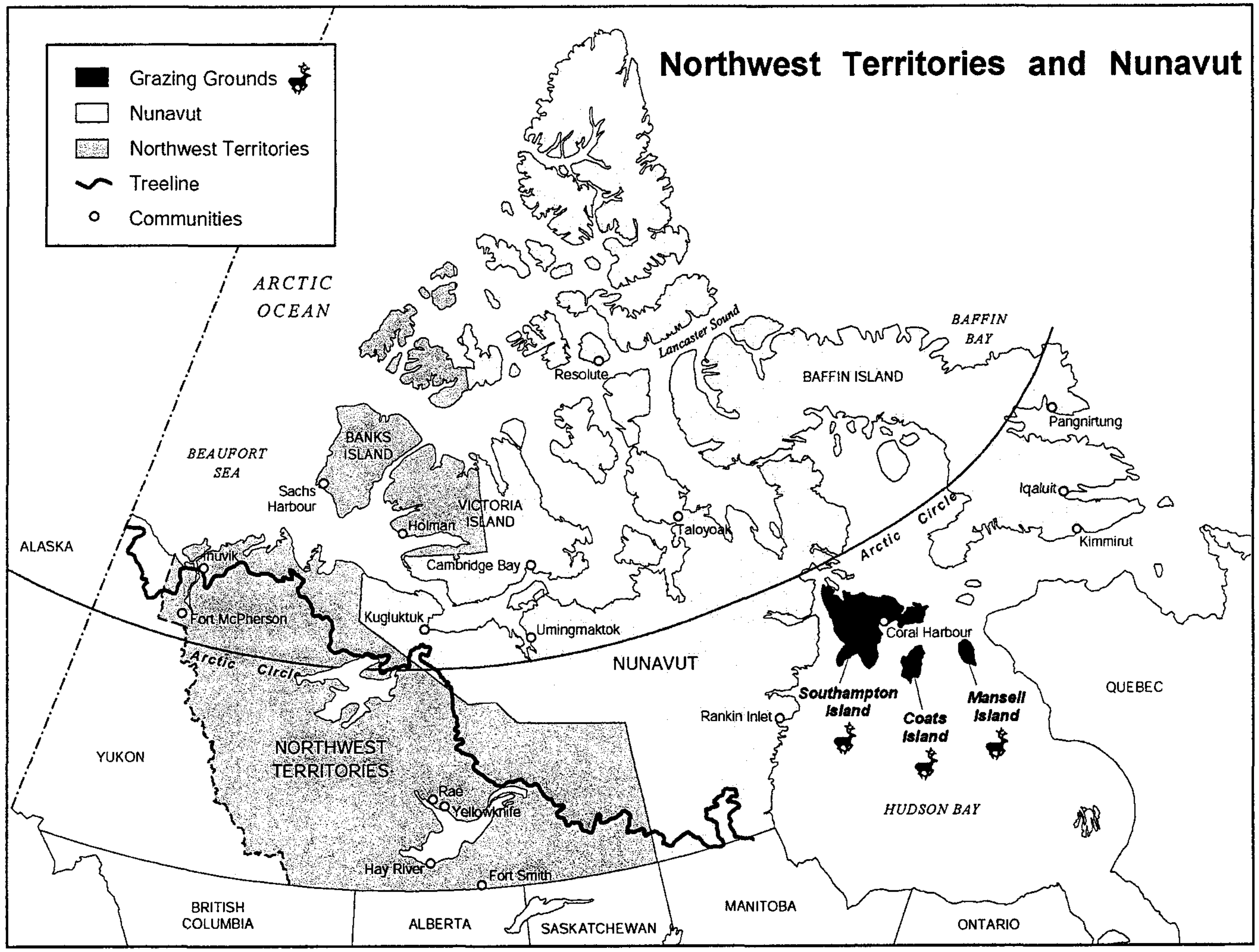


Figure 7-3 Areas recommended to be reserved for reindeer and muskoxen grazing grounds by the Royal Commission of 1919.

The goals of the large-scale commercial hunts on SHI are two-fold: stabilize the caribou population within carrying capacity and generate economic development opportunities (employment and business opportunities) for the local residents of Coral Harbour. Currently, the commercial hunt employs approximately 34 to 50 local community residents and has been estimated to inject approximately Can$250 000 to $300 000 into the local economy through salaries and local contracting of supplies and services (B. Threadkill, pers. comm. 2001).

In this chapter, I will examine the economic dynamics of commercial hunting activities on the caribou population of SHI. Using the model simulation, I will evaluate whether large-scale commercial caribou harvesting can stabilize the SHI system by removing the overshoot and collapse cyclical pattern. Additionally, using capital budgeting economic theory, I will assess whether or not the large-scale commercial hunting operation on SHI is a viable long-term option for the HTO while ensuring population regulation. This will be attempted by conducting an economic assessment of the investment analysis using net present value (NPV) concepts. Data for model development were collected from existing literature, government reports, yearly hunt reports, and personal interviews. The analysis complements the population model simulation developed in chapter six which describes the SHI caribou population and vegetation model development and details of variables used.

Another factor I will consider is government subsidies. It should be noted that the SHI large-scale commercial hunting project, since its inception, has been subsidized by territorial government agencies. However, the level of assistance has decreased as the harvest operation became more efficient and local expertise developed (Threadkill & Associates Ltd., 1999). Government subsidization has been utilized by the SHI commercial operation through non-repayable grant contributions, which in recent years has averaged around Can$ 75 000.

The specific objectives of this modeling simulation exercise are:

- Determine whether large-scale commercial harvesting of caribou can stabilize the SHI caribou population;
- Assess the economic returns to various levels of commercial hunts given changing biological and economic conditions;
- Determine the effects of price and demand variation for caribou meat on the economic viability of the project;
- Determine the effect of government subsidies on the feasibility of conducting large-scale commercial hunts on SHI;
- Address future management implications of the SHI population ecology system.

STUDY AREA

SHI is located on the north end of Hudson Bay (Figure 7-1) and is approximately 43 000 km^2 in area (Ouellet, 1992; Parker, 1975). The largest island in Hudson Bay, SHI has been classified by Parker (1975) into two physiographic regions that are described as Canadian Shield and Hudson Bay Lowlands. The island is divided by an abrupt escarpment which has low, flat limestone plains dominated by Dryas barrens and sedge meadows on one side and steep to rolling Precambrian shield dominated by *Alectoria* and *Cetraria* lichens and heaths on the other (Heard and Ouellet, 1994).

SHI is completely surrounded by open water year-round, which creates a climate as harsh as that found on most of the High Arctic islands (Parker, 1975). Snow cover generally lasts from mid-September or early October until mid-June. Snowmelt rapidly occurs in mid-June and the growing season typically lasts from July to the beginning of September. The mean daily temperature recorded at Coral Harbour was -11°C and the annual precipitation for rain and snow is 13 cm and 113 cm respectively (Heard and Ouellet, 1994). Coral Harbour recorded double the snowfall of Baker Lake, which is located at the same latitude as Coral Harbour on the mainland (Parker, 1975). The average wind speed at Coral Harbour is 20 km/hr. Fog and low overcast conditions are often present during the snow-free months.

MODEL STRUCTURE

The model is a dynamic deterministic simulation programmed using STELLA simulation software by High Performance Systems. STELLA was selected for its simplicity, graphic object orientation, and strict adherence to systems dynamics conventions. Versions beginning with 5.0 Research allow for subscripted variables, offering new scope for dealing with distributed systems.

The operating environment within STELLA is composed of a multi-level, hierarchical environment that includes a high-level map (Figure 7-4), a model construction layer (Figures 7-6 – 7-10, Appendix 7-2), and an index of terms for model (Appendix 7-3) (see Chapter 6 for a detailed description of STELLA).

Modeling approach

The objective for building the model is to understand the relationships between the introduced SHI caribou population and the SHI vegetation base (lichen and vascular plants), community subsistence harvesting, wolf introductions, and large-scale commercial hunts in order to make management recommendations. Simulations suggested that local Inuit subsistence hunting as well as wolf re-introduction would not stabilize the SHI system (Chapter 6). Furthermore, wolf re-introduction is an unrealistic management option, as the local community does not want wolves introduced on the island (Chapter 6). Therefore, wolves were excluded from simulations of commercial harvest operations. The goal of this chapter is to develop a commercial harvest sector within the model that would allow for the evaluation of various sizes of commercial harvests under plausible biological and economic conditions.

The *Caribou* sector was developed using a gender and age structured model that utilized calf, yearling, and adult pools to depict the SHI caribou population. This age structure matched available life history schedules and complemented population survey information used for model verification. Fecundity and mortality values of each pool were derived from published literature sources and were influenced within the model by available forage biomass. In addition, a correlation factor for different grazing responses relative to mean density of vegetation, Mdens, and the hunting sector further influence the mortality values of the SHI herd (Chapter 6).

The *Hunting* sector was developed to ascertain the effects of commercial harvesting on the SHI population. Harvesting of caribou within the model is based on maintaining a target population of caribou on SHI. Based on this target population, a harvest quota is developed and then incorporated in the allocation for either subsistence or commercial harvesting activities. The model was constructed to maintain subsistence hunting of the local Aboriginal people as the first harvesting priority. Once all subsistence hunting requirements are met, the model then determines the allocation of caribou for commercial harvesting activities.

A particularly important economic constraint that affects the SHI commercial harvests is the ability to fill transportation aircraft with meat supplies (see Factors Constraining Commercial Harvests on SHI). Consequently, the model is developed to harvest only in 40 000 pound (18 144 kg) increments (Hercules aircraft load capacity).

Once the level of commercial caribou harvest is determined in the *Hunting* sector, this value is then transferred to the *Level of Production* sector to determine the actual production of processed caribou meat (Abattoir Production variable) and to begin the economic valuation of the operation. From the Abattoir production values, both the revenue and expenses (overhead and operating costs) are determined for the commercial hunts. In determining the revenues, the model allows for price simulations in the form of either a random price generator or the ability to maintain the price of meat throughout the simulation. Alternative hunt revenues such as government grants and contribution to the commercial harvests are also factored into the model. The revenues and expenses are then entered into the *Harvest Enterprise Budget* sector where the model calculates the profit or loss of the commercial hunting operation.

The economic evaluation includes economic assessment criteria as well as assessment of impacts on the biological factors specific to the SHI system. This model examined the relationships between the price of caribou meat, the associated risk factor of an operation such as this, effect of changing demand, and effects of government subsidization to determine the economic viability of large-scale commercial harvests. Economic parameters are evaluated within the model based on NPV and determining the level of hunt that provides the optimal NPV value (i.e. the best level of hunt).

The great dilemma in analyzing the SHI system was whether to formulate the model as an inter-temporal optimization problem or as a simulation model. An alternative method for determining NPV could have been an optimization approach. However, challenges surrounding the temporal dimension of an optimization model and the incorporation of stochastic elements within the model (the complexity of the basic lichen-caribou system) dictate that the simulation approach was superior for this analysis.

The caribou/vegetation model (Chapter 6) was based on numerous habitat and population studies conducted on Southampton Island (Parker, 1975; Ouellet 1992; Ouellet et al., 1993; Heard and Ouellet, 1994; Ouellet et al., 1994; and a

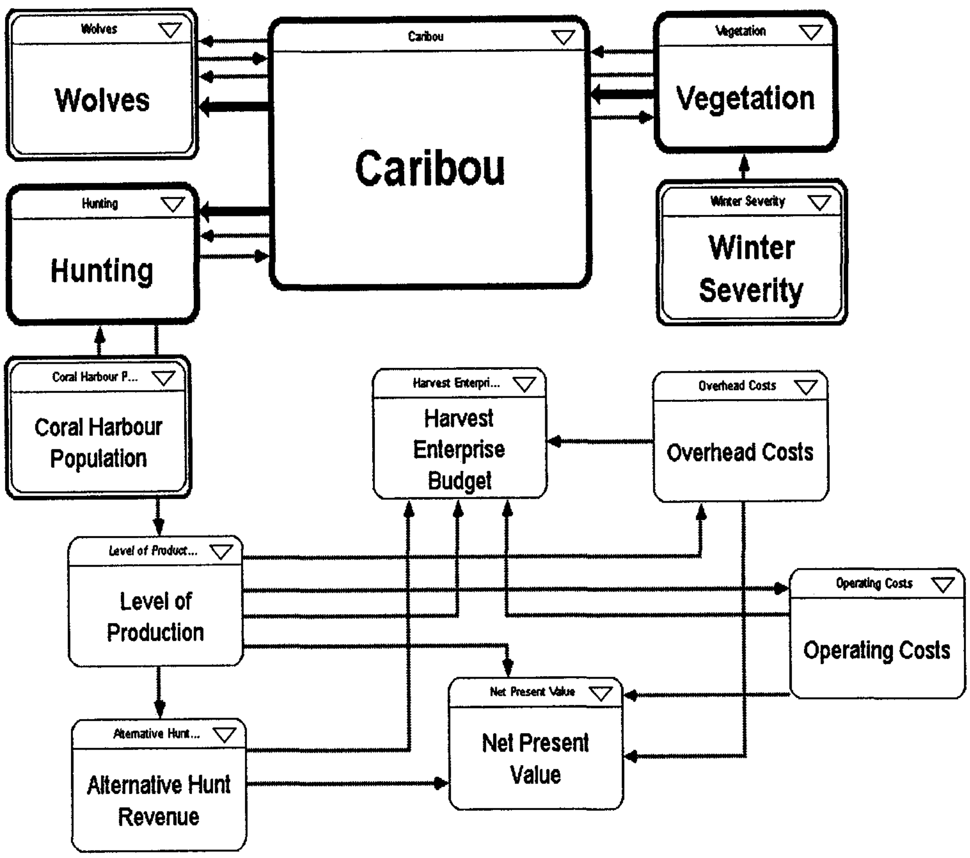


Figure 7-4 High-level map level depicting sectors for SHI caribou re-introduction model.

Note: The large arrows represent a bundled flow that corresponds to the material flows between processes in the model. The small arrows represent bundled connectors that correspond to any sector-to-sector connectors that exist in the model.

nearby island, Coats Island, (Adamczewski et al., 1987a,b; Adamczewski et al., 1988; Gates et al. 1986a,b). These studies and others will provide the basis for this chapter on the population and economic dynamics of the large-scale commercial hunting operation on SHI.

In the following sections, I review the model construction layer of conducting large-scale commercial harvesting operations on SHI based upon key sources of information, assumptions, and constraints as described in Chapter 6.

POPULATION PARAMETERS

Hunting Sector / Coral Harbour Population Sector

In the Canadian Arctic, subsistence harvesting is an integral part of Aboriginal peoples lifestyles (Chapter 3). Caribou harvesting is particularly important to Aboriginal people in many regions in the Canadian Arctic. Thomas and the Beverly Qamanirjuaq Caribou Management Board (1996:4) noted:

> "Caribou flesh is an important staple in the diet of Aboriginal people living with the ranges of the Beverly and Qamanirjuaq herds in north-central Canada. The herds' combined economic-cultural value is incalculable".

Subsistence harvesting is a requirement under the Nunavut Comprehensive Land Claim Agreement (1993) (Chapter 4). The agreement clearly identifies traditional users having top priority in terms of allocation of resources (Hall and Lloyd, 1989). Therefore, within the model, subsistence hunting quotas are filled before any commercial harvesting is completed. Subsistence hunting is defined as the harvesting of caribou for food and clothing for personal, family, or community use. Subsistence hunting on SHI was calculated based on the community population sector (Figure 7-5) and the assumption that the residents would continue to harvest caribou at their present rate of 1.6 caribou per person per year. Based on historical data, it is assumed that all caribou harvested on SHI are taken from the adult pool.

At the onset of the model, the predominately Inuit community of Coral Harbour had a population of 325 individuals. By 1996, the community had increased to 669 and continues to grow at a rate of 3.2 percent per year (Bureau of Statistics, 1996). The KP variable in the model is the carrying capacity for the community of Coral Harbour. This value was set at 1 500 residents. Realistically, without a strong employment base, the community could not continue support a larger population base and it is assumed that this number would stabilize in later years with emigration to other communities within Nunavut.

A *Hunting* sector (Figure 7-6) was required within the model in order to see the effects of subsistence hunting and commercial hunting on the SHI caribou herd. In order to allow the herd to grow from re-introduction, the resident Inuit hunters accepted strict no hunting guidelines in 1967 (Parker, 1975). Starting in 1978, a small quota allowed Inuit to hunt caribou on SHI (Ouellet, 1992). All harvesting activities of caribou on SHI to date (this includes subsistence harvesting, research use, and commercial harvesting) are depicted in the model as a separate input variable (ActHarv) to distinguish the effects of past community harvests from prospective subsistence requirements and future commercial activities.

The model allows for subsistence hunting when the caribou population of yearling and adults, One Year or Older variable, is greater than the target population. For the purposes of this model, the target population was assumed to be 10 000 females and 5 000 males, well below the carrying capacity of 40 000 suggested by Parker (1975). Government biologists, using spreadsheet analysis, determined that a harvest would have to consist of 70 percent female and 30 percent males from the SHI herd in order to limit population growth

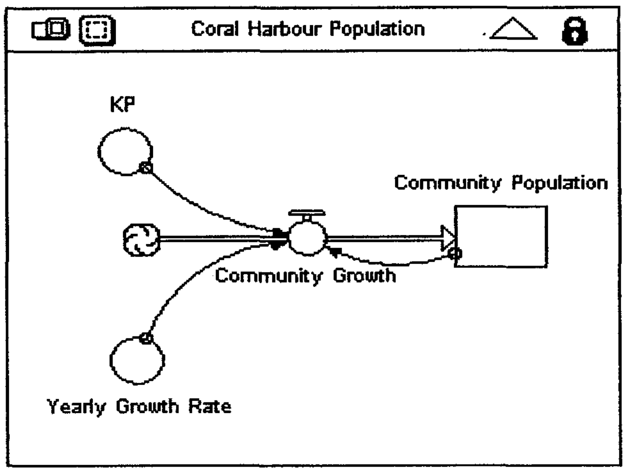


Figure 7-5 Model construction level for Coral Harbour population sector.

(Mulders, R. pers. comm. 2001; Williams and Mulders, 1994) and this was built into the model through the HarvMale% variable.

Ginsberg and Milner-Gulland (1994) noted that cropping may have several effects, either deleterious or advantageous, to an ungulate population and that female based harvesting may lead to increased competition for females among the remaining males.

Lublow et al. (1996:792) commented on sex harvest strategies for cervid populations:

> "Female harvesting reduces population size, thereby increasing juvenile survival rates or recruitment, enabling more males to reach harvest age. Besides additional male harvest, the added benefit of female harvest can (sometimes) produce substantially higher yields than a males-only harvest (McCullough, 1984), if density dependence is operating in the population".

Caughley (1977:192) commented on selective harvesting of sexes:

> "In the link between the male segment and female segment of the population there is considerable play that allows us to bend the relationship to our advantage. So long as density is held constant, an increase or decrease in the rates at which males are harvested has no necessary effect on the harvesting rate permissible for females. Most populations contain more males than are needed to fertilize all the females capable of reproduction. Progressive reduction of the proportion of males in the population has little effect on the fecundity of females until a critical threshold is reached".

Generally, the majority of the females, yearlings, and calves on SHI are located northeast of the community (about 60 to 200 km) after December whereas the bulls typically occupied small pockets throughout the island on the outskirts of the female/yearling/calves range. This segregation would seem to allow the hunt

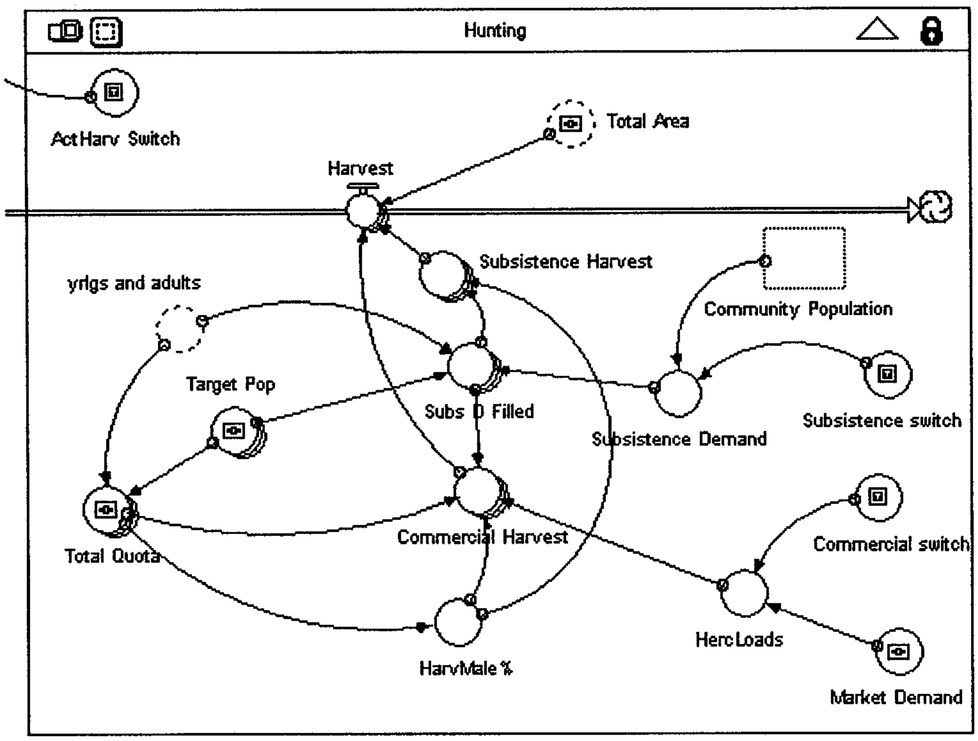


Figure 7-6 Model construction level for hunting sector.

operators to harvest the 70/30 sex ratios desired but this has not always been the case on SHI (see Factors Constraining Commercial Harvest on SHI).

Commercial harvesting

For the purposes of this paper, large-scale commercial harvests will be defined as hunting by an Aboriginal community organization, which complies with federal meat inspection guidelines determined by Agriculture Canada, for sale in either domestic or export markets (Chapter 3).

SHI is a unique situation because harvests began as a sustained cropping exercise but quickly turned into a reduction cropping or culling operation because of the large increase in caribou numbers (Heard and Ouellet, 1994). Since 1995, approximately seven large-scale harvests on SHI have produced approximately 17 144 caribou carcasses that have been federally approved for export sale (Table 7-1).

Factors constraining commercial harvests on SHI

There are many factors influencing the commercial harvesting of caribou on the Arctic island location of SHI that ultimately determine the hunt's economic viability of such activities. Critical components required to begin a large-scale commercial harvest are cold weather, a good ice platform, and access to animals. Cold weather, minus 20 degrees Celsius to minus 25 degrees Celsius, is the optimal temperature for hard freezing of carcasses. Abattoirs are always built on frozen lakes or near other accessible sources of water (J. Colford, pers. comm. 1999). Clean water supplies are required to satisfy federal meat processing regulations dictated by Agriculture Canada. The timing of year plays an integral role in the dynamics of a hunt. Daylight, temperature, and general weather conditions affect all facets of these operations. There are two annual windows of time to commercially harvest caribou in the Canadian Arctic, the fall and spring seasons.

On SHI, the fall hunting window could begin in early November and last until early December. The spring hunt window can begin in March and continue until the end of April (Appendix 7-1). After trial hunts during both seasons, consensus has favoured spring hunts because of a longer period of time available to conduct hunting activities due to: higher average day-length; warmer temperatures; and in general, better weather conditions in terms snowfall and periods of extreme temperatures (D. Pelling, pers. comm. 1997).

With no meat processing and distributing facilities on SHI, sufficient numbers of animals must be available to keep transportation costs economically feasible (B. Threadkill, pers. comm. 1998). Carcasses stored in combo bins are transported by a chartered Hercules aircraft (Appendix 7.1). The Hercules aircraft can haul approximately 40 000 pounds of caribou meat or 727 caribou carcasses per load (assuming 55 lb or 25 kg/caribou). However, to remain cost effective, each load must be filled to capacity (B. Threadkill, pers. comm. 1998). Chartered aircraft loads that are not filled to capacity quickly jeopardize the profit of this operation. Although SHI operations sell all meat F.O.B. (Freight On Board) Coral Harbour, southern companies purchasing the meat still only purchase supplies based on planeload capacity (B. Threadkill, pers. comm. 1998) thereby continuing the need to determine production on aircraft loads within the model structure.

Using information from actual commercial harvests to determine full capacity loads and profit ratios, I designed the model so that only harvests of 120 000 pounds (54 431 kilograms) or 2 282 caribou, 160 000 pounds (72 575 kilograms) or 3 009 caribou, and 200 000 pounds (90 718 kilograms) or 3 736 caribou would be conducted (each figure includes 100 extra caribou for condemned carcasses). Commercial harvests of 120 000 pounds or 2 282 caribou carcasses are considered good break-even harvests by camp operators (B. Threadkill, pers.

comm. 1998). A harvest of 160 000 pounds or 3 009 caribou carcasses has been determined as the optimal financial harvest while a hunt of 200 000 pounds or 3 736 caribou carcasses has never been done before on SHI. With a harvest of this magnitude, the chance of incurring a financial loss is increased if the chartered aircraft is not filled to capacity. As well, a 200 000 pound harvest would require relocation of the hunting camp. Therefore, camp relocation is built into the model by increasing costs by $10 000 for a commercial harvest of 200 000 pounds (3 736 caribou carcasses) or greater (B. Threadkill, pers. comm. 1998).

Based on actual operations it is assumed that a hunt of 240 000 pounds (108 862 kilograms) or 4 463 caribou carcasses would be highly unlikely due to weather constraints, labour constraints, and ultimately herd dynamics (Chapter 3) (D. Pelling, pers. comm. 1997).

Another factor affecting economic viability of commercial harvests on SHI is availability of labour. With such a small population base, it is hard to find suitable local workers. Although these commercial harvests last for three to five weeks, work hours are long, duties are monotonous, and employment at the campsite requires workers to be away from family members (workers stay in camps adjacent to the abattoir site). In addition, the hunt requires the presence of federal meat inspectors. A federal inspector must be flown in from the south (Alberta or Saskatchewan) to the project site. As it is typical for inspectors to take shifts during the harvest period (D. Pelling, pers. comm. 1997), using a two camp strategy could present problems in acquiring the services of two inspectors at the same time.

Unpredictable events surrounding the dynamics of the harvest operations invariably change the eventual production outcome. For example, in 1999, a harvest resulted in only 80 000 pounds (36 287 kilograms) of caribou meat. A breached contract resulted in the operation conducting only a small harvest (domestic sale order to Cambridge Bay Processing Plant –storage capacity 80 000 lbs of meat) in order to attempt to recoup the initial monetary investment. To reduce costs, the hunt took place close to the community and consequently consisted mainly of bulls. Although the male carcasses produced more weight with less overhead costs for the camp operations, the harvest ratio did not meet the SHI population reduction objectives (Chapter 3).

As discussed earlier, the model was designed to give first priority to subsistence hunting (Figure 7-6). Once subsistence hunting demands were met, then commercial harvests are determined by a market demand variable which was designed to randomly designate harvests between the three harvesting capacities mentioned previously. The market demand variable then determines aircraft load capacity by allowing for only complete loads of aircraft to be filled. Finally, based on the available quota for the SHI caribou herd, the model determines the appropriate commercial harvest level by assessing the three harvest capacities.

ECONOMIC PARAMETERS

Within the model, I applied capital budgeting or investment analysis concepts to determine whether the SHI large-scale commercial operation is economically viable (Barry et al. 1988). The SHI commercial hunting operation is a unique investment situation because all capital assets have already been obtained through government subsidies. Therefore, in order to measure the objectives of capital budgeting I used return-to-equity theory, which measures the profitability of an investment after the costs of borrowed funds are accounted for (Barry et al. 1988). Barry et al. (1988) notes:

> "Now, consider that the capital budgeting objective is to measure the profitability of the equity capital committed to an investment project. The return to equity is measured by projecting the payment flow, net of the cash outflows for

> principal and interest on debt, and then discounting the payments to present value, using the firm's cost of equity capital as the discount rate".

Within the simulation model, the investment criterion applied is a net present value (NPV) analysis (Figure 7-10). As well, a sensitivity analysis was also performed on key parameters that included discount rates, production rates (harvest levels), market price variations of caribou meat (F.O.B. Coral Harbour), and sensitivity to government subsidies (see Results/Discussion section). The break-even analysis was used to determine the break-even price of caribou meat for each harvest level for this investment.

Level of production sector/ harvest enterprise budget

The *Level of Production* sector (Figure 7-7) was developed within the model to set abattoir production values and price per pound of caribou meat, and subsequently calculate the commercial hunt revenues (i.e. abattoir production multiplied by price per pound). Abattoir production is determined by multiplying the commercial hunting variable, which determines the harvest level within the Hunting sector (Figure 7-6), by the average finished carcass weight of 55 pounds (D. Pelling, pers. comm. 1997).

Prices for caribou meat have ranged from Can$2.50 to $3.45 per pound or Can$1.13 to $1.57 per kilogram (Table 7-2). Since 1999, hunt managers have pursued contracts F.O.B Coral Harbour to minimize enterprise risk by eliminating another financial aspect that could jeopardize the harvest's profit margin.

Once the level of production is set, the model calculates the profit or loss of the hunt by using a harvest enterprise budget (Figure 7-7). The harvest enterprise budget calculates the harvest revenue by adding the commercial hunt revenue (carcass sales) and alternative hunt revenues (goods and service tax refund,

Table 7-2 Prices for caribou meat exported from commercial hunts on Southampton Island, Nunavut (1995-2001).

Year	Freight On Board (FOB) Location	Price of Caribou Meat (per lb)	Price of Caribou Meat (per lb)
1995	Edmonton, AB	$ 2.85	$ 1.29
1996	Mississauga, ON	$ 3.05	$ 1.38
1997	Mississauga, ON	$ 3.20	$ 1.45
1998	Mississauga, ON	$ 3.45	$ 1.57
1999	Coral Harbour, NU	$ 2.50	$ 1.13
2000	Coral Harbour, NU	$ 2.50	$ 1.13
2001	Coral Harbour, NU	$ 2.50	$ 1.13

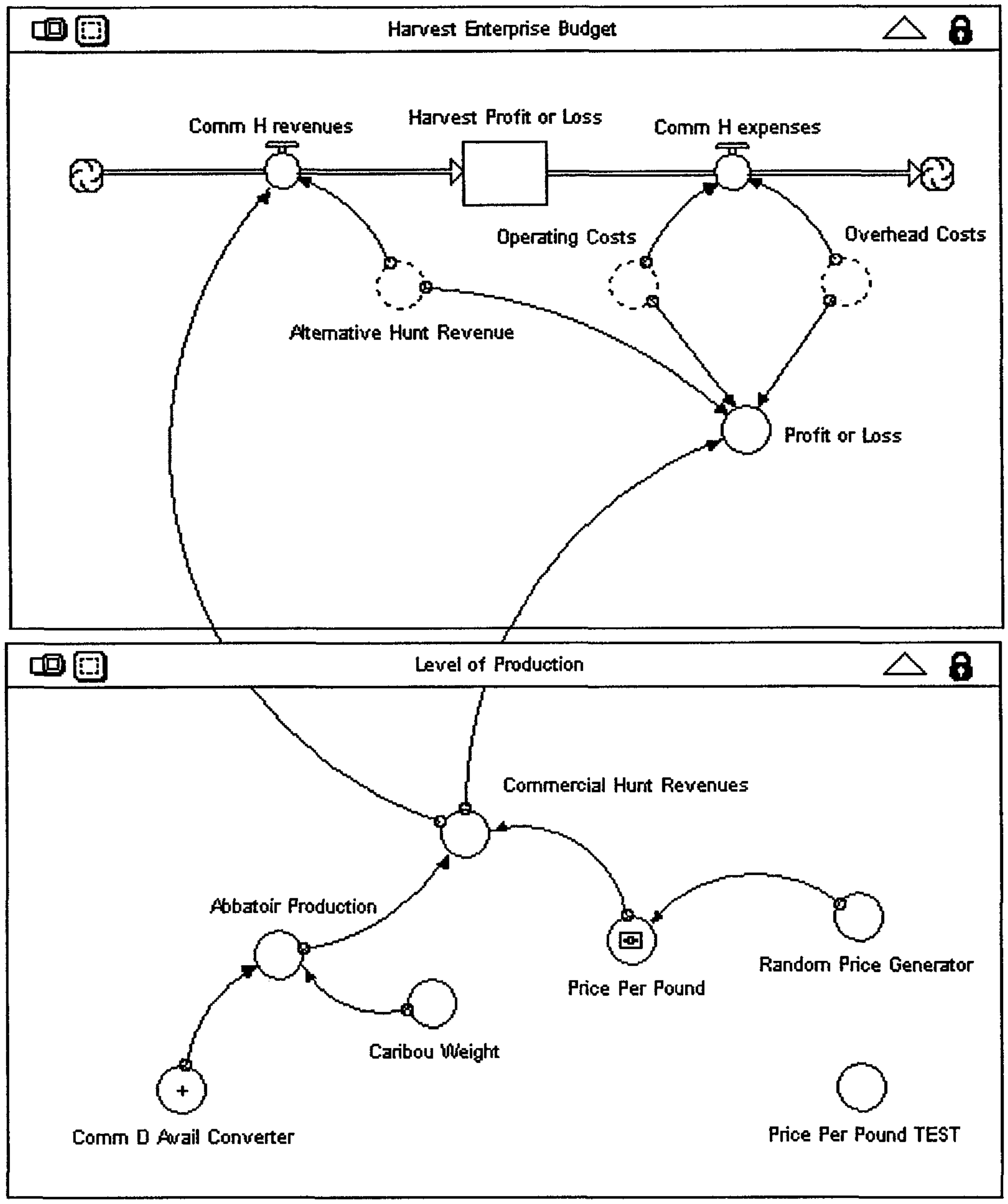


Figure 7-7 Model construction level for level of production sector and harvest enterprise budget sector.

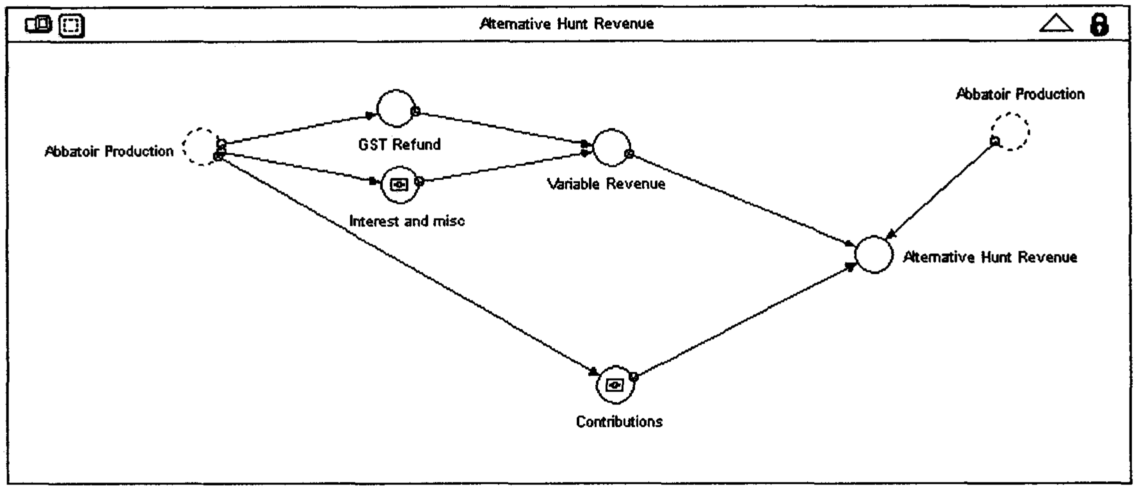


Figure 7-8 Model construction level for alternative revenue sector.

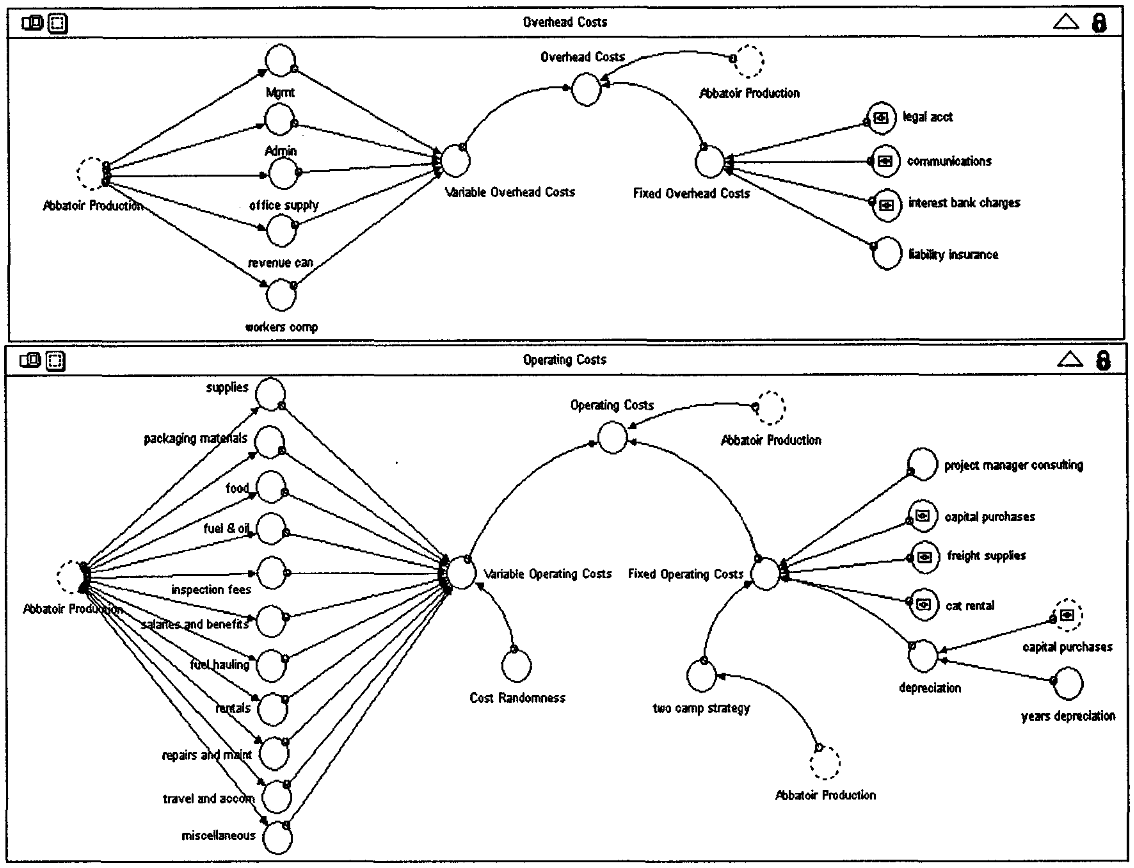


Figure 7-9 Model construction level for overhead and operating cost sectors.

interest and miscellaneous revenue, and government grants and contributions) (Figure 7-8) and subtracting the commercial harvest's costs.

The commercial harvest overhead and operating costs are based on the values associated with the 1998 commercial harvest (Figure 7-9). This hunt was chosen by camp operators and camp managers as most representative of a 'ideal' hunt scenario (D. Pelling, pers. comm. 1998; B. Threadkill, pers. comm.1998). Within the overhead and operating sectors, there were both variable and fixed costs identified (Figure 7-9).

Net present value sector

The NPV rule was used in this analysis because: 1) it recognizes the time value of money; 2) it depends solely on the forecasted cash flows from the project and the opportunity cost of capital; and 3) present values are all measured in today's dollars and therefore can be summed (Brealey et al. 1992).

For this analysis, the decision rule for accepting or rejecting a proposed investment relates directly to the NPV. The NPV is the sum of the present values for each year of an investment. An investment is efficient if the NPV is greater than or equal to zero. This indicates returns equal or exceed costs in net present value terms. A positive net present value means that the investment pays better than the opportunity cost of capital and should be accepted (Bauer, 1994) (i.e. the Aiviit HTO would be getting at least as much or even more than the opportunity cost of its resources). If the investment were less than zero, the investment would be rejected.

For this model, a discount rate of 15 percent was used. This was calculated by using a five percent rate of return for GICs (risk free rate) and a 10 percent risk premium. Although this might seem high, risk premiums for southern wild animal production systems have been reported around five percent (Armstrong et al., 1993; Seidle et al., 1994). However, due to logistics, weather related delays, production efficiency, history of hunt contract cancellations, and overall uncertainty of completing hunts in the Canadian Arctic, I used the 10 percent figure for risk premium. Given the fairly large discount rate, the critical period to analyse NPV criteria of this investment will be in the first years of operation as this is when most of the activity is taking place. When the discount rate is high enough, the analysis of NPV effects will not change with the addition of more years. Therefore, economic interpretation within the model is based on a time horizon of ten years. The ten-year horizon has also been used in other ungulate production analyses (Armstrong et al., 1993; Seidle et al., 1994; Wall and Knopf, 1993a,b).

It should also be noted that this investment analysis has not included taxes for the calculations. As well, depreciation of the abattoir facilities is negligible due to the abattoir framework construction and removable camps. Instead, an on-going expense in the *Operating Cost* sector (Figure 7-9), termed capital purchases, is used by camp operators to maintain the facilities from year to year (B. Threadkill, pers. comm. 1998).

RESULTS/DISCUSSION

The model was developed to project the future impacts of large-scale commercial harvests on the SHI caribou herd and to assess the economic returns to various levels of hunts.

POPULATION SIMULATIONS

The following three types of population simulations were tested.

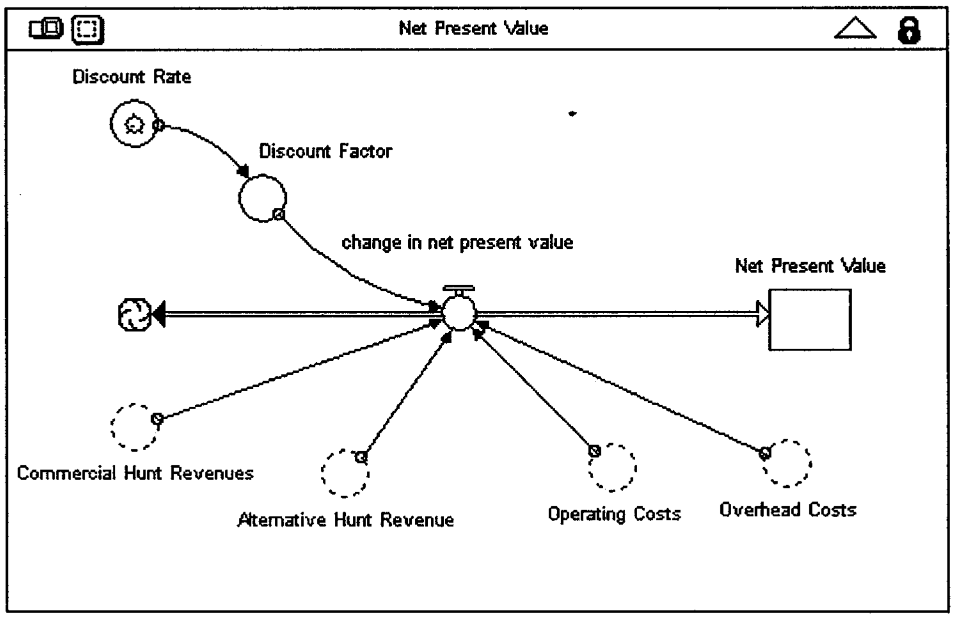


Figure 7-10 Model construction level for net present value sector.

1. **Density of caribou: with actual known harvesting values and subsistence harvesting.**
2. **Density of caribou: with actual known harvesting values, subsistence harvesting, and commercial harvesting (random selection of hunt production)*.**

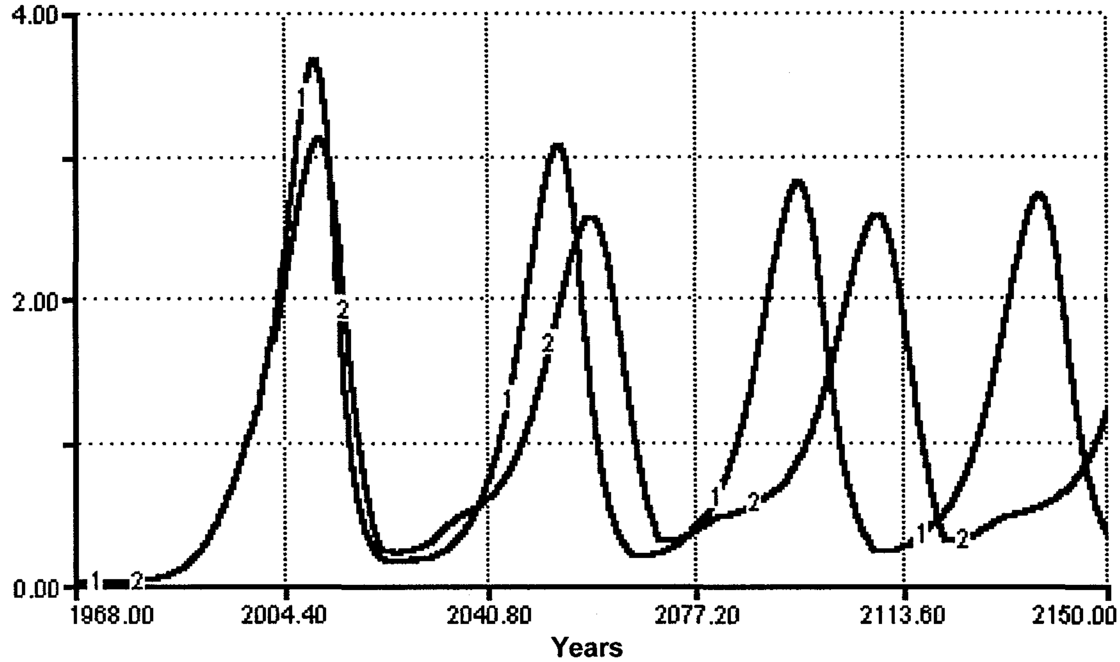


Figure 7-11 Modeled simulations of the effects of commercial hunting on Southampton Island caribou population from 1968 to 2150.

*Note: Hunt production values were 120 000, 160 000, and 200 000 pounds of caribou meat.

A) Random commercial harvest levels test

Commercial hunting on SHI was initially developed to act as a herd management initiative to control the growth of the SHI caribou herd (Threadkill and Associates, 1999). However, commercial hunts on SHI are dependent on many factors that determine the numbers of animals processed in a particular year. Previous hunt records show yearly variability in the number of animals harvested from SHI (Table 7-1). Therefore, in the first simulation the model randomly chose between the three levels of harvests that could be realistically achieved on SHI (120 000, 160 000, and 200 000 pounds) (Figure 7-11). Consequently, the model demonstrated that although commercial hunting could limit the intensity of the initial rise of the caribou population and decrease the amplitude of the herd's rapid increases, it could not stabilize the SHI system.

By continuing commercial harvests at the randomly selected production rates, commercial harvests would basically delay the cyclical nature of the caribou population but did not change the character of the system. Once the population crashed, the commercial harvest delayed the impending growth of the herd. However, under this type of scenario, commercial hunting cannot contain the herd's rapid growth.

B) Non-random or deterministic commercial harvest levels test

The next step in assessing the impact of commercial harvests effect on the SHI caribou population was to simulate the harvests by choosing only one level of hunt (Figure 7-12). As witnessed in the analysis of random selected production values, the system remained cyclical although the increasing production values decreased the amplitude and time between irruptions. Under current harvesting regimes, commercial hunting cannot stabilize the SHI system.

1. Density of caribou: with actual known harvesting values and subsistence harvesting.

2. Density of caribou: same as #1 with commercial harvesting (120 000 harvest production).

3. Density of caribou: same as #1 with commercial harvesting (160 000 harvest production).

4. Density of caribou: same as #1 with commercial harvesting (200 000 harvest production).

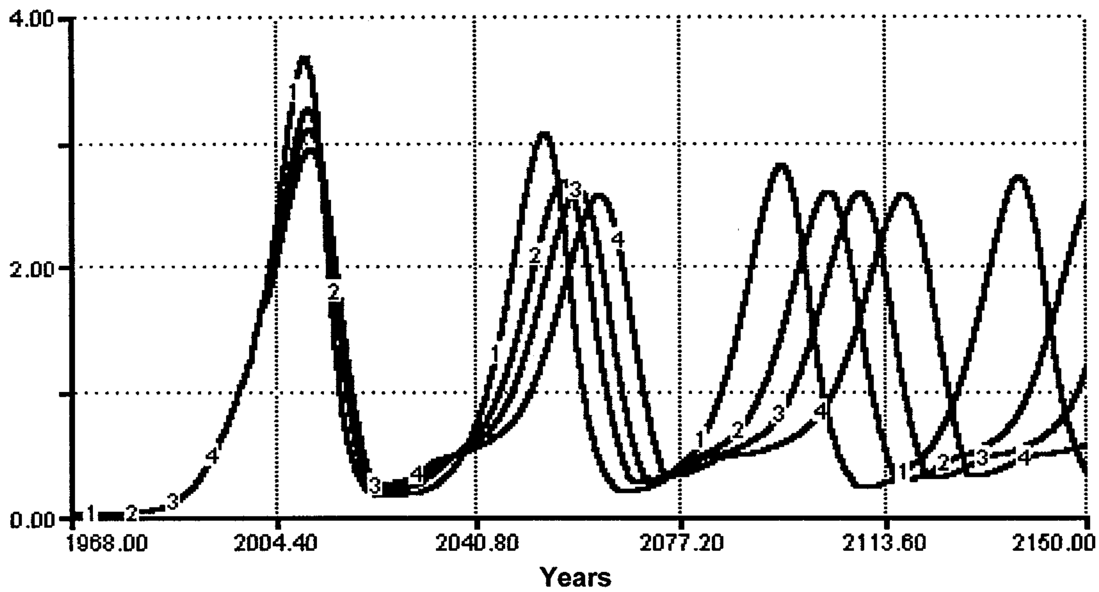


Figure 7-12 Modeled simulations of the effects of commercial hunting on Southampton Island caribou population from 1968 to 2150.

1. Density of caribou: with commercial hunt demand set at 200 000 pounds.
2. Density of caribou: with commercial hunt demand set at 280 000 pounds.
3. Density of caribou: with commercial hunt demand set at 360 000 pounds.
4. Density of caribou: with commercial hunt demand set at 400 000 pounds.

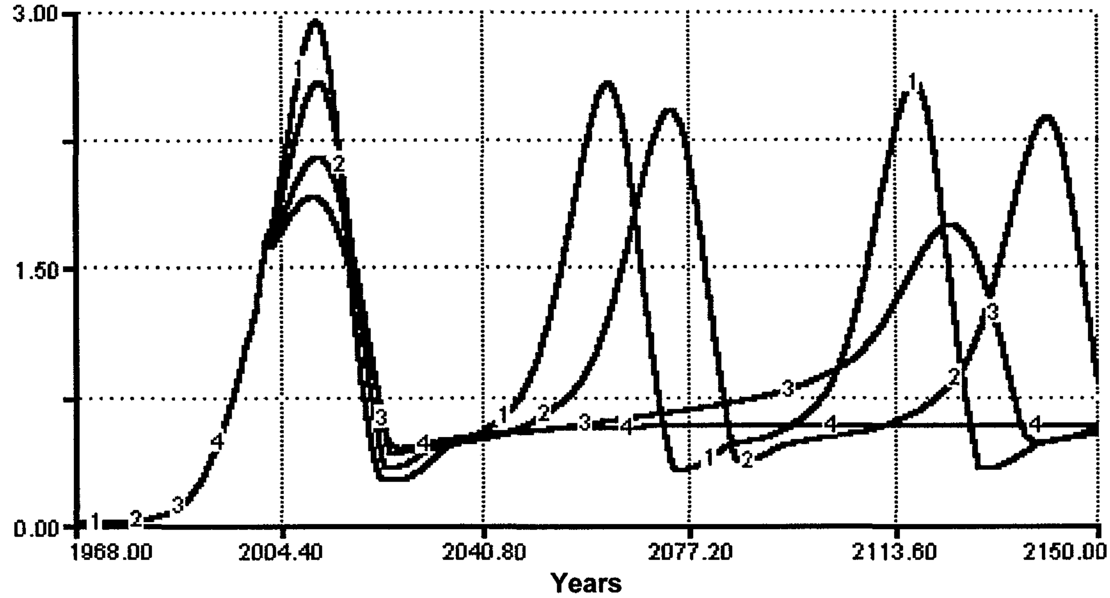


Figure 7-13 Modeled simulations of the effects of commercial hunting on Southampton Island caribou population from 1968 to 2150.

The model was then tested to determine the size of harvest required to stabilize the SHI system (Figure 7-13). In the model, I continued to calculate hunt production based on 40 000 pound increments (Hercules aircraft load criteria). The model calculated that it would take a hunt production of 400 000 pounds or 7 373 caribou to stabilize the SHI caribou herd. At this level of continual production, the caribou herd would stabilize at a density of 0.58 caribou per kilometer or 21 500 animals.

ECONOMIC ANALYSIS

Discount Rate

Although seven large-scale, federally approved commercial harvest operations have been completed on SHI since 1995, there are still volatile business risks involved in conducting operations of this nature. Discount rates were manipulated using different percentages of risk varying from 5 (risk free) to 30 percent (very risky) at each realistic production level (120 000, 160 000, 200 000, and 240 000 pounds of caribou meat) and at Can$ 2.50 (current contract price sought by Southampton Meat Company (SMC) to analyze the effects of discount rates on NPV (Table 7-1). This sensitivity analysis of discount rates on large-scale harvest operations showed that there was not much sensitivity to risk premium and variations from 5 to 30 percent had little effect on the NPV of the large-scale harvesting model simulation based on a Can $2.50 price obtained for caribou meat FOB Coral Harbour. However, the sensitivity analysis demonstrated that, assuming the operation would receive government contributions (Can$ 75 000), harvests of 160 000 to 240 000 were favorable investments for SMC. A harvest of 120 000 was shown to have a negative NPV and subsequently should not be pursued at a price of Can$2.50.

Table 7-3 Sensitivity analysis of discount rate for SHI large-scale commercial model simulation.

Production Level (lbs.)	**Price Per Pound** (with Gov't Contributions)	**Price Per Pound** (without Gov't Contributions)	**Discount Rate**	**Net Present Value** (with Gov't Contributions)	**Net Present Value** (without Gov't Contributions)
120 000 (2282 carcasses)	$ 2.50	$ 2.50	0.05	- $ 64 956	- $ 843 527
			0.15	- $ 59 307	- $ 770 177
			0.30	- $ 52 464	- $ 681 310
160 000 (3009 carcasses)	$ 2.50	$ 2.50	0.05	$ 22 392	- $ 756 179
			0.15	$ 20 445	- $ 690 424
			0.30	$ 18 086	- $ 610 760
200 000 (3736 carcasses)	$ 2.50	$ 2.50	0.05	$ 109 740	- $ 668 831
			0.15	$ 100 198	- $ 610 672
			0.30	$ 88 637	- $ 540 210
240 000 (4463 carcasses)	$ 2.50	$ 2.50	0.05	$ 197 089	- $ 581 483
			0.15	$ 179 950	- $ 530 919
			0.30	$ 159 187	- $ 469 659

Price Sensitivity and Net Present Value Analysis

Prices and F.O.B. locations have varied for caribou meat harvested on SHI as the hunting operation developed (Table 7-2). By stipulating that the harvested meat be delivered F.O.B. Coral Harbour, SMC has effectively eliminated one area of concern and the financial liabilities associated with sending meat out of the community. The model demonstrates that SHI commercial harvest operations are extremely price sensitive. For the purpose of this investment analysis, prices for caribou meat were systematically scaled down by the cent until the NPV was either zero or the closest positive value (Table 7-4).

In determining NPV values for the four viable production levels, the break-even NPV values were Can$2.56, $2.49, $2.45, and $2.43 for 120 000, 160 000, 200 000, and 240 000 pounds of caribou meat respectively with current levels of government subsidy (Table 7-3 and Table 7-4). As demonstrated in the sensitivity analysis, the model calculated that a hunt of 120 000 pounds should not be undertaken unless Can$2.56 could be obtained for the caribou carcasses. This finding was further verified in the spring of 2000 when approximately 121 595 pounds of caribou was harvested during a commercial hunt and was sold for Can$2.50 per pound thus realizing a net loss of Can$10 500 to the operation (B. Threadkill, pers. comm. 2000).

Predictably, the model demonstrated that the price of caribou carcasses required to obtain positive NPV values increased dramatically when government subsidization was eliminated (Figure 7-14). For the past few years, government subsidies have averaged Can$75 000. When government contributions are eliminated from the simulation, NPV break-even prices increase as much as 24 percent (120 000 pounds) and gradually decline to a 13 percent increase for a harvest of 240 000 pounds (Table 7-4). In determining NPV values for the four viable production levels, the break-even NPV values were Can$3.18, $2.96, $2.83, and $2.74 for 120 000, 160 000, 200 000, and 240 000 pounds of caribou

Table 7-4 Sensitivity analysis of price of caribou meat for SHI large-scale commercial model simulation.

Hunt Production Level (lbs.)	Discount Rate	Price Per Pound (With Contributions)		Net Present Value (With Contributions)	Price Per Pound (Without Contributions)		Net Present Value (Without Contributions)
120 000 (2282 carcasses)	0.15		$ 2.58	$ 31 650		$ 3.20	$ 25 698
			$ 2.57	$ 20 280		$ 3.19	$ 14 329
		B/E Price	**$ 2.56**	**$ 8 910**	**B/E Price**	**$ 3.18**	**$ 2 959**
			$ 2.55	- $ 2 459		$ 3.17	- $ 8 411
			$ 2.54	- $ 13 829		$ 3.16	- $ 19 780
160 000 (3009 carcasses)	0.15		$ 2.51	$ 35 605		$ 2.98	$ 37 233
			$ 2.50	$ 20 445		$ 2.97	$ 22 074
		B/E Price	**$ 2.49**	**$ 5 286**	**B/E Price**	**$ 2.96**	**$ 6 914**
			$ 2.48	- $ 9 874		$ 2.95	- $ 8 245
			$ 2.47	- $ 25 033		$ 2.94	- $ 23 405
200 000 (3736 carcasses)	0.15		$ 2.47	$ 43 350		$ 2.85	$ 52 558
			$ 2.46	$ 24 400		$ 2.84	$ 33 608
		B/E Price	**$ 2.45**	**$ 5 451**	**B/E Price**	**$ 2.83**	**$ 14 659**
			$ 2.44	- $ 13 499		$ 2.82	- $ 4 291
			$ 2.43	- $ 32 448		$ 2.81	- $ 23 240
240 000 (4463 carcasses)	0.15		$ 2.45	$ 66 254		$ 2.76	$ 60 303
			$ 2.44	$ 43 515		$ 2.75	$ 37 563
		B/E Price	**$ 2.43**	**$ 20 775**	**B/E Price**	**$ 2.74**	**$ 14 824**
			$ 2.42	- $ 1 964		$ 2.73	- $ 21 926
			$ 2.41	- $ 24 703		$ 2.72	- $ 30 655

meat respectively with current levels of government subsidy (Table 7-3 and Table 7-4). The lower production hunts are most seriously affected by the loss of government subsidization whereas; hunts with higher production values, are less affected as production efficiencies within the hunt operation are realized with larger harvests.

From a financial viewpoint, commercial hunting operations on SHI have positive economic repercussions in the community through salaries and local contracts for supplies and services. However, the analysis clearly points out that break-even NPV values vary for each level of hunt. Although the hunts provide many economic spin-offs, they rely on government subsidies to remain viable. Therefore, the question becomes one of determining if government subsidization should be allocated to other resources in the community in order to overcome this dependence on continual aid in the form of subsidy. This predicament has fuelled many remote, Arctic communities and the respective community development projects and further research should be completed in this area.

The sensitivity analyses conducted on meat prices obtained from large-scale harvest operations clearly indicate that net present values are very sensitive to prices for this type of activity. Consequently, SMC officials need to be aware of break-even prices before entering into long-term contracts. However, the world game meat industry has grown tremendously during the past several decades (Krostitz, 1996, Reinken, 1998). The various sectors of the game meat industry worldwide have performed numerous marketing studies but are for the most part, unavailable to the general public (R. J. Hudson, pers.comm. 2002). However, the growth and development of the specialized livestock industry continues to flourish worldwide (Hobbs, 2000). Recently, the Canadian market for game meats in Canada has taken a downward turn in demand since the events of September 11, 2001 and will need time to turnaround. The recent decline in the industry has been attributed to the fact that the majority of consumers buying these types of specialty meats are foreign visitors/travellers to Canada. The

SMC have been able to buffer these effects by entering into multi-year contracts with southern meat dealers. These contracts are for a specified period of time (2-3 years) and for a specific amount of caribou meat per year.

CONCLUSIONS

The interesting management scenario with SHI is that caribou harvests have already taken place on SHI and have had some effect on the SHI herd. It is likely that these previous harvests have delayed the increase of the herd but really have not changed the character of the system (cyclical overshoot and collapse scenario). Under current commercial harvest production limitations, the model demonstrates that the SHI system cannot be stabilized. However, by increasing the harvesting levels to almost double the current capacity, the SHI system could be stabilized. The great difficulty with this type of demand is that there is no way of knowing whether or not these levels of harvest are achievable. For the hunts to be economically feasible without subsidy, the amounts southern retailers would be willing to pay for caribou will have to be higher. Unless such increases in demand occur, the simulation predicts that the hunts will not be economically viable.

There are both economic and population dynamics that continually surround the viability of this operation. The ideal situation would be to find a balance between keeping the caribou population in check and remain economically viable from a population standpoint – sustained cropping. The balance of harvesting the appropriate number of animals to permit sustainable harvesting from an insular population and also remain economically sound, is a dilemma which SMC faces each year. Gunn et al. (1991:202) notes:

> "the dilemma is that the most appropriate economic harvesting strategy may not be the most appropriate ecologically".

The inverse of this statement is appropriate when discussing commercial hunting activities of a wild species.

The existing SHI large-scale commercial harvesting operations have reached many of the intended goals by managers such as: increased self reliance in the local community; injecting cash into the local economy through employment opportunities and job training; refined the large-scale hunting process through the use of portable abattoir systems; and curtailing the rapid increase of the caribou population. However, my simulation model implies that without changes to the current production levels and harvesting regime, it appears that the SHI population is destined to increase beyond the island's suggested carrying capacity and could possibly collapse similar to other insular *Rangifer* populations. The loss of this industry to the community of Coral Harbour would have negative consequences to the local economy as well as the local people, who have become accustomed to this type of labour activity for a source of livelihood and well being.

In conclusion, it must be noted that model simulation cannot be applied by itself as a form of ecosystem management on SHI. From an ecological perspective, wildlife managers must now approach the SHI system as an adaptive management experience in order to validate the model by conducting updates on empirical studies and processes on SHI. As the caribou population continues to increase exponentially, frequent population surveys must be used to determine the population's increase, male to female ratio, and general health of the caribou population. In addition, it is imperative that the loss of habitat on SHI is monitored, as this will ultimately decide the fate of the caribou herd. From an economic perspective, alternative options for government subsidies must be fully understood to contemplate the repercussions of discontinuing funding to these hunting operations. In addition, further research should examine the social ramifications to the local community of either continuing or discontinuing these large-scale commercial hunts.

APPENDIX 7-1: Harvest and processing methods for large scale commercial caribou harvest in Coral Harbour, NU – March-April, 1997

In the next section, I will describe the Southampton Island harvest and processing methods witnessed in 1997.

Harvesting activities begin with the mobilization of a base camp, which is usually located within a radius of 65-100 km of the community and centrally located to the caribou herd. The camp location is determined by community members to be optimal for access to the potential caribou that will be harvested. The camp is equipped with a large kitchen tent, accommodation tents for workers, generator tents, and washroom facilities adequate to service 40-50 people. A portable abattoir facility, which is equipped with a railing system for easy movement of carcasses, is located in the camp to process these animals. This camp must also be located within an area that has a clean water supply to satisfy federal meat processing specifications.

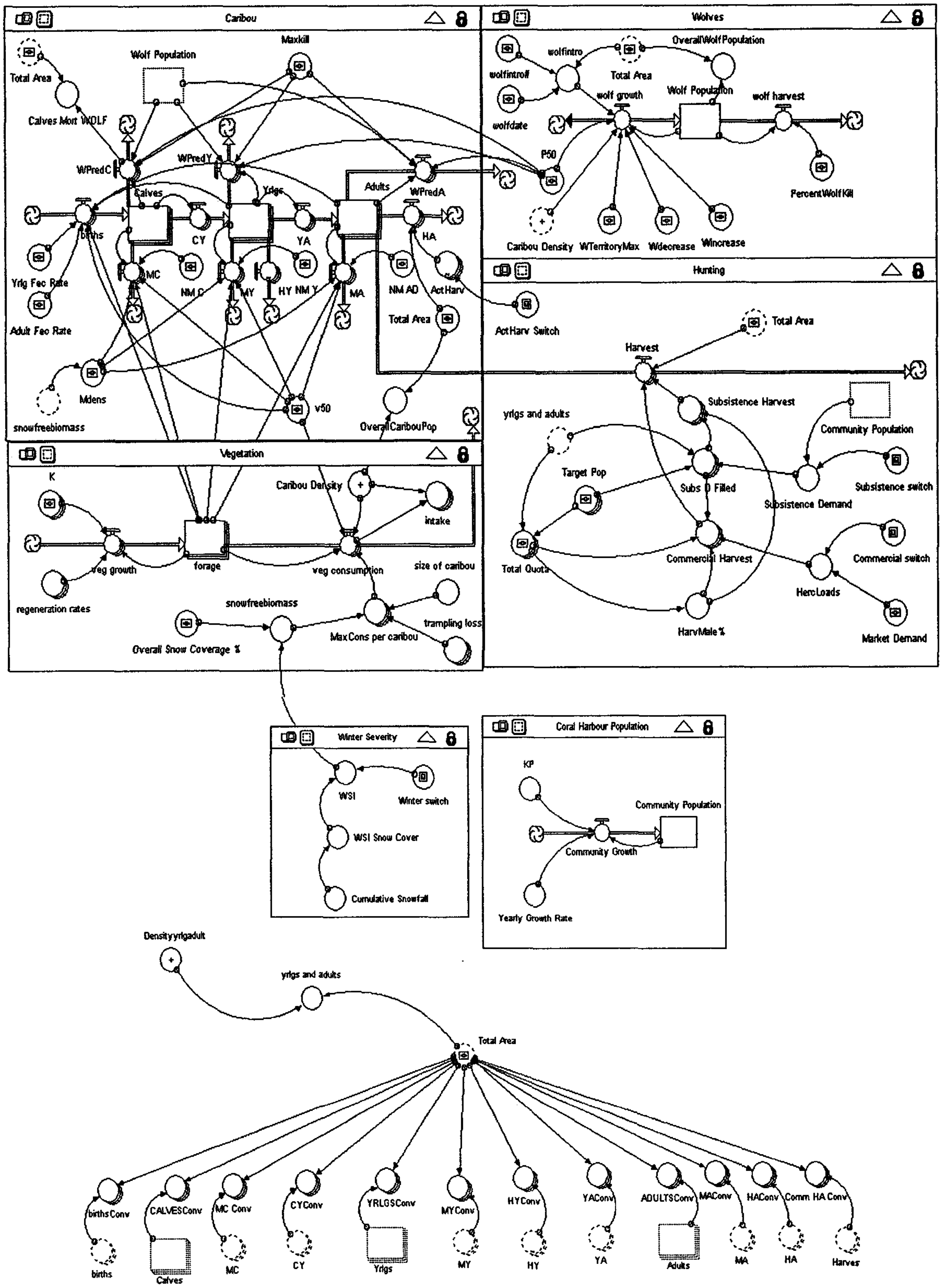
The group anticipated obtaining an average of 90 animals per day. The hunters take off from base camp on snowmobile, towing an empty komatik or Inuit sled. The hunters shoot the caribou in the head or neck area to reduce wastage of meat. Upon being shot, the caribou is immediately bled by cutting the carotid artery. The throat or esophagus is also cut to reduce bloating. The hunter then puts the caribou on his komatik and continues to hunt. From the moment a hunter shoots the first caribou, they have approximately one hour to transport all the acquired caribou carcasses back to the portable abattoir. This time limit was set by meat inspectors with the Canadian Food Inspection Agency to reduce bacterial contamination of the meat.

Typically, hunters arrive back at camp with two to seven caribou for processing. As the hunt progresses, the hunters generally have to travel farther from the base camp to hunt caribou and consequently have less time to hunt. Managers acknowledge that hunting success typically declines after approximately 2 200 to 2 500 animals have been harvested.

Once caribou are delivered to the abattoir, they are hooked onto a railing system where they are skinned, gutted, examined by federal officials, cut into halves, and trimmed for excess fat and haemorrhaging. However, if an animal is not shot in the head or neck, all traumatized tissue will be removed during the meat cutting process. Federal officials condemn any animals that are shot in the stomach area, any meat that has come into contact with other non-sanitary surfaces, and any meat that does not meet Agriculture Canada's meat inspection standards due to arthritis, emaciation, parasites, infections, and/or pneumonia. Over the years, the territorial government has worked with Agriculture Canada to refer to carcasses that are removed from the line as "downgraded for community use" if the problem is very isolated and/or cosmetic in nature. Animals are defined, as "condemned" when there is significant involvement of parasites, infections, etc. (J. Colford, pers. comm. 1999).

The carcasses are wrapped with cheesecloth and sent outside the abattoir on the railing system to freeze in the ambient temperature. The frozen meat is put into a combo bin that is located on a skid or barge system. This skid system is loaded with combo bins and transported back to Coral Harbour with a D-6 Cat. The combo bins are delivered to the airport where they are set on wooden pallets for ease of movement. Pallets are loaded onto an aircraft and transported to Thompson, Manitoba where they are loaded onto refrigerated trucks and delivered to meat processing facilities in Proton Station, Ontario where they are delivered to final end users. Carcasses are then cut into desirable meat cuts and distributed for sale.

APPENDIX 7-2: Model construction level for SHI caribou re-introduction model.



APPENDIX 7-3: Index of terms for SHI caribou simulation model..

Caribou

Adults[f](t) = Adult female population.
INIT Adults[f] = Initial introduced population of adult female caribou on SHI.
Adults[m](t) = Adult male population.
INIT Adults[m] = Initial introduced population of adult male caribou on SHI.

INFLOWS:
YA[gender] = Yearly transition from yearling to adult pool.
OUTFLOWS:
HA[gender] = Harvest of adult population.
WPredA[gender] = Wolf predation on adults.
Harvest[f] (IN SECTOR: Hunting)
Harvest[m] (IN SECTOR: Hunting)
MA[gender] = Natural mortality for adult pool.
Calves[f](t) = Female calves population.
INIT Calves[f] = Initial introduced population of female calves.
Calves[m](t) = Male calves population.
INIT Calves[m] = Initial introduced population of male calves.

INFLOWS:
births[gender] = Yearly ratio of caribou calves born on SHI (50/50 ratio)
OUTFLOWS:
CY[gender] = Yearly transition from calves to yearling pool.
MC[gender] = Mortality of calves.
WPredC[gender] = Wolf predation on calves
INIT Yrlgs[f] = Initial introduced population of female yearlings.
Yrlgs[m](t) = Male yearling population.
INIT Yrlgs[m] = Initial introduced population of male yearlings.

INFLOWS:
CY[gender] = Yearly transition from calves to yearling pool.
OUTFLOWS:
MY[gender] = Mortality of yearling population.
HY[gender] = Harvest of yearlings.
YA[gender] = Yearly transition from yearling to adult pool.
WPredY[gender] = Wolf predation on yearling pool.
ActHarv[gender] = Actual historical harvests on SHI.
Adult_Fec_Rate = Adult fecundity rate
Calves_Mort_WOLF = Wolf predation on calves.
Mdens = Correction factor for grazing responses relative to mean density of vegetation.
NM_AD = Natural mortality percentage for adult population.
NM_C = Natural mortality percentage for calf population.
NM_Y = Natural mortality percentage for yearling population.
OverallCaribouPop = Caribou population.
Total_Area = Total available caribou habitat on SHI.
v50 = Measure of caribou feeding efficiency.
Feeding efficiency = 500 kg/ha (Trudell& White, 1981);

Yrlg_Fec_Rate = Yearling fecundity rate.
ActHarv[gender] = Actual harvest of adult caribou population

Coral Harbour Population

Community_Population(t) = Coral Harbour population pool.
INIT Community_Population = Initial value for Coral Harbour population.

INFLOWS:
KP = Carrying capacity for the community of Coral Harbour.
Yearly_Growth_Rate = Estimate growth of community.
Community_Growth = Interaction of yearly growth rate and carrying capacity for the communitiy of Coral Harbour

Hunting

Harvest[f] = Harvest of adult females.

OUTFLOW FROM: Adults[f] (IN SECTOR: Caribou)
Harvest[m] = Harvest of adult males.

OUTFLOW FROM: Adults[m] (IN SECTOR: Caribou)
ActHarv_Switch = Switch used to turn on/off actual harvests.
Commercial_Harvest[f] = Commercial harvest of adult females.
Commercial_Harvest[m] = Commercial harvest of adult males.
Commercial_switch = Switch used to turn on/off commercial harvests.
HarvMale% = Percentage of males harvested.
HercLoads = Determination of Hercules aircraft loads.
Market_Demand = Random determination of market demand.
Randomizer = Variable which randomly calculates market demand.
Subsistence_Demand = Subsistence demand for community harvests.
Subsistence_Harvest[f] = Estimated number of female caribou utilized for subsistence harvesting.
Subsistence_Harvest[m] = Estimated number of male caribou utilized for subsistence harvesting.
Subsistence_switch = Switch used to turn on/off subsistence hunting.
Subs_D_Filled[gender] = Variable to ensure subsistence values are filled before any additional hunting can take place.
Target_Pop[f] = Target population.
Target_Pop[m] = Target population for males.
Total_Quota[gender] = Total quota for caribou harvesting.

Vegetation

forage[lichen](t) = Available lichen habitat.
INIT forage[lichen] = Initial lichen habitat.
forage[vascular](t) = Available vascular plant habitat.
INIT forage[vascular] = Initial vascular plant habitat.

INFLOWS:
veg_growth[plants] = Vegetation growth rates.
Forage Growth rate = regeneration rates of lichen and vascular plants.

OUTFLOWS:
veg_consumption[lichen] = Lichen plant consumption.
veg_consumption[vascular] = Vascular plant consumption.
Caribou_Density = Caribou density.
K[lichen] = Lichen plant biomass.
K[vascular] = Vascular plant biomass.
MaxCons_per_caribou[lichen] = Maximum consumption of lichen per caribou.
MaxCons_per_caribou[vascular] = Maximum consumption of vascular plants per caribou.
Overall_Snow_Coverage_% = Percentage of snow cover.
regeneration_rates[lichen] = Regeneration rate of lichen plants.
regeneration_rates[vascular] = Regeneration rate of vascular plants.
size_of_caribou = Weight of caribou.
snowfreebiomass = Snow –free biomass.
trampling_loss[lichen] = Caribou trampling loss of lichen mat.
trampling_loss[vascular] = Caribou trampling loss of vascular plants.

Winter Severity

Cumulative_Snowfall = Cumulative snowfall.
Winter_switch = Switch used to turn on/off winter varible.
WSI = Relative Winter Severity Index (WSI) is based on snow accumulations recorded at Coral Harbour from 1971-1990. The WSI is calculated according to Gunn et al., (1989) and is based upon percent deviations from the long term mean of accumulated snow depth on the last day of the month, for the periods of early winter (Sept. - Nov.), mid winter (Dec-Feb), and late winter (March-May). Snow accumulations are taken from Ouellet et al. (1996).
WSI_Snow_Cover = Percentage of snow cover.

Wolves

Wolf_Population(t) = Wolf population pool
INIT Wolf_Population = Initial wolf population.

INFLOWS:
wolf_growth = Wolf growth variable.
OUTFLOWS:
wolf_harvest = Number of wolves harvested by hunters.
bountywolves = Wolf bounty.
OverallWolfPopulation = Overall wolf population.
PercentWolfKill = Percentage of killed by hunters.
Wdecrease = Wolves rate of decrease.
Wincrease = Wolves rate of increase.
wolfdate = 1968
wolfintro = Introduction of wolves to SHI system.
wolfintro# = Number of wolves introduced.
WTerritoryMax = Maximum territory for wolves.
Wolf Pack Size = size of wolf packs.
social capacity = Social capacity of wolf packs.

Harvest Enterprise Budget

Harvest_Profit_or_Loss(t) = harvest revenue minus expenses
INIT Harvest_Profit_or_Loss = 0

INFLOWS:
Comm_H_revenues = commercial hunt revenues plus alternative hunt revenues.

OUTFLOWS:
Comm_H_expenses = operating costs plus overhead costs.
Profit_VS_Loss = commercial hunt revenue plus alternative hunt revenue minus operating costs and overhead costs

Level of Production

Abbatoir_Production = abbatoir production (in pounds).
Caribou_Weight = dressed weight of caribou carcass on SHI abattoir (55 pounds).
Commercial_Hunt_Revenues = Abbatoir_Production*Price_Per_Pound
Comm_D_Avail_Converter = converter to determine commercial demand available.
Price_Per_Pound = price per pound of caribou meat.
Price_Per_Pound_TEST = variable to test prices on model sensitivity
Random_Price_Generator = variable to test random generated prices on model sensitivity

Net Present Value

Net_Present_Value(t) = net present value.
INIT Net_Present_Value = 0

INFLOWS:
change_in_net_present_value =
Commercial_Hunt_Revenues*Discount_Factor+Alternative_Hunt_Revenue*Discount_Factor-Operating_Costs*Discount_Factor-Overhead_Costs*Discount_Factor
Discount_Factor = 1/(1+Discount_Rate)
Discount_Rate = 0.15 (assuming a 5% return on GIC's and a 10% risk factor).

Operating Costs

capital_purchases = on average, $15000 /yr in capital purchases.
cat_rental = SMC does not own Cat, therefore must rent at $15,000/yr from Coral Harbour company.
Cost_Randomness = variable to test costs sensitivity in abattoir production.
depreciation = depreciation of capital purchases.
Fixed_Operating_Costs = these are fixed operating costs that remain the same no matter what level of production. They include:.project_manager_consulting, capital_purchases, cat_rental, depreciation, freight_supplies, two_camp_strategy.
food = food for camp
freight_supplies = cost of shipping supplies to SHI: Freight is charged for hauling supplies - 747 airplane -- $40,000 sealift - $22,000 (Brian Threadkill, 2000)
fuel_&_oil = fuel and oil expense.
fuel_hauling = fuel hauling expense.
inspection_fees = inspection fees for Agriculture Canada officials.

miscellaneous = miscellaneous expenses.
Operating_Costs = fixed operating costs plus variable operating costs
packaging_materials = packaging materials expense.
project_manager_consulting = project manager/consultant is a yearly operating cost no matter what level of hunt. Set at $30,000/yr.

rentals = rental equipment expense
repairs_and_maint = repairs and maintenance expenses.
salaries_and_benefits = salaries and benefits of workers.
supplies = supplies for commercial hunt.
travel_and_accom = travel and accommodation for staff.
two_camp_strategy =expense of conducting two camp hunting strategy.
years_depreciation = severity of winters determine that a 5 year lifespan of equipment for hunt activities

Overhead Costs

Admin = administration expense.
Communications = communications expense
Fixed_Overhead_Costs = fixed overhead costs includes: communications, interest_bank_charges, legal_acct, and liability_insurance.
interest_bank_charges = interest bank charges on bank loan by SMC.
legal_acct = legal accounting expense.
liability_insurance = liability insurance for hunt.
Mgmt = management expense.
office_supply = office supplies expense.
Overhead_Costs = overhead costs (Fixed_Overhead_Costs plus Variable_Overhead_Costs)
revenue_can = Revenue Canada tax expense
Variable_Overhead_Costs = variable overhead costs which includes: management, administration, office supplies, Revenue Canada expense, and workers compensation.
workers_comp = workers compensation expense.

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CHAPTER 8

SYNTHESIS

INTRODUCTION

Many countries look to Canada's innovation in community-based resource management (Freese, 2000; Treseder et al., 1999). Innovative management has been expressed in many ways in Northern Canada and specific cases that I have examined included market hunting and large-scale commercial harvesting of caribou as representative of the overall initiative.

The great dilemma of commercially harvesting caribou (*Rangifer tarandus*) in the Canadian Arctic and Sub-Arctic is the delicate balance between maintaining caribou populations and meeting human economic and social needs. For centuries, Aboriginal people of the Canadian Arctic have depended on caribou for subsistence as well as cultural values. In the last century, development in the Canadian Arctic has had profound effects on the cultural and social aspects of Aboriginal people, especially in relation to a self-reliant lifestyle based on the harvesting of wildlife resources.

Historically, the origins of commercial harvesting of caribou can be traced to initial trading practices among Aboriginal bands (Chapter 2). Present day use is a result of adaptation by the Aboriginal people from a nomadic existence to a permanent rural society and subsequent government programs to help bridge the gap for Aboriginal people to participate in a wage economy society (Chapter 3). Government policies pertaining to the commercial harvesting of caribou in the Canadian Arctic have tried to strike a balance between the maintenance of Aboriginal hunting traditions, protection of the resource, and the generation of economic development opportunities in small, predominately Aboriginal communities (Chapter 4). While commercial harvesting policies have kept pace with the changing needs of the Aboriginal people of the Canadian Arctic however, legislation has lagged behind. This lag needs to be addressed to reflect today's harvesting practices as well as provisions in Aboriginal land claim agreements (Chapter 4).

This thesis focused on the economic viability of two examples of resource harvesting programs currently taking place in the Canadian Arctic and Sub-Arctic, specifically market hunting (Chapter 5) and large-scale commercial caribou hunts (Chapter 6 and 7).

Market hunting

Today, Aboriginal people rely less upon the wildlife resources due to their participation in the wage economy, associated modern conveniences, and the move to permanent residence in a community. Reliance on the land for subsistence by the Aboriginal people of the Canadian Arctic and Sub-Arctic is limited to a select few and the option of returning to this type of existence is becoming scarcer. In contrast, the demand for wild caribou meat remains strong within the Aboriginal communities and has been the impetus for the development of market hunting activities in the Canadian Arctic and Sub-Arctic (Chapter 5). I recommend that clearly defined policies and legislation for market hunting activities must be enacted to keep pace with this developing industry.

Although my research reveals that current market hunting practices are not jeopardizing the migratory caribou herds (Aboriginal hunters are presently allowed to sell to other Aboriginal people only), guidelines need to be enacted to provide the public with consistent meat quality assurances and continued sustainable use of the resource.

Currently, market hunting activities are a side occupation for only a few Aboriginal hunters, who maintain full time jobs, in order to finance the capital requirement of this activity. This is contrary to the perception in the communities that market hunters get compensated very well for their harvests. My research demonstrates that compensation from market hunting was not indicative of the amount of work and the risks associated with this type of hunting activity.

Large-scale commercial harvesting

To provide remote Aboriginal communities with economic development opportunities, the territorial government developed, in conjunction with Aboriginal organizations, large-scale commercial harvesting programs. However, these programs have all been subsidized and I investigated whether it was possible to develop an economically viable industry. An exponentially growing population of caribou on an island in the eastern Arctic, Southampton Island (SHI), Nunavut provided an excellent opportunity to study the population and economic effects of various types of harvests, including large scale commercial hunts (Chapters 6 and 7). As well as looking at economic viability, I evaluated harvesting as an option to stabilize population growth in order to have a stable resource base for a harvest based economy.

Using model simulation, my research demonstrated that subsistence harvesting by the local Inuit populations has had little impact on the dynamics of caribou populations and their food supply. At best, subsistence harvests only slightly delay the eventual cyclical, overshoot and collapse scenario of the caribou population (Chapter 6). Harvesting more caribou or commercial harvesting had a greater effect on the dynamics of this Arctic ecosystem. The model predicted that a harvest that is almost twice the current hunt's capacity would be required to stabilize the overshoot and collapse scenario on SHI. However, this level of commercial harvesting resulted in operational requirements that were unrealistic

(Chapter 7). The following factors limited ability to harvest enough animals to keep the population in a relatively stable cycle include: fluctuating market demand, logistics of obtaining free-roaming caribou, logistics and high costs of transporting caribou carcasses to southern locations, weather constraints which decrease the amount of time available to hunt caribou on SHI during the spring months, and the inability to provide a year-round supply of caribou meat to southern retailers.

The socio-economic aspects of large-scale commercial harvesting on SHI are very positive for the community of Coral Harbour, NU. Hunting operations provide much needed employment and influx of dollars in the community. However, my research showed that in order to remain economically viable, many interrelated factors (i.e. filling aircraft to maximum capacity, contract prices obtained from buyers, consistent shipping and freight charges, and well maintained equipment) must be coordinated. Most importantly, my research concludes that government subsidization of the hunts was critical for economic viability of this operation. Without subsidization, hunt operations would have to rely on southern market demand to accept higher sale prices for the caribou meat. Utilizing net present value theory, model simulation demonstrated that the price of caribou meat obtained from the large scale harvesting operation was very price sensitive when assessing the acceptance or rejection of this business venture.

CONCLUSION

Commercial harvesting of caribou has been part of Aboriginal cultures for centuries in the Canadian Arctic and Sub-Arctic. However, once Aboriginal society entered the wage economy, remuneration from commercial harvests was no longer economically viable. The evolution of this practice to current day activities has been the direct result of various government programs, trying to develop relief programs and generate economic development initiatives in small, predominately Aboriginal communities throughout the Canadian Arctic.

Consequently, some programs have not addressed the cultural needs of Aboriginal people (see Chapter 3 – Reindeer Herding). However, current practices of market hunting, organized community hunts, and large-scale commercial hunts have been developed cooperatively with Aboriginal people and overall have exceeded their goals of providing fresh meat within the respective communities, injecting cash into the local economies, and providing employment opportunities for local Aboriginal people.

The territorial government has addressed these changes in resource use and economic development initiatives by adopting flexible, innovative policy concerning the commercial use of caribou in the Canadian Arctic. The government also has taken great strides in allocating the financial resources required to start up operations through grant and contribution programs (infrastructure support) and effectively worked with other government agencies to address protocol issues (e.g. Agriculture Canada's meat inspection guidelines). Although government policy has been proactive in the development of the commercial use of caribou, legislation has lagged behind and needs to be addressed to conform to the changing roles of the territorial and Aboriginal governments in the Canadian North.

The logistical and financial constraints of commercial harvesting in the Canadian Arctic and Sub-Arctic dictate that government support through policy and legislation procedures, as well as monetary subsidization, must be integral components of future of commercial harvesting. The revision of legislation to address the changing roles of government within the Canadian Arctic and Sub-Arctic is imperative for the continued protection of wildlife resources as well as the economic development involving Aboriginal peoples.

Commercial harvesting of caribou will continue to have a place in the changing role of Aboriginal culture and governance in the Canadian Arctic. By adapting to ever-changing demands of both the resource and the Aboriginal people who rely on this resource, commercial harvesting of caribou should be able to remain a viable opportunity for Aboriginal people in the Canadian North.

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