THE ECOLOGICAL AND SOCIAL DYNAMICS OF INUIT NARWHAL FORAGING AT POND INLET, NUNAVUT

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ABSTRACT

Research over the past several decades on the nature of Inuit hunting of narwhals has focused upon harvesting technologies and the traditional ecological knowledge of modern hunting of the species. However, as much as such work has contributed to our understanding of Inuit and narwhal interaction, less is known about contemporary Inuit hunting behaviour of narwhal. The research presented in this dissertation redresses this gap by providing a detailed behavioural description and analysis of the Inuit narwhal hunting in two critical environments utilized by the Inuit of Pond Inlet – those of the spring floe-edge and the summer open water.

This information and its analysis are presented through three manuscripts. The first manuscript forms the analytical basis of the behavioural description by presenting through the use of a decision flow chart, the parameters that affect narwhal hunting. The second and third manuscript explore different foraging strategies involved in several major decisions the Inuit typically face when pursuing narwhal at the floe-edge (Manuscript Two) and in the open water environment (Manuscript Three). The data pertinent to the major decision factors influencing actions in both environments were obtained through participant observation, supplemented by interviews with hunters and elders.

The main results of this research pertain to the different, but complementary, strategies employed by *Mittimatalingmiut* (Pond Inlet Inuit) hunters during the floe-edge and ice free seasons, as well as during the transition between the two. Before break-up, the most frequent method employed in floe-edge and outpost camp hunts is an ambush or a sit-and-wait strategy. Interestingly, during the transition between floe-edge and complete open water, Pond Inlet Inuit utilized both sit-and-wait and pursuit hunting strategies to maximize their hunting opportunities.

RÉSUMÉ

Lors des dernières décennies, les recherches portant sur la nature de la chasse aux narvals par les Inuit ont surtout mis l'accent sur les technologies utilisées et sur le savoir écologique traditionnel de la chasse moderne. Cependant, bien que ces recherches contribuent à notre compréhension du rapport entre les Inuit et les narvals, nous en savons très peu sur les comportements de chasse contemporains des Inuit. La recherche qui est exposée dans cette dissertation veut rectifier cette lacune en apportant une description comportementale élaborée et une analyse de la chasse aux narvals par les Inuit dans deux environnements critiques utilisés par les Inuit de Pond Inlet – ceux des lisières des banquises côtières (floe-edge) au printemps et dans les eaux dégagées (open water) en été.

Cette information et son analyse sont présentées tout au long de trois manuscrits. Le premier manuscrit forme la base analytique de la description comportementale en présentant, grâce à un organigramme décisionnel, les paramètres qui affectent la chasse aux narvals. Le deuxième et troisième manuscrit explorent différentes stratégies alimentaires impliquées dans les décisions majeures auxquelles les Inuit doivent faire face lors de la chasse aux narvals sur les lisières des banquises côtières (Deuxième manuscrit) et dans les eaux dégagées (Troisième manuscrit). Les données pertinentes aux facteurs décisionnels majeures influençant les actions dans ces deux environnements ont été obtenues par observation participante et complétées par des entrevues avec les chasseurs et les anciens.

Les résultats principaux de cette recherche se rapportent aux stratégies différentes, mais complémentaires, employées par les chasseurs *Mittimatalingmiut* (Inuit de Pond Inlet) pendant les saisons des lisières des banquises côtières et des eaux dégagées, et aussi lors de la transition entre les deux. Avant le bris des glaces, la méthode employée le plus fréquemment sur les lisières des banquises côtières et dans les campements éloignés est celle de la chasse à l'affût (sit-and-wait). Pendant la transition entre les saisons, les Inuit de Pond Inlet utilisent aussi cette stratégie de chasse à l'affût, mais ils la complémente par de la poursuite (pursuit) pour maximiser leurs opportunités de chasse.

CONTRIBUTIONS OF AUTHORS AND COMMITTEE MEMBERS

The present thesis comprises three manuscripts, all of which pertain to a single cohesive program of research focusing on the current hunting of narwhal by Pond Inlet Inuit. The first and third manuscript has one author: the candidate. The second manuscript has two authors: the candidate and his supervisor, Dr. George Wenzel. The respective contributions to each of the manuscripts are as follows. The initial idea to describe the entire decision-making process for a floe-edge and open-water narwhal hunt in manuscript one was developed through discussions between the author and his supervising committee (Dr. Donald Kramer, Dr. James Savelle, Dr. Oliver Coomes, and Dr. George Wenzel). The methodology and theoretical approach were adopted independently by the candidate. The idea in manuscript two of utilizing foraging mode as a theoretical framework to explore Inuit hunting behavior of narwhal was developed through discussions between the author and Dr. Donald Kramer. The idea of comparing foraging mode with other species in manuscript two was developed between the author and Dr. George Wenzel. The idea in manuscript three of analyzing foraging mode in the open water environment and its comparison with the floe-edge environment was developed through discussions between the candidate and Dr. George Wenzel. Again, the theoretical approach and methodology were adopted independently by the candidate. All participant observation, data analysis and writing of the manuscripts were done by the candidate. Dr. Donald Kramer, Dr. Oliver Coomes, and Dr. James Savelle edited drafts of the second manuscript. The candidate's supervisor edited several drafts of each manuscript.

STATEMENT OF ORIGINALITY

Past ecological research on the interaction between Inuit and narwhals has generally concentrated on hunt ethnographies (see Bissett 1968; Degerbøl and Freuchen 1935; Mary-Rousselière 1984). Often, data about narwhal hunting is restricted to a brief mention in a harvest table. More recent work has centered on: 1) the cultural and/or nutritional importance of *maktaaq* (narwhal skin; Bisset 1968; Mathiasson 1992), 2) the economics of the narwhal ivory trade (Land 1977; Reeves 1992), 3) the animal's place in the modern Inuit subsistence system (Baffin Regional Inuit Association 1982, 1983, 1984, 1985; Donaldson 1988), and 4) the modern and traditional ecological knowledge component of narwhal hunting (Remnant and Thomas 1992; Thomsen 1993; Stewart et al. 1995). As much as these works contribute to our understanding of the Inuit and narwhal relationship, none provide a comprehensive analysis of contemporary narwhal hunting behaviour.

Accordingly, the primary contribution of my thesis involves a contemporary behavioural analysis of Inuit foraging tactics and strategies for hunting the narwhal. The three manuscripts included in this thesis contribute to the advancement of knowledge in the fields of cultural ecology and human behavioural ecology. These papers represent the first attempts to present and describe in detail the Inuit hunt of narwhal in the floe-edge and open-water environments in the eastern Canadian Arctic.

By filling a gap in the literature, this research advances our knowledge of the Inuit-narwhal relationship in several ways. Firstly, it represents an important initial phase of inquiry by providing an extensive description of the major Inuit decisions, environmental parameters, goals and assumptions underlying floe-edge and open-water based narwhal hunting trips. Secondly, it improves our understanding of the organization and pattern of Inuit hunting behaviour with respect to the narwhal in each of these environments. Thirdly, it builds upon our current knowledge of human foraging behaviour in "traditional" foraging societies. Fourthly, it contributes to the knowledge of human decision making and environmental problem-solving in a modern foraging situation. Lastly, it contributes to improving the comprehension by non-Inuit of contemporary Inuit hunting practices.

INTRODUCTION: RATIONALE AND OBJECTIVES OF THE RESEARCH

Narwhals are currently harvested by both Canadian and Greenland Inuit in the Arctic and their products have widespread cultural importance. The narwhal is hunted by Inuit for its tusk, skin and other edible parts (Reeves 1992). Most notably, "the so-called *maktaaq*, which is the whole skin, is extremely popular as the greatest delicacy an Eskimo can get" (Degerbøl and Freuchen 1935, 247), and is still highly desired by Inuit today (Personal observations). Traditionally, the *maktaaq* was eaten raw, while much of the meat was fed to sled dogs and the blubber was rendered down for heating and lighting (Brody 1976).

The hunting of narwhals continues to be a major part of Inuit subsistence activities in the north Baffin region. The annual harvest of narwhals by north Baffin Island Inuit represents a unique historical relationship in terms of a continuous and relatively undisturbed utilization of a local marine resource. However, Inuit hunting behaviour of narwhals along with the sharing and distribution of its products has undergone some major changes during the past century. This is in part due to several major historical and current influences that include the relocation of Inuit from large expanses to focal centralized communities, the introduction and adoption of modern technology, and the concurrent influences of local and global political and socio-economic pressures.

Despite the ethnographic and cultural importance of small whales to Inuit, research on Inuit hunting behaviour of narwhals in the Arctic has been limited both in terms of number of studies and depth of analysis (with notable exceptions of Dahl 1990, 2000; Smith 1991). The major purpose of this thesis is to uniquely enhance our current understanding of the historically distinctive and extant relationship between Inuit and narwhals in the Canadian Arctic through the case study of Pond Inlet Inuit. This is achieved through the study of Inuit hunting behaviour of narwhal in the floe-edge and open-water environments.

The three major objectives of the program of research presented in this thesis are: 1) to collect detailed data on the individual foraging behaviour of Inuit with respect to narwhals in the natural environment, 2) to identify the parameters and goals of major

Inuit hunting decisions, and 3) to analyze the mechanisms underlying these decisions. Throughout these three manuscripts, I will argue and illustrate how a behavioural ecology approach is a valid theoretical framework for the study of Inuit-narwhal interaction.

The first manuscript (to be submitted) provides an extensive description of some of the major Inuit decisions in both floe-edge and open water narwhal hunting trips for the spring and summer hunting seasons. This has been done in order to improve our general knowledge of the Inuit hunt for narwhals in these two seasonal environments. Results are organized and presented in a manner that reveals some of the critical factors that Inuit consider for each major decision of the hunting trip. The purpose of the second manuscript (submitted to and accepted by *Études Inuit/Inuit Studies*) is to show how foraging theory can contribute to our understanding of Inuit hunting behaviour. A participant-observation study reveals that Pond Inlet Inuit primarily engage in a sit-and-wait foraging mode when hunting narwhals in the floe-edge environment. The third manuscript (to be submitted) continues the analysis of foraging mode for the open water environments and also discusses the pursuit phase of the narwhal hunts. The specific aspects of the narwhal hunt for two different open water environments are also compared to the floe-edge environment.

CHAPTER 1: REVIEW OF THE LITERATURE

Pond Inlet Inuit hunt narwhals in the eastern Pond Inlet ice floe-edge from late spring to early summer (approximately June and July) and in the open water of Pond Inlet and surrounding bays, fjords, sounds, and inlets throughout the remainder of summer and fall (approximately July to October). This particular community was selected as a case study because of its large annual narwhal quota and exceptional narwhal hunting opportunities. This is due in part to the geographical position of the community of Pond Inlet in the Lancaster Sound region that provides these Inuit with ideal access to intercept narwhals on their annual migration route to and from their summering grounds (see Figure 1). During the study period, the communities of Arctic Bay and Pond Inlet shared the highest narwhal quotas of one hundred animals per community. This is in sharp contrast to the eleven other Nunavut communities that possessed a narwhal quota of fifty animals and less (see Table 1).

In this section, I first present a description of the study area followed by a literature review of the narwhal, of Pond Inlet Inuit and of their historical relationship. Finally, I introduce the theoretical background that underlies the three manuscripts at the core of the present thesis.

The Study Area

The study area comprises the following environments: 1) the open coastal waters of northern Baffin Island concentrating in and around the community of Pond Inlet, 2) the open coastal waters located near outpost camp shore sites located west of the community of Pond Inlet and concentrated in and around Navy Board Inlet, and 3) the Pond Inlet floe-edge located adjacent to the community of Pond Inlet (see Figures 1 and 2). A floe is any relatively flat piece of ice 20 m of length or more (MANICE 2002). In this study, the Pond Inlet floe-edge refers to the interface between the relatively contiguous Pond Inlet floe and the open water of Baffin Bay.

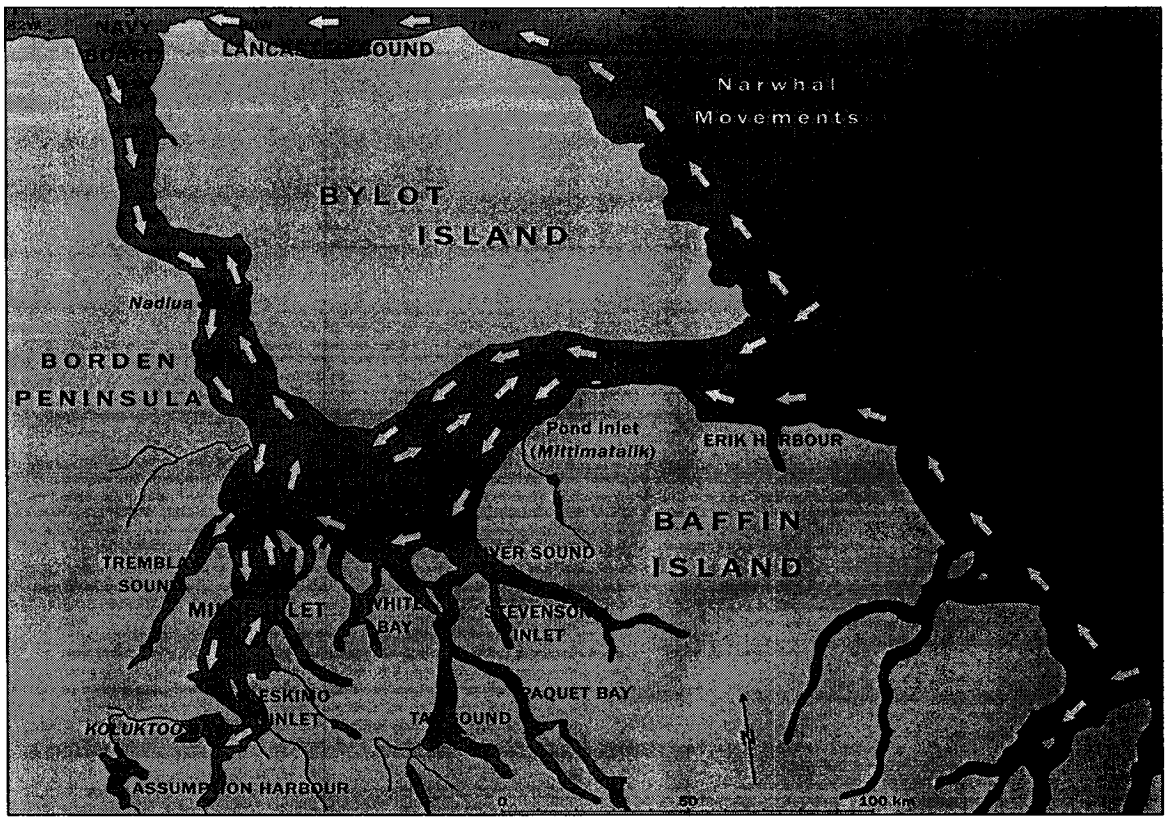

Figure 1. Narwhal distribution in the Pond Inlet and Lancaster Sound regions during summer and fall hunting seasons (June – October).

Table 1 Narwhal hunting Statistics in Canada (1993-1998). Source: Department of Fisheries and Oceans (1998).

Community	Quota	Reported Catch				
		1993-1994	1994-1995	1995-1996	1996-1997	1997-1998
Arctic Bay	100	85	99	46	99	66
Broughton I.	50	52	50	50	21	50
Clyde River	50	34	25	26	10	15
Gjoa Haven	10	0	0	0	0	0
Grise Fiord	20	9	12	9	1	1
Hall Beach	10	0	6	0	1	2
Igloolik	25	27	25	18	5	3
Iqaluit	10	0	0	0	0	0
Pangnirtung	40	24	33	6	19	2
Pelly Bay	10	0	0	5	7	15
Pond Inlet	100	79	91	73	100	75
Resolute	32	8	3	4	2	7
Taloyoak	10	0	0	0	0	0
Total	467	318	344	237	265	236

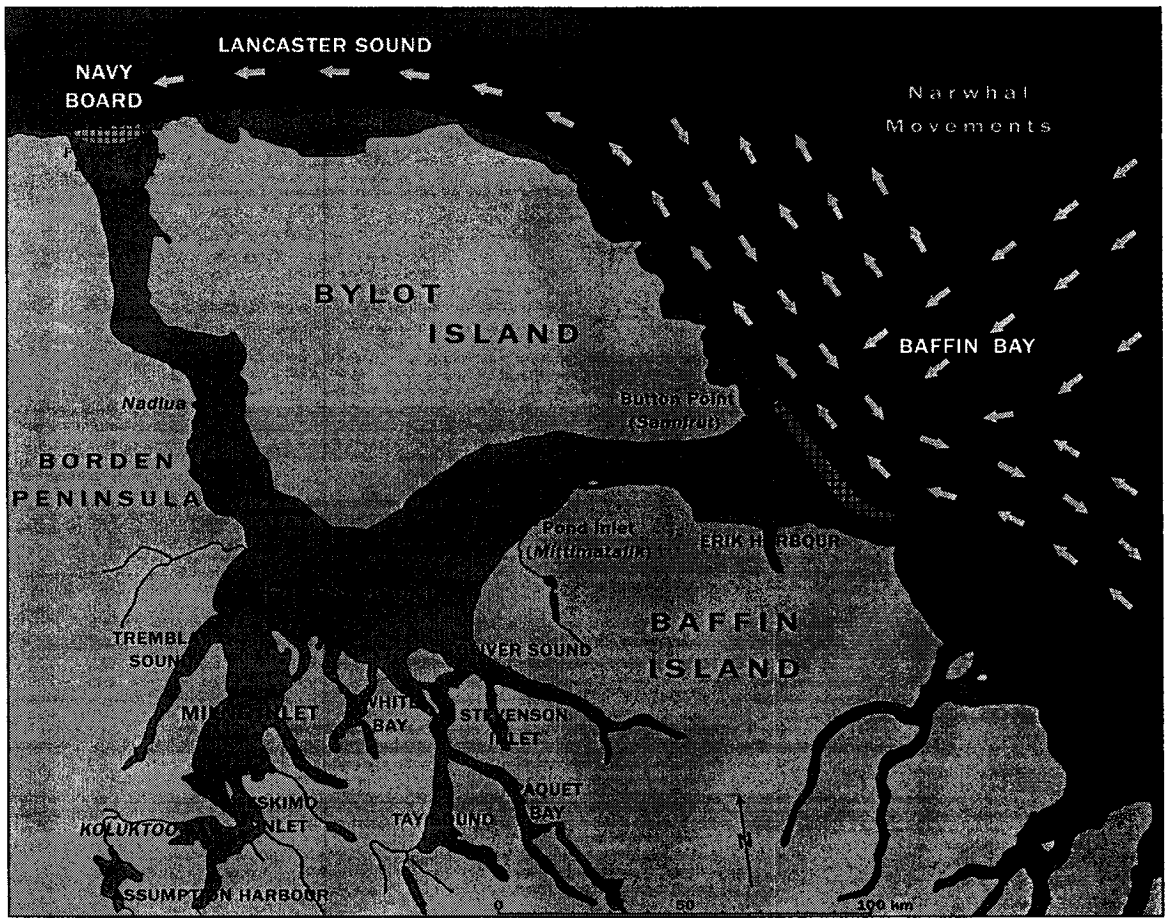

Figure 2. Location of the Pond Inlet floe-edge and narwhal movements in Baffin Bay and Lancaster Sound during spring (approximately May to late June).

In absolute position, the community of Pond Inlet is situated at latitude 72°41' N and longitude 77°58' W. In relative position, the community of Pond Inlet is located at the north eastern end of Baffin Island in the Canadian Arctic, at 644 km above the Arctic Circle (see Figure 3). The Inuktitut name for the community is "*Mittimatalik*", which means "the place where *Mittima* is buried". The Inuit also refer to the Pond Inlet area as "*Purtujuq*" which means "land with depth", referring to the geography of Bylot Island and north Baffin Island. The current population is approximately 1220 individuals with a division of 650 males and 570 females (see Figure 4). The community comprised 94 percent cent Inuit and 6 percent non-Inuit (Statistics Canada 2001). Although English is widely spoken, Inuktitut is the most commonly used language by Inuit.

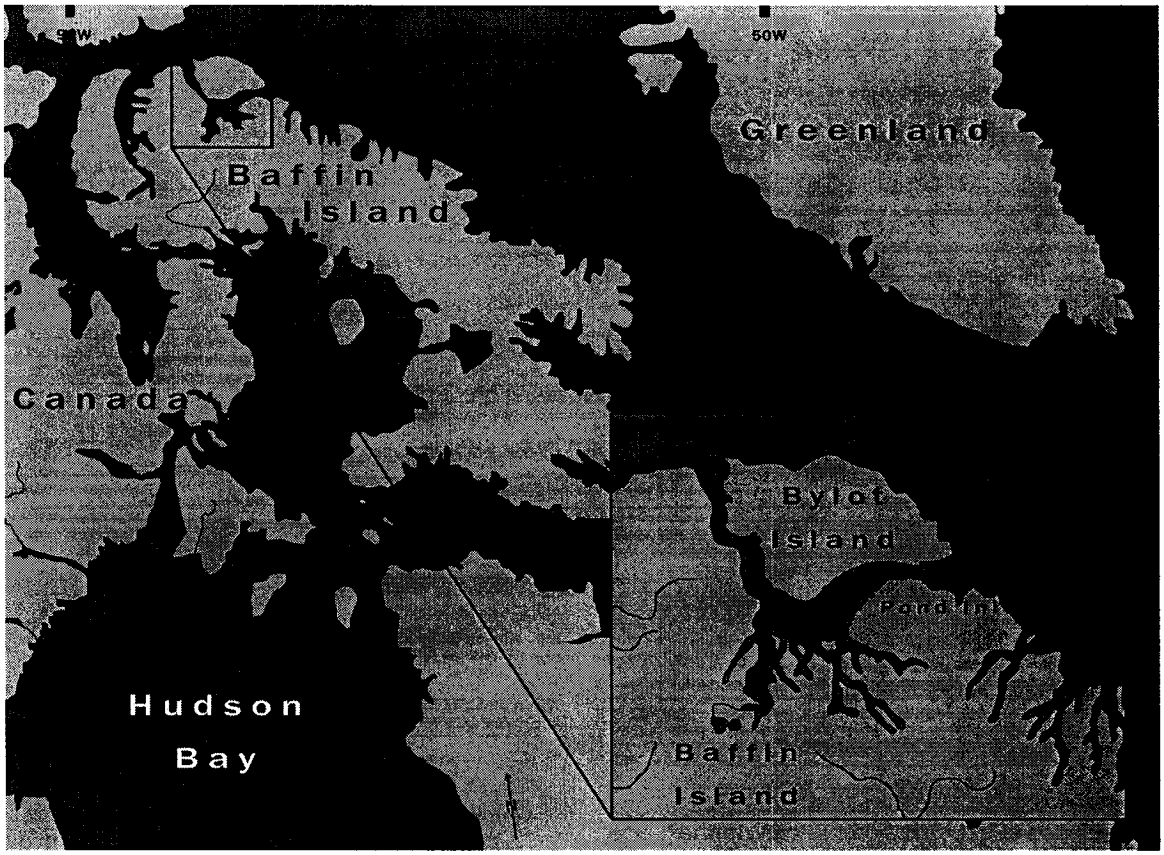

Figure 3. Location of Pond Inlet (*Mittimatalik*) on Baffin Island.

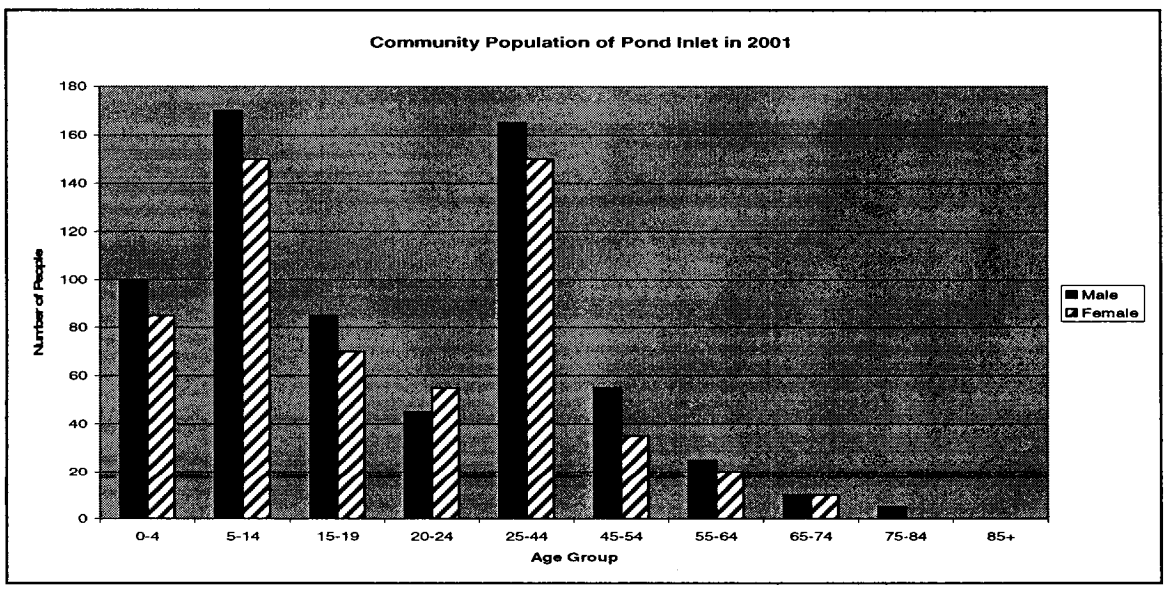

Figure 4. Population of Pond Inlet by Age and Sex. (Data from Statistics Canada 2001.)

The Narwhal (*Qilaluqak; Monodon Monoceros*)

Distribution in the study area

The narwhal has been known to inhabit the marine waters of the northern third of the northern hemisphere (see Figure 5; Reeves and Tracey 1980; Hay and Mansfield 1989). As such, its distribution area includes the open waters of the nation states of Canada (Nunavut), Denmark (Greenland), Iceland, Norway (Svalbard), the Russian Federation and the United States (Alaska). However, the vast majority of narwhal hunts occur in Canada and Greenland, where they are currently only hunted by Inuit. Three major narwhal centres of distribution are recognized nowadays: 1) Baffin Bay/Davis Strait and adjoining channels, 2) northern Hudson Bay/southern Foxe Basin and 3) Greenland Sea/Svlabard area (IWC 2000). The present study area of Pond Inlet lies within the effective area of the Baffin Bay/Davis Strait centre of distribution.

Figure 5. Narwhal Distribution in the World. (Data from Reeves 1992.)

The presence of narwhals at the Pond Inlet floe-edge near Button Point of Bylot Island was first documented by Mathiassen (1928). This was supplemented by observations of marine wildlife in the Lancaster Sound region made by Degerbøl and Freuchen (1935) in their Fifth Thule expedition report. Several government expeditions, notably those reported upon by Anderson (1934), also took note of the marine mammals encountered in the study area. Other published accounts of marine wildlife in the region include those by Ellis (1957) and Miller (1955). Tuck (1957) also reported on the distribution of seabirds and marine mammals at Cape Hay, northwest Bylot Island. The general knowledge of narwhal distribution in the area was considerably enhanced through aerial surveys during the 1970's, with reports by Greendale and Brousseau-Greendale (1976), Webb (1976), Johnson and others (1976), and Renewable Resources Consulting Services Ltd. (1977). For example, a westward migration of several thousand narwhals through Lancaster Sound was observed by Greendale and Brousseau-Greendale through aerial surveys. Sergeant and Hay (1979) and Bradstreet (1982) provided a more extensive report on narwhal distribution and other sea mammals in northern Baffin Island. In summary, these reports reveal that the Baffin Bay population of narwhal resides mainly in the high Arctic, often amongst the pack ice and generally offshore. Its summer range includes most of the waters of the Canadian Arctic Archipelago. Main summering areas in Canada are Admiralty Inlet, Barrow Strait, and Prince Regent Inlet. Overall, narwhals were observed in various sounds, inlets, and bays such as Eclipse Sound, Koluktoo Bay, Navy Board Inlet, Milne Inlet, and Tay Sound (see Figure 1).

More recently, satellite tagging data and aerial surveys have revealed that the distribution of the Baffin Bay/Davis Strait population of narwhal is concentrated in the open waters of the eastern Canadian Arctic and northern Greenland from approximately early May to late September (see Dietz and Heide-Jørgensen 1995; Dietz et al. 2001). This population is considered to be a shared population between Canada (Nunavut) and Denmark (Greenland) in which narwhals migrate from their shared wintering grounds of Baffin Bay and Davis Strait to their separate summering grounds in the Canadian High Arctic and the West-Northwest Coast of Greenland. This population is thought to have a winter distribution (approximately from late September to early May) in the pack ice of

Baffin Bay and Davis Strait (Born et al. 1994; Dietz et al. 1994; Heide-Jørgensen et al. 2003; Kingsley, Cleator and Ramsay 1994; Koski and Davis 1994; Richard et al. 1994).

The advance and retreat of the ice appears to initiate narwhal migration. Heide-Jørgensen and colleagues (2003) tagged and tracked two female whales from the Baffin Bay population for twelve months and revealed that these whales showed remarkable site fidelity to summering grounds and had specific migratory routes that followed sea ice formation and recession. These tagged narwhals were shown to have utilized three focal areas between their spring and autumn migration: 1) a coastal area in the open-water season in August in the Canadian High Arctic, 2) a wintering area from November through April in the consolidated pack ice of Baffin Bay, and 3) an early summer area in front of the receding fast ice edge in Lancaster Sound. Westward migration through Lancaster Sound and Pond Inlet to reach presumable summering grounds is initiated during the break-up of ice that begins approximately in May and continues through June (Hay 1984; Silverman 1979). The presence of narwhals in the open water in Eclipse Sound, Navy Board Inlet, Koluktoo Bay, Tay Sound, and other adjoining bays, sounds and inlets throughout the summer suggests that these areas represent major summering grounds for narwhals (Heide-Jørgensen et al. 2003). In autumn, narwhals began their fall migration eastward from these areas to the wintering areas in Baffin Bay and Davis Strait.

Population estimates

Smith and colleagues (1985) provided an estimate of 13 200 to 18 000 narwhals in Lancaster Sound and adjoining waterways. This estimation was based on surveys made of Lancaster Sound, Barrow Strait, and Prince Regent Inlet in August. However, it should be noted that they did not include an estimate for whales summering in Pond Inlet, Eclipse sound, Navy Board Inlet or the east coast of Baffin Island. Such information was provided by Strong (1988), based on aerial photographic surveys of Eclipse Sound, Admiralty Inlet, Prince Regent Inlet, and Peel Sound in August 1984. He produced an estimate of 17 900 narwhals for this region. Later, confidence limits for this estimate were set at 13 100 to 21 400 (Cosens, Craig and Shortt 1990). Richard and colleagues (1994) produced an estimate of 18 000 narwhals (confidence limits: 15 000 – 21 000)

based on aerial surveys conducted in 1984 for this same region. Koski and Davis (1994) produced an estimate of 34 700 narwhals (confidence limits: 21 600 - 54 600) based upon an aerial survey of western Baffin Bay in May 1979. This survey covered approximately two-thirds of Baffin Bay. Based on the cumulative research conducted through the 1970s and 1980s, Reeves, Dietz and Born (1994) produced a population estimate of the whole Baffin Bay stock to be 34 000 (confidence limits: 12 600 - 54 600).

In all of the above cases, the population estimates were based on the sightings of narwhal at the surface of the water and did not take into consideration narwhals that may have dived to deeper water. This is an important point as dive data from tagged narwhals in the Canadian High Arctic, Melville Bay and Baffin Bay suggest that there may be a significant number of narwhals that are not seen during an aerial survey (Martin, Kingsley and Ramsay 1994, Heide-Jørgensen and Dietz 1995). Most recently, Innes and colleagues (2002) produced an estimate of 45 358 narwhals (confidence limits: 23 397 - 87 932) for the Canadian Arctic that took into account narwhals that may have been diving. Additional large-scale aerial surveys were conducted in 2002 and 2003 in the Canadian Arctic (CITES briefing 2004). The results were still in the process of being analyzed as this thesis was being written.

Physical characteristics of the narwhal

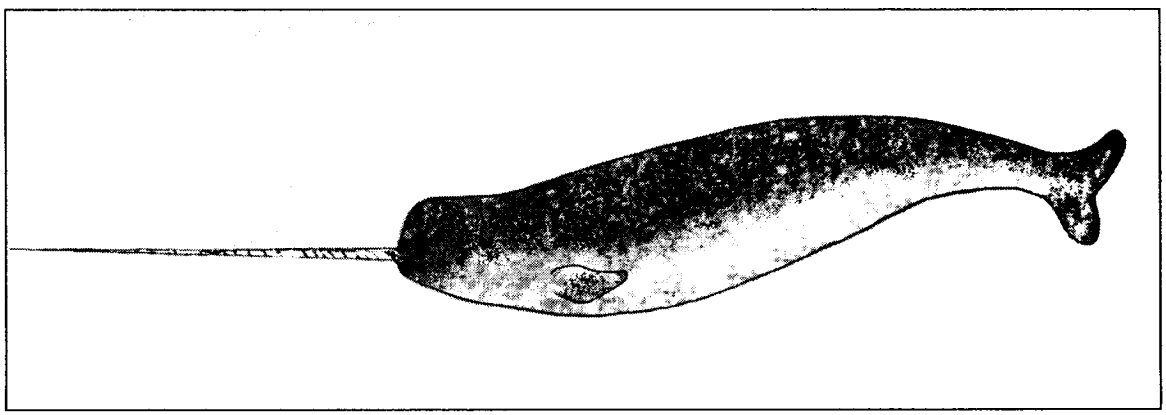

Figure 6. Illustration of adult narwhal with tusk. Source: Yun J. Lee (2004).

Hay (1984) has performed one of the most comprehensive studies of the life history of the narwhal. Foremost, he underscores the lack of biological research conducted on narwhal. Such research is at best limited in their natural environment and none has been undertaken in captivity. Despite limited biological knowledge of the narwhal, much information has been extrapolated from the beluga *(Delphinapterus leucas)*, as they share many physical characteristics. For example, most of the narwhal reproductive values are based upon the beluga species (Kingsley 1989). The narwhal and beluga belong to the same family *Monodontidae* and are similar in shape and size, possess similar short beaks, rounded heads, lack dorsal fins and have a thick layer of blubber. However, the narwhal is specifically characterized by a rounded head with a very short rostrum, and pectoral flippers upturned at the tips (see Figure 6; Hay 1984).

After a gestation period of approximately fifteen months, the young are born about 1.5 m long and about weigh 80 kg. Newborn narwhal are a blotchy brownish grey. By the time they are weaned at eighteen to twenty months, they are uniformly purplish black. During the years of adolescence, white patches or splotches may begin to appear. Females become sexually mature after five years at approximately 3.5 m long and 725 kg. Males mature after eight years at approximately 5.0 m long and 1450 kg. At maturity, both sexes are greyish with black or dark brown smudges; very old animals (twenty-five to thirty years of age or older) can be almost entirely white. Hay (1984) suggests that the longevity of a narwhal is about fifty years based on application of dentinal growth layers deposited annually. Bada, Mitchell and Kemper (1983) provided acid racemization-determined ages of four narwhals as ranging from twenty-five to fifty-two years.

One of the most noticeable characteristics of the mature narwhal males is the outgrowth of the left tooth through the jaw that forms an elongated and virtually straight ivory tusk (see Figure 6). Most narwhals possess two teeth in the upper jaw. When males are approximately one year old, the left tooth erupts through the upper lip to become the tusk. However, it should be noted that some females have been observed also to develop a tusk, but this has been so rarely observed that the tusk is considered a sexually dimorphic trait (Hay 1984; Personal communications with Pond Inlet Inuit). As the narwhal grows, its tusk increases in length and spirals counter-clockwise. The tip of

the tusk is usually brilliant white and polished smooth. The lip at the base of the tusk never seems to heal and is often infested with several pounds of ectoparasites[1] (Reeves 1992). The tusk may grow to 3 m with a 20 cm circumference at its base, and weigh up to 10 kg. The narwhal tusk is hollow for most of its length and quite brittle at its tip (Personal observations). In roughly one third of individuals, it has been observed that the tusk is broken (Hay 1984). Studies suggest that males engage in aggressive behaviour using their tusk when they compete for females: males cross tusks and spike at one another, leaving scars and broken tusks (Hay 1984; Silverman 1979). Though the primary function of the male's tusk is thought to be a sexual feature to establish social dominance within its own species, evidence suggests that they do in fact use their tusk aggressively against other species. Hunters harvesting a beluga whale noticed scars and the tip of a narwhal tusk embedded in its head (Hay 1984). It is thought that because narwhals and belugas share the same prey species and that their habitats cross at certain times of the year, interspecies aggressive acts and behaviour may occur over conflict in food and spatial resources (Hay 1984; Silverman 1979).

Narwhal diet

Narwhal possess a varied diet, feeding upon squid, fish and crustaceans (Hay 1984). Narwhal have also been documented to feed on fish species such as halibut (Vibe 1950; Finley and Gibb 1982). With few functional teeth, this animal must use suction and the emission of a jet of water to disturb prey such as bottom-living fish and molluscs (Hay 1984). Its highly flexible neck also aids the scanning of a broad area and the capture of more mobile prey such as arctic cod. In turn, the narwhal is preyed upon by polar bears (*nanuq*; *Thalarctos maritimus*), walruses (*aiviq; Odobenus rosmarus*), killer whales (*aarluk*; *Orcinus orca*), a number of sharks, and humans (Personal communication with Inuit).

Narwhal behaviour

Helen Silverman (1979) studied narwhal behaviour and social organization in the Lancaster Sound region. Narwhal occasionally migrate in herds with thousands of

[1] Ectoparasites are parasites which live on the surface of a host.

individuals, but groups of twenty are more typical. Narwhal herds are segregated into three groups: juveniles, cows and calves, and tusked males. Because they are thought to be important in mating contests, the male with the biggest tusk establishes dominance in the herd. This visible indicator of size and age gives the dominant male the primary opportunity to mate with females, giving him the first chance to pass on his genes to the next generation.

More recently, Heide-Jørgensen and colleagues (2003) conducted surveys of narwhal diving behaviour and distribution in the north Baffin Island region using satellite radio tagging methods. Information was collected on maximum depth of dives. Results revealed that narwhals in this study area apparently dived to the floor or close to the floor (approximately 1500 m) in the areas they inhabit in both summer and winter presumably to feed on bottom fish (see also Heide-Jørgensen and Dietz 1995).

International conservation and management organizations

In 1979, narwhals were included in the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). Canada was one of the original eighty signatories of the text of this Convention that was initially implemented in 1975. CITES provides an international framework for regulating trade in animals and plants that are or may become threatened with extinction. Essentially, it represents an international effort towards sustainable management of natural resources. There are currently 128 countries that are member of CITES. Environment Canada is the lead agency responsible for implementing CITES for the Canadian government. Within Environment Canada, the Canadian Wildlife Service administers CITES through interaction with the provincial and territorial governments and other federal agencies such as the Department of Fisheries and Oceans, Canadian Forest Service, Canadian Food Inspection Agency, Canada Customs and Revenue Agency and the Royal Canadian Mounted Police. In Nunavut, both Fisheries and Oceans and the Nunavut Wildlife Management Board apply CITES with respect to narwhals through the issue of narwhal tags for the export of narwhal ivory (CITES 2003).

Another conservation and management organization, the World Conservation Union (IUCN), does not officially recognize the narwhal as being threatened given that it

is categorized as being "data deficient". This means that no assessment of its risk of extinction has been made due to lack of data on abundance, distribution and/or population status:

> A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. (IUCN 2003 Red List Category Definitions).

The narwhal is included in the Convention on Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention). This convention aims to conserve terrestrial, marine and avian migratory species throughout their range and went into force in 1983. There are currently eighty-six member countries. However, Canada is not a member of this convention (CMS 2002).

More specific to the narwhal, the International Whaling Commission (IWC) was set up under the International Convention for the Regulation of Whaling in 1946 in order to maintain sustainable whaling practices. The purpose of the convention is to provide conservation of whaling stocks and management of the whaling industry. There are currently fifty-two member nations. Canada was one of the founding members but removed itself from the convention in 1982 on the grounds that it does not engage in commercial whaling (High North News 1994). Another factor in this decision was related to pressure from Canadian Inuit and their perception of the IWC agenda: "We strongly support Canada's historical position that the IWC should be dedicated to the conservation and sustainable use of whales. Instead, it has come to be dominated by the protectionist anti-hunting sentiment, and it has lost any hope of instituting a rational or scientific whale management regime. Inuit interests and Inuit rights would be gravely compromised by Canada's rejoining the IWC" (R. Kuptana , High North News 1994).

Lastly, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is a body of qualified experts from jurisdictional agencies and non-government organizations, independent scientists, and members of the academic

community whose mandate is to identify and assign status to indigenous wildlife species at risk of extinction or extirpation across their range in Canada. The narwhal is currently listed as not at risk. This status was designated in April 1986 and confirmed in April 1987. There has been no reassessment since this date (COSEWIC 2003).

Pond Inlet Inuit and a History of Whale Exploitation

> The use of cetaceans for human subsistence in high-latitude regions of the Northern Hemisphere is widespread and ancient. Commercial exploitation of arctic cetaceans, especially bowhead whales but also narwhals and belugas had begun by the early seventeenth century and continued well into the twentieth century. In general terms, the subsistence use of cetaceans was limited to aboriginal people, especially the maritime Inuit whose own range was nearly circumpolar (Reeves 1992, 1).

Prehistory of Canadian Inuit

The contemporary Pond Inlet Inuit are considered to be close descendants of the Thule culture. Archaeological evidence supports Mathiassen's hypothesis that the Thule culture (AD 1000–1600) developed in northern Alaska and spread eastward across the Canadian Arctic and Greenland (see McGhee 1984). For example, archaeological remains of Thule artefacts have been found throughout the coastal areas of arctic Canada. The artefacts of Thule technology were specialized for the hunting of large marine wildlife such as bowhead whales but could also have been utilized to hunt narwhals. The Thule migration across the Canadian Arctic has been hypothesized to have been precipitated by the movement of bowhead whales into the water of the central and eastern arctic as a result of the moderate warming of the Second Climatic Optimum (Little Climatic Optimum). This was a period from AD 750 to 1200 when the climate of Europe and North America was considerably warmer than the previous period (Lamb 1985). McGhee (1969, 1984) has argued that this warming climatic trend resulted in the reduction of the seasonal extent of the summer pack ice in the Arctic seas. As a result, a population of bowhead whales may have extended their range from Alaskan waters into the western Canadian Arctic waters. This migration of bowhead whales is hypothesized to have initiated Thule migration and settlement patterns across the western and eastern Canadian Arctic as Thule hunted bowhead whales for subsistence.

Prior to this migration wave, the eastern Canadian Arctic, including the study area of northern Baffin Island, had been occupied by the peoples of the Dorset culture. The Dorset culture is believed to have developed during 3000 years of isolation from co-existing Inuit populations of Alaska (see Figure 7; McGhee 1984). They are thought to have been one of the first migrations across the Bering Sea as they pursued terrestrial prey across the eastern Arctic. Around AD 1000, their isolation was interrupted by the arrival of the Thule in which they are thought to have been displaced by the Thule. Recent genetic evidence from Southampton Island indicated that the Thule culture Inuit group on Southampton Island that survived until 1902 was identified as a relic, mainly Paleoeskimo Dorset community suggesting some level of intercultural mixing. However, there was little or no indication of Dorset to Thule gene flow (Shields and Jones 1998).

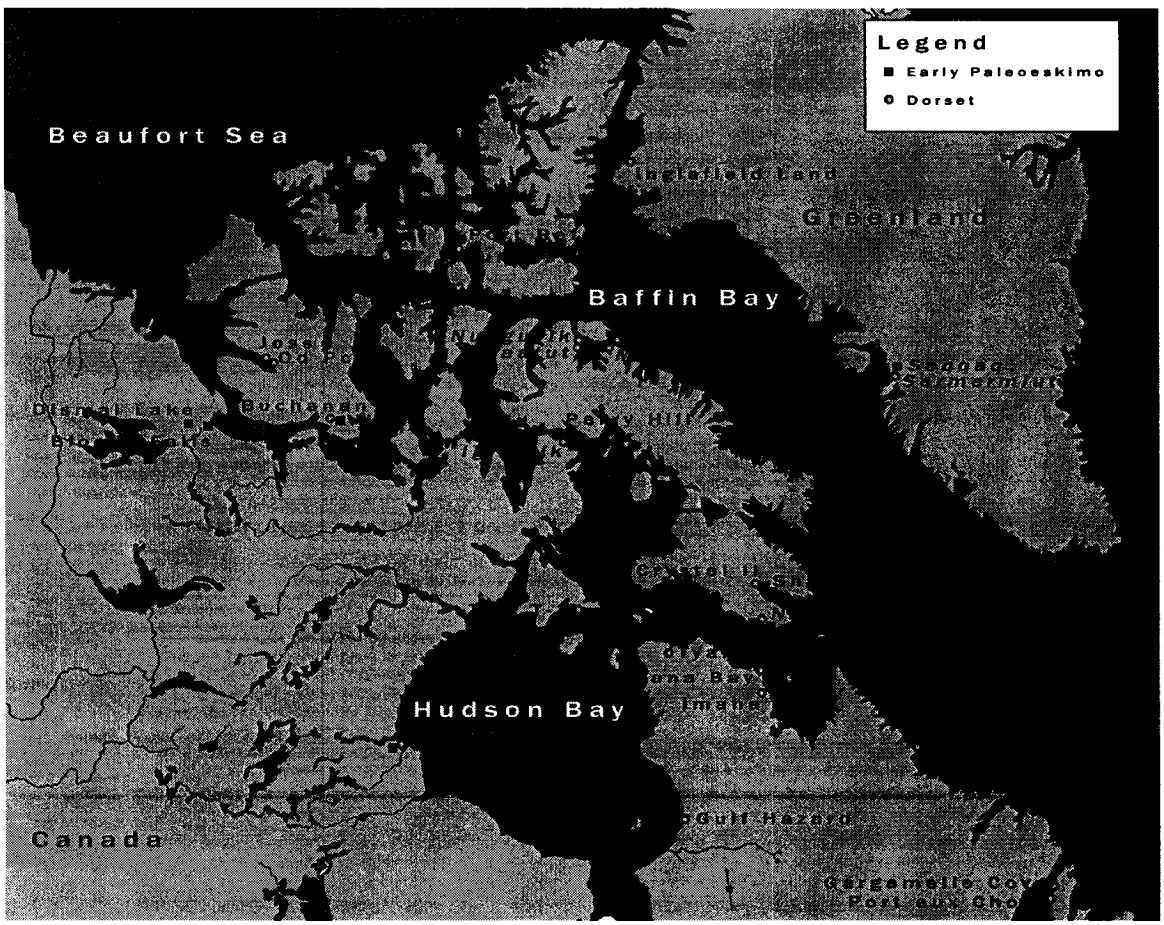

Figure 7. Early Paleoeskimo and Dorset archaeological sites. (Data from Maxwell 1984.)

The whale hunting techniques that could have been used by Thule during their migration to Arctic Canada involved stalking and chasing whales in the open sea using a large person capacity skin boat (*umiak*) and a small fleet of kayaks. Animal remains and hunting weapons found at Thule sites indicate the wide range of hunting techniques used by these people in adapting to their changing environments. For example, Thule utilized bow and arrows to hunt caribou and smaller harpoon heads to hunt ringed seals and narwhals (McGhee 1984).

According to McGhee (1984), one of the most impressive finds are the bones of bowhead whales and large whaling harpoon heads used in conjunction with skin floats, represented archaeologically by ivory or wood plugs and toggles. Presumably, this technology could have also been utilized to hunt small whales such as narwhals. A Thule *umiak* frame found in northern Greenland (Knuth 1952) reveals the structure and nature of the large open skinned boats that Inuit ancestors historically used to whale and to travel. Kayak parts were also discovered. Engraved representations suggest that the Thule kayak was a sea-going craft with upturned bow and stern (McGhee 1984). All sea mammals found in the Arctic waters were represented by bones in the food refuse of Thule villages (McGhee 1984). Although baleen whales were the largest and most impressive prey species for the Thule, other prey species such as narwhals were not ignored (Taylor 1966).

By AD 1100-1300, the second phase of the Thule expansion had populated most of the southern Arctic Archipelago, the coasts of Hudson Bay, and the coastal mainland to the west. Mathiassen's "classic" Thule sites of *Naujan*, *Qilaukan*, *Mittimatalik*, and *Malerualik* (see Figure 8) belong in this second phase of Thule expansion and most likely date from the twelfth and thirteenth centuries. The characteristic Thule artefact types listed by Mathiassen (1928) refer specifically to this phase in the development of Thule technology. During this period, there was increased regional diversification of Thule material culture, probably resulting from regional isolation and the development of local types of economic adaptation (McGhee 1984). By AD 1450 Thule Inuit were forced to adapt their culture to a severe climate change. During the Little Ice Age (AD 1450-1890) Thule culture in northern Baffin Island underwent a significant change (McGhee 1978). The development of heavy ice cover and the extreme cold of the sixteenth and

seventeenth centuries reduced the amount of open water and accessibility of bowhead whales. This in turn shifted the focus from bowhead whales as the principal subsistence resource to a reliance on other marine resources such as ringed seals and narwhals. This formed the basis of the transition between Thule culture and what presently exists in the central and eastern arctic regions.

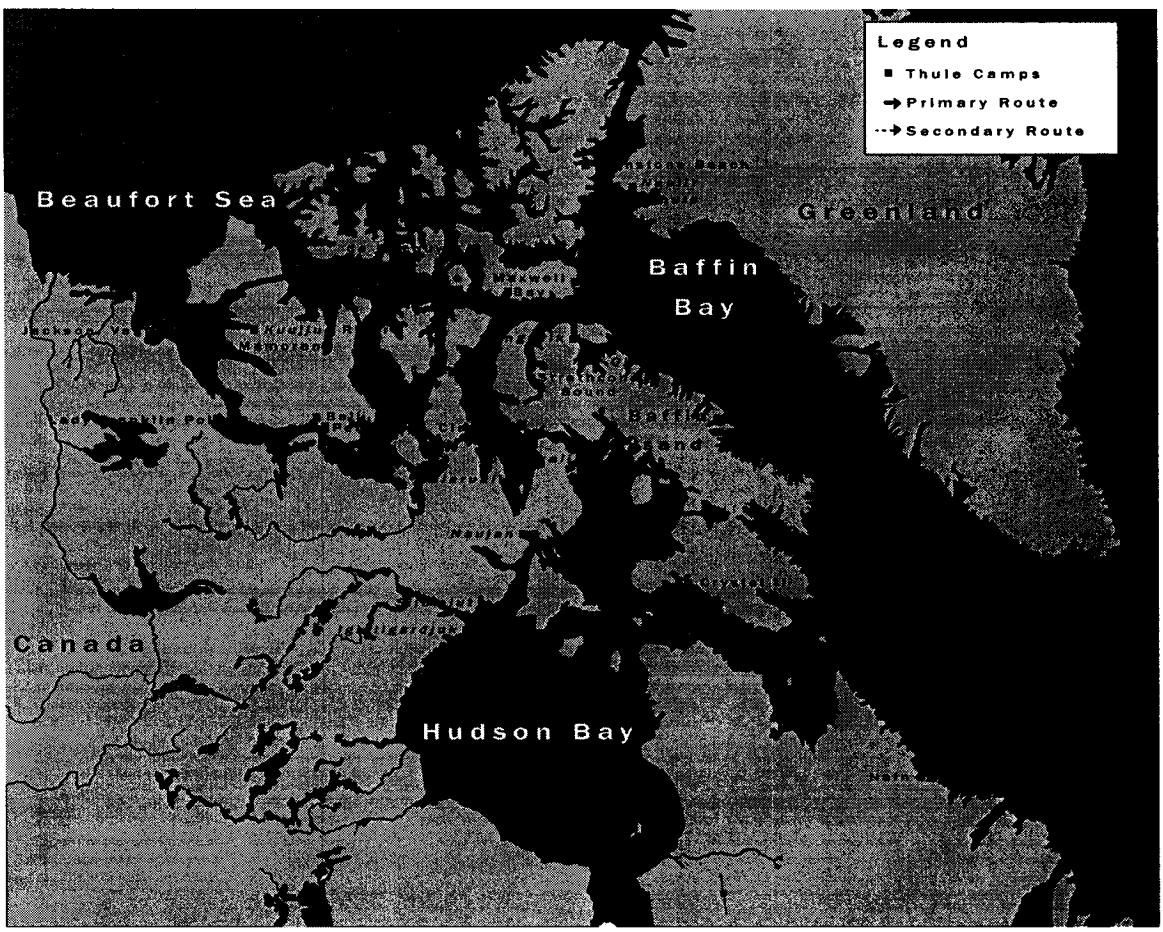

Figure 8. Thule migration route and archaeological sites. (Data from McGhee 1984.)

Although, at present, the archaeological record does not provide conclusive evidence of the importance of narwhal in the subsistence economy of Northern Baffin Island Inuit in the distant past, archaeology has demonstrated that narwhals have been hunted in this region for some two millennia (Savelle 1994). More specifically, it is clear that the descendants of the Thule possessed the technology, expertise and ecological

knowledge to hunt this species intensively since at least the early nineteenth century (Mary-Rousselière 1979).

Early contact period (1500-1900)

During the sixteenth century, European explorers sailed along the coast of Baffin Island in search of the Northwest Passage to the Orient. A northwest passage was desired for shorter and safer trade routes to the Orient than those which currently lay exposed to attacks from other countries. The first Europeans who are believed to have explored the study area were Robert Bylot and William Baffin who traveled through the entrance to Lancaster Sound in 1616. They sailed north as far as Smith Sound and discovered the entrances to both Lancaster and Jones sounds. On their return trip southward, they mapped a considerable portion of the Baffin coast. However, after this voyage, northern Baffin Island was overlooked for two centuries.

British whalers had reached northern Baffin Island by 1817, in search of bowhead whales, which at the time was highly prized for its oil and baleen, used for corset stays, buggy whips and other products requiring elasticity and flexibility. Narwhal resource products such as the ivory tusks were also desired. In 1818, Captain John Ross entered Lancaster Sound and erroneously considered it to be a bay rather than a strait. The name "Ponds Bay" was first given in 1818 to the area about 5 km east of the present community of Pond Inlet. The British explorer, John Ross, named the area after John Ponds who was the Astronomer Royal during this period. In 1819, Lieutenant William Edward Parry, traveled through Lancaster Sound. The following summer he discovered the entrances to Admiralty and Navy Board Inlets. He returned in 1822 and after their ships became trapped in the sea ice, spent the winter of 1822-23 among the Inuit (Mountfield 1974; Neatby 1984).

The term *Iglulik* is commonly used to designate three major Inuit groups and one subgroup of the Eastern Canadian Arctic. These three groups are the *Iglulingmiut proper*, the *Aivilingmiut*, the *Tunnunirmiut*, and the subgroup *Tununirusirmiut* (Boas 1888; Mary-Rousselière 1984; see Figure 9). The *Iglulingmiut proper*, the *Aivilingmiut*, and the *Tununirmiut* "... are so closely related that they must be regarded as forming one Eskimo tribe with in all essentials a uniform culture." (Mathiassen 1928, 1) The territory

historically occupied by the *Iglulik* extended approximately from the north of Baffin Island to Cape Fullerton in the south. It was bordered by Committee Bay and Prince Regent Inlet in the west and Lancaster Sound and Baffin Bay in the north then southwest to Foxe Basin (see Figure 9). This area includes the community of Pond Inlet.

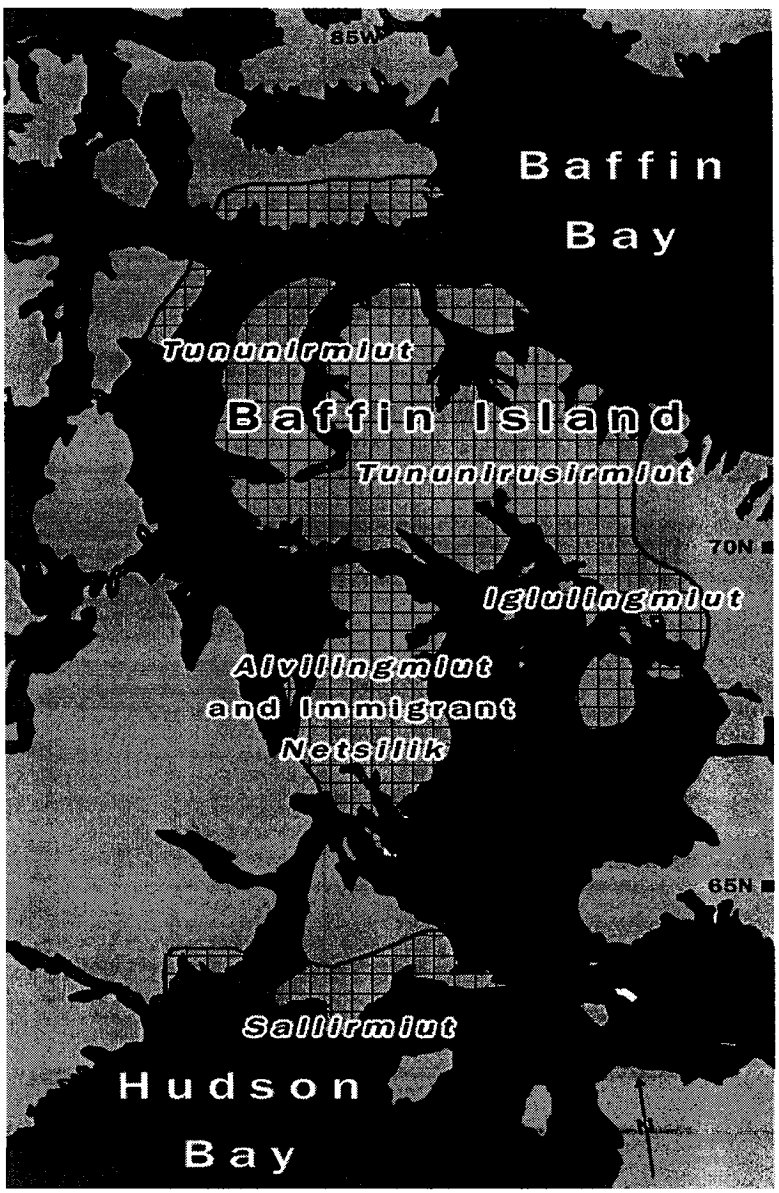

Figure 9. Major Inuit groups of Northern Baffin Region. (Data from Mary-Rousselière 1984.)

Iglulik are separated dialectically and geographically from the *Netsilingmiut* group of *Netsilik* in the west; the *Qairnirmiut* and the *Hauniqtuurmiut* groups of Caribou Eskimo and the *Sallirmiut* on Southampton Island to the south; and the *Akudnirmiut* and *Oqomiut* groups of Inuit to the east (see Figure 10).

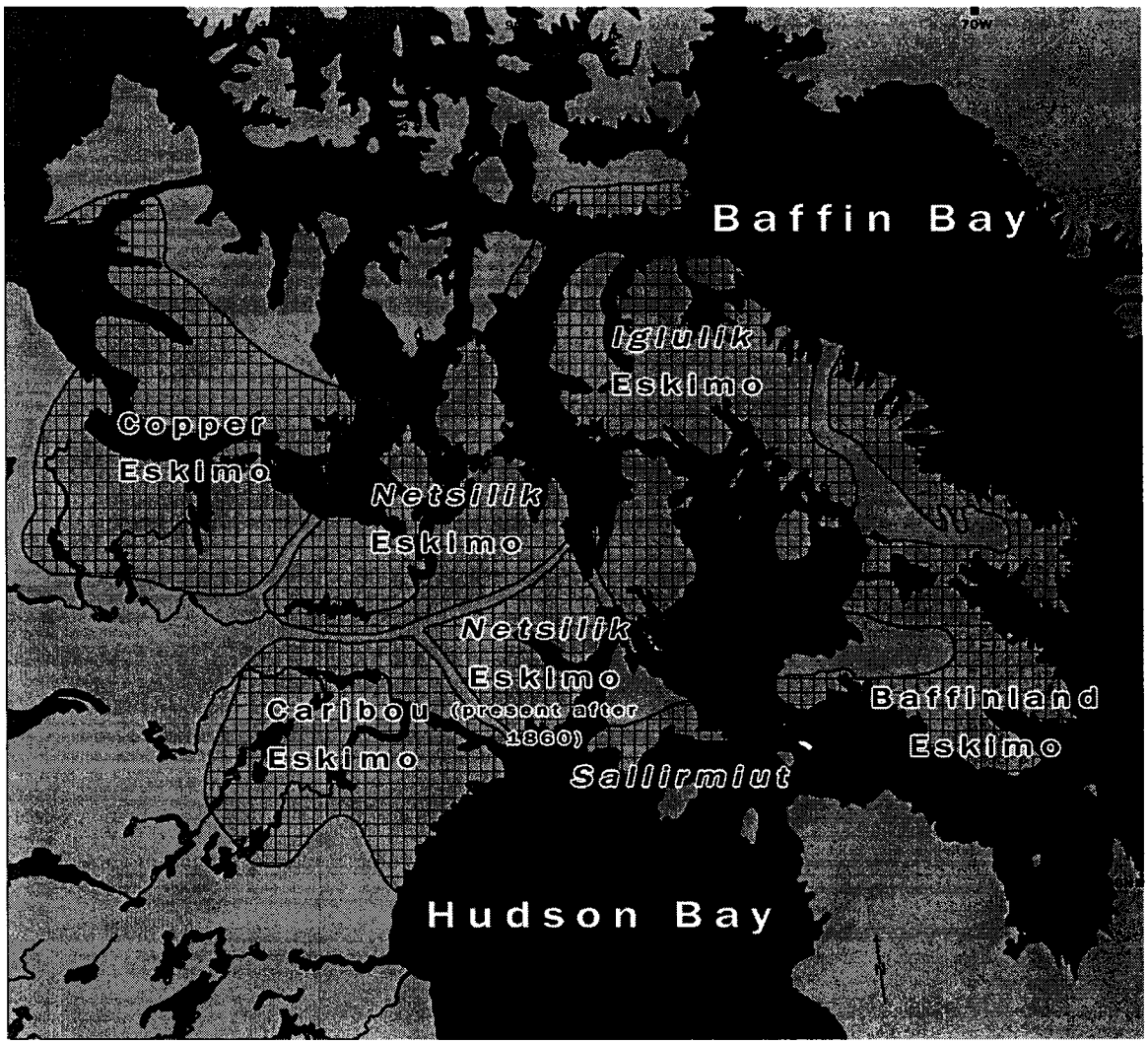

Figure 10. Major Historical Inuit Groups of Central and Eastern Canada. (Data from Damas 1984.)

The Inuit of Pond Inlet are considered to be descendents of the *Tununirmiut*. *Tununirmiut* is the Inuktitut term that is used to refer to Inuit who historically inhabited the northeast region of Baffin Island in and around Eclipse Sound and Pond Inlet during

this period (Mary-Rousselière 1984; see Figure 9). The *Tununirmiut* have hunted narwhal since their arrival in this area in the nineteenth century as indicated by traditional technology. For example, harpoon heads were crafted specifically for this purpose and kayaks were widely used in hunting bowhead whales and narwhals available in this area (Mathiassen 1928; Mary-Rousselière 1984; Rasmussen 1929). They have historically relied heavily on marine mammals, especially in the winter and spring. Narwhals were opportunistically hunted in the marine environments of Navy Board Inlet, Eclipse Sound, Pond Inlet and surrounding bays and inlets where there was a rich abundance and variety of marine mammal types (Mary-Rousselière 1984; Matthiasson 1992; Treude 1977). Elderly Inuit hunted narwhals in the northern Baffin region during the summer months as the younger hunters traveled inland to hunt caribou (Mary-Rousselière 1984). Younger hunters were fit to track caribou while elder hunters had less inclination for the heavy packing involved with caribou hunting. Elder hunters also possessed more experience with kayaking and hunting in the open water environment. Both groups would then congregate at the end of autumn. In midwinter, all *Iglulik* Inuit moved to the sea ice where they could conduct breathing-hole sealing and hunt at the floe-edge. During the spring, the large winter sealing villages dispersed for the period of *uttuq*. *Uttuq* is the Inuktitut term for the hunting of ringed seals that were found basking on the sea ice. The spring also represented a period in which Inuit families would visit one another.

It should be noted that some Pond Inlet Inuit displayed a different pattern of subsistence for the spring. For example, Button Point on Bylot Island (see Figure 3) was identified as an important winter and spring campsite for some Inuit families. For Inuit families located in this area, ringed seals were hunted in breathing holes and along the floe-edge during winter and spring. Historically, narwhal hunting in the northern Baffin Region practiced by these Inuit was seasonally focused upon the spring narwhal migration near the floe edge (Mathiassen 1928; Mary-Rousselière 1984). They hunted narwhals and bowhead whales from spring into June. As the ice receded into Pond Inlet and Eclipse Sound, these Inuit then moved westward and engaged in *uttuq*. In the spring, some hunters would also cross Lancaster Sound to hunt polar bear or musk-oxen on northern Devon Island. When the inland caribou hunters and the sea mammals hunters met again in the fall, they would move into stone huts for much of the winter season

(Mary-Rousselière 1984). The technology utilized included kayaks, throwing harpoons, harpoon heads, and seal skin floats (Mathiassen 1928; Rasmussen 1929).

Contact traditional period (1900 – 1960)

The use of narwhal blubber oil by Inuit during the early part of this period was critical for heating and illumination in igloos and sod houses (Whitney 1910). The oil was an important resource for Inuit groups who did not have access to imported alternatives such as petroleum (Reeves 1992). For example, Mathiassen (1928) remarks that Pond Inlet Inuit made efforts to recover the oil from the heads of narwhal. Following the decline of the bowhead population, other narwhal products such as the ivory tusk became important trade items with Europeans (Bernier 1909, 1911). Apart from its use in trading, historically narwhal ivory has been widely used by Inuit. For example, a sled shoe made of narwhal ivory was discovered by Maxwell (1984) from an archaeological site within the vicinity of Navy Board Inlet. Mathiassen (1928) noted that bow drills that were used for drilling holes in ivory and antler were sometimes partly constructed from narwhal ivory. Soper (1924) documented that Inuit used ivory to make multiple items such as toggles for dog harnesses, fishing gear, beads, and carvings. Elders in Pond Inlet also mentioned the historical use of narwhal tusks for tent posts (Personal communication). Lyon (1824) also described the use of narwhal tusks as spears or staffs amongst the people of *Iglulik*.

Narwhal meat was also a major source of dog food for Inuit that resided in or around the communities of Arctic Bay, Clyde River, Grise Fiord, Hall Beach, and Pond Inlet (Brody 1976; RCMP 1963-1964; Riewe 1976). This was important because of the continued dependence by most Inuit families upon dogs for transportation and hunting until the advent of snowmobiles after 1965.

Narwhal sinew was also historically utilized as sewing thread (Nooter 1972-73; Whitney 1910; Wilkinson 1955). Narwhal sinew is strong, inelastic and resistant to cold and moisture (Vibe 1950). As such, narwhal sinew was preferred for sewing waterproof seams in sealskin boots and other clothing (Mathiassen 1928; Wilkinson 1955). Up to the 1950s, Wilkinson (1955) documented the continued usage of narwhal sinew by northern Baffin Island Inuit for multiple purposes such as securing prey onto the sled and

making dog harnesses. More specifically, Kemper (1980) found the usage of narwhal sinew actually up to the 1970s in Pond Inlet for the use of securing narwhal skin (*maktaaq*) on the sleds for transport.

The Contact Traditional Period represents a major historical period in which contemporary Inuit groups were first exposed to foreign influences. These were primarily European explorers and whalers. Scottish whalers established a shore whaling station at Albert Harbour near Pond Inlet in 1903 primarily for bowhead whale commerce, but narwhal products, especially tusks, contributed to their annual economic returns. In the early twentieth century, European whalers would conduct commercial hunts for narwhals primarily for their ivory tusks in order to supplement their annual bowhead capture. This system continued until the mid-twentieth century, with skins, blubber and narwhal ivory being exported to Europe (Reeves 1992). Although narwhal ivory is no longer the object of Inuit-European trade that it once was, it does continue to be an economically valuable export by-product of the contemporary Inuit narwhal hunt (Reeves 1992; Reeves and Heide-Jørgensen 1994).

The opening of the Hudson's Bay Company (HBC) post in 1921 at Pond Inlet instigated the move of several families from distant parts of the region to this centralized location. The HBC bartered with Inuit for resource products such as fox furs and narwhal tusks. The arrival of the Anglican and Catholic missions and the trading post also created a center of Western activity in the area that gradually became the focus of Inuit settlement (Vestey 1973). The post, complemented by the missions, became the service center for the Inuit around north Baffin.

Mittimatalingmiut were also among the first Canadian Inuit to be influenced by the Royal Canadian Mounted Police (RCMP) as the first RCMP post in the High Arctic was also established in Pond Inlet in 1921 as a response to perceived threats on Canada's sovereignty of the High Arctic as well as legal issues that arose with respect to non-Inuit and Inuit relations (Matthiasson 1967). For example, the first and most prominent Arctic Canadian legal trial took place in Pond Inlet concerning the murder of Robert Janes by local Inuit practicing their customary laws (Grant 2002).

By 1949 there were two large villages, *Mittimatalik* with a population of sixty-eight and *Qarmat* whose population was eighty-three; as well, there were nine smaller

villages in the *Iglulik*-Foxe Basin area (Damas 1963). The indigenous population of Pond Inlet soon doubled at this time due to a higher infant survival rate. In 1949, children out-numbered adults 1.2 to 1 (Stevenson 1993).

The presence of a trading post, Anglican Church and rectory, as well as the availability of seasonal employment continued to attract Inuit to Pond Inlet (Damas 1963). Money became increasingly more important to obtain as new hunting technology became available through importation into the community from the south.

At this time, both Pond Inlet and its southern neighbour, Clyde River, were growing centres, but the majority of the population remained dispersed in small villages or camps. This can be seen from Brody (1976, Map 30) who shows that before permanent settlement into the community of Pond Inlet, *Mittimatalingmiut* harvesting was conducted along the entire east coast of Baffin Island, Bylot Island, Baffin Bay, and Pond Inlet. The spatial arrangement of the Pond Inlet harvest activities in northern Baffin Island continued to remain concentrated around these areas during the study period. Treude (1977) and Bissett (1968) recorded the settlement pattern, population size and distribution, and seasonal activities of Inuit in the northern Baffin region.

Despite movement into the settlement of Pond Inlet during the late 1950s, the seasonal and annual economic cycles of *Tununirmiut* did not appear to have changed dramatically from contact times. Thus, even as *Tununirmiut* contact with Europeans intensified, traditional subsistence activities remained important in the indigenous economy (Beaubier 1970; Mary-Rousselière 1984; Matthiasson 1992; Vallee et al. 1984). Up until the time of permanent resettlement (between 1950 and 1965), the *Iglulik* Inuit of the North Baffin region relied primarily on a mix of marine and terrestrial animals. Seals, walrus, narwhal, caribou, fish and a variety of bird species provided the principal food resources for *Tununirmiut* and were the basis of the cash-economy through the sale of harvest by-products, notably seal skins and narwhal ivory primarily to European buyers (Wenzel 1981, Reeves 1992).

Permanent centralization (1940-Present)

Beginning in the late 1940s, the Canadian government implemented broad-scale policies with respect to northern development. In this early process of centralization, nomadic Inuit families were encouraged to relocate into permanent settlements such as Pond Inlet (Brody 1975). The Canadian government planned that the institutions provided at these centers would be a means to apply several social programs such as education and health (Brody 1976; Damas 2002; Diubaldo 1985). In the late 1950s, a federal school was built in the community and children from neighbouring communities were sent to Pond Inlet to receive formal education. In the mid-1960s, the federal government implemented a housing program, and most Inuit in this region were then permanently resettled in Pond Inlet. It was during the 1960s that the administrative and legal machinery of government began to significantly affect *Mittimatalingmiut* mobility and economic autonomy. For example, local government was established through the development of the position of the hamlet mayor and board of councillors.

With the expansion of the centralized community infrastructures (new schools, RCMP post, nursing center, etc.), employment in the wage sector began to disrupt seasonal groupings and hunting activities. At this time, new opportunities and obligations through wage labour became a reality of *Mittimatalingmiut* life. With the concentration of *Mittimatalingmiut* settled permanently in the community, a new set of socioeconomic forces came into play (Wenzel 1991). For example, there was more restricted movement of families from campsites to hunting areas, and extended families became oriented towards service centers (Vallee et al. 1984). Especially throughout the last century, traditional Inuit materials were supplanted by the adoption of imported technologies, most notably the rifle and also clothing and housing material manufactured outside the Arctic (Matthiasson 1967). In addition, during this period, increased access to snowmobiles replaced dog teams; for some Inuit, this transportation was essential to continue hunting in distant hunting grounds from the centralized community (Graburn 1969; Freeman 1974-1975; Usher 1972; Wenzel 1981, 1991).

Despite the centralization of Inuit into one community, Pond Inlet Inuit have continued to engage narwhals in different geographical environments and displayed a dynamic range of foraging behaviour in order to harvest successfully this species. The

hunting of whales continues to play a vital role in the subsistence and social activities of Inuit (Mathiasson 1992; Freeman 1998).

Current management system (1970-Present)

In 1971, the Canadian government introduced interim Narwhal Protection Regulations under the Fisheries Act. These made hunting by anyone except Inuit illegal and set a maximum catch limit of five narwhals per year for each subsistence hunter. In 1976 and 1978 the regulations were made more explicit. During the study period, Pond Inlet represented one of the major narwhal harvesting communities of the Eastern Canadian Arctic and was allocated an annual quota of one hundred animals.

When Canada removed itself from the IWC in 1982, the Canadian government replaced the Whaling Convention Act of the IWC, which allowed the harvest of whales for subsistence use by indigenous peoples, with the Cetacean Protection Act. This act permits the Minister of Fisheries and Oceans to establish quotas and issue hunting licenses to Canadian Aboriginal peoples for the hunting of cetacean species including narwhals. The establishment of the quota limits by the department of Fisheries and Oceans were based upon historic harvest levels by Inuit in this region (Strong 1988). Hunters were then required to affix a tag to the carcass or tusk of any narwhal that was killed. The tags[2] were issued to settlements on a quota basis and were intended to manage the harvest.

Until 1999, Baffin Bay narwhal exploitation was managed through a quota system in thirteen Inuit communities including Pond Inlet (see Table 1). In 1999, a new narwhal management system was developed by the Narwhal Working Group of the Nunavut Wildlife Management Board (NWMB), which lifted the federal narwhal quotas for three communities – *Qikiqtarjuaq*, Pond Inlet and Repulse Bay for a period essay of three years. However, these communities were required to institute a reporting system to help the Department of Fisheries and Oceans and the NWMB monitor the number of narwhals struck and landed, wounded and escaped, and struck and lost for each season.

[2] It is illegal to possess or sell a tusk that is not accompanied by a tag. Because the narwhal is listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, tusks exported from or imported into Canada must be covered by an export or import permit or a re-export certificate (Reeves, 1992).

Furthermore, the Hunters and Trapper's Organizations of each of these communities was responsible for specifying details such as hunting methods and safety requirements. The quota system was re-instituted in 2002 and the hunt is currently co-managed by the Nunavut Wildlife Management Board and the Canada Department of Fisheries and Oceans. Hunting regulations are implemented under the Fisheries Act and the Marine Mammal Regulations by the Department of Fisheries and Oceans.

CHAPTER 2: THEORETICAL CONTEXT

Environmental Determinism and Possibilism

Franz Boas's ethnography *The Central Eskimo* (1888) was the first major anthropological work done on Baffin Island Inuit. One of Boas's major contributions to anthropology was to educate and stimulate other social anthropologists to utilize hunter-gatherer societies as a means to explore patterns of associations between economies, social organizations, subsistence systems, and technologies. In the late nineteenth century, Boas embarked upon a major set of human subsistence and social behaviour studies among the Baffin Island Inuit (Boas 1888, 1901, 1907). Boas developed his theoretical stance that Inuit foraging behaviour was governed directly by features of the physical and natural environment based primarily upon the empirical observations and associated analyses of Inuit seasonal settlement patterns. In support of his arguments, Boas presented two major causal relationships by which features of the physical environment determined major features of Inuit subsistence such as prey selection and choices of settlement.

The first causal relationship that Boas posited was that the environment directly influences Inuit movements and access to resources through physiographic features and processes. For example, Inuit movements and choices of settlement are restricted by ice formation and topography. This relationship reflects the ideal of environmental determinism that was predominant in the nineteenth century. As presented by Boas, ice type, prey abundance, and settlement are directly linked. The second causal relationship that he posited was that Inuit settlement decisions are influenced by the distribution and abundance of prey species. Furthermore, Boas argued that Inuit settlement behaviour is primarily influenced by the physical environment. In this regard, Boas's Baffin Island research was the most significant to date because of the recognition that many features of Inuit behaviour and culture were related to and dependent upon features of the natural environment.

Both Boas and Alfred Kroeber, a student of Boas later adopted a position known as "environmental possibilism" in which he argued that the environment sets limits on

how a culture may develop. This position acknowledged more of an interaction between culture and environment than previously afforded by environmental determinism. Environmental possibilism asserts that environmental factors play a constraining and limiting role upon Inuit subsistence decisions and behaviour.

Cultural Ecology

One particular difficulty with the theoretical development of nomothetical[1] principles in hunter-gatherer literature was historical particularism. Historical particularism acknowledges that each culture has a unique history such that one should not assume that universal laws exist to explain how cultures have developed and continue to operate. This particularized descriptive approach has made any broader cross-cultural theoretical development in hunter-gatherer society inherently problematic.

Julian Steward, a social anthropologist, cultural geographer and student of Kroeber attempted to address this challenge by developing the cultural ecological approach (Steward 1955). Cultural ecology became one of the most dominant socio-analytical approaches for hunter-gatherer studies through the 1960s and 1970s primarily because of its methodological approach. The emergence of cultural ecology as a theoretical framework was first formally presented in Steward's *Theory of cultural change: The methodology of multilinear evolution* published in 1955.

Steward, an environmental possibilist, conjectured that elucidating the role of environmental factors on human culture could provide an effective means of comprehending cultural variations between different groups. He then proceeded to develop a method of analyzing "environmental adaptations to show how new cultural patterns arise" (Steward 1955, 34). Steward envisioned cultural ecology as the study of adaptive processes, whereby cultures adapted to an environment through their subsistence strategies and ultimately their behaviour. His specific methodology involved 1) the establishment of the interrelationships between environment and exploitative technology, 2) the examination of the patterns of subsistence behaviour associated with concurrent technologies, and 3) the assessment of the degree to which these subsistence behaviours

[1] Relating to or involving the search for abstract universal principles.

influenced and shaped other aspects of culture (Steward 1955, 37-39). It should be noted that he emphasized ecological factors as an important but not exclusive factor in determining culture change. He also sought to explain the choices made by cultures by examining their history as well as their environments.

In this work, Steward rejects the relativist framework of Boas and Sauer and revived the value of nomothetical principles in anthropological research. Steward incorporated Darwinian evolutionary principles in his approach. He argued that biological adaptation was a useful approach for explicating similarities in the form, function and developmental processes of different traditions in certain cultures (Steward 1955). He assumed that, although socio-cultural features could change independently of environmental features, hunter-gatherer adaptations are closely adjusted to environmental features. This was the foundation of his cultural ecological method. Its substance lays in the comparison of key cultural traits identified as the culture core, which should arise independently in differing societies who inhabit different geographical locales but who experience similar environmental pressures.

Following from Steward, there were several major studies that contributed to the development of cultural ecology as a major research paradigm in hunter-gatherer studies. For example, biological concepts such as adaptation and niche were utilized, and later with the emergence of General Systems Theory (GST) (Boulding 1956; Von Bertalanffy 1956) and Cybernetics (Ashby 1956), ideas such as homeostasis, and feedback were implemented. The first major contribution after Steward was a study done by Barth (1956) who studied three groups and revealed how they could achieve a symbiotic relationship within a single environment by exploiting different niches. The concept of niche was used to describe and analyze how different groups interacted with each other, their geographical distribution, why some groups predominated over others in certain areas, and what factors contributed to the structure and stability of multi group communities.

In 1963, Geertz compared two different agrosystems in Indonesia in relation to the structure, productivity, energy flows, and stability of the tropical rainforest that they had replaced. Geertz uncovered that the comparison of these ecosystems revealed important insights into the human environment relationship. He also demonstrated the

utility of studying productivity and nutrient flows in order to understand these ecosystems better as a means of empirical comparison. Finally, Geertz concluded that agricultural systems needed to be placed within a broader historical context of European colonization and exploitation thereby introducing the importance of cultural history and context. Following Geertz and still subscribing to the ecological framework intiated by Steward, Carneiro (1960) introduced and elaborated the concept of carrying capacity within the framework of cultural ecology. His studies investigated the maximum population that could be supported by a particular environment with a particular technology.

However, the next two major contributors to the development of cultural ecology departed slightly from the methodological approach from their predecessors in that they were heavily influenced by GST (Von Bertalanffy 1962). Buckley (1967) first proposed that human societies were "complex adaptive systems". These complex adaptive systems were comprised of behaviours that include cognitive mapping of the environment. Buckley introduced and focused upon ideas of cognition, decision-making, and perception in understanding the relationship of the members of the society with their environment. Rappaport (1984) also influenced by GST and cybernetics, collected a massive amount of quantitative caloric data to analyze the energy cycle of a New Guinean group. In this study, both carrying capacity and energy expenditure are utilized to study the ecological interaction between the structure of the society and the effective environment. He also set in motion a school of energetics which studied the energy cycles of various groups such as Inuit (Kemp 1971).

Present day cultural ecology studies continue to draw upon both geography (Turner II 1989) and anthropology (Butzer 1989). The major theme of most cultural ecology studies is to understand the relationships between people, resources, and space. Cultural ecology "... emphasizes that human behaviour has a cognitive dimension and is dependent on information flow, values, and goals. Cultural ecologists recognize that actions are conceived and taken by individuals, but that such actions must be examined and approved by the community, in light of the tradition and the prevailing patterns of institutions and power, before decisions can be implemented" (Butzer 1989, 193).

As described through the major contributions above, cultural ecologists focus upon how people manage their resources through diet, technology, reproduction,

settlement, system maintenance, and ultimately behaviour. Human behaviour is a major component that remains a strong focus of cultural ecology studies. In cultural ecology studies of Canadian Inuit, this has been achieved by in-depth studies of energy-flows (Kemp 1971), information-flows (Wenzel 1981), how alternative options are developed and selected, and how process and form are interrelated (Wenzel 1991). Cultural ecology has become a significant paradigm for studying the relationship of subsistence hunter-gatherer societies and their environments. Cultural ecology research on hunter-gatherer societies, including on Inuit, has subsequently grown with an accumulation of anthropological, biological and geographical data.

Human Behavioural Ecology

It soon became apparent that the cultural ecological method was limited because it relies heavily on plausibility arguments and particularistic qualitative and quantitative data. Consequently, it was inherently difficult to validate broad cultural ecological explanations from ethnographic facts due to its lack of hypothesis testing (Popper 1972). This is in part attributable to the apprehension of trivializing hunter-gatherer diversity and the inefficacy to develop general models of hunter-gatherer subsistence and social organization. In response, a number of optimal foraging models borrowed from behavioural ecology were applied to human hunter-gatherer foraging settings. This approach is collectively termed human behavioural ecology (for a review see Winterhalder and Smith 2000).

Optimal foraging theory is a branch of behavioural ecology that has recently been applied to hunter-gatherer foraging studies. Historically, it was the study of foraging decisions by MacArthur and Pianka (1966) and Emlen (1966) that introduced the general principles of optimality into behavioural ecology and stimulated the construction and use of various types of models among animals. MacArthur and Pianka (1966) proposed that a set of behavioural decision rules for an optimal forager could be formulated from first principles based upon the premise that natural selection would favor organisms that foraged optimally. Thus, patterns of behaviour of foragers could be predicted from the theoretical principles of optimization.

This body of theory as reviewed in the biological and social sciences literature is concerned with the construction of models by which hypotheses can be tested. These models are based upon general principles of optimization (Foley 1985; Maynard Smith 1978; Smith 1983b) and provide explication and prediction of foraging behaviour among animals. The concept of optimality is central to these models which attempts to understand organisms' traits in terms of their adaptive value for survival, mating, and reproduction. These studies focus upon the ultimate[2] explanation of traits as opposed to the proximate explanation of traits[3]. These include mathematical models where ecological parameters are entered into formulated algorithms to make testable predictions of foraging behaviour such as which prey to include in its diet (diet breadth), where to forage (patch choice), the duration of foraging (time allocation), with whom to forage or share (social foraging), group size (optimal group size) among many others.

The subsequent adoption of these models and their concomitant optimality principles in the field of behavioural ecology (Krebs 1978; Pyke, Pulliam and Charnov 1977; Schoener 1971; Stephens and Krebs 1986) significantly expanded both the conceptual and technical analyses of observed patterns of animal behaviour. Krebs and Davies (1997) identify three advantages to the modeling of behaviour. First, it forces researchers to make explicit assumptions. Second, modeling emphasizes the generality of simple decision rules and third, it provides mathematical precision that affords the capacity to make precise predictions. Behavioural ecology research has since broadened to include central place foraging (Orians and Pearson 1979), the potential importance of the stochastic or variable nature of the world (Caraco 1980; McNamara 1982; Stephens and Charnov 1982), the potential influences of competitor behaviour on food and patch choice, nutrient limitation, and predator avoidance (e.g. Abrahams and Dill 1989; Gilliam and Fraser 1987; Godin and Smith 1988; Schoener 1987; Stephens and Krebs 1986).

However, historically, since the mid 1970s, human behavioural ecology has applied those models to study the subsistence practices of indigenous peoples. For example, optimal foraging models of diet composition, optimal group size and patch selection have been used in studies of the Ache of Paraguay (Hawkes, Hill and O'Connell

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[2] "The evolutionary, historical basis for why something is the way it is." (Alcock 1993, 579).

[3] "An immediate, underlying cause, one related to the operation of the internal machinery of an individual or thing."(Alcock, 1993, 578).

1982), the Siona-Secoya of Equador along with the Ye'Kwana and Yanomamo of Venezuela (Hames and Vickers 1982), the !Kung San of the Kalahari desert (Sih and Milton 1985), the Cuiva of Venezuela (Hawkes and O'Connell 1985), The Yora of Peru (Hill 1988), the *Inujjuamiut* of Hudson Bay (Smith 1991) and the Cree of northwest Ontario (Winterhalder 1981).

A review of the social science literature relating to applications of behavioural optimal models reveals that most models of optimal choice that employ energy as a cost-benefit currency assume a maximization of energetic efficiency (Smith 1983a). Thus, optimal foraging theory as applied to human foraging groups has been severely criticized by both social and natural academics because it assumes that traits promoting increased energetic efficiency are universally adaptive (Pyke 1984; Smith 1987). Furthermore, it has received criticism for its lack of descriptive utility and its inability to incorporate the rich qualitative data found in ethnographic studies (see Smith 1983a). It has been argued that the foraging models utilized are simple and reductionistic because of their failure to integrate social, economic, historical, and cultural variables.

Problems that impede the utility of the optimal foraging method in these studies include difficulty in defining and operationalizing variables such as encounters and patches, the absence of independent data on resource occurrence, and the inappropriate use of optimal foraging models in cases where the correspondence between the foraging model and the actual foraging situation is very poor. Early attempts to apply the diet breadth model exemplified by the work of Smith (1980) and Winterhalder (1981) suffered considerably from a lack of appropriate empirical data or fundamental misunderstandings of model assumptions and use. For example, the simple diet breadth model requires that resource types be randomly distributed throughout the forager's environment and that the forager has "perfect knowledge" (forager knows the abundance of all food types), a prescription which can be challenging to satisfy in these human settings.

Thus, the application of optimal foraging models has not evoked as great a response in anthropology or cultural geography as in the field of animal behaviour. This may be due to the numerous difficulties that have encumbered these applications in

human foraging settings as well as the critical responses from cultural anthropologists and geographers.

This thesis purports that the behavioural ecology approach is an extremely useful approach for several reasons. It builds upon cultural ecology by focusing upon foraging behaviour, by aiding the researcher to define the problem, organize thought about it, generate hypotheses, test the hypotheses and alternative hypotheses, and make further predictions. Some behavioural ecology studies also utilize a cost-benefit approach that has been extremely useful to explicate the adaptive significance of animal behaviour within a particular environment, and to reveal general principles that can explain animal behaviour in the environment in which it occurs. It is precisely some of these features that appealed to researchers such as Smith (1979) and Winterhalder (1981) to implement optimal foraging theory and its associated optimality models to understand patterns of behaviour among human foraging groups.

An excellent example is provided by Gillis, Pikitch and Peterman (1995) who revealed how principles of behavioural ecology theory could provide important insights into current issues of resource use. Their paper specifically addressed the decision by fisherman to discard or retain fish of low value to make room for more valuable fish in the hold of a boat (high-grading) which is a situation similar to diet choice problems faced by natural foragers. Gillis and colleagues derived a state-dependent temporal model of discarding behaviour within a fishing trip. This model considered the availability of differently valued fish, trip quotas set by the regulatory agency, and the risk of premature trip termination due to loss of gear or injury. The predictions were consistent with the trends in discarding observed in the Oregon trawl fleet. Behavioural models such as these can be useful to fishery managers by providing a means to test the potential responses of fisherman to new regulations before they are implemented.

Behavioural Ecology: Mode of Foraging

Therefore, to address the criticisms of past human subsistence studies and to build upon the human behavioural ecology approach, I want to introduce an important ethological and descriptive approach initiated by Tinbergen (1963) and Lorenz (see

Lorenz 1982). It is based upon a descriptive identification, categorization and analysis of animal foraging behaviour. In this dissertation, I first present a general description of the major hunting decisions faced by Inuit for each environment. Then, I use the concept of mode of foraging and its related terms from behavioural ecology in order to describe the behaviours associated with the search component of the Inuit foraging cycle for narwhal (see Holling 1959; Kramer 2001). At present, no cultural ecology study has been carried out that specifically addresses human foraging mode with respect to narwhals.

My program of research on Inuit hunting behaviour adds to the present literature of cultural ecology and human behavioural ecology through an analysis of mode of foraging. I investigate the foraging behaviour of Inuit and address some major criticisms of human behavioural ecology analyses by departing from an optimal foraging approach; instead, one goal of this thesis is to focus on the role of foraging mode (see Holling 1959; Kramer 2001) as a useful analytical tool in relation to Inuit ecological activities. It is my intent that this alternative theoretical perspective will place Inuit hunting behaviour in a richer and more realistic context. The application of foraging mode to a human population is the result of extensive observations which suggest a strong correspondence between the foraging mode of Inuit and other animals.

Although a few studies have used terms from behavioural ecology to describe Inuit narwhal hunting behaviour (Finley, Davis and Silverman 1980; Finley and Miller 1982), they do not present the theory or, in fact, an analysis of the foraging mode. The application of foraging mode is useful because it describes the actual hunting behaviour Inuit display in their habitats. It also elucidates some of the observable ecological factors that influenced this behaviour. This alternative theoretical perspective will place Inuit hunting behaviour in a richer and more realistic context.

In the ethological literature on animal foraging, it was observed that some predators attack their prey from ambush, whereas others usually hunt through movement. Pianka (1966) termed these modes of foraging respectively "sit-and-wait" and "widely-foraging". In the sit-and-wait foraging mode, a forager remains stationary for long periods of time, waiting for a prey item to come within short pursuit or striking distance. In the widely-foraging mode, a forager spends much of its time actively searching for prey (Huey and Pianka 1981). Although this dichotomy can be somewhat artificial,

numerous animal and human groups (see Binford 1980) fall into one or the other category.

The Present Thesis

Recent work on the nature of narwhal whaling by Inuit has centered on: 1) the cultural and/or nutritional importance of *maktaaq* (Fediuk 2000; Kuhnlein and Soueida 1992; Reeves 1992), 2) the economics of the narwhal ivory trade (Land 1977; Reeves 1992; Reeves and Heide-Jørgensen 1994), 3) the animal's place in the modern Inuit subsistence system (Baffin Regional Inuit Association 1982, 1983, 1984, 1985; Donaldson 1988), and 4) the traditional ecological knowledge component of narwhal hunting (Remnant and Thomas 1992; Thomsen 1993; Stewart et al. 1995). Far rarer are studies in which the focus is the comprehensive analysis of Inuit foraging decisions, most notable exceptions those done by Smith (1991). Unfortunately, no such study has been carried out to date with respect to Inuit narwhal hunting processes in the Canadian Arctic. Thus a number of fundamental questions remain with respect to Inuit hunting of narwhal. These include:

1) In what environments do Pond Inlet Inuit currently hunt narwhals and how do Inuit interact with narwhals in these environments?
2) What are the major hunting decisions that Pond Inlet Inuit face when hunting narwhals?
3) What is the foraging mode executed by Pond Inlet Inuit to hunt narwhals in these environments?

To address the first two questions, the major hunting decisions of the floe-edge and open water narwhal hunt as executed by Pond Inlet Inuit are presented and analyzed in the first manuscript. This is first presented through the novel construction of a decision flowchart. The decision flowchart is a hierarchical structure of the critical decisions that Inuit must make with regard to the narwhal hunting process in each specific environment. The flowchart is a graphical presentation that readily displays the

flow of the decisions regarding the narwhal hunting process for each season and environment.

The flowchart serves two major objectives. The first is to deconstruct the narwhal hunting process by articulating the major decisions and alternatives that Inuit consider in a particular season and environment with a concise, consistent and logical framework. The second objective is to present the contextual setting and a baseline amount of information to assess and select the most appropriate and relevant ecological, geographical and social factors to investigate these decisions and explicate current Inuit foraging behaviour. The deconstruction of the foraging process to major hunting decisions provides particular environmental and behavioural information. This paper also qualitatively provides cost and benefits that may provide insights into the adaptive processes that Inuit may currently and have historically employed. Cost-benefit analysis is a process commonly utilized in behavioural ecology to analyze a complex behaviour. Hypotheses were based upon contributing factors that were presented in manuscript one, and were tested in the following two manuscripts presented in this thesis.

In manuscript two (accepted by *Études Inuit/Inuit Studies*), one major purpose of the study is to show how foraging theory could contribute to our understanding of hunting behaviour. A participant-observation study revealed the importance of the search stage of the foraging cycle for floe-edge based narwhal hunts. Pond Inlet Inuit were shown to engage in a sit-and-wait foraging mode when hunting narwhals in this environment. This was due to several environmental factors that included the movement and distribution of narwhals, the behaviour of narwhals, and the floe-edge sea-ice environment.

Manuscript three continues this methodological approach by investigating the search behaviour executed by Inuit to hunt narwhals in the open water environment during the summer hunting season. In addition, the pursuit behaviour for summer camp hunting trips is also presented and discussed as it was found to be a critical component of the hunt.

CHAPTER 3: MANUSCRIPT 1

The first manuscript addresses the major Inuit hunting decisions of the floe-edge and open water narwhal hunt in order to provide important insights into modern Inuit hunting behaviour. A comprehension of this behaviour is important to attain a better grasp of the major factors influencing Inuit narwhal hunting behaviour. The delineation of the entire foraging process for each environment is first achieved through the construction of a decision flow chart. The decision flow chart is a hierarchical and cascading structure of a set of critical decisions that Inuit must make with regard to the narwhal hunting process in each specific environment and context.

INUIT NARWHAL HUNTING IN THE POND INLET FLOE-EDGE AND OPEN WATER ENVIRONMENTS: A DESCRIPTION AND ANALYSIS OF MAJOR HUNTING DECISIONS

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Abstract

The annual harvest of narwhals by the Inuit of Nunavut represents a unique and culturally important activity. To our knowledge, research on the hunting of narwhals by Canadian Inuit has been limited both in terms of number of studies and depth of analysis. The present research addresses this shortcoming by presenting detailed field and interview data of major Pond Inlet Inuit decisions for narwhal hunting trips in the floe-edge and open water environments during the spring and summer hunting seasons. Some major decisions presented include habitat selection, group formation, and travel route selection. Different ecological and sociocultural factors influencing the nature of the hunting decisions are also presented and discussed.

Keywords: Inuit, decision, narwhal, floe-edge, open water

Résumé

La chasse annuelle aux narvals par les Inuit du Nunavut représente une activité unique et importante au point de vue culturel. À notre connaissance, la recherche portant sur la chasse aux narvals par les Inuit du Canada est limitée aussi bien que par le nombre d'études que par l'étendue de ses analyses. La présente recherche veut rectifier cette lacune en présentant des données sur le terrain détaillées et des entrevues portant sur les décisions importantes prises par les Inuit de Pond Inlet lors de leur voyages de chasse aux narvals dans les environnements des lisières des banquises côtières (floe-edge) et dans les eaux dégagées (open water) lors des saisons de chasse printanières et estivales. Quelques décisions importantes qui sont présentées portent sur la sélection de l'habitat, la formation des groupes, et la sélection des trajets de voyage. Différents facteurs écologiques et socioculturels influant sur la nature des décisions prises sont présentés et discutés.

Mots-clés: Inuit, décision, narval, lisière des banquises côtières, eaux dégagées

Introduction

Despite the current importance of small whales to Inuit, research on Inuit hunting behaviour of narwhals in the Arctic has been limited both in terms of number of studies and depth of analysis (with notable exceptions of Dahl 1990, 2000; Smith 1991). The major objective of this paper is to address this gap through a comprehensive analysis of Inuit behaviour in the floe-edge and open water foraging environments. This will be done by describing the major decisions involved in floe-edge and open water narwhal hunts and by analyzing the major ecological and sociocultural factors that influence these decisions. In the next section, some basic facts about the narwhals, Inuit and the two main environments which Inuit utilize to hunt them will be presented. Finally, the methodology utilized to document the decisions Inuit make when hunting narwhals is presented.

Inuit, narwhals and the traditional and current head decision maker

The narwhal is a small cetacean found in the marine environment of the Canadian Arctic from early May to late September. The narwhal mainly frequents north-western Baffin Bay, Lancaster and Jones Sounds, western Foxe Basin, and eastern Barrow Strait (see Figure 1; Heide-Jørgensen et al. 2003; Kingsley, Cleator and Ramsay 1994; Koski and Davis 1994; Reeves 1992; Richard et al. 1994; Silverman 1979; Smith et al. 1985, Strong 1988). Although, at present, the archaeological record does not provide conclusive evidence of the importance of narwhal in the subsistence economy of northern Baffin Island Inuit in the distant past, archaeology has demonstrated that narwhals have been hunted in this region for some two millennia (Savelle 1994).

Narwhal hunting has been and still is integral to Inuit lifestyle. The annual harvest of narwhals by north Baffin Island Inuit represents a unique historical relationship in terms of a continuous and relatively undisturbed utilization of a local marine resource. As such, narwhals and their products have widespread cultural importance for Inuit. The skin (*maktaaq*), with some attached fat, is the most important food item furnished by narwhal hunting and is often considered a delicacy (Reeves 1992; Personal observations).

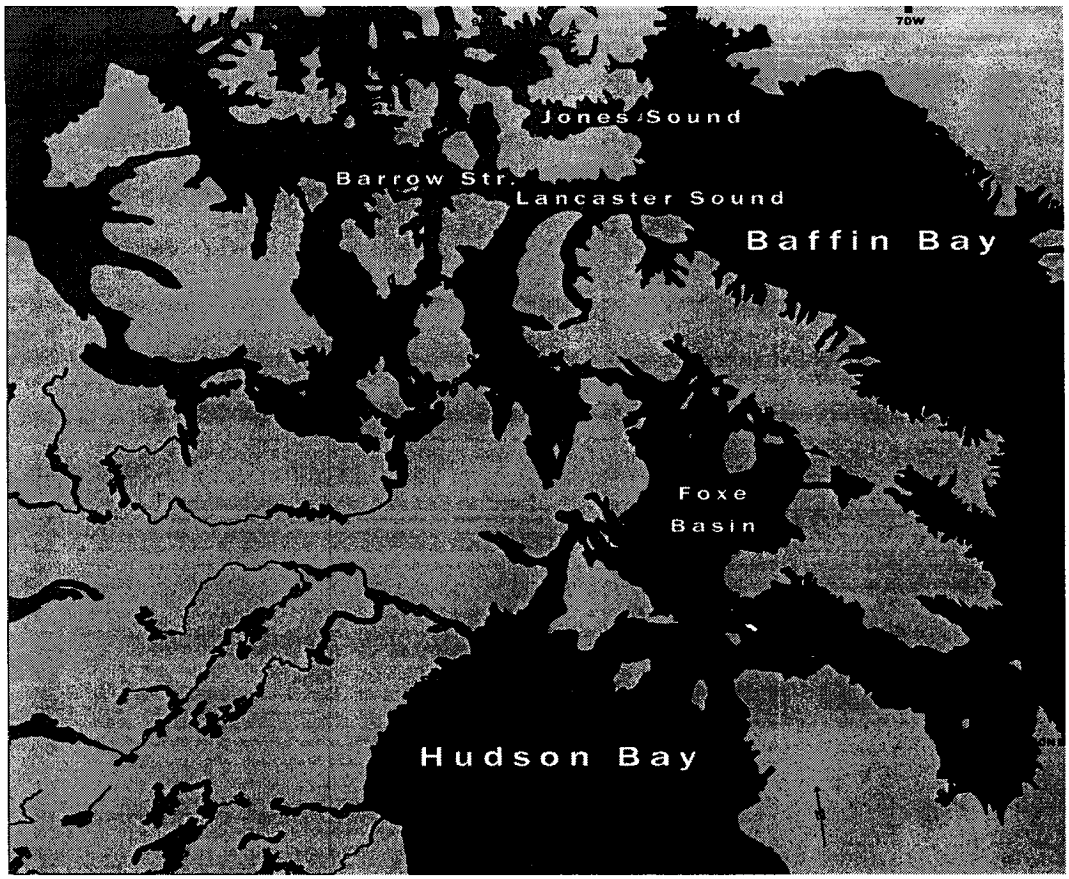

Figure 1. Major bodies of water that narwhals currently utilize: Barrow Strait, Lancaster Sound, Baffin Bay, Jones Sounds, and Foxe Basin.

Historically, the narwhal also provided raw materials for domestic use items, such as dried sinews used to make thread for waterproof seams. However, it was the species' unique ivory tusk that served as the principal basis for a burgeoning late nineteenth century and early twentieth century trade between Inuit and Europeans (Bernier 1909, 1911). Although narwhal ivory is no longer the object of Inuit-European commerce that it once was (Markham 1874; Tremblay 1921), it does continue to be an economically valuable element of the contemporary narwhal hunt (Reeves 1992; Reeves and Heide-Jørgensen 1994), with tusks roundly valued at one hundred Canadian dollars per foot of length (Personal observations).

Traditionally, the head decision maker of major hunting decisions, including narwhal hunting, was the head of the extended family. During the pre-contact period in the Canadian Arctic, the individual who had the power to make the major decisions was

the leader of the extended family (*isumataq*) and of the local camp. Usually, this individual also possessed the most experience in hunting and demonstrated superior leadership skills (Mary-Rousselière 1984; Matthiasson 1992; Stevenson 1993). Accordingly, the *isumataq* was historically responsible for making major hunting decisions such as prey selection, hunting party composition, hunt site location, timing of the hunt, and the hunting tactics and strategies (Matthiasson 1992; Stevenson 1993; Wenzel 1991). In addition, the *isumataq* would also establish and enforce normative rules of behaviour for all members of the extended family within a foraging environment. For example, he would govern human movement at the floe-edge in order to minimize noise disturbance when hunting narwhals. Lastly, the authority of the *isumataq* often extended to socio-economic matters that influenced the entire camp, including the sharing and distribution of game and other resources (Damas 1963; Stevenson 1993; Wenzel 1981).

However, recent changes (1960 – now) have led to a redefinition of this role. During this period of centralization instituted by the Canadian government, nomadic Inuit families were encouraged to relocate into permanent settlements such as Pond Inlet (Brody 1975). Such centralized communities served as a channel to apply several social institutions such as education and health (Brody 1975; Damas 2002; Diubaldo 1985). During the early phase of this period, the *isumataq* continued to be the head decision maker with respect to major narwhal hunting decisions (Matthiasson 1992). However, within the next three decades, the authority and role of the *isumataq* began to change markedly (Damas 1963, 2002; Wenzel 1981).

There are two major developments that affected the role of the *isumataq* with respect to narwhal hunting. The first development was the combined effect of the relocation of extended families into a centralized community and the consequent population increase that resulted in numerous separate households (Matthiasson 1992; Wenzel 1981). This centralization of the population provided stability and security in terms of health, food and shelter which in turn provided the opportunity for a significant increase in population size (Royal Commission on Aboriginal Peoples 1996). The resulting increase in the average size of the extended family logistically required the division of the extended family into many separate households within the community. In

order for these separate households to function effectively, the head of the extended family (*isumataq*) relinquished some of his power to the newly created heads of households. Obviously, these heads of households addressed issues such as household distribution of resources and food which was previously the domain of the *isumataq* (Matthiasson 1992; Nooter 1976; Stevenson 1993). However, it should be noted that the *isumataq* does continue to exercise some larger scale social mechanisms such as distribution of narwhal resource products throughout the entire extended family.

A second major development was the change in control and access over required equipment to hunt prey species such as ringed seals and narwhal (Wenzel 1991, 1994). The recent proliferation of equipment such as snowmobiles and high powered rifles permitted those Inuit who were not an *isumataq* to gain access to these modern resources and hunt narwhal independently of the *isumataq*. During the period of the present study, we observed that the head decision maker of narwhal hunting trips was characterized as being a head of household who possessed or could gain access to required equipment and time to hunt narwhal (see also Wenzel 1994). However, it should be noted that we still observed that most independent hunters would still obey directions from their *isumataq* if accompanied by him on a narwhal hunting trip.

Methodology

The primary data presented here were collected from 1996 through 1998, utilizing a participant-observation methodology supplemented by directed interviews.

Almost eleven months were spent in total accompanying and observing *Mittimatalingmiut* narwhal activities in the floe-edge and open water environments. The accompanied hunters were highly varied as to age, social relationships and experience in narwhal hunting (see Table 1). This participatory approach to data collection was ideal for recording such information as the temporal length of hunter movements, stops and campsites, while also allowing the observation of contiguous or passing narwhal hunters.

Table 1. Social and Demographic Characteristics of Floe-edge Hunting Groups

Trip #	*Date*	*Social Relations*	*Age*
1	27-30/05/1996	Father-Son	55/18
2	06-09/06/1996	Father-Son	55/18
3	08-09/06/1996	Father/Wife/Son	37/35/10
4	13-16/06/1996	Single Hunter	30
5	14-16/06/1996	Single Hunter	29
6	22-24/06/1996	Cousins	25/18
7	28/06-05/07/1996	Single Hunter	40
8	13-15/06/1997	Father/Grand-son/Son-in-Law	55/10/40
9	18-22/06/1997	Brothers	45/55
10	21-28/06/1997	Single Hunter	29
11	22-27/06/1997	Single Hunter	18
12	16-21/06/1998	Single Hunter	45
13	16-21/06/1998	Single Hunter	35
14	19-21/06/1998	Brothers	30/18
Mean			33

Participant-observation of hunter behaviour served two immediate purposes. First, it allowed the recording of the details of hunting behaviour providing rich context that would have been challenging or impossible to validate through an interview process. Second, participant-observation permitted the recording of time and other important variables that are otherwise impossible or challenging to elicit and to validate through an interview process (Bernard 1998; Bernard 2002). As well as the eleven hunts that were accompanied in their entirety (from departure to return), detailed behavioural and time allocation information were obtained for three additional floe-edge narwhal trips. In these cases, although they were not observed from actual start to end, these three hunts were under near-constant observation because of their proximity to and, on some occasions, amalgamation with the hunt that was being accompanied.

To supplement our participant-observation data, interviews were conducted with both current hunters and elders in the Pond Inlet community. First, interviews with current hunters were guided by a questionnaire, but were unstructured in format to allow the interviewee to respond dynamically. I formally interviewed twenty-five hunters. They were all male and their ages ranged from twenty-five to fifty. Their hunting experience varied widely from beginner to renowned narwhal hunting specialist. Also,

about 150 hunters were informally interviewed, that is, while shopping at the COOP, attending community events, or visiting homes. It should be noted that Pond Inlet is a relatively small community, where about 250 Inuit were registered as hunters at the time of the study. As such, we believe we have interviewed a fairly representative sample of this Inuit community.

In these interviews, we asked information about the economic, social and political status of the individual, and also about annual foraging activities. Information was also acquired about narwhal hunting activities and the rationale for hunting narwhals and other prey types. Second, informal interviews with elders were conducted to solicit information about the economic and historical past of the community and the social and political standing of members and families of the community. Interviews were again loosely structured around key economic and social themes with questions remaining open-ended. About ten elders were interviewed, all older than sixty years of age, and they were known to be hunting experts by members of the community.

Interviews generally did not exceed one hour and a half and were executed in the language of the interviewee's choice (English or Inuktitut). About 95 percent of individuals were comfortable to be interviewed in English. In fact, only the interviews with the Elders were carried in Inuktitut. In these cases, we were accompanied by an interpreter. Two of the interpreters were school teachers, and the other was a highly-educated professional.

Overview of Current Pond Inlet Inuit Narwhal Hunting

The study area for the present research comprises the coastal waters of northern Baffin Island, especially concentrating around Pond Inlet. These localities are frequented in summer by large quantities of narwhals migrating to their summering grounds. Inuit hunt the narwhals which frequent the floe edge environment from late spring to early summer (approximately June and July) and in the open water of Pond Inlet from early summer to late summer (approximately July to October).

Spring floe-edge hunting

Timing of a typical floe-edge hunt. An ice floe is a large flat free mass of floating sea ice. As soon as the environmental factors of salinity, air and water temperature, and wind conditions reach specific values, certain areas of sea surface become seasonally frozen and relatively stable to embody a flat mass of floating sea ice that permits travel by snowmobile upon this medium (see Figure 2).

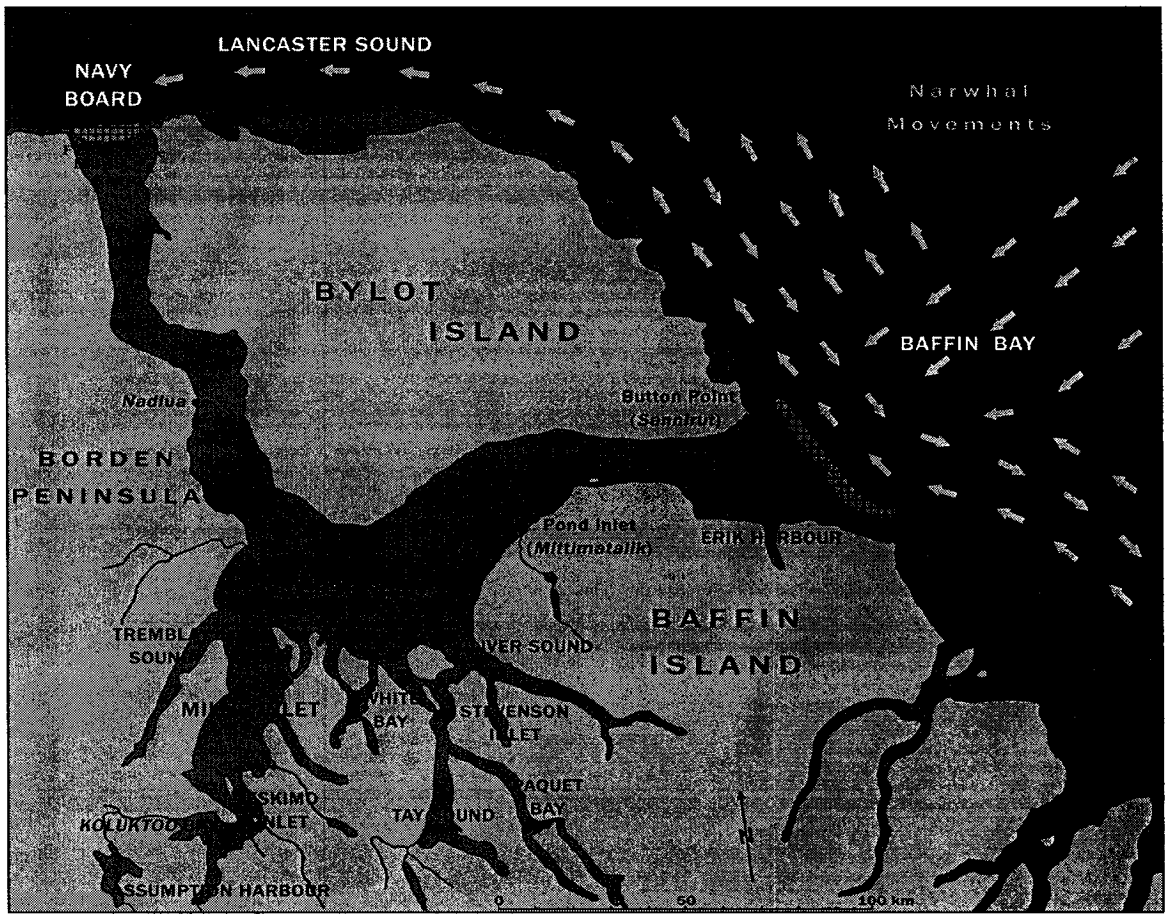

Figure 2. The location of the Pond Inlet and Navy Board Floe Edge Hunting areas.

By winter, a specific environmental interface consisting of the mass of solid Pond Inlet sea ice and the unfrozen open sea of Baffin Bay is formed and identified as the Pond Inlet floe-edge. A floe-edge is also formed at the Navy Board Inlet - Lancaster Sound interface.

The floe-edge is a very dynamic physical geographical environment that is recognized as an area of high primary productivity (Freeman 1984; France et al. 1998) providing and sustaining a complex array of wildlife. Animals that frequent this environment include numerous species of birds including thick-billed murres, several species of seagulls, ringed seals, harp seals, hooded seals, bearded seals, arctic cod, walrus, polar bears, bowhead whales and narwhals (Bradstreet 1982). It represents the first major environment that presently provides Pond Inlet Inuit opportunities to hunt narwhals as they migrate from their wintering grounds located in areas of Baffin Bay to their summering grounds located in and around Pond Inlet and surrounding bays and inlets including Navy Board Inlet, Milne Inlet, and Koluktoo Bay (Hay 1984; Heide-Jørgensen et al. 2003; Silverman 1979).

There exist two major floe-edges that are readily identifiable and accessible to Pond Inlet Inuit from the community of Pond Inlet by snowmobiles. These are the Pond Inlet floe-edge and the Navy Board Inlet floe-edge. It is the first of these that is most often used by *Mittimatalingmiut*. In the early spring, when narwhals start to appear at the Pond Inlet floe-edge, a few Inuit hunters begin to travel to these floe-edges in order to hunt narwhals. However, the vast majority of Pond Inlet Inuit hunters do not travel to the Pond Inlet floe-edge until mid-May when narwhals are more abundant in this environment. All Inuit narwhal hunters travel to the Pond Inlet and Navy Board Inlet floe-edges by snowmobile and sled. On the sled, hunters carry their equipment which include tents, stove, naphthalene, gasoline, spare snowmobile parts, tools, food, rope, harpoons, rifles, clothing, sleeping materials and other necessary hunting and camping equipment (Personal observations).

In mid-May when the number of narwhals at the eastern floe-edge has substantially increased (Hay 1984; Silverman 1979; Personal observations), most Inuit hunters travel directly to Button Point and then proceed to the Pond Inlet floe-edge to hunt narwhals. This pattern of proceeding to Button Point before proceeding to the floe-edge continues into late May. Hunters stop proceeding to Button Point after this period because the sea-ice conditions around this area deteriorate and become dangerous for travel.

Description of a typical floe-edge hunt. Upon reaching the Pond Inlet floe-edge, Inuit hunters first scan the open water for narwhals and other environmental factors such as sea-ice conditions, weather conditions, strength of currents, and ice conditions in the open water off the floe-edge. Hunters then select a direction to travel that is parallel to the floe-edge until a position for a campsite is chosen. Upon selection of a campsite, the camp consisting of a tent, boat, and supplies is deployed. At the campsite, hunters wait for narwhals to come within striking distance or take active trips by snowmobile or foot along the floe-edge to hunt narwhals. When a narwhal comes within firing distance, the hunter(s) uses high-powered rifles (.303 calibre or larger) to incapacitate the whale. Narwhals are retrieved by harpoons attached with floats or lines that are connected to hooks that have been thrown to secure the whale before it sinks. They are then hauled onto the ice either by a pulley system by person power or by a snowmobile (Personal observations).

In addition, at any point while at the floe-edge, hunters can redeploy their campsites. For example, hunters immediately reposition if broken ice moves into the area and blocks access to open water. Hunters also move their campsite location if they perceive better hunting opportunities at a different geographic position, usually after a long period of time in which there are no narwhal hunting opportunities encountered at the initial campsite. Once a narwhal is captured or when the head decision-maker decides to depart from the floe-edge, the camp is packed up and a return travel route is taken to the community of Pond Inlet.

Summer open-water hunting

As spring season progresses into the summer season (approximately late June and early July), the previously frozen sea-ice surface of Pond Inlet begins to melt providing large expanses of open water that are interspersed with melting pieces of floating sea-ice. This open water is utilized by narwhals during the early summer months to migrate through Pond Inlet to their summer feeding grounds west and north of the community (see Figure 3; Hay 1984; Silverman 1979; Heide-Jørgensen et al. 2003; Personal observations). By mid summer, the sea-ice has melted and there is only open water in the Pond Inlet region.

Local Pond Inlet water. During the early phase of the summer (approximately end of June), the first open water accessible to Pond Inlet Inuit is located adjacent to the centralized community of *Mittimatalik.* In this area, Inuit engage narwhals in small boats (12 feet or less) during this early phase and may utilize larger craft during the latter phase of the season as the sea-ice dissipates and no longer hinders movement of larger vessels (greater than 12 feet).

Generally, Inuit cruise in their boats searching for narwhals, ringed seals, and patches of ice on which to land their boats. Once landed, hunters wait for prey until a pursuit event is launched in which they fire on a narwhal with their rifles and harpoons. Hunters continue this pattern of hunting until a prey is captured or until exhaustion of resources (Personal observations).

Figure 3. The location of Pond Inlet (*Mittimatalik*) and Button Point (*Sannirut*).

Summer campsites. As the season progresses, the second open water hunting area located in the eastern region of the northern Baffin marine network becomes accessible to Pond Inlet Inuit as sea-ice melts. This includes Navy Board Inlet (*Nalluata imanga*), Oliver Sound (*Kangiqluruluk*), Eclipse Sound (*Tasiuja*) and surrounding bays and inlets (see Figure 4). On these trips, hunters and their families travel to a campsite which has been historically occupied. From the campsite, hunters wait for narwhals to come within pursuit distance. Hunters pursue narwhals in their boats always attempting to drive them towards the shoreline while firing upon them with their rifles and harpoons.

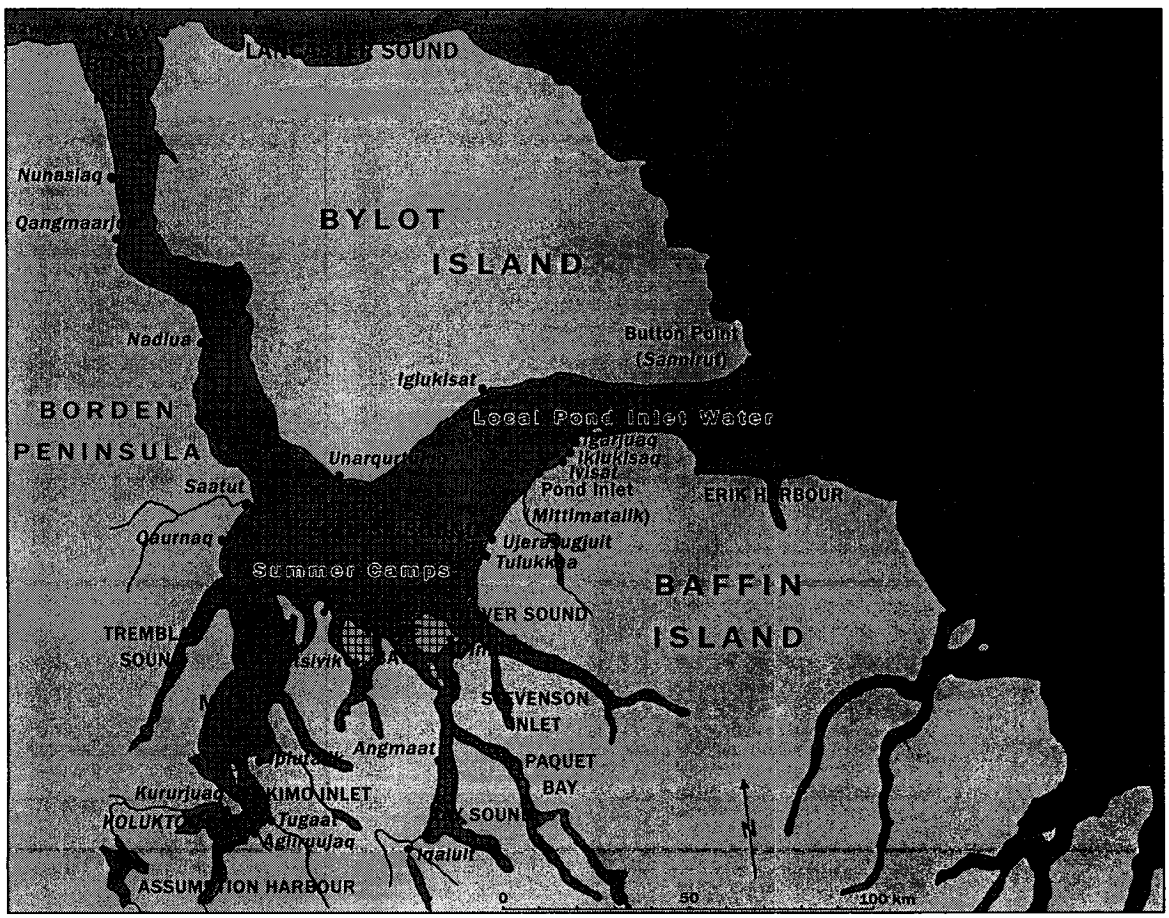

Figure 4. The Local Pond Inlet Water and Summer Camps open water hunting areas (shaded areas).

Results and Discussion: Analysis of Observed Narwhal Hunts

In this section, the major decisions Inuit faced when narwhal hunting in each environment, floe-edge and open-water, are outlined in flowcharts and are systematically discussed (see Figures 5, 6, 7). A flowchart is a pictorial representation describing a process being studied. Flowcharts provide an excellent graphical heuristic to describe the process under study, and are quite often useful when examining how various steps in a process work together.

The present flowcharts were structured upon the decisions of a head decision maker for each narwhal hunting trip as presented in the introduction. This person traditionally represented the head of household or the head of the extended family (*isumataq*; see Wenzel 1991). Today, this person is any individual who possesses or has access to requisite equipment, resources, and the time to hunt narwhals.

For the actual analysis of the decisions, two main approaches are utilized. For each decision, the major geographical, ecological and social factors that were observed and revealed through interviews to influence each decision are presented and discussed. Secondly, a qualitative cost-benefit approach is applied to each decision.

For all hunting trips, the first major decision faced by Inuit is habitat selection. The second major decision involves the selection of the members of the hunting party. The third major decision is the selection of the traveling party. The next major decisions are specific for each environment. Each addresses the selection of the travel route to the destination, the engagement of sealing en route to the destination, the formation of campsite membership, the selection of hunting strategies and the selection of the return travel route. The search and pursuit behaviour exhibited by Inuit in hunting narwhals at the floe-edge and in the open water is the focus of another paper and is not addressed in detail here (Lee and Wenzel Forthcoming; Lee n.d.).

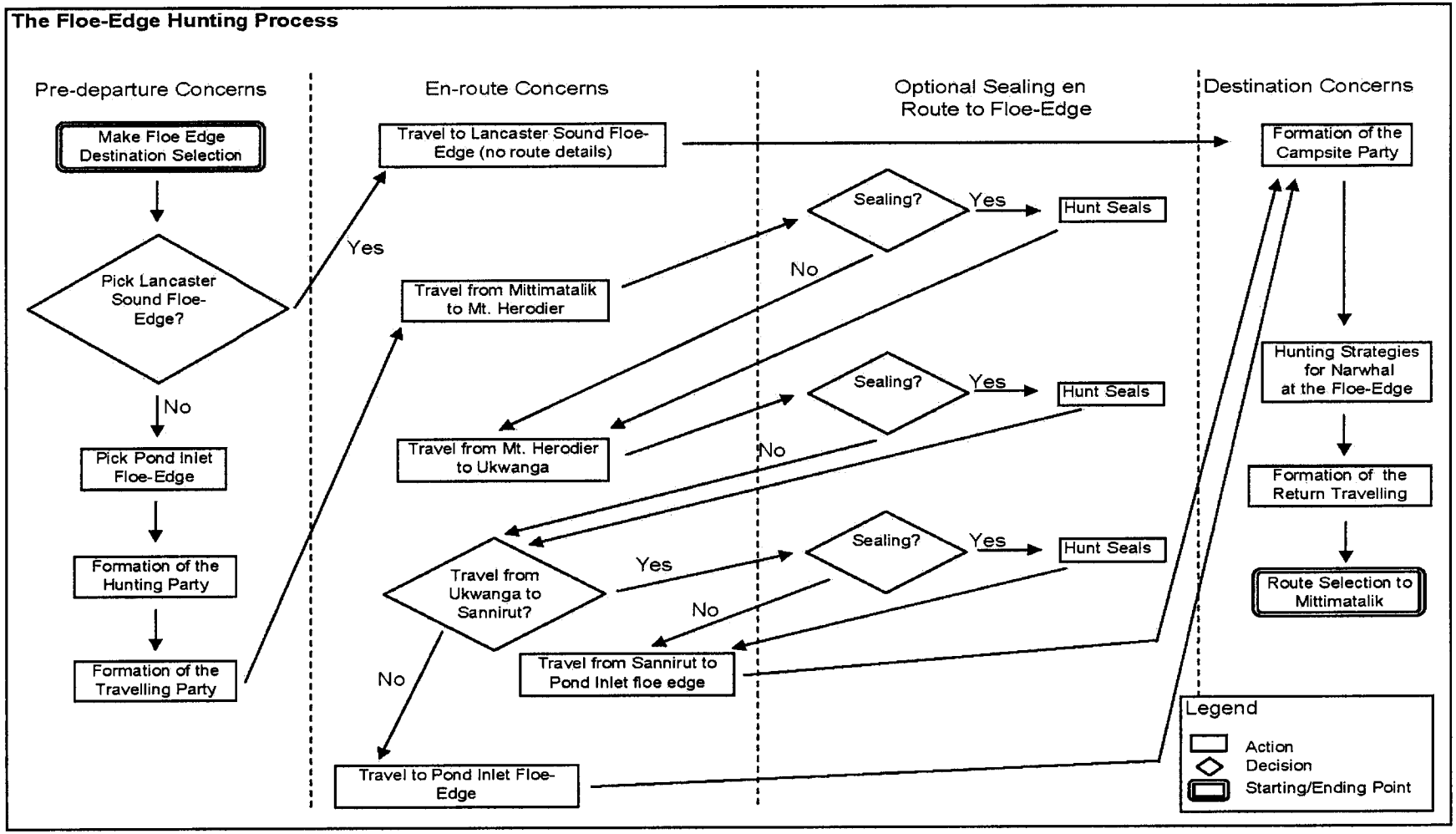

Figure 5. Major actions and decisions displayed by Pond Inlet Inuit in their hunting process at the floe-edge.

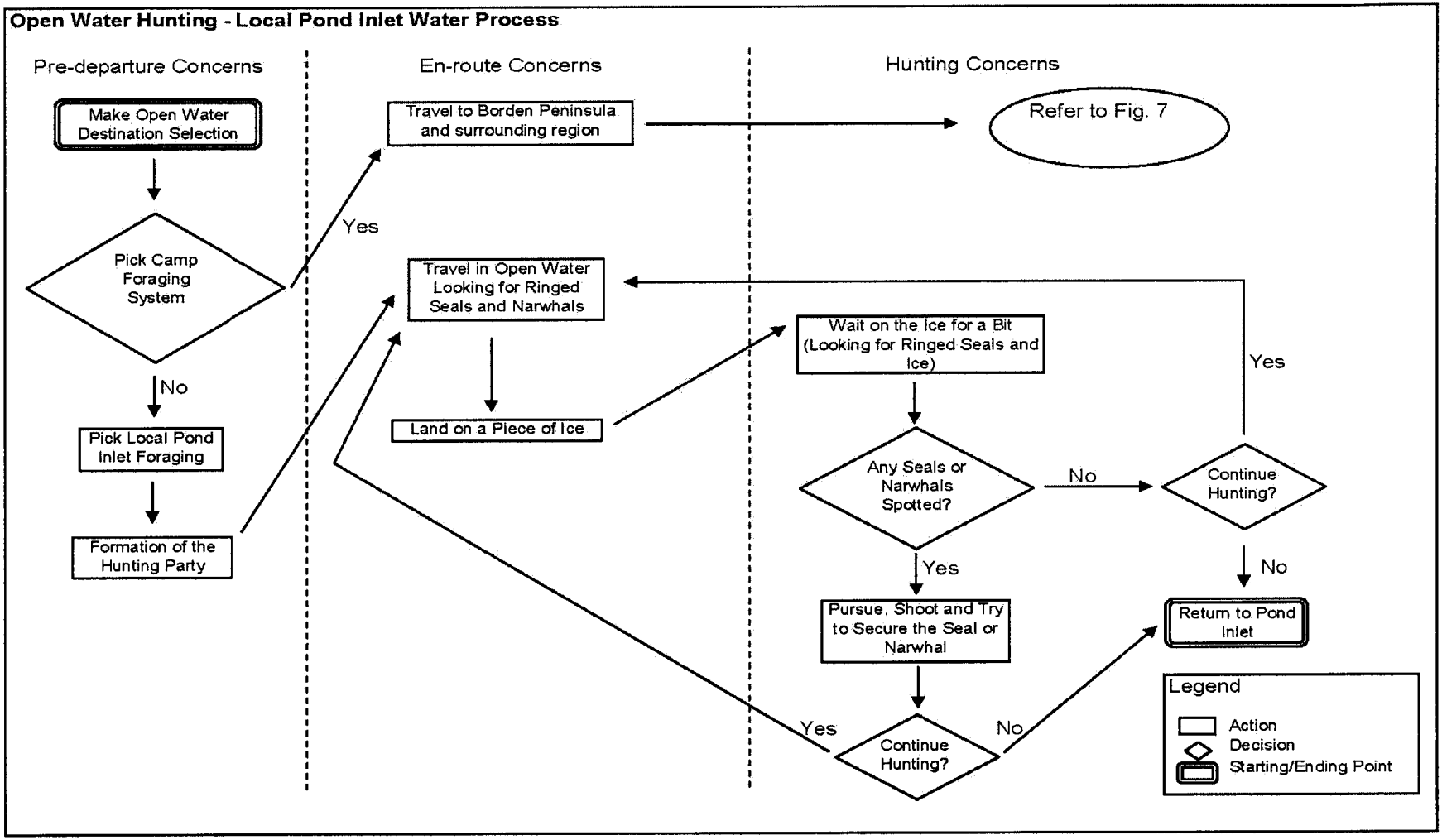

Figure 6. Major actions and decisions displayed by Pond Inlet Inuit in their hunting process in the local Pond Inlet water.

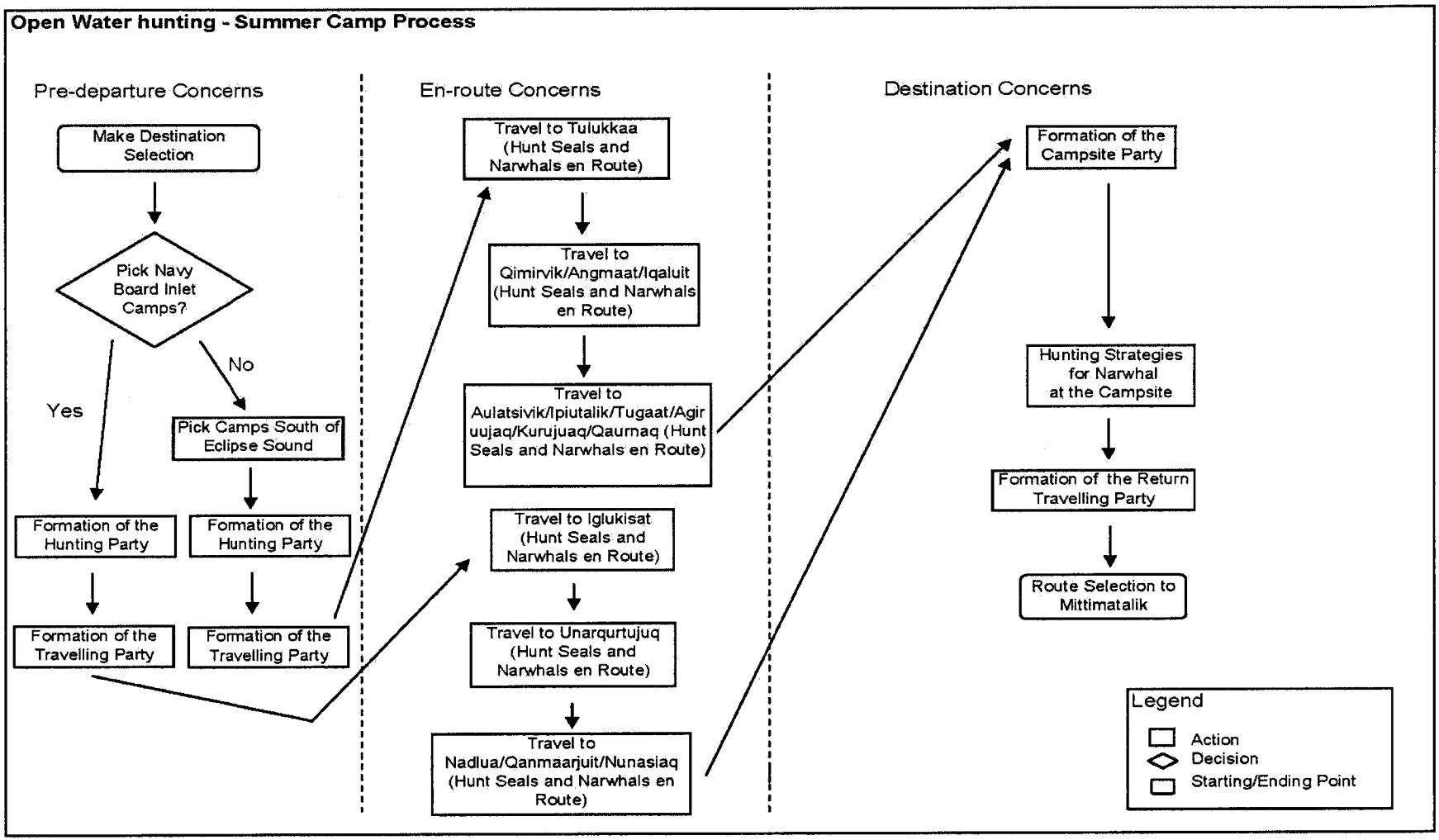

Figure 7. Major actions and decisions displayed by Pond Inlet Inuit in their hunting process in the summer camp region.

Habitat selection (floe-edge and open water selection)

During the early- to mid-spring hunting season, Inuit hunters based from the community of Pond Inlet are first faced with the decision of selecting a floe-edge. The first major option is the Pond Inlet floe-edge whose absolute location is latitude 72°45' north, longitude 75°05' west. It is positioned approximately 85 km east of the settlement of Pond Inlet and adjacent to Baffin Bay (see Figure 2). The second option is the Navy Board Inlet floe-edge whose absolute location is latitude 73°51' north, longitude 81°14' west and is positioned approximately 200 km northwest from the settlement of Pond Inlet, adjacent to Lancaster Sound (see Figure 2). The two major floe-edges were utilized by Pond Inlet hunters during the study period and served as the staging area from which to hunt narwhals. They both provided reliable access and exceptional opportunities to hunt migrating narwhal (Hay 1984; Silverman 1979). However, their respective usage was observed to be disproportionate during the study period. Very few trips to the Navy Board Inlet floe-edge were noted during the study period in contrast to the Pond Inlet floe-edge to which hunters regularly traveled.

During the open water summer hunting season, Pond Inlet hunters are first faced with the decision of selecting two distinctive open water regions to hunt narwhals. The first major option comprises the local waters immediately beside the community of Pond Inlet (see Figure 4). The second option comprises the summer camps of the eastern region of the Northern Baffin Island marine environment (see Figure 4). Hunts in this distant area required several days and nights away from the community.

In order to understand the selection of each option for these environments, the major geographical, ecological and social factors that were observed and elicited through interviews are next presented.

Geographical, ecological and social factors. The primary factor stated by most Inuit hunters that influenced both their floe-edge and open water selection was related to the absolute geographic position of each hunting area. In regard to the floe-edge selection, the Pond Inlet floe-edge is located approximately 115 km closer to the community than that of Navy Board Inlet floe-edge (see Figure 2). Due to the geographic difference between the two floe-edges, the average travel time to the Pond Inlet floe-edge

was approximately three hours[1] less than the average travel time to the Navy Board Inlet floe-edge. In regard to the open-water selection, the Pond Inlet local water hunting area is located immediately beside the community, while some summer camps can be located up to 150 km (*Nunasiaq*; see Figure 2) away from the community. As such, there was no travel time to hunt in local Pond Inlet water because Inuit immediately engaged in hunting upon departure from the community, while travel time is obviously longer to reach outpost summer camps.

The impact of geographic position was especially crucial for wage earners because their hunting time was limited to weekends (from Friday evening to Monday morning, excepting holidays). For example, wage workers expressed that the Pond Inlet floe-edge during the spring hunting season was their only practical choice. Travel time to the Navy Board Inlet floe-edge significantly reduced the actual hunting time at the floe-edge to the point that it was not perceived as worthwhile for the effort.

Another major geographical and ecological decision factor for both the floe-edge and open water is related to the stage of narwhal migration. During the early spring hunt, migrating narwhals arrived earlier at the Pond Inlet floe-edge than at the Navy Board Inlet floe-edge (Hay 1984; Silverman 1979; Personal observations). Narwhals then migrated through Pond Inlet as soon as the sea-ice deteriorated and there was sufficient open water. As a result, the earliest opportunities for Inuit hunters from the community of Pond Inlet to hunt narwhals occurred at the Pond Inlet floe-edge during spring and the local Pond Inlet water during early summer.

For the spring floe-edge hunt, this was an important factor for some Inuit because of the spring narwhal quota. The overall quota system is regulated by the Department of Fisheries and Oceans. One hundred narwhal tags were allocated to the Pond Inlet community during the study period. In turn, the Pond Inlet Hunters and Trappers Organization established a spring floe-edge quota of thirty animals (out of the one hundred). Due to this quota limit, some Inuit who wished to capture at least one narwhal or in some cases as many narwhals as possible expressed their motivation to hunt at the earliest possible times during the spring narwhal hunt.

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[1] This is based upon optimal ice conditions during the spring hunting season and an average driving speed of 40 km/h.

Thirdly, a major factor that specifically influenced floe-edge selection was related to the physical geography of each floe-edge. Although, both floe-edges share many physical similarities, the Navy Board Inlet floe-edge possesses a significant difference due to its local geography and climate. Interviews with hunters who were familiar with both areas indicated that the quality and grade of the ice encountered along the Navy Board Inlet floe-edge consisted of more pressure-lifted ice ridges and compacted ice floes. These conditions are mainly due to the strong current and wind conditions that are prevalent in this locality. These types of ice made travelling into and around the area challenging and dangerous. Interviewed hunters stated that the Navy Board Inlet floe-edge is in general considered to be a much more hazardous area to navigate and in which to operate. For example, in 1996 a Pond Inlet school group was stranded and rescued from a floe that broke off while traveling through this area. Accordingly, a majority of interviewed Inuit expressed their preference to utilize the Pond Inlet floe-edge because of their better ecological knowledge and experience with it. With respect to this area, all accompanied and many interviewed Inuit showed some familiarity with its major landmarks and utilized them to navigate to and from the floe-edge. They used such landmarks to observe if any floes they were traveling or resting upon had shifted. This was important in order to assess whether the floe that they were situated upon had broken off because it could then potentially drift out to Baffin Bay whereupon rescue would be necessary.

Another major factor for both floe-edge and open water selection was personal experience. Some hunters expressed preferences for different geographical regions of the floe-edge based upon their hunting experience. For example, some interviewed hunters indicated that they selected the southern area of the floe-edge because it had presented good narwhal sighting and firing opportunities within the past few years. For summer camp locations, hunters indicated a desire to return to familiar hunting areas that they had historically utilized.

Summer camp hunting trips were observed to be mostly family oriented; as such, they had a distinct social element not present in floe-edge hunting trips and local Pond Inlet water hunting trips where the composition was adult male. Summer camp hunting trips afforded families time to engage socially away from the community. In addition, for

some Inuit, spring floe-edge and summer camp trips to locations such as *Nadlua* in the Navy Board Inlet region were motivated by a desire to visit relatives living there year round. While visiting their relatives, visiting Inuit would then take the opportunity to travel to the Navy Board Inlet floe-edge to hunt narwhals. During the summer open water hunting season, Inuit would camp at *Nadlua* and hunt narwhals as they moved through the region. Such visits not only strengthened social bonds between relatives but also facilitated the movement of goods. For example, relatives would bring supplies such as fuel and store food from the community to the outpost camps[2] and return with country food such as narwhal skin.

Costs and benefits. Both wage and non-employed hunters expressed that travel costs for the Navy Board Inlet floe-edge and summer camps was a key factor in their reluctance to chose these hunting locations. The lower cost of material resources such as gas, food, oil, and naphthalene to travel to the Pond Inlet floe-edge and for local Pond Inlet water hunting trips represented a lower friction of distance[3].

In local Pond Inlet hunting trips, fewer resources were utilized because long distances were not travelled and campsites were not established. These lower costs allowed some hunters to engage in narwhal hunting that would have otherwise been untenable for the Navy Board Inlet floe-edge or summer camp hunting trips. For example, several interviewed hunters indicated that the Pond Inlet floe-edge and the local Pond Inlet open water were the only areas that they could access to hunt narwhals because the cost hunting in these locales were low. Other hunters were also observed to take advantage of this lower friction of distance by engaging in multiple trips to the Pond Inlet floe-edge and the local Pond Inlet water during the same hunting season. Furthermore, some hunters benefited from an increase in the absolute number of hunting opportunities and hunting experience that was afforded by a lower friction of distance for the Pond Inlet floe-edge and local Pond Inlet water hunting trips. Finally, the proximity to the community also provided cost efficient replenishment of resources such as

[2] It should be noted that since the field study took place, these outpost camps have been abandoned and the Inuit inhabiting them have moved to *Mittimatalik*.

[3] Friction of distance is a measure of the retarding effect of distance on human interaction (e.g. transport costs).

snowmobile parts, food, and fuel from other Inuit traveling into the area which represented a major benefit of selecting the Pond Inlet floe-edge.

Another general benefit of selecting Pond Inlet floe-edge was trip safety. The short travel time to the area meant less fatigue and stress. Secondly, some Inuit were always located at the Pond Inlet floe-edge or in close proximity during the study period. This provided a higher level of security because Inuit could readily contact each other through shortwave radio in the case of an emergency. In contrast, help or rescue is less readily available at the Navy Board Inlet floe-edge due to the low hunter density. Rescue in this area must usually be organized and launched from Pond Inlet. Lastly, the proximity of the Pond Inlet floe-edge and the local Pond Inlet water to the community reduced the return travel time which is a critical stage of hunting trips because of potentially dangerous traveling conditions coupled with fatigue from the total trip time.

A cost of selecting the Pond Inlet floe-edge and the water around the community was related to the consequent increased hunter density at these locations. This included limited number of favoured campsites at the floe-edge and increased noise disturbance in both areas and thus decreased narwhal hunting opportunities.

Summary. The selection of the Pond Inlet floe-edge was primarily driven by geographical and ecological factors. The relatively close geographical position of the floe-edge to the community and associated lower operating costs compared to the Navy Board Inlet floe-edge were primary reasons that were stated for selecting this floe-edge. However, some Inuit were noted to travel to the Navy Board Inlet floe-edge. These trips were mostly motivated by social factors (visiting extended family in outpost camps such as *Nadlua*).

The selection of local Pond Inlet open water was also driven by geographic and ecological factors. For example, during the early summer, the local Pond Inlet water was the only open water environment that was accessible to hunt ringed seals and narwhals because sea-ice was still blocking access to the summer camp region. The local Pond Inlet environment also provided access to migrating narwhals at lower operational cost than the much more distant summer camp region. When summer camp areas became accessible as the ice floes deteriorated, summer camp hunting trips were generally limited

by high equipment and resource costs and requirements again due to its geographic position.

The selection of summer camp open water areas was influenced by both ecological and social factors. One participant-observed summer camp hunting trip was motivated by a desire primarily to hunt narwhals. This was accomplished by traveling to a prime hunting location in Navy Board Inlet where increased narwhal hunting opportunities were observed. However, other summer camp hunting trips were social visits to outpost camps and social family oriented trips in which members of the extended family could spend time together and engage in traditional activities.

The hunting party: Size and composition

For floe-edge hunting trips, the hunting party consisted of all members that travelled on one snow machine and one sled. For local Pond Inlet water and summer camp hunting trips, the hunting party consisted of all members that travelled on one boat. The major physical and social factors that appeared to influence the size and composition of the hunting party are next presented and discussed.

Physical and social factors. Generally, the nature of the summer camp groups differed significantly from the floe-edge and local Pond Inlet water hunting groups because many summer camp trips were observed to be family oriented in which hunters took their families out "on the land" from days to weeks during the summer holiday months. Thus, these groups could comprise women and children. Yet, there were still some summer camp trips which were more strictly hunt oriented in which the group was characterized by adult male hunters whose main focus were hunting prey.

The actual size of the hunting and camp party was observed to be physically limited by the size of the sled and the spatial capacity of the boat. On all participant observation trips and observed hunts, if the length of the sled was six feet or less, no more than one passenger was taken. Sleds longer than six feet and up to twelve feet were observed to accommodate a maximum of three passengers but most frequently were observed with two or less passengers. The sled size of all accompanied hunting trips lay within this medium range. The average hunting party size for accompanied hunting trips was two (see Table 2).

Table 2. The Hunting, Travelling and First Camping Party Size for Pond Inlet floe-edge hunting trips.

Trip #	*Date*	*Hunting Party Size*	*Travelling Party Size to Floe-edge*	*Traveling Party Size to Pond Inlet*	*Camping Party Size for first camp*
1	27-30/05/1996	2	1	2	1
2	06-09/06	2	1	2	1
3	08-09/06	3	1	1	1
4	13-16/06	1	1	2	2
5	14-16/06	1	1	2	2
6	22-24/06	2	1	1	2
7	28/06-05/07	1	2	2	2
8	13-15/06/1997	3	2	2	2
9	18-22/06	2	1	2	2
10	21-28/06	1	1	2	2
11	22-27/06	1	2	2	2
12	16-21/06/1998	1	2	3	2
13	16-21/06	1	2	3	2
14	19-21/06	2	1	3	3
Mean		2	1	2	2

During the early summer hunt when only small boats of less than ten feet were utilized, no more than three persons were observed in each boat. The average hunting party size was two (see Table 3). During the later stage of the summer hunt, larger boats (ten feet or greater) could be utilized which carried more than three people. Hunting party sizes of four or more adults were never observed for the floe-edge and local Pond Inlet water trips. However, hunting party sizes that consisted of three or more passengers were frequently observed in family oriented summer camp trips in which two or more of the passengers were small children. The average family summer camp party size was four (See Table 4).

Table 3. The Hunting Party Size for Local Pond Inlet Water Hunting Trips.

Trip #	*Date*	*Hunting Party Size*
1	14/07/1996	2
2	23/07/1996	2
3	02/07/1997	2
4	05/97/1997	2
5	08/07/1997	3
6	11/07/1997	2
7	21/07/1997	3
8	24/07/1997	2
9	29/07/1997	3
10	20/07/1998	3
11	26/07/1998	2
12	10/08/1998	3
Mean		2

Table 4. The Hunting Party Size for Summer Camp Hunting Trips.

Trip #	*Date*	*Hunting Party Size*	*Travelling Party Size to Summer Camp*	*Travelling Party Size to Pond Inlet*	*Camping Party Size*
1	11-15/08/1996	2	1	2	4
2	01-04/08/1997	3	1	1	1
3	17-18/08/1998	4	1	1	1
4	27-29/08/1998	6	1	1	3
Mean		4	1	1	2

In all observed hunting trips, the composition of the hunting party was determined by the relationship of each of the hunting party members to one other. Members of the hunting party shared some measure of familiarity and hunting experience. For example, in almost all observed hunting trips, these relationships were based upon kinship. The composition of all observed hunting parties were described by at least four major relationships: father-son (*attata-irngiik*), older brother-younger brother (*angayuk-nuka*), uncle-nephew (*aqak-qaniak*), cousin-cousin which could be paternal cousin-paternal cousin (*agak-agak*), maternal cousin-maternal cousin (*angak-angak*), or paternal cousin-

maternal cousin (*agak-angak*), and friendship[4] (Damas 1963; Wenzel 1981). While there were certainly other kin relationships observed such as grandfather-grandson (*ituk-irngutaq*), the majority of the hunts observed could be described by the first four major relationships.

For some summer camp hunting trips, because they were often family oriented, the composition of some observed summer camp hunting parties could be described by all kin relations. All such trips included multi-generational extended family groups.

The membership of both the hunting and camp party were observed to be dependent upon several major factors. Foremost, the availability of regular hunting party members was necessary. Secondly, the potential resource contribution from each member was critical if resources were a limiting factor. For example, for hunting trips in which resources was a limiting factor, hunting partners who could contribute food, gasoline, or equipment necessary for the hunt were among the first to be considered for the hunting party. Regular hunting partners who could not provide supplies would then be secondary. This of course, did not apply to those hunting trips in which resources were not a limiting factor. For example, in the father-son partnership, there were several cases in which the son did not contribute resources to the hunt. For family oriented summer camp parties, the scheduling of the trip was most important. That is when both the leader of the trip and his family and other members who wished to go on the camping trip could be ready to embark on the trip.

Costs and benefits. During the travel leg for hunting trips, there was an increase in travel safety by increasing group size. For example, additional hunting party members could provide the necessary assistance when a snow machine or sled fell through the ice or became lodged in deep snow or high pressured ice ridges. On all observed hunting trips, snow machines and sleds were frequently pushed through wet snow, melting ice and deep pools of water. On one trip, an entire snow machine that was completely submerged in deep water was rescued.

Another major benefit of increasing party size is that each driver can take turns navigating to and from the destination point. This was rarely observed for floe-edge

[4] Almost everyone in the community of Pond Inlet is in some manner related to each other. The friendship bond refers to a relationship that extends beyond immediate cousins and the other more direct relationships mentioned.

hunting trips and summer camp hunting trips but frequently observed for local Pond Inlet water hunting trips. This was important for local Pond Inlet water hunting trips because hunters could take turns firing upon the prey and reducing fatigue due to continuous navigation of the boat.

For both summer camp and local Pond Inlet water hunting trips, additional hunting party members were able to help survey pieces of floating ice and to navigate to open water by moving ice pieces apart. Additional hunting party members also helped moor the boat onto pieces of ice.

With regard to the floe-edge campsite component of the hunting trip, additional hunting party members increased security by maintaining watches for dangerous circumstances such as the approach of predators and the movement of the ice floe upon which one is camped. This was the case in all accompanied hunting trips where members of the hunting party executed shifts for the duration of the camping period.

A second major benefit is the contribution each hunter makes to the hunting effort. For floe-edge hunting trips additional hunting party members contributed to the sealing effort while en route to the floe-edge to increase the probability of capturing ringed seal through the coverage of multiple breathing holes. This activity was carried out on several hunting trips.

Similarly, additional hunting party members contributed to the hunting effort for both summer camp and local Pond Inlet water hunting trips. When hunting narwhals or ringed seals, one hunter drove the boat while the other hunter shot and harpooned the animal. If there was a third person, this person would also shoot and harpoon the animal. This significantly enhanced the probability of securing both ringed seals and narwhals.

Another major benefit for both floe-edge and summer camp hunting trips was the increase in the contribution each additional party member made to the camp effort. This included activities such as setting up and breaking camp, preparing water and meals, picking berries and cleaning, handling and caching captured prey.

A fourth major benefit of increasing group size was the increase in the detection of narwhals and probability of capturing a narwhals through the expanded surveillance of the environment by partitioning surveillance among the different hunting party members over the entire time period. This was observed in all accompanied floe-edge hunting trips

where at least one member of the hunting party remained awake to watch for and hunt narwhal while other members rested. The increased surveillance improved the probability of sighting narwhal and, because each member of the hunting party received a share of captured prey, this ultimately improved the probability of securing some prey. Our observations revealed that Inuit almost always preferred to form hunting parties as opposed to hunting alone. Interviewees stated a preference to hunt with regular hunting partners and would only hunt alone if there was no one available. From a sample of fifty interviewed hunters, only three chose to hunt solitarily. For open water trips, the detection of narwhal was improved through the expanded surveillance of the environment simultaneously by all hunting members. This was observed in all accompanied hunting trips where each member of the hunting party would call out the direction and approximate distance of a ringed seal or narwhal when sighted.

One last benefit arises whereby hunting relationships invariably strengthen the social relations between hunting party members through the time spent with each other in exercise of common goals. The father-son relationship represents a significant relationship in terms of educating youth about traditions, hunting, and the floe-edge environment. For example, sons were frequently observed driving the snow machine with the father guiding. On one open water narwhal hunting trip, one cousin educated the other cousin about hunting and handling captured marine prey such as ringed seals.

One major cost associated with increasing group size expressed by some Inuit for both floe-edge and open water hunting trips was the diminished distribution of narwhal products. With increasing group size, the actual share per individual decreases depending upon the sharing practice. For example, in most observed hunting trips, the hunter that killed the narwhal was usually given the largest share of *muktaaq*. However, there were exceptions when hunting members expected reduced shares based upon their status in the hunting party or their role in the hunting and retrieval of the narwhal. For example, in one floe-edge case, an elder hunter seized a larger share of the narwhal because of his seniority in the hunting party. In an open water case, hunters disputed who had shot the narwhal first which was a means of claiming the ownership of the narwhal. Clearly, there are fewer disputes with lower hunting party sizes.

Summary. The most important factor in determining the composition of the hunting party was socially driven. It depended primarily upon the availability of regular hunting members who were usually closely related and secondly on the requisite equipment and supplies. These could be contributed by members of the community who could then join the hunting party. Lastly, the absolute maximum number of people that could be accommodated on a hunting trip was physically limited by the spatial capacity of the sled or the boat.

Traveling party selection

The traveling party was observed for floe-edge and summer camp hunting trips. It is defined as the group of hunting parties that travelled to and from the floe edge and outpost and summer camps together. The traveling party was not observed for local Pond Inlet water hunting trips because there was no ultimate travel destination. Furthermore, co-operation between different hunting parties was not observed with the exception of emergencies. Hunters immediately engaged in hunting as soon as they departed Pond Inlet in this local environment.

Geographical, ecological and social factors. Social factors influenced the selection of other hunting parties to travel with: some level of relation usually through kin was preferred, but with some level of experience hunting and traveling together.

While the composition of hunting parties was observed to be prearranged, the formation of the traveling party to the floe-edge was shown to be highly opportunistic. Hunting parties fused and divided depending upon which hunting parties were ready to travel to and from the floe-edge. For example, on two participant-observation trips in 1997 and 1998, our hunting party departed with a different hunting party to the floe edge than was previously arranged. This type of behaviour was also observed for travel from the floe-edge to *Mittimatalik.*

In contrast to the opportunistic traveling parties established for floe-edge based hunting trips, the formation of the traveling party for summer camp hunting trips was shown to be more rigid. Hunting parties that had agreed to travel together waited for each other before departure. Frequently, traveling parties which consisted of more than one boat included members of families from outpost camps. The entire family from these

outpost camps would usually visit the community in order to bring *maktaaq*, visit relatives, and purchase provisions.

The selection of the return traveling party to Pond Inlet was highly dynamic but dependent upon the availability of other hunting parties. Hunters would schedule their return to Pond Inlet to be flexible with other hunting parties so that they could travel back together. This was observed on one return trip from *Nadlua*.

Costs and benefits. The major benefit of traveling party fusion was to secure safe travel to and from the destination area. This was especially important during the latter stages of the narwhal spring hunt where the ice conditions were deteriorating and made navigation to Pond Inlet especially dangerous. In this case, there is additional security provided by the fact that there are two separate transportation machines. For floe-edge trips, the additional snow machine can be used to rescue the other snow machine. For summer camp hunting trips, the additional boat can be used to rescue people or the other boat in the open water. For example, in one hunting trip to the summer camps, a boat that was jammed was rescued by two other boats. This can be especially critical because of the inherent danger of the risks of traveling in open water. For example, if one enters the water, the frigid water temperature can cause shock, hypothermia, and potential drowning if one is not rescued immediately.

A second major benefit of increasing the number of snowmobiles for floe-edge hunting trips was the rotation of principal navigators. Each snowmobile driver of each hunting party would take turns navigating to and from the destination point. The hunting party following usually had a decreased risk because the hunting party in front was testing the ice and finding a suitable travel route to and from the floe-edge. This was especially critical during the late spring floe-edge hunt because ice conditions were deteriorating and the risk of falling through the ice was high. For example, in 1998, one hunter lost his life when he fell through a hole in the sea-ice as he was driving his snowmobile back to the community.

A final benefit to travel with other hunting parties was to increase hunting effort of ringed seals on the return section of floe-edge trips. On some floe-edge hunting trips, hunters engaged in breathing hole seal hunting where a higher number of persons meant that more ringed seal breathing holes could be covered. This, in turn, improved the

success rate of capturing a ringed seal. This was because at least one person would usually encounter a ringed seal at one of the covered holes.

One major cost of traveling together is the increased responsibility to each hunting party. For example, if the other hunting party's snowmobile has a mechanical or technical problem, the other hunting party will usually stop to help. This can significantly extend the hunting trip time and was experienced on several hunting trips.

Summary. Selection of the traveling party primarily depended upon which hunting parties were ready to depart to and from the floe-edge. The selection of the traveling party for floe-edge hunts was highly opportunistic for both the travel phase to and from the floe-edge. While hunters were observed to prefer to travel in groups, if there were none available, this would not preclude the hunting party from departure unless there were poor weather conditions. Thus, selection of the traveling party was secondarily dependent upon the prevailing environmental conditions. If the ice or weather conditions were particularly poor, hunters were observed to wait for other hunting parties before departure to and from the floe-edge.

For summer camp hunting trips, the traveling party was usually determined prior to departure. This was because these hunting parties usually travelled to and from the same summer camp destination.

Route selection

A major component of the hunting trip for floe-edge and summer camp hunting trips is the travel phase which includes route selection to the destination. Route selection for local Pond Inlet water hunting trips is not discussed because the nature of this type of hunting trip did not warrant travel routes to a particular destination. Hunters navigated and hunted throughout this region as soon as they departed the community and there were no specified travel routes to select. The route selection for the Pond Inlet floe-edge and the summer camp hunting trips will be analyzed separately because they are significantly different.

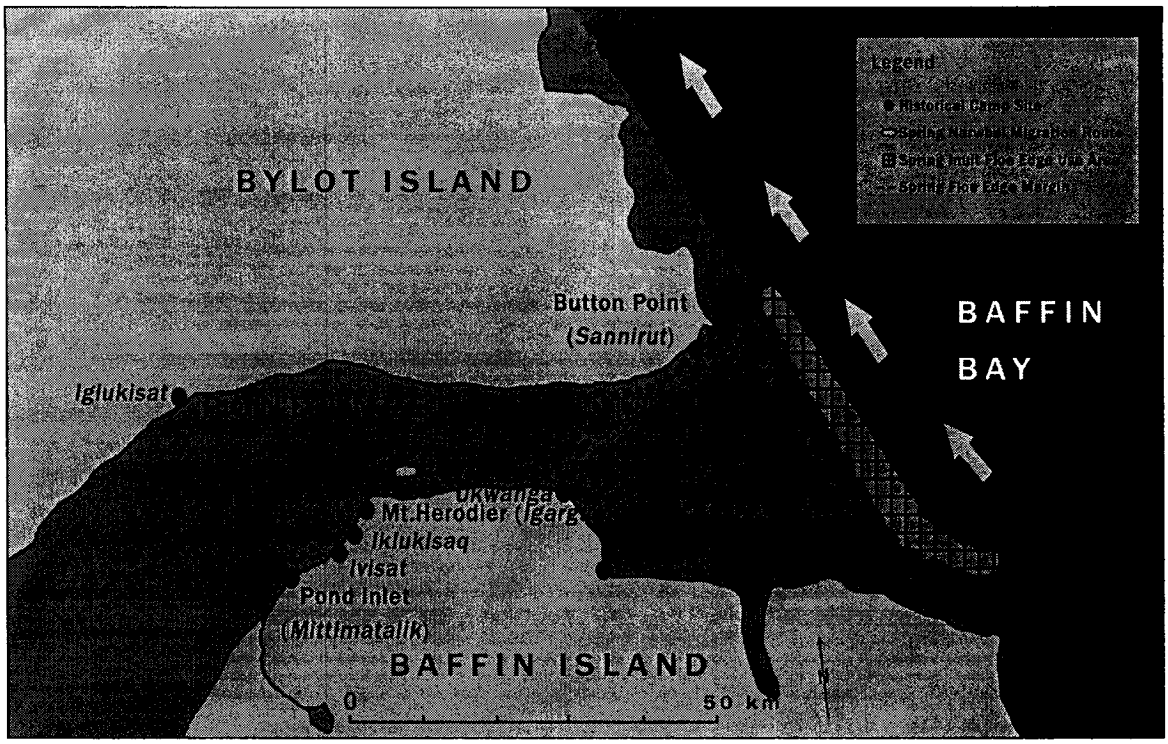

Figure 8. The travel routes by Pond Inlet Inuit taken to travel to the Pond Inlet floe-edge from the community of Pond Inlet.

Route selection to and from the Pond Inlet floe-edge

This involves decisions of route selection from the community of Pond Inlet to the floe-edge. For this section, three major legs of the trip are presented and the costs and benefits of selecting different options are discussed.

Geographical factors. i) The first leg consists of the area from the community of Pond Inlet to Mount Herodier (*Igarjuak*; see Figure 8). In all participant-observed trips, Inuit displayed the most amount of consistency in terms of the travel routes that were selected. For all trips, Inuit generally travelled in close proximity to the northern coastline of Baffin Island and utilized landmarks such as Mount Herodier to navigate through this area (see Figure 8). Travel through this area usually required crossing at least one open ice crack. An ice crack was an area of open water between two ice floes. During early spring, these leads were relatively small and did not pose a significant risk.

However, as the season progressed, the ice cracks significantly widened and could pose serious risk to hunters and their equipment. As such, as the cracks enlarged, hunters

would survey the ice to select a suitable point to cross. One of the key features for ice crack crossing was the identification of a piece of ice on the opposite side that would not collapse when landed upon by the snow machine. A second feature was an appropriate slope on the other side upon which to land the snow machine after gliding along the water. A third major feature was an area with minimal distance between the ice platforms and that satisfied the above two features.

ii) The second leg of the travel route consists of the area from Mount Herodier to *Ukwanga* (see Figure 8). This leg also showed low variance in terms of travel routes taken by Inuit. On all participant-observed hunting trips, *Ukwanga* was always reached. *Ukwanga* was selected because it was a specific geographical position from which it was easier and safer for Inuit to embark for the final leg to the floe-edge. This was because the physical geography at this position did not produce a lead that was as wide as along other part of the Baffin shore. However, the size of this ice crack also depended upon the time of the season.

iii) The third leg of the travel route consists of the area from *Ukwanga* to the floe-edge (see Figure 8). This leg showed the most variation in terms of travel routes selected because there were two major options. The first option was to travel to Button Point (*Sannirut*) and then proceed to the floe-edge (see Figure 8). The second option was to bypass Button Point and proceed directly to the floe-edge.

iv) The selection of return travel routes to Pond Inlet was found to be highly variable and dependent upon the prevailing ice conditions. Again, almost all hunters proceeded to *Ukwanga* to cross a major ice crack at this point. However, this was not the case in all hunting trips. Some hunters did cross at points that were not at such a southerly position. The actual factors influencing these decisions are less well understood.

Costs and benefits. Finally, in order to elucidate the differences in the route options, we next present some costs and benefits that appeared to influence the selection of each.

In eight of the fourteen participant-observation trips, hunters selected to travel to Button Point after crossing the ice crack at *Ukwanga* (see Figure 8). In the remaining six trips, hunters chose to travel directly to the floe-edge.

Button Point represented a strategic geographical waypoint for several major reasons. One of the major benefits of Button Point was that it provided a secure on land resting and preparation waypoint. For example, on two trips, repairs to the sled and snow machine were made while pausing at Button Point. Other preparations included gun sight adjustment, equipment checks, and refuelling. In addition, it provided shelter from poor ice or weather conditions because there are two community supported cabins.

Secondly, it served as a place to collect recent information on narwhal sightings, weather conditions and ice conditions at the floe-edge and the location of other hunters' camps. This was collected from other hunters encamped there.

Thirdly, Button Point provides a broad view of the floe-edge. The route through Button Point allowed hunters to sample a larger expanse of floe-edge area more efficiently. From the point across from Button Point, hunters could travel due south continuously until they selected a campsite. The amount of floe-edge sampled was significantly greater than hunters who proceeded directly to the floe-edge from *Ukwanga*. This was because, when hunters traveled directly to the floe-edge from *Ukwanga*, this position was located much further south than the point across from Button Point. Furthermore, from this position directly across from *Ukwanga*, hunters would need to select to travel north or south parallel to the floe-edge. If they traveled north, they would not be able to sample the area south unless they went back over the same ice. The same case was valid if they traveled south from this point.

However, the benefit of selecting a direct travel route to the floe-edge from *Ukwanga* was that this was the shortest route to the floe-edge. Hunters that selected this travel route were always observed to select a campsite that was directly across from *Ukwanga* or in relatively close proximity to the route they had travelled. Thus, this travel route provided a considerably lower expenditure of both fuel and time.

The most significant cost of traveling to Button Point was expenditure of time. Since *Ukwanga* is located at the northern tip of Baffin Island, hunters must traverse the entire width of Pond Inlet in order to reach Button Point (see Figure 8). A second major cost of selecting Button Point was the use of fuel, oil and other material resources spent to reach this position.

Summary. The primary factor influencing route selection to the Pond Inlet floe-edge was safety. To this end, geographical and ecological factors were dominant. The first and second legs of the travel route were observed to be the most rigid in terms of travel route selection. The second leg of the travel route almost always proceeded to *Ukwanga.* This was because *Ukwanga* represented a unique geographic position that provided a relatively safer place to cross an ice crack that was located at this position. This was because the width to cross the ice crack at this position was much smaller than at other positions of the ice crack. The selection from Ukwanga to Button Point was driven either to secure safety or to acquire information regarding the floe-edge conditions. The selection from Ukwanga directly to the floe-edge was dominated by the hunter's geographical preference of a campsite area.

Route selection for summer camp hunting trips

The open water season involves decisions of route selection from the community of Pond Inlet to the summer campsite. For this section, three major legs of the trip are presented and the costs and benefits of selecting different options are discussed. For this section, the travel routes that were taken to different campsites will be discussed

Geographical, ecological and social factors. i) When trips were made to summer camps in Navy Board Inlet such as *Nadlua*, Pond Inlet hunters usually travelled across to *Iglukisat*, Bylot Island (see Figure 4). However, there was some variation observed in the first part of this trip, the crossing from Pond Inlet to Bylot Island. During the early part of the summer season, ice pans could still be encountered and thus a direct straight trajectory was not always possible when crossing Pond Inlet.

Hunters typically proceeded in relative close proximity to the Bylot Island shoreline (approximately 10 km or less from the shoreline depending upon ice conditions) to *Unarqurtujuq* (see Figure 4). From *Unarqurtujuq*, hunters then traveled directly across Eclipse Sound to Borden Peninsula in Navy Board Inlet slightly above *Saatut.* They would then follow the Borden Peninsula shoreline until they reached a campsite of their choice. Frequent choices were *Nadlua, Qanmaarjuit, and Nunasiaq.* This pattern of route selection was observed for two participant-observation trips made to camps in Navy Board Inlet.

ii) When trips were made to campsites located south of Eclipse Sound such as *Quarnaq*, *Iqaluit*, *Angmaat*, and *Qimirvik* (see Figure 4), Pond Inlet hunters cruised due west close to the northern shoreline of Baffin Island as far as *Tulukkaa*. From *Tulukkaa*, they would then proceed south to either *Qimirvik*, *Angmaat*, or *Iqaluit*. Otherwise, they would continue west, following the coastline to campsites located in Eclipse Sound and Milne Inlet such as *Aulatsivik*, *Ipiutalik*, *Tugaat*, *Agiruujaq*, *Kurujuaq*, and *Qaurnaq* (see Figure 4). In all participant-observation trips hunters were observed to camp at or near historical campsites.

iii) The selection of return travel routes to Pond Inlet was observed to be similar to the route selection taken on outbound trips. In all participant-observation trips, hunters proceeded in close proximity to the shoreline using the same waypoints.

Costs and benefits. One of the major benefits of selecting to travel in close proximity to the shoreline was the security it provided in case there was any type of emergency such as a motor breakdown. Hunters could then paddle or use a small portable engine to land on the shoreline.

Iglukisat and *Unarqurtujuq* provided secure resting and preparation waypoint and these sites provided shelter from weather and ice conditions because they are situated on Bylot Island. For example, on one trip to *Nadlua*, we stopped at *Unarqurtujuq* to rest during foggy weather conditions. Once the fog had cleared, we surveyed the ice and proceed west to Borden Peninsula. Other preparations included gun sight adjustment, equipment checks, and refuelling. There was also a cabin located at *Iglukisat* which was frequently occupied by hunters. Thus, stopping at this location also served as a place to collect recent information on narwhal sightings, ice, sea, and weather conditions.

Summary. Again, the primary factor driving the selection of the majority of the summer camp travel routes was to improve safety in case of a catastrophic event in the open water. Ecological knowledge of ice conditions, weather conditions, and landmarks were critical in safe and successful navigation to the destination. Hunters also utilized numerous landmarks to navigate in close proximity to the shoreline to the summer camp locations.

Hunting ringed seals and narwhals en route to the destination

While traveling to the floe-edge, hunters could engage ringed seals either opportunistically if they were sighted basking on the sea-ice or by waiting at their breathing holes. In the first case, the stalk usually consumed less time as hunters would immediately engage in pursuit of the ringed seal by approaching the ringed seal by snowmobile or by foot until within firing range upon which a shot is fired. In the second case, Inuit would deploy within an area where ringed seals were actively using breathing holes determined by examining the condition of the breathing holes, and each hunter would then wait at separate ringed seals holes for ringed seals to appear.

For local Pond Inlet water and summer camp hunting trips, hunters have the option of hunting ringed seals and narwhals that are opportunistically encountered. When narwhals were encountered, they were always pursued if within hunting range. When baby ringed seals were encountered, they were always pursued. When adult ringed seals were encountered, their pursuit was dependent upon the hunters.

Geographical and ecological factors. Ringed seals could be found basking on the sea-ice or utilizing breathing holes in the sea-ice of Pond Inlet up to Baffin Bay. Ringed seals were encountered en route to the floe-edge in certain areas of Pond Inlet, often time in the open water of cracks between ice floes, but also while basking on the sea-ice or taking air from their breathing holes.

For the local open water and summer camp hunting trips, both ringed seals and narwhals could be encountered in the open water of throughout the entire Pond Inlet and Eclipse Sound region during the travel and hunt phases of each hunting trip. Indeed, during boat trips, these two phases were often indistinguishable.

Costs and benefits. One important benefit for hunting ringed seals and narwhals en route to the destination was that it provided additional food for the hunting trip. This could significantly extend the duration of the camping trip. Some hunters mentioned that this food also provided some measure of security for single hunters if a polar bear encroached on a campsite while the hunter was asleep. This was because the polar bear would usually consume the ringed seals and narwhals first and leave the camp once satiated. This had been the case for several individual hunters who had been interviewed.

A second crucial benefit stated by Inuit for capturing ringed seals en route to the floe-edge was that it decreased the impulse to hunt ringed seals that appeared in the open water near the floe-edge. This was important because any noise, especially gunfire, is disturbing to narwhals and thus, decreases opportunities for this preferred species. The most experienced narwhal hunters were observed to avoid hunting ringed seal or any other marine mammal except narwhals when at the floe-edge.

The most significant cost of hunting ringed seals and narwhals while en route is the expenditure of time to hunt and process them. For example, weekend hunters were never observed to engage in breathing hole sealing while en route to the floe-edge. Narwhals would have to be processed and a portion was usually cached because of the amount of meat and skin.

Summary. The primary factor influencing the decision to hunt ringed seals en route to the floe-edge was based upon decreasing the desire to hunt ringed seals at the floe-edge. This reduced the noise disturbance at the floe-edge which could drive narwhals away from the area and decrease narwhal hunting opportunities. On the return trip from the floe-edge, hunters would occasionally engage in breathing hole sealing in order to secure food for their families in the community.

Campsite and campsite party selection

Hunting parties that had traveled together to the destination could decide to camp in the same location for several reasons such as improving security and increasing surveillance of prey. The campsite party was the term used to describe the portion of traveling parties that decided to camp at the same location during floe-edge and summer camp hunting trips. This did not occur for local Pond Inlet water hunting trips because hunters did not establish campsites for these trips.

Geographical, ecological and social factors. Inuit knowledge of the ice conditions and narwhal behaviour at the Pond Inlet floe-edge reflected certain preferences for floe-edge campsite selection. For example, it is a widespread belief among hunters that narwhals tend to dive under an open water ice embayment. Some hunters explained that narwhals possibly test the nature of the ice in such a way as they attempt to migrate through the inlet.

Choice of summer camp sites was usually decided before leaving the community of Pond Inlet. In these cases, the selection of a camp site was usually recursive or traditional. That is the camp site is often located on or near previous camp locations that Inuit at some point in their history have occupied. The selection of the geographical area of the campsite was correlated with access to different types of prey. For example, in one participant-observation trip, a hunt was scheduled to *Nadlua* in order to hunt narwhals primarily because it provided exceptional narwhal hunting opportunities. A second participant-observation trip was made to Oliver Sound and Tremblay Sound regions. This destination was selected on the basis of other activities that could be done by other family members in this area such as berry picking. A third participant-observation trip was made to *Ipiutalik* that was primarily oriented towards hunting caribou but also to hunt narwhals opportunistically. The last participant-observation trip was made to *Aulatsivik* to hunt both narwhals and caribou.

As each traveling party reaches the floe-edge or summer camp, it has two options. Members can either select to camp in the same site, camp with another hunting party, or separate and establish another camps. For all participant-observed floe-edge based hunting trips, the opportunistic group traveling behaviour did not result in the hunting parties camping in close proximity with the exception of two cases. This is because these hunting parties wished to camp in a geographical area that did not coincide with the desire of other members.

Costs and benefits. During the study period, there were very few observations of Inuit camping alone at the floe-edge. Single party hunters stated that decreasing risk from environmental hazards such as ice floe drifting, poor weather conditions and polar bears were primary reasons for camping with others at the floe-edge.

Secondly, increasing the size of the camping party also increased the number of individuals that could survey the open water for narwhals, thereby increasing the potential detection and capture of narwhal.

One major cost of increasing the number of individuals at one campsite was a decrease in the number of individual hunting opportunities. In addition, as mentioned in the hunting party scenario, the sharing of captured prey was observed to be more complex when several individuals were involved.

Summary. The selection of a campsite for the floe-edge environment was a critical decision because the primary search behaviour was executed from these locations (Lee and Wenzel Forthcoming). One of the primary factors that appeared to influence the selection of the campsite was the hunter's ecological knowledge and geographical preference for certain hunting areas such as the southern edge of the floe-edge. Upon reaching this area, a secondary factor was the availability of a location that satisfied the party's criteria for a campsite. These factors included sea-ice physiognomy (the presence of embayments), sea-ice conditions (the location and distance of floes and the condition of the ice immediate to the site), local hunter density, open water conditions (the presence of sea pack-ice), and information of recent narwhal sightings obtained from informants at Button Point or in the community.

The selection of the campsite for the summer camp hunting trips was, on the other hand, predetermined. Hunters usually travelled to traditional hunting grounds to spend time with their families and hunt a variety of species, of which caribou and narwhals were the most highly desired during this time. Thus, the primary factor influencing the selection of these campsites was the geographical preference of the hunters. Usually, camp density was low for the summer camp hunting areas and multiple families were observed to camp together principally for social and security reasons.

Foraging behaviour

For all participant-observation trips of floe-edge and summer camp hunts, the selection of the campsite was a critical component. This was because campsite selection related closely to foraging behaviour. However, the relation between the selection of a campsite and the hunting strategies utilized to hunt narwhals is the focus of two other papers (Lee and Wenzel Forthcoming; Lee n.d.) and therefore is not discussed at length here.

Briefly, with respect to the stage of search behaviour (see Table 5), while both sit-and-wait and active foraging were observed for both floe-edge and open water hunting trips, active foraging was found to be the dominant search strategy for local Pond Inlet water hunts. Active foraging was defined as when hunters moved continuously through the open water while searching for prey items. Sit-and-wait foraging was the dominant

search strategy utilized by Inuit for both floe-edge and summer camp hunting trips. Sit-and-wait foraging was the process of selecting one position and waiting for prey items to come within pursuit distance.

Table 5. General Inuit Narwhal Foraging Cycle

Search – Begins when the hunter comes into visual contact with the environment from which the hunt is based and ends when a narwhal is successfully detected or return begins. Two major search behaviours were observed. These were "active searching" in which the hunter scans for prey while moving and "sit-and-wait searching" in which the hunter waits for prey to approach him.
Assessment – This is the stage when the hunter acts to pursue or abandon a detected narwhal. A narwhal could be sighted (i.e. a sighting event), but because of distance from the hunter, the presence of intervening broken ice and/or the whale's direction of movement, sightings do not always present firing opportunities. If the narwhal is fired upon (firing event) and struck, the hunter immediately engages in a pursuit event.
Pursuit - How the hunter engages narwhal and, if a kill is made, recovers them for processing. In floe-edge hunting, the hunter does not actively pursue narwhal in this environment (as, for instance, in open water by boats); rather, the animal is allowed to approach the floe-edge to create a firing opportunity. Upon a narwhal being shot, the hunter immediately uses a boat to secure the wounded or dead animal from being lost by escape or sinking.
Handling – This component refers to the processing and distributing of narwhal products (skin, meat, tusk and sinew). It also includes food consumption since some amount of narwhal skin is always consumed upon successful capture of a narwhal.

With respect to the pursuit stage of the narwhal hunt, narwhals were not pursued in the floe-edge environment and the open water for local Pond Inlet water hunting trips. However, in sharp contrast, the pursuit stage was a critical component of summer camp narwhal hunting trips. This was because Inuit drove narwhals into shallow areas that enhanced visibility and recovery and significantly increased successful captures.

Conclusion

The present paper arose out of a need to improve our general knowledge of the Inuit hunt for narwhal in the Canadian arctic. This was accomplished here by providing empirical data and a comprehensive outline of both floe-edge based and open water based narwhal hunting trips. Results were organized and presented in a manner respective of the major decisions that Inuit typically face on a narwhal hunting trip to the Pond Inlet floe-edge, in the open water near the community of Pond Inlet and in the open water in camps.

A key finding was the description and analysis of the composition and size of the core hunting group that engages in narwhal hunting. Group composition included numerous factors but the social relationship was revealed to remain a major factor in hunting party selection. I also elucidated the association and importance of traveling groups to and from the floe-edge and campsite groups. The formation and dissolution of these groups were explained through a description and analysis of major benefits and costs associated with increasing group size. Increasing safety was a major factor for the formation of traveling groups. However, the formation of campsite groups was more important for lone hunters or less experienced hunters as this increased vigilance for polar bears and narwhals in the floe-edge environment.

A second key finding is the elucidation of major decisions available to hunters before they arrive at the floe-edge. The choice of hunting ringed seals before arriving at the floe-edge is an important option as it not only decreases noise disturbance at the floe-edge by ignoring seals at the floe-edge but also potentially increases the length of the hunting trip by providing additional food resources. This study also revealed some key geographical decisions made by Inuit hunters. The selection to travel to Button Point provided different costs and benefits than proceeding directly to the floe-edge.

This study represents an important initial phase of inquiry of Inuit narwhal hunting decisions. A complete description of the entire hunting trip process including all of the options and decisions has been lacking in the literature. An elaboration of the entire hunting trip improves our understanding of the nature of narwhal hunting. Furthermore, it provides an identification and appreciation of different measures of

hunting trip success based upon safe travel to and from the destination without loss of life and major injury or loss of equipment. Other measures of a successful hunting trip include increasing the social bonds between hunting group members and increasing experience in traveling and hunting decisions.

Yet, it is apparent that further research needs to be conducted in order to improve our understanding of particular details of Inuit behaviour such as group size, travel route selection and hunting party composition. For example, we intend to explore how practices related to the sharing of the captured prey influences hunting party selection. In our observed trips, we asked hunters about rules of sharing, and their responses were extremely variable and appeared to be in flux. It would be important to document the evolution of these rules from more traditional times to present.

On another level, this study has revealed some major factors considered to influence major Inuit hunting trip decisions during a period where the quota scheme was in place. For example, the selection of group members who may have a strong desire to hunt narwhals before the narwhal quota is filled may drive some hunters to hunt at the earliest possible times of the season. Conversely, if the narwhal quota has not been filled, it may lead some hunters to continue hunting late in the season despite deteriorating and dangerous sea-ice conditions. This was observed for the 1998 season in which one hunter lost his life due to deteriorating ice conditions. Elders in the community had expressed their concern over hunters continuing to travel to the Pond Inlet floe-edge during the latter stages of the spring season.

In most part, little or no effort has been made to understand how quota schemes affect Inuit hunting behaviour. To our knowledge, the analysis of quota based management schemes has been extremely limited. In summary, we hope the present research will provide a framework of empirical data to aid in the future formulation of several testable hypotheses to explicate some of decision choices presented.

Appendix: Inuktitut Kinship Terms

This appendix provides readers with a list of Inuktitut kinship terms based on Damas 1963, Wenzel 1981 and personal observations.

Inuktitut -	English
nulliaq -	wife
uii -	husband
anaana -	mother
ataata -	father
irngnik -	son
paniq -	daughter
ituk -	grandfather and males of his generation
ningiuk -	grandmother and females of her generation
aqak -	uncle (on father's side), alternatively a male cousin
angak -	uncle (on mother's side), alternatively a male cousin
attak -	aunt (on father's side), alternatively a female cousin
aiyak -	aunt (on mother's side), alternatively a female cousin
amauq -	all those in the greatgreatgrandchild generation
irngutaq -	grandchild generation
illuligik -	greatgrandchild generation
naiyak -	male ego's sister, alternatively a female cousin
angayuk -	male ego's elder brother, or female ego's elder sister
nuka -	male ego's younger brother, or female ego's younger sister
aniq -	female ego's brother, alternatively a male cousin
qaniak -	male ego's nephew or niece (on brother's or a male cousin's side)
uyuruk -	male ego's nephew or niece (on sister's or a female cousin's side)
angnak -	female ego's nephew or niece (on brother's or a male cousin's side)
nubaq -	female ego's nephew or niece (on sister's or a female cousin's side)
ningauk -	all in-marrying males, same or descending generation from ego
ukkuaq -	all in-marrying females, same or descending generation from ego, also female affines first ascending generation, female ego
ai -	all in-marrying females, first ascending generation, male ego, also spouse's same or descending generation collaterals
angutikattik -	male ego's male cousin or female ego's female cousin (on father's brother's side)
arngnakattik -	male ego's male cousin or female ego's female cousin (on mother's sister's side)
illu -	male ego's male cousin or female ego's female cousin (on father's sister's or mother's brother's side)
sakkik -	parent-in-laws and their same generation consanguines

CHAPTER 4: MANUSCRIPT 2

The first manuscript provided a framework and analysis of empirical data that revealed that the foraging behaviour at the floe-edge was a critical component of the narwhal hunting trip. To analyse the search behaviour that Inuit engaged in the floe-edge environment, the use of foraging mode was borrowed from behavioural ecology. In manuscript 2, we explore whether Inuit display a difference between two main search strategies of sit-and-wait foraging versus active foraging. This is achieved by participant-observation of fourteen narwhal hunting trips in which the time spent in each foraging mode was recorded and analyzed.

NARWHAL HUNTING BY POND INLET INUIT: AN ANALYSIS OF MODE OF FORAGING IN THE FLOE-EDGE ENVIRONMENT

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Abstract

Research on Inuit hunting with respect to narwhals has been limited despite the major role narwhals play in the subsistence of hunters, their extended families and the community (Bissett 1968; Mary-Rousselière 1984; Mathiassen 1928). Moreover, the annual harvest of narwhals by the Inuit represents an important relationship in terms of a continuous utilization of an indigenous marine resource. In order to address this gap, the present research investigated Inuit foraging behaviour for narwhals in the Pond Inlet floe-edge environment. A participant-observation study revealed that Pond Inlet Inuit primarily engage in a sit-and-wait foraging mode when hunting narwhals in the floe-edge environment.

Keywords: Nunavut; Pond Inlet; Mode of Foraging; Floe-edge Hunting Strategies; Narwhal

Résumé

La recherche portant sur la chasse des narvals par les Inuit est limitée bien que le narval constitue une part importante de la subsistance des chasseurs, de leur famille étendue et de la communauté (Bissett 1968; Mary-Rousselière 1984; Mathiassen 1928). De plus, la chasse annuelle aux narvals par les Inuit représente une relation importante en terme d'une utilisation continue d'une ressource marine indigène. En vue de rectifier cette lacune, la présente recherche a exploré le comportement alimentaire des Inuit face aux narvals dans l'environnement de la lisière des banquises (floe-edge) de Pond Inlet. Une étude par observation participante a démontré que les Inuit de Pond Inlet pratiquent principalement la chasse à l'affût (sit-and-wait) lorsqu'ils traquent le narval dans l'environnement de la lisière des banquises.

Mots-clés : Nunavut; Pond Inlet; Comportements Alimentaires; Stratégies de Chasse sur les Lisières des Banquises; Narval

Introduction

Research on Inuit hunting of narwhals (*Monodon monoceros*; Inuktitut: *qilalugaq*) in the floe-edge environment has been limited both in number of studies and depth of analysis (see for instance, Bissett 1968; Degerbøl and Freuchen 1935; Mary-Rousselière 1984). For example, most data on Inuit-narwhal interaction consists only of a few numbers in harvest tables (see Baffin Regional Inuit Association 1982, 1983, 1984, 1985; Donaldson 1988). Clearly, there is a general paucity of analytical literature on Inuit cetacean hunting, despite the acknowledged ethnographic and current importance of narwhal to Inuit (notable exceptions are Dahl 1990, 2000; Smith 1991).

Nevertheless, the actual use of narwhals by Inuit has not gone completely unremarked. Both anthropological and biological literatures have explored the culture of the hunt (Mathiassen 1928), the animal's dietary importance (Bissett 1968; Treude 1977) and its socioeconomic value (Land 1977; Mary-Rousselière 1984; Matthiasson 1992; Reeves 1992). With reference to the actual hunt, Finley and others (Finley, Davis and Silverman 1980; Finley and Miller 1982; Roberge and Dunn 1990; Weaver and Walker 1988) have investigated harvesting technologies while Remnant and Thomas (1992), Thomsen (1993) and Stewart and others (1995) have investigated features of the traditional ecological knowledge of modern narwhal hunting. As much as these works contribute to our understanding of the Inuit and narwhal relationship, none provide a comprehensive analysis of contemporary narwhal hunting behaviour.

The main objective of this paper is to redress this gap by employing a behavioural ecology approach to study the Inuit floe-edge narwhal hunt. An analysis of Inuit hunting strategies is critical to understand the organization and pattern of Inuit hunting behaviour with respect to the prey species and the environment. In the present study, we specifically focus on one of the most important components of the Inuit narwhal hunt during the spring floe-edge season: the foraging or search phase (see Table 1). We believe this stage to be crucial for the overall foraging cycle as it is time-consuming, precarious and is most influential in the successful capture of a narwhal.

Table 1. Inuit Floe-Edge Narwhal Foraging Cycle

Search	Begins when the hunter comes into visual contact with the floe-edge and ends when a narwhal is successfully detected. This paper details two strategies that are utilized to search for narwhal. These are "active searching" in which the hunter scans for prey while moving and "sit-and-wait searching" in which the hunter waits for prey to approach him. For this study, travel between different search areas along the floe-edge was considered a part of the active search mode. This phase also includes one of the most important decisions of the hunting trip - campsite selection. Travel to and from the floe-edge is not considered as part of this phase.
Assessment	This is the stage when the hunter acts to pursue or abandon a detected narwhal. A narwhal could be sighted (i.e. a sighting event), but because of distance from the hunter, the presence of intervening broken ice and/or the whale's direction of movement, sightings do not always present firing opportunities. If the narwhal is fired upon (firing event) and struck, the hunter immediately engages in a pursuit event.
Pursuit	Describes how the hunter engages narwhal and, if a kill is made, recovers them for processing. In floe-edge hunting, the hunter does not actively pursue narwhal in this environment (as, for instance, is done in open water using boats); rather, the animal is allowed to approach the floe-edge to create a firing opportunity. Upon a narwhal being shot, the hunter immediately uses a boat to secure the wounded or dead animal from being lost by escape or sinking.
Handling	This component refers to the processing and distributing of narwhal products (skin, meat, tusk and sinew). It also includes food consumption since some amount of narwhal skin is always consumed upon successful capture of a narwhal.

A second objective is to examine whether the foraging mode currently used at the floe-edge to hunt narwhal in the spring is specific to this species and environment or represents a widespread strategy. Hunting processes for other species such as caribou hunting, winter breathing hole sealing, and spring basking seal hunting will be compared to narwhal hunting to present the variation in foraging mode. Winter and spring sealing represent two harvest activities that might be considered to "compete" with whaling at this season. Finally, it is important to mention that no comparison will be made here between floe-edge and open-water narwhal modes of foraging as this is the subject of a future paper (Lee n.d.).

Next, we review the relationship between Pond Inlet Inuit and narwhals to illustrate the contemporary pattern and importance of Inuit narwhal harvesting. We will also review the human behavioural ecology framework as it will be the basis of our present analysis of Inuit narwhal hunting behaviour.

Pond Inlet, Narwhals and Inuit

Narwhals and their products have widespread cultural importance for Inuit. The skin (*maktaaq*), with some attached fat (*uksuq*), is the most important food item furnished by narwhal hunting and is often considered a delicacy (Reeves 1992; Personal observations). Historically, the narwhal also provided raw materials for domestic use, such as dried sinews for waterproof seams. However, it was the species' ivory tusk that was the principal object of late nineteenth and early twentieth century trade between Inuit and Europeans (Bernier 1909, 1911).

The narwhal is found today in the open water environment of the Eastern Canadian Arctic from early May to late September. The narwhal mainly frequents northwestern Baffin Bay, Lancaster and Jones Sounds, western Foxe Basin, and eastern Barrow Strait (Kingsley, Cleator and Ramsay 1994; Koski and Davis 1994; Reeves 1992; Richard et al. 1994; Silverman 1979; Smith et al. 1985, Strong 1988). Pond Inlet (*Mittimatalik*) is the northernmost community on Baffin Island located at latitude 72°41" north, longitude 77°58" west, and is adjacent to the Baffin Bay-Pond Inlet floe-edge (see Figure 1). This location was selected for the present study because of its large annual narwhal quota of one hundred animals. The area of Inuit-narwhal interaction of direct interest here is the Pond Inlet spring floe-edge (see Figure 2). This floe-edge represents a primary habitat that has long provided *Mittimatalingmiut* (Pond Inlet Inuit) with access to northward migrating narwhals (Kingsley et al. 1994; Koski and Davis 1994; Reeves 1992; Richard et al. 1994; Silverman 1979).

Although the archaeological record is intermittent, it seems that narwhals have been hunted in this region for some two millennia (Savelle 1994). More specifically, it is clear that *Mittimatalingmiut* have possessed the technology, expertise and ecological knowledge to hunt this species intensively since at least the early nineteenth century (Mary-Rousselière 1984).

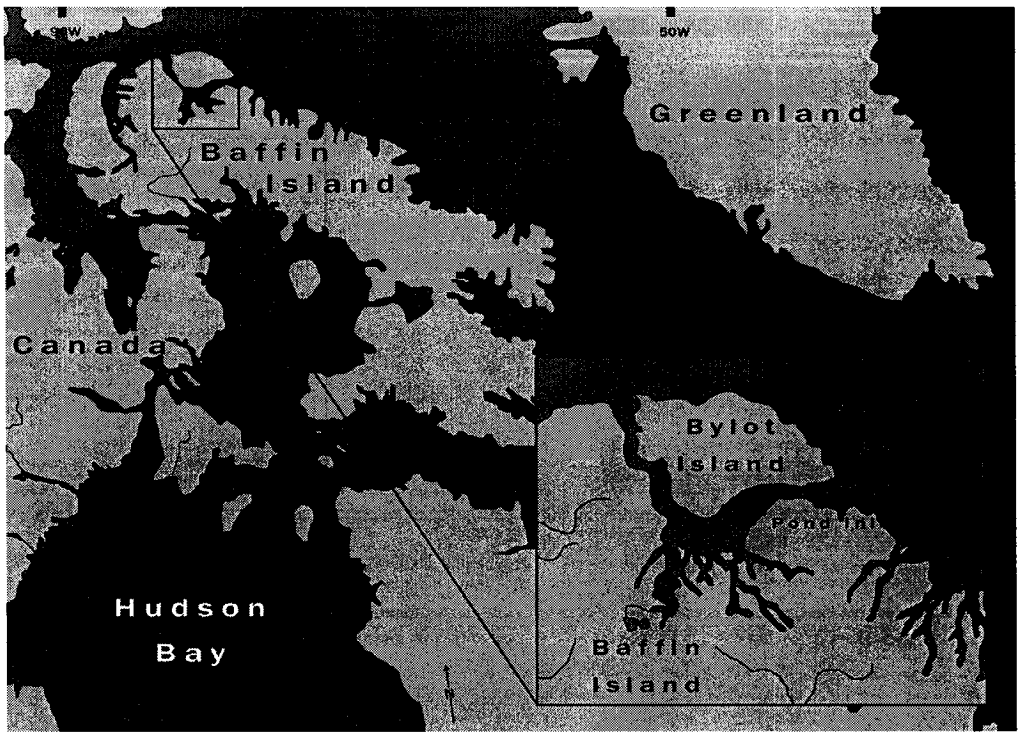

Figure 1. Location of Pond Inlet (*Mittimatalik*) and Study Area.

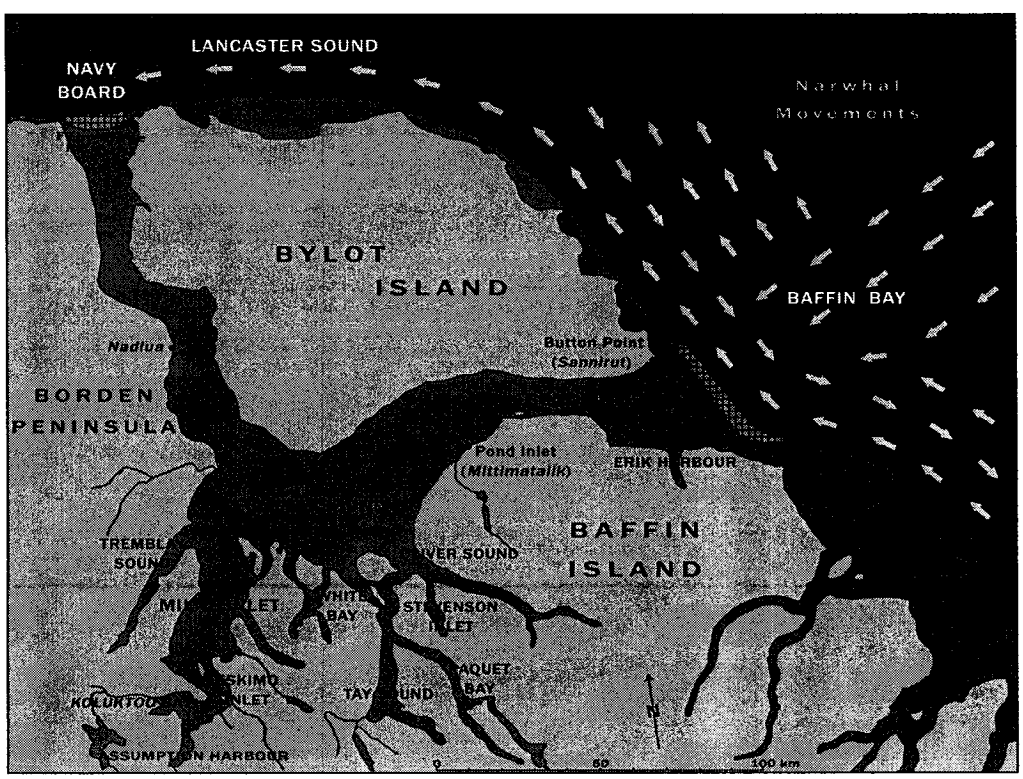

Figure 2. Spring Floe Edge Inuit Use Area and Narwhal Migration Routes.

The hunting skill of *Mittimatalingmiut* developed as a result of their geographic situation (see Figure 2) that provides exceptional opportunity to intercept spring-migrating, as well as summering narwhals (Kingsley, Cleator and Ramsay 1994; Koski and Davis 1994; Richard *et al.* 1994; Silverman 1979; Smith *et al.* 1985). More recently, the introduction of modern hunting and transportation technologies (notably high-powered rifles, motor-equipped canoes and snowmobiles) has allowed *Mittimatalingmiut* to continue to exploit narwhals despite centralization from their former dispersed pattern of settlement to residence in modern Pond Inlet (see Brody 1975; Damas 2002; Matthiasson 1967).

Mittimatalingmiut commence narwhal hunting in spring (approximately mid-May) and continue hunting from the floe-edge until break-up (approximately mid-June). In early May, the first narwhals begin to arrive at the eastern floe-edge (Hay 1984; Silverman 1979), and a few hunters, considered by their peers to be particularly adept at floe-edge hunting, begin to seek narwhals at this time. These hunters often stage their forays onto the sea ice from Button Point (Inuktitut: *Sannirut*) on southwest Bylot Island where there are two community-supported cabins (see Figure 2).

By mid-May, the number of narwhal at the eastern floe-edge substantially increases (Hay 1984; Silverman 1979). At this time, the movement pattern of hunters undergoes a shift. While a few individuals continue to camp at Button Point, most hunters now stop there only to rest briefly and to acquire information on floe-edge and weather conditions, narwhal sightings, and camp locations along the floe-edge from other Inuit camped and moving through Button Point. This pattern of proceeding to Button Point before actually beginning operations along the floe-edge continues into early June; by then, narwhals are present along the entire extent of the floe-edge, except when pack ice jam along the floe.

Human Behavioural Ecology: Mode of Foraging

Our study of Inuit hunting behaviour adds to the present literature of human behavioural ecology (HBE; see Winterhalder and Smith 2000) through our analysis of mode of foraging. Historically, since the mid 1970s, HBE studies have applied optimal

foraging models to study the subsistence practices of indigenous peoples (see Hawkes, O'Connell and Blurton Jones 1991; Hawkes and O'Connell 1985; Hawkes, Hill and O'Connell 1982, 1992; Hames and Vickers 1982; Hill 1988; Sih and Milton 1985; Smith 1991; Winterhalder 1977, 1983). Optimal foraging models assume that foragers attempt to maximize their immediate energy gains over time (Stephens & Krebs, 1986). These are mathematical models where ecological parameters are entered in formulated equations to make testable predictions of foraging behaviour such as diet composition, group size and patch selection among different groups in different habitats. As robust as the optimal foraging approach is in its predictions, it has received criticism for its lack of descriptive utility and its inability to incorporate the rich qualitative data found in ethnographic studies (e.g. see Smith 1983).

We address such criticisms by departing from an optimal foraging approach as applied in HBE studies; instead, we focus on the role of foraging mode (see Holling 1959; Kramer 2001). Whereas optimal foraging models attempt to condense and generalize foraging behaviour in order to address universal questions such as what individuals eat, where they look for food, and how long they search for their food, our proposed focus on foraging mode offers a more descriptive and qualitative analysis of specific search behaviour of prey. We hope this alternative theoretical perspective will place Inuit hunting behaviour in a richer and more realistic context. Our application of foraging mode to a human population is the result of our extensive observations which suggest a strong correspondence between the foraging mode of Inuit and other animals. The application of foraging mode is useful because it describes the actual hunting behaviour Inuit display in their habitats. It also elucidates some of the observable ecological factors that influence this behaviour.

In the ethological literature on animal foraging mode, it was observed that some predators attack their prey from ambush, whereas others usually hunt while on the move. Pianka (1966) termed these modes of foraging respectively "sit-and-wait" and "widely-foraging". In the sit-and-wait foraging mode, a forager remains stationary for long periods of time, waiting for a prey item to come within short pursuit or striking distance. In the widely-foraging mode, a forager spends much of its time actively searching for prey (Huey and Pianka 1981). Although this dichotomy can be somewhat artificial,

numerous animal and human groups (Binford 1980) seem to fall into one or the other category.

Research Methodology

The primary data presented here was collected from 1996 through 1998, utilizing a participant-observation methodology supplemented by directed interviews. In total, almost eleven months were spent accompanying and observing *Mittimatalingmiut* narwhal activities in the floe-edge and open water environments. The floe-edge hunting component of the research comprised fourteen trips. The accompanied hunters were varied with respect to age and individual experience in narwhal hunting (Table 2). This participatory approach was ideal for recording hunter movements, stops and campsites, while also allowing the observation of contiguous or passing narwhal hunters. Additionally, all search, pursuit, and handling activities were timed and amounts of fuel, ammunition and other expendables used were all recorded. Finally, travel routes, encountered hazards, camping/resting sites, and narwhal sightings/firing events were recorded.

Table 2. Social and Demographic Characteristics of Hunting Groups

Trip #	*Date*	*Group size*	*Social Relations*	*Age*
1	27-30/05/1996	2	Father-Son	55/18
2	06-09/06	2	Father-Son	55/18
3	08-09/06	3	Father/Wife/Son	37/35/10
4	13-16/06	1	Single Hunter	30
5	14-16/06	1	Single Hunter	29
6	22-24/06	2	Cousins	25/18
7	28/06-05/07	1	Single Hunter	40
8	13-15/06/1997	3	Father/Grand-son/Son-in-Law	55/10/40
9	18-22/06	2	Brothers	45/55
10	21-28/06	1	Single Hunter	29
11	22-27/06	1	Single Hunter	18
12	16-21/06/1998	1	Single Hunter	45
13	16-21/06	1	Single Hunter	35
14	19-21/06	2	Brothers	30/18
Average		2		33

Floe-edge Mode of Foraging

Active foraging mode

> At 11:30, we reach the floe-edge almost directly across from *Sannirut*... D. is scanning the area as we continue to travel south. (Lee, Field Notes, 14/06/96)

An active or widely foraging mode was characterized as a relatively continuous movement where hunters traveled parallel to the floe-edge in one direction while simultaneously scanning the open water for narwhal. Movements between camps were also considered as part of the active foraging mode because hunters continued to search for narwhal while traveling. Arguably, inter-camp movements could be considered simply as travel time; however, the scanning for prey supported inclusion as active foraging search.

Active foraging by snowmobile began as soon as hunters arrived at the floe-edge (Table 3). Upon arrival at the floe-edge, initial scans for narwhals were made and a travel direction was then chosen. This phase was particularly important because critical environmental information for travel safety and campsite selection was collected and given a priority greater than, or at least equal to, the search for narwhal. For example, the structural stability of the ice edge, sea conditions, weather patterns and the movements of drifting ice were all collected and synthesized. Equally important to the physical characteristics, this phase also provided the hunters with the number and distribution of the status of campsites located within the regional vicinity.

Snowmobile foraging was frequently punctuated by scan-stops. Scan-stops were brief pauses that generally lasted from ten to thirty minutes and almost always occurred if a narwhal was sighted in order to evaluate the narwhal's position and/or to hunt the narwhal with sit-and-wait foraging tactics. Such tactics should not be confused with the sit-and-wait foraging mode. Sit-and-wait foraging tactics refers to manoeuvring and positioning to hunt narwhal over a short term. These tactics were always employed because narwhal would readily dive and be very challenging or impossible to track actively in the pack ice environment. Scan-stops were also executed to evaluate the stability of an ice platform with an ice probe before traveling upon it.

Table 3. Number and Duration of Active Foraging Events (AFE) Based from Campsite and Total Duration of All Active Foraging (all duration in minutes)

Trip #	*Duration of Active Foraging Activity Before First Camp*	*# of AFE Based from Campsite*	*Total Duration of AFE Based from Campsite*	*Average duration of AFE Based from Campsite*	*Active Foraging Based on travel between campsites*	***Total Duration of All Active Foraging Activity****
1	30	1	30	30	30	**90**
2	30	1	15	15	115	**160**
3	10	0	0	0	0	**10**
4	50	0	0	0	65	**115**
5	30	0	0	0	65	**95**
6	28	4	295	74	75	**398**
7	30	1	40	40	0	**70**
8	120	1	90	90	0	**210**
9	30	0	0	0	0	**30**
10	105	3	465	155	180	**750**
11	0	3	465	155	30	**495**
12	30	2	150	75	30	**210**
13	30	2	150	75	30	**210**
14	30	2	120	60	0	**150**
Mean	40	1	136	55	44	**214**

*Includes active foraging before first camp, AFE, and foraging between campsites

Hunters who carried out extensive active searching by snowmobile incurred two kinds of costs. The first was monetary as a snow machine consumed about twenty-five Canadian dollars in gasoline and oil for roughly every three to four hours of operation (average price at the time of study, 1996-1998). Perhaps even more important was that the noise associated with snowmobile use was said by Inuit to affect how closely narwhal would approach the floe-edge and ultimately affect hunting opportunities.

Finally, a negligible amount of active foraging along the floe-edge based from the campsite was also done on foot. Walking provided the advantage of almost no disturbance. It did, however, have disadvantages. First, only a limited extent of floe-edge could be covered. Second, if a narwhal was shot, the chance of a successful

retrieval without a boat was unlikely. Third, venturing any significant distance from camp meant risking exposure to possible deteriorating ice or rapid weather change. Last, it was difficult to be perfectly quiet while walking; some Inuit stated that the sounds of a hunter's footsteps are interpreted by nearby narwhal as the sound of a polar bear shuffling on the sea ice.

Sit-and-wait foraging mode

> At 13:40 hours, we sighted 3 narwhals moving south from our camp location. They are approximately 200 meters away from our location. They breathe for 8-10 minutes and then one takes a very deep breath and dives. The others follow almost immediately afterwards. They were very large in size with white coloration. (Lee, Field Notes, 29/06/96)

The sit-and-wait foraging mode was observed when hunters deployed a campsite where they searched for narwhal by remaining stationary for an extended period of time. The sit-and-wait foraging mode comprised all of the time spent by hunters who were stationary in their campsites. Although this included additional activities such as cooking, cleaning, resting, preparing and repairing equipment, hunters were always vigilant for narwhal while remaining stationary in their campsite.

Overall, the average length of stay at the floe-edge for the fourteen hunts observed over these three years was two and a half days (see Table 4) (*SD* = 1.74; *Range* = 0.2 - 7.4 days). Given this average length of stay at the floe-edge, each hunt established at least one camp (see Table 4). In fact, the average number of campsites for all trips was two (see Table 4) (*SD* = 0.97).

Camp routine was as such that at least one person was on alert and scanning for whales at all times in multi-occupant camps. This explains why the average number of groups per camp in all three years was two even though seven[1] of the fourteen hunts that were accompanied through their entirety were by single hunters (see Table 2). Solitary camping was actually relatively rare as visits from passing hunters were frequent. This was usually due to the high camp density location chosen by the solitary camper.

[1] It should be noted that this may be an overestimation since the hunter could have perceived the participant observer as a member of the hunt group.

Although narwhal was the primary objective while waiting in camp, Inuit were also continuously scanning the local environment for deteriorating ice conditions, weather conditions and polar bears.

Table 4. Number of Camps Established and Camp residence Duration, and Total Duration of All Sit-and-Wait Foraging (all duration in minutes)

Trip #	*# of Camps Established*	*Total Camp Residence Duration*	*Mean Camp Residence Duration*	***Total Duration of all Sit-and Wait Foraging Activity****
1	2	2410	1205	**2380**
2	1	1655	1655	**1640**
3	1	230	230	**230**
4	3	2935	978	**2935**
5	3	2665	888	**2665**
6	1	2437	2437	**2142**
7	1	3495	1748	**3455**
8	1	2430	2430	**2340**
9	1	3480	3480	**3480**
10	4	10335	2584	**9870**
11	2	6660	3330	**6195**
12	2	4260	2130	**4110**
13	2	4260	2130	**4110**
14	1	1980	1980	**1860**
Mean	2	3568	1968	**3387**

*Includes camp residence duration not including active foraging activity based from campsite (see AFE in Table 3)

Comparison of foraging mode

The time spent engaged in each foraging mode reveals the dominant search behaviour of Inuit narwhal hunting at the floe-edge. Of the overall 840 hours spent at the floe-edge for the fourteen trips, an average of 94 percent of hunters' time was spent in the sit-and-wait foraging mode (*SD* = 3.62; Figure 3; Table 5).

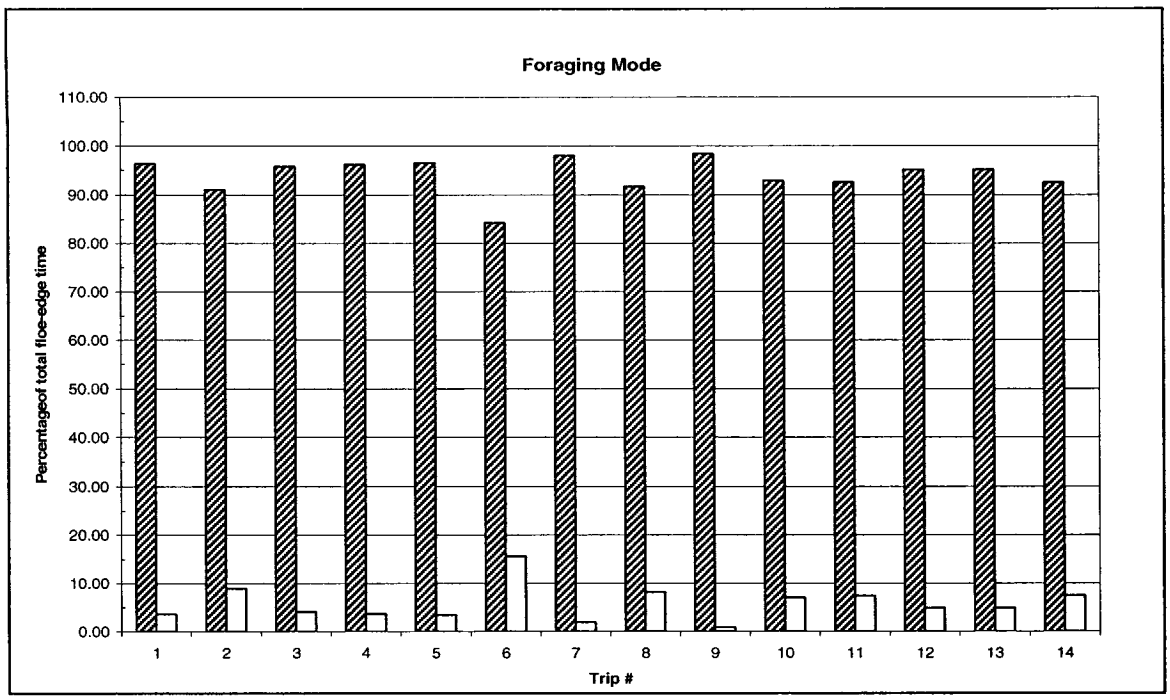

Figure 3. Sit-and-wait (cross-hatched bars) and active (white bars) foraging behavior distributions for each trip relative to total foraging time is presented.

Table 5. Duration of Sit and Wait vs. Active Foraging Activity (in minutes).

Trip #	*Date*	*Total Trip Duration*	*Total Duration at Floe-Edge*	***Total Duration of all Sit-and Wait Foraging Activity***	***Total Duration of All Active Foraging Activity***
1	27-30/05/96	4220	2470	**2380**	**90**
2	06-09/06	2310	1800	**1640**	**160**
3	08-09/06	840	240	**230**	**10**
4	13-16/06	3590	3050	**2935**	**115**
5	14-16/06	3240	2760	**2665**	**95**
6	22-24/06	3130	2540	**2142**	**398**
7	28/06-05-07	5710	3525	**3455**	**70**
1996	*Mean*	3291	2341	**2207**	**134**
8	13-15/06/97	3045	2550	**2340**	**210**
9	18-22/06	3990	3510	**3480**	**30**
10	21-28/06	11385	10620	**9870**	**750**
11	22-27/06	7170	6690	**6195**	**495**
1997	*Mean*	6398	5843	**5471**	**371**
12	16-21/06/98	6150	4320	**4110**	**210**
13	16-21/06	6150	4320	**4110**	**210**
14	19-21/06	2610	2010	**1860**	**150**
1998	*Mean*	4970	3550	**3360**	**190**
Total	*Mean*	4539	3600	**3387**	**214**

A 3 (years) x 2 (foraging mode) mixed-model ANOVA was conducted, where years was set as the between-subject factor and foraging mode was set as the within-subject factor. The analysis revealed a significant main effect for foraging mode, $F(1, 11) = 42.95$, $p < 0.01$; that is, hunters spent significantly more time in sit-and-wait foraging than in active foraging. As expected, the interaction between years and foraging mode was not significant, $F(2, 11) = 3.42$, $p = NS$; that is, the pattern of relatively higher time spent in sit-and-wait foraging was consistent over the years. Despite the large number of trips reviewed here, and the large amount of time spent in both modes of foraging, the rate of successful narwhal capture was low. Overall, only one narwhal was captured. Generally, even the most assiduous hunter was often prevented from having success because of numerous environmental barriers, such as high waves or fog along the floe edge that obscured narwhal target, to broken ice inhibiting any opportunity for retrieval of a kill. Still, there were more actual firing events (capture opportunities) when hunters were engaged in the sit-and-wait foraging mode (see Table 6).

Table 6. Floe-Edge Narwhal Sightings and Firing Events.

Trip #	*Narwhal sightings*	*Total Narwhal firing events*	*Narwhal firing events during sit-and wait foraging mode*	*Narwhal firing events during active foraging mode*
1	1	1	1	0
2	4	0	0	0
3	1	1	1	0
4	2	2	2	0
5	2	2	2	0
6	3	3	3	0
7	7	2	2	0
8	8	2	2	0
9	5	1	1	0
10	11	4	4	0
11	5	4	4	0
12	3	2	2	0
13	3	2	2	0
14	2	2	2	0
Total	57	28	28	0
Mean	4	2	2	0

Campsite selection

Given the inherent importance of campsites for the sit-and-wait foraging mode, campsite selection bears some discussion. Indeed, when camp residence duration and total trip duration are compared, it indicates that 79 percent of hunters' time was spent in camp. This comparison was even more salient when the total time spent at the floe-edge was compared to the camp residence duration: hunters spent 99 percent of their time near their campsite.

Seasonality and geography. Historically, hunters mostly established their campsites near *Sannirut* during the spring season (Degerbøl and Freuchen 1935; Mary-Rousselière 1984). Presently, the majority of hunters from Pond Inlet actually venture across a larger expanse of the floe-edge. In terms of scheduling and seasonality, more specialized Pond Inlet Inuit concentrate their campsite selection in the southern extent of the floe-edge (see Figure 2); the geographical area where the probability of sighting and intercepting northward-migrating narwhals is highest (Hay 1984, Silverman 1979). By early June, all hunters disperse their campsites along the entire extent of the floe-edge.

Interviews with *Mittimatalik* elders suggest another reason for why some hunters concentrate on the southern section of the floe-edge in early spring. They stated that when noise disturbance is minimal, narwhals often travel in very close proximity to the floe-edge (as close as 5 m). This was the case before mechanized transport (that is before ca.1960) became ubiquitous in the Pond Inlet area. In fact, this is a point remarked upon by Degerbøl and Freuchen (1935, 259) in their section on narwhal: "...the Eskimos were continually catching those that come near the ice edge, without the others apparently being disturbed in the least by it." In early spring it is possible, because of the paucity of snowmobile traffic, to take narwhals at much closer range than later in the season. Presently, active hunters generally concurred with the elders' conclusion that, by the time spring is well advanced, snowmobile and other noise sources make it increasingly difficult to hunt narwhals in close proximity to the floe-edge. Thus, the selection of the southern region of the floe-edge in early spring appears to be an attempt by hunters to select narwhal that exhibit a propensity to travel in close proximity to the floe-edge before excessive noise affects their migratory behaviour.

During the mid stage of the hunting season, distribution of hunters along the entire expanse of the floe-edge hunting area was observed. However, as the season progressed into late June, hunters did not proceed near *Sannirut* as the ice conditions were observed to be hazardous and elders advised avoidance of this area.

Physiognomic features. The physiognomy of the ice front also plays an important role in campsite selection. This is because there are indented patches along the floe-edge, essentially areas where embayments are formed, that offer certain tactical advantages to hunters. Accordingly, it was observed that most hunters establish their campsites near embayments.

Hunters explained that narwhals tend to dive toward embayments, which allows a clear view of, and shot at, the animal's spine (dive hump). Also, narwhals take a large amount of air into their lungs when about to make a deep dive, which helps keep these animals afloat after a fatal shot. The additional float time associated with this deep dive buoyancy gives hunters critical additional time to launch a boat to effect retrieval. Therefore, hunters target the "dive hump" in order to immobilize an animal and increase the probability of retrieval. Inuit contrast this situation to times when narwhals are swimming or resting at the surface, as at these times a "dive hump" is not visible and, thus, this vital area is less likely to be struck when fired upon.

While historically narwhals would have been harpooned while traveling along the floe-edge (while swimming very close to and parallel to the floe-edge), harpooning was rarely observed during the trips that were accompanied for the present study. Instead, in almost every hunting event that occurred, narwhals were fired upon while making deep dives as they swam toward the floe-edge in one of these embayments. Clearly, while rifles and outboard motor-equipped boats now play a critical technological role in narwhal hunting at the floe-edge, Inuit have also had to adapt their foraging behaviour to compensate for some of the changes in narwhal behaviour precipitated by these tools.

Discussion

First, we summarize our analysis of Inuit foraging mode for narwhal hunts during the floe-edge spring season. Second, we discuss foraging modes for other species with

special reference to breathing hole seal hunting and basking seal hunting. Finally, we explore the dynamic effect of the floe-edge environment upon the Inuit foraging mode for narwhals and we discuss the impact of rifle and snowmobile technologies upon foraging mode.

Our observations show that Inuit foraging behaviour for narwhals in the floe-edge environment can clearly be categorized into two major foraging modes: active foraging and sit-and-wait foraging. Our observations also revealed that the sit-and-wait foraging mode was the dominant one utilized to hunt narwhals in the floe-edge environment during the spring hunting season.

The decision to engage in a sit-and-wait strategy is due to several key factors related both to the highly mobile and acoustically sensitive nature of narwhals (Cosens and Dueck 1988; Finley et al. 1990; Ford 1976) and the dynamic ice environment (Parkinson 1999, 2000). For example, the reluctance to engage in active foraging trips by snowmobile seems to indicate the importance of minimizing noise disturbance and maximizing firing opportunities. This is supported by interviews with both elders and active hunters who related their perception that narwhals were extremely acoustically sensitive to noise. *Mittimatalingmiut* elders also stated that historically (ca. 1900), there were strict rules on human behaviour while at the floe-edge that were utilized in order to minimize noise disturbance. For example, an Inuit elder stated that while hunting narwhals at the floe-edge during spring, any movement among family members not engaged in hunting was not permitted. Furthermore, several elders mentioned that the contemporary snowmobile noise along the floe-edge had drastically changed narwhal migration behaviour along the floe-edge. Even though active trips by foot created much less noise disturbance along the floe-edge, they offered very limited range beyond the camp deployment area.

Notwithstanding, the active foraging mode was shown to play a key role in the initial phase of the hunting trip. In every accompanied trip a preliminary evaluation of the geographical, physical and environmental conditions began as soon as the hunters reached the floe-edge. In these evaluations, hunters first examined the spatial geography and physical status of the floe-edge within viewable range in order to gauge the costs and challenges involved in traveling along the floe-edge and in locating potential campsite

areas along the entire floe-edge extent. The foremost concern was whether an area or stretch of floe-edge might rapidly erode or break away. Other factors included whether near-edge travel would require moving over or crossing between separated floes, traversing compacted and uplifted ice ridges, or the possibility of encountering snow conditions that might impede movement. Finally, local weather patterns were considered.

Once a preliminary scan of the physical conditions was done, hunters' turned to an assessment of the migration stage of narwhals in the immediate area. The number of narwhal sightings made in these initial scans ultimately influenced a hunter's decision to travel either north or south along the floe-edge and where camps might be feasible. It should be noted that, along with their own preliminary scans, hunters also frequently benefited from information provided by other hunters already on or returning from the floe-edge through direct contact and radio. Approaching the floe-edge from Button Point (see Figure 2) aided this scanning as Button Point not only provided hunters with shelter if poor or violent weather developed or floe-edge conditions deteriorated, but also allowed an extended view of the floe-edge.

Foraging mode for other species

The hunt for narwhals at the floe-edge represents the most intensive example of the sit-and-wait method employed by Inuit for any species and differs markedly from virtually every other Inuit foraging activity, except for spring and autumn arctic char fishing. For instance, caribou hunting today involves a large component of active search and pursuit. Notably, this is a recent change, as ethnographic studies in the 19th and early 20th centuries described caribou hunting as a more passive activity in which interception or ambush at water bodies was the dominant hunt form. Other types of Inuit large game hunting, such as polar bear, walrus or large and small whales in certain open-water environments also follow an active foraging mode and pursuit mode in which the active search mode is critical to locating the prey species.

Although, there is an important sit-and-wait foraging component with respect to winter breathing hole sealing, it is still unique from the sit-and-wait mode executed in the floe-edge environment with respect to narwhal. We will discuss both the foraging mode

of breathing hole seal hunting and basking seal hunting to elucidate the unique behaviour Inuit currently employ for narwhal in the spring floe-edge season.

Breathing hole seal hunting (mauluqpuk). *Maulukpuq* sealing is conducted in virtually every community in Nunavut from the onset of the ocean freezing (for most areas by December) until roughly late May or early June when the snow and ice that cover the seals' *agluit* (breathing holes) melt. Thereafter, seals begin to haul out onto the ice surface. Ethnographic accounts of this type of sealing from the last two centuries (Boas 1888; Jenness 1922; Rasmussen 1929, 1931) are notable for their emphasis on the patience of hunters and the extended duration of some hunts, indicating that a hunter might wait up to several hours at an active *aglu*. Even in the early 1970s, it was recorded that hunters from the village of *Aqviqtiuq*, north of Clyde River on average spent approximately 50 minutes at an *aglu* (Wenzel 1991). It was not extraordinary for a hunter to wait beyond an hour: the longest wait recorded by Wenzel was 94 minutes.

More recently, Wenzel (1991) has pointed out that the rifle has had a negligible impact in terms of overall efficiency relative to the traditional use of the harpoon. However, this is not to deny that the traditional mode of breathing hole hunting has not undergone modification due to introduced technology. Rather, the search phase of *mauluqpuk* has been significantly affected by the replacement of the dog team with the snowmobile. Traditionally, once a suitable sealing area was located (in this dogs proved themselves superior to snowmobiles due to their keen sense of smell), there was only a very limited amount of time expended in search and travel between active holes (see Wenzel 1981, 1991). By the mid-1980s, the advent of the snowmobile significantly increased time spent searching and traveling between seal breathing holes. Data recorded by Wenzel (1991) for fourteen winter seal hunts at Clyde River indicated that this active search element of such hunts consumed, on average, 30 percent of total hunt. A hunter would usually wait at a hole for no more than 30 minutes and then return to his snowmobile to search for other breathing holes. This pattern was confirmed in 2000 (Wenzel n.d.b.). Far from the exemplar sit-and-wait foraging that breathing hole hunting once was, hunters now invest more time searching and traveling between holes. Significantly, this means that narwhal hunting at the floe-edge currently represents a more intensive sit-and-wait foraging activity than *mauluqpuk* and one of the most

intensive sit-and-wait foraging behaviours displayed by Pond Inlet Inuit today. It is interesting to note that the advent of the snowmobile led to the shift form a sit-and-wait mode of foraging to an active one in the case of *mauluqpuk* hunting, but not in the case of narwhal hunting.

Basking seal hunting (uuttuq). *Uutuq* commences when two changes occur in the North Baffin sea ice environment. The first is that daylight is lengthening and daytime temperatures begin to melt the snow cover. The other is that this warming collapses the ice domes that cover the seals' *agluit*, exposing these openings and also widening them. As these conditions begin to be dominant, virtually any bright-hazy and near windless conditions will elicit ringed seals to come out through these exposed breathing holes onto the surface of the ice. Similarly, as pressure and tidal cracks widen, seals will use these openings to gain the ice.

By mid to late May, these physical conditions mitigate an almost complete end to *maulukpuq* sealing and a shift to *uuttuq*. With respect to the amount of active searching as opposed to sit-and-wait foraging involved in modern breathing hole hunting, *uuttuq* sealing could be perceived as a perfect example of the active mode of foraging; indeed, it is only when a hunter sights a seal that the pace slows.

The most basic element in this mode of foraging, whether done by dog team or snowmobile, is near-constant movement. As seals can be seen at distances up to two kilometres, hunters are always scanning the area around them as they move. Dog team hunters frequently stood on their sleds to gain a better view as the dogs moved along, while snowmobilers will kneel on the seats of their machines as they drive.

The only interruption from searching in basking seal hunting is when an animal is spotted and a stalk is begun. When dog teams were in use, the actual approach segment of the hunt required that the hunter dismount and either crawl toward the animal or carry out a slow walk while holding a white cloth screen in front of him until he was in shooting range. Approaching on dog team meant that a seal, alerted by the team's barking, would escape before a hunter came within shooting range so hunters often walked as much as one-half kilometre, with a stalk lasting 15 to 20 minutes (Wenzel 1991).

Not surprisingly, the snowmobile has also precipitated a change in this type of sealing affecting both the search and pursuit phases of *uuttuq* hunting. Change is most notable in the pursuit phase, as hunters no longer try to approach seals on foot (Wenzel 1991). Instead they cover the snowmobile's hood with either a white cloth or a white plywood board and drive directly at the seal, stopping at about 40-50 meters distance to shoot. Such a method would seem counter-intuitive, especially as it is in such contrast to the quiet, slow foot approach, but observations, and continued use, suggest that it is almost as effective.

Frequently overlooked, however, is the effect that snowmobiles have had upon the search phase of this hunt. The snowmobile's speed allows hunters to cover far more area than was previously possible with dogs. Given that the nature of basking seal hunting is to search until an animal is sighted and because dog teams were extremely slow, much of a hunter's time in the pre-snowmobile era was consumed by the pace dictated by dog use and the need to carry out a stalk on foot. Indeed, the snowmobile has made *uuttuq* hunting a process of nearly constant movement in sharp contrast to floe-edge narwhal hunting.

Conclusion

This study of foraging mode provides a number of insights into the nature of the spring floe-edge hunt. Our analysis revealed various features of Inuit hunting behaviour that would have otherwise been excluded in an optimal foraging modeled study. For example, we were able to reveal and investigate the role of the initial phase of active search upon arrival at the floe-edge. It represented an essential process of Inuit environmental and campsite sampling. Furthermore, previous optimal foraging diet breadth studies have treated environments such as the floe-edge as one relatively homogenous habitat to be compared with different habitats (Smith 1991). One purpose of this study was to show how foraging theory can contribute to our understanding of hunting behaviour within one habitat by displaying the heterogeneity that exists within

that habitat. For example, the use of embayments suggests that the floe-edge is anything but homogenous in terms of its campsite and narwhal hunting value.

Last, this research suggests that Inuit ecological knowledge remains an essential aspect of the spring floe-edge narwhal hunt. This knowledge includes information specific to narwhals and their behaviour under a range of physical and human-affected conditions. It is critical given the rapid manner in which the floe-edge can be adversely changed by wind and currents, and also by the rapid manner in which technologies change. This knowledge is also obviously important in terms of utilizing the various technologies now available to hunters to the greatest effect.

With regard to spring floe-edge whaling, the dynamic effect that this particular environmental situation imposes on foragers, even when they are equipped with new technologies (e.g. rifles, snowmobiles), is worthy of note. In contrast to the winter and spring seal foraging situations that have been described, these technologies appeared to offer little advantage relative to the effect they have had upon both *maulukpuk* and *uuttuq* sealing. This is the case despite the fact that the rifle appears to be beneficial in extending a narwhal hunter's striking range; this, however, is offset by the fact that narwhals killed or wounded even a few tens of meters from the floe-edge may be irretrievable.

In fact, the data suggest that when whaling at the floe-edge, Inuit are still reliant on traditional knowledge of the habitat, on endurance in the face of difficult physical conditions, and on individual patience. As much as the snowmobiles and rifle have "modernized" floe-edge whaling for Pond Inlet hunters, the foraging mode still practiced is essentially unchanged from that of the pre-snowmobile and pre-rifle "era". The impact of the snowmobile on narwhal hunting has been to extend the area that Pond Inlet Inuit use to hunt narwhals. This is a significant change as hunters can now venture into areas that were not previously utilized on a continuous basis. However, the foraging mode having reached these areas has not significantly changed.

CHAPTER 5: MANUSCRIPT 3

The second manuscript showed that the application of foraging mode was an extremely useful approach as it articulated the Inuit search behaviour in the floe-edge environment. For example, this study revealed the importance of campsite selection as sit-and-wait foraging was executed from these locations. Furthermore, environmental sampling was always executed upon arrival at the floe-edge through active foraging. Manuscript three furthers this theoretical approach by investigating the mode of foraging executed by Pond Inlet Inuit to hunt narwhals in the open water environment during the summer hunting season in two geographically separate open water environments: the local Pond Inlet water and the summer camp environment. In addition, the pursuit phase of summer camp narwhal hunting trips is described and discussed. This is because it was found to be a critical component of the Inuit foraging cycle for summer camp hunting trips that was not observed for either the floe-edge or the local Pond Inlet water environments.

NARWHAL HUNTING BY POND INLET INUIT: AN ANALYSIS OF SEARCH AND PURSUIT OF NARWHALS IN THE OPEN-WATER ENVIRONMENT

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Abstract

The annual harvest of narwhals by the Inuit represents an important relationship in terms of a continuous utilization of an indigenous marine resource. However, the research on Inuit hunting with respect to narwhals has been limited despite the major role narwhals play in the subsistence of hunters, their extended families and the community. In order to address this gap in knowledge, the present research investigated Inuit foraging behaviour for narwhals in the open-water environment. A participant-observation study revealed that Pond Inlet Inuit primarily engaged in an active foraging mode when hunting narwhals in the open-water environment near the community of Pond Inlet. However, Inuit primarily engaged in a sit-and-wait hunting strategy in the open water in summer camp locations. This study also revealed the importance of the pursuit stage of the open-water hunts of summer camps in order to secure whales successfully. This is in sharp contrast to Inuit narwhal hunts in the open water near the community of Pond Inlet and in the floe-edge environment where open water pursuits were not observed.

Keywords: **Nunavut; Pond Inlet; Mode of Foraging; Open-Water Hunting strategies; Narwhal**

Résumé

La chasse annuelle aux narvals par les Inuit représente une relation importante en terme d'une utilisation continue d'une ressource marine indigène. Cependant, la recherche portant sur la chasse des narvals par les Inuit est limitée bien que le narval constitue une part importante de la subsistance des chasseurs, de leur famille étendue et de la communauté. En vue de rectifier cette lacune, la présente recherche a exploré le comportement alimentaire des Inuit face aux narvals dans l'environnement des eaux dégagées (open water) de Pond Inlet. L'étude par observation participante a révélé que les Inuit pratiquent principalement la chasse active (active foraging) lorsqu'ils traquent le narval dans le milieu immédiat des eaux dégagées près de la communauté de Pond Inlet. Par contre, ils pratiquent davantage la chasse à l'affût (sit-and-wait foraging) lorsqu'ils chassent le narval dans les eaux dégagées lors de leur voyage de chasse aux campements extérieurs. Cette recherche démontre aussi l'importance de la phase de poursuite lors de la chasse dans les eaux dégagées près des campements extérieurs en vue de capturer avec succès une baleine. Ceci est diamétralement opposé aux chasses dans les eaux dégagées près de la communauté de Pond Inlet ou dans l'environnement des lisières des banquises côtières (floe-edge) où la phase de poursuite en eaux dégagées n'a pas été observée.

Mots-clés : Nunavut; Pond Inlet; Comportement Alimentaire; Stratégies de Chasse en Eaux Dégagées; Narval

Introduction

Research on Inuit hunting of narwhals (*Monodon monoceros*) in the floe-edge and open-water environment has been limited both in number of studies and depth of analysis. There is a general paucity of analytical literature on Inuit cetacean hunting, despite the acknowledged ethnographic and current importance of narwhal to Inuit (notable exceptions are Dahl 1990, 2000; Smith 1991).

In an attempt to address this gap in knowledge, our recent line of research has sought to apply an analysis of mode of foraging to the hunting strategies utilized by Inuit to hunt narwhals in the floe-edge environment (Lee and Wenzel Forthcoming). This research provided insights into the nature of Inuit hunting and the ecological knowledge utilized by Inuit specifically in the floe-edge environment. A participant-observation study revealed that Pond Inlet Inuit primarily engaged in a sit-and-wait foraging mode when hunting narwhals in the floe-edge environment. Sit-and-wait foraging was the process of selecting one position and waiting for prey items at this location for a period of time for the prey to come within pursuit distance.

The main objective of the present paper is to continue and enhance our study of Inuit foraging behaviour in the open water environment. To our knowledge, no comprehensive study of open-water narwhal hunting has been conducted. Based on our previous research (Lee and Wenzel Forthcoming), we continue to develop the use of behavioural ecology to study Inuit hunting behaviour by replicating our foraging mode analysis in a different environment, the open-water, and by presenting a description of the pursuit phase of summer camp hunting trips (see Table 1). The pursuit phase was not investigated in detail in the floe-edge study (Lee and Wenzel Forthcoming) because Inuit did not display a lengthy pursuit phase once narwhals had been shot and had elicited a dive response in this environment.

Next, a brief review of the relationship between Pond Inlet Inuit and narwhals is presented to illustrate the contemporary pattern and importance of Inuit narwhal hunting. The human behavioural ecology approach is also reviewed as we borrow and utilize terms from behavioural ecology to analyze the search and pursuit stages of the Inuit narwhal foraging cycle.

Table 1. Inuit Open Water Narwhal Foraging Cycle

Search – Begins when the hunter enters the open-water environment and ends when a narwhal is successfully detected. This paper details two strategies that are utilized to search for narwhal. These are "active searching" in which the hunter scans for prey while moving and "sit-and-wait searching" in which the hunter waits for prey to approach him.
Assessment – This is the stage when the hunter acts to pursue or abandon a detected narwhal. A narwhal could be sighted (i.e. a sighting event), but because of distance from the hunter, the presence of intervening broken ice and/or the whale's direction of movement, sightings do not always present firing opportunities. If the narwhal is fired upon (firing event) and struck, the hunter immediately engages in a pursuit event.
Pursuit - How the hunter engages narwhal and, if a kill is made, recovers them for processing. In open-water hunting, the hunter actively pursues narwhal in this environment. Upon a narwhal being shot, the hunter immediately attempts to harpoon the narwhal in order to secure the wounded or dead animal from being lost by escape or sinking.
Handling – This component refers to the processing and distributing of narwhal products (skin, meat, tusk and sinew). It also includes food consumption since some amount of narwhal skin is always consumed upon successful capture of a narwhal.

Narwhals, Pond Inlet and Inuit

The narwhal is a small cetacean species that currently frequents the waters of the eastern Canadian Arctic and northern Greenland from approximately early May to late September (Born et al. 1994; Dietz et al. 1994; Heide-Jørgensen et al. 2003; Kingsley, Cleator and Ramsay 1994; Koski and Davis 1994; Reeves 1992; Richard et al. 1994; Strong 1988). During the summer hunting season, Inuit communities around northern Baffin Island (Pond Inlet and Arctic Bay) and in the High Arctic (Grise Fiord) engage in narwhal hunting in the open water as narwhals migrate through Pond Inlet (see Figure 1). Narwhals migrate through Pond Inlet and through Navy Board Inlet to utilize inshore areas of northern Baffin Island to feed.

More generally, narwhals are currently harvested by Pond Inlet Inuit (*Mittimatalingmiut*) for a range of products of nutritional, cultural and commercial value (Matthiasson 1992; Reeves 1992) during the spring floe edge hunt and the summer open water hunt. Pond Inlet Inuit utilize the skin (*maktaaq*), as well as some fat (*uksuq*)

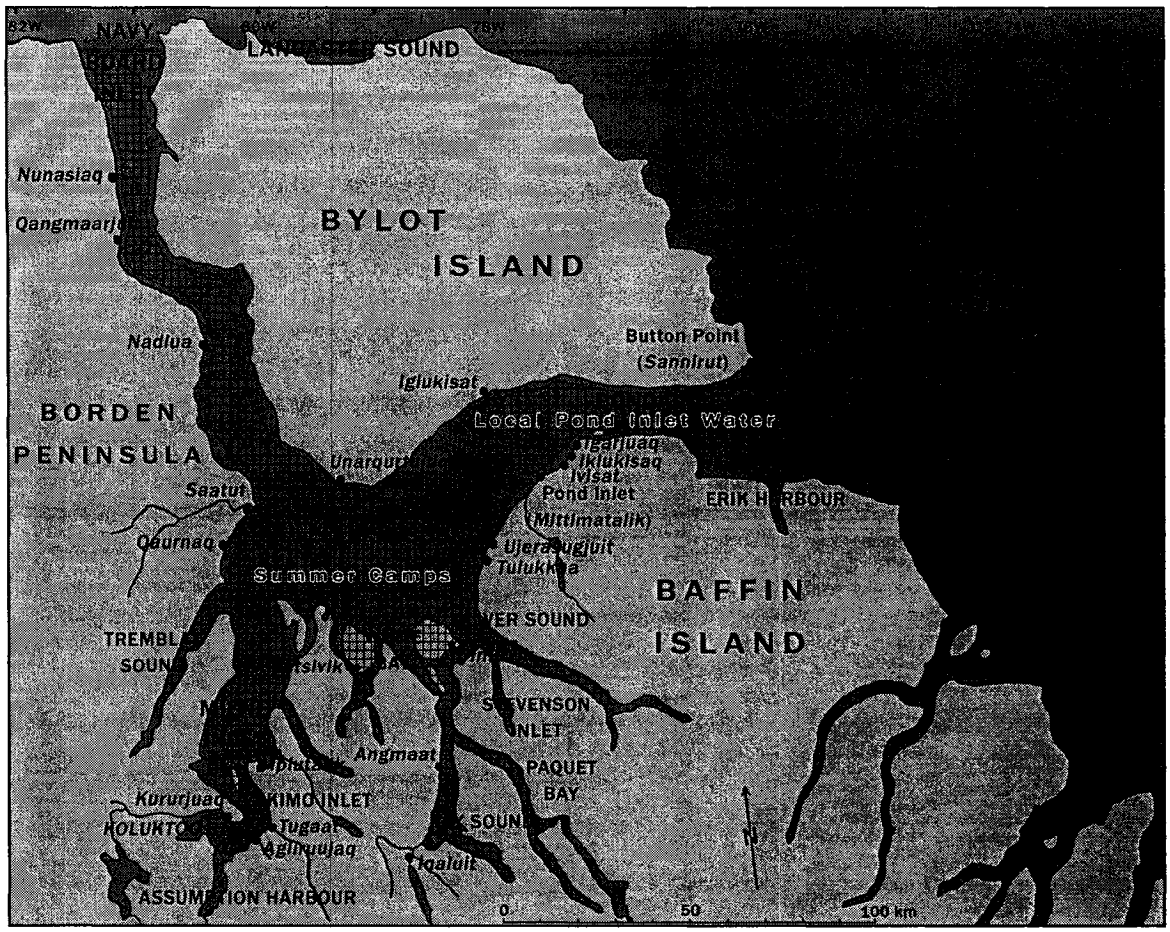

Figure 1. The Local Pond Inlet Water and Summer Camps open water hunting areas.

and meat (*niksik*), as food. Various other products of the narwhal, including organs, sinew and rendered oil, possess household non-food economic importance, although much less so today than historically as these products have been replaced by more available and imported substitutes. Narwhal tusks were once the basis of a major late nineteenth century trade system between Inuit and Euro-Canadians on northern Baffin Island (Bernier 1909, 1911). While narwhal ivory is no longer the singular most important item of exchange it once was during the early contact period, it remains an extremely valuable export product and therefore of monetary significance to Inuit hunters today (Reeves 1992). An indication of the overall importance of narwhal to *Mittimatalingmiut* may be drawn from the fact that Pond Inlet, among the various narwhal hunting communities in Nunavut, once had, along with Arctic Bay, a quota allocation of one hundred animals – a ceiling that was reached annually. Presently, the

narwhal quota has been reinstated after a three year trial period in which the quota had been removed in order to test a community based management system as well as to improve current community-gathered strike and retrieval-loss information. The narwhal, after the ringed seal, is the most important marine mammal in the Pond Inuit monetary and subsistence economy (Matthiasson 1992; Reeves 1992; Reeves and Heide-Jørgensen 1994).

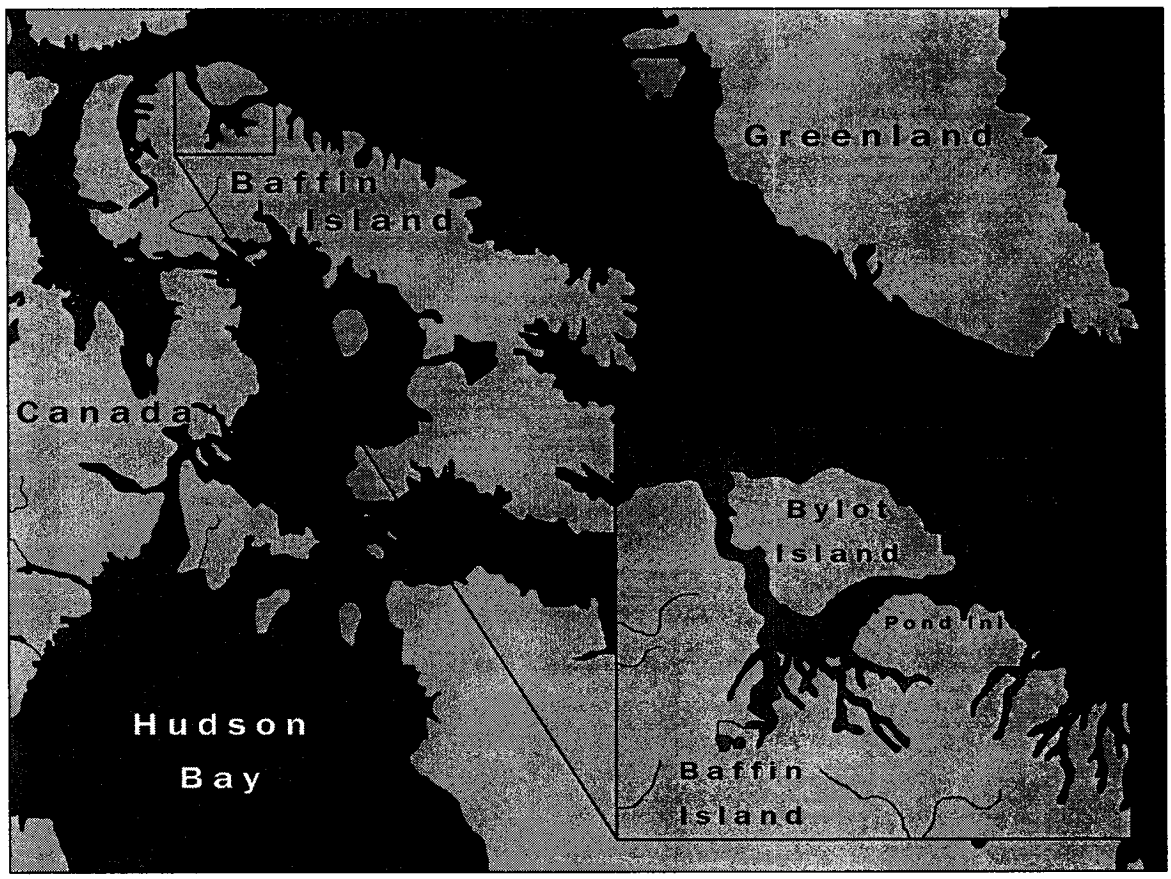

Figure 2. The location of Pond Inlet (*Mittimatalik*) and Button Point (*Sannirut*).

The community of Pond Inlet (*Mittimatalik*) is the northernmost community on Baffin Island located at latitude 72°41" north, longitude 77°58" west, and is adjacent to Baffin Bay-Pond Inlet floe-edge (see Figure 2). This location was selected for the present study because of its large annual narwhal quota of 100 animals. The area of Inuit-narwhal interaction of direct interest here is the open water in the general vicinity of this community. This region represents a primary habitat that has long provided Pond

Inlet Inuit (*Mittimatalingmiut*) with access to northward migrating narwhals (Hay 1984; Mary-Rousselière 1984; Reeves 1992; Silverman 1979). There are currently two main narwhal hunting seasons for Pond Inlet Inuit. The spring hunting season from May to June takes place primarily at the Pond Inlet floe-edge (see Figure 3). The summer hunting season from June to September occurs in the open water near the community of Pond Inlet and in the open water of adjacent bays, inlets and sounds located west of the community (see Figure 1). The present paper specifically focuses on summer season hunt.

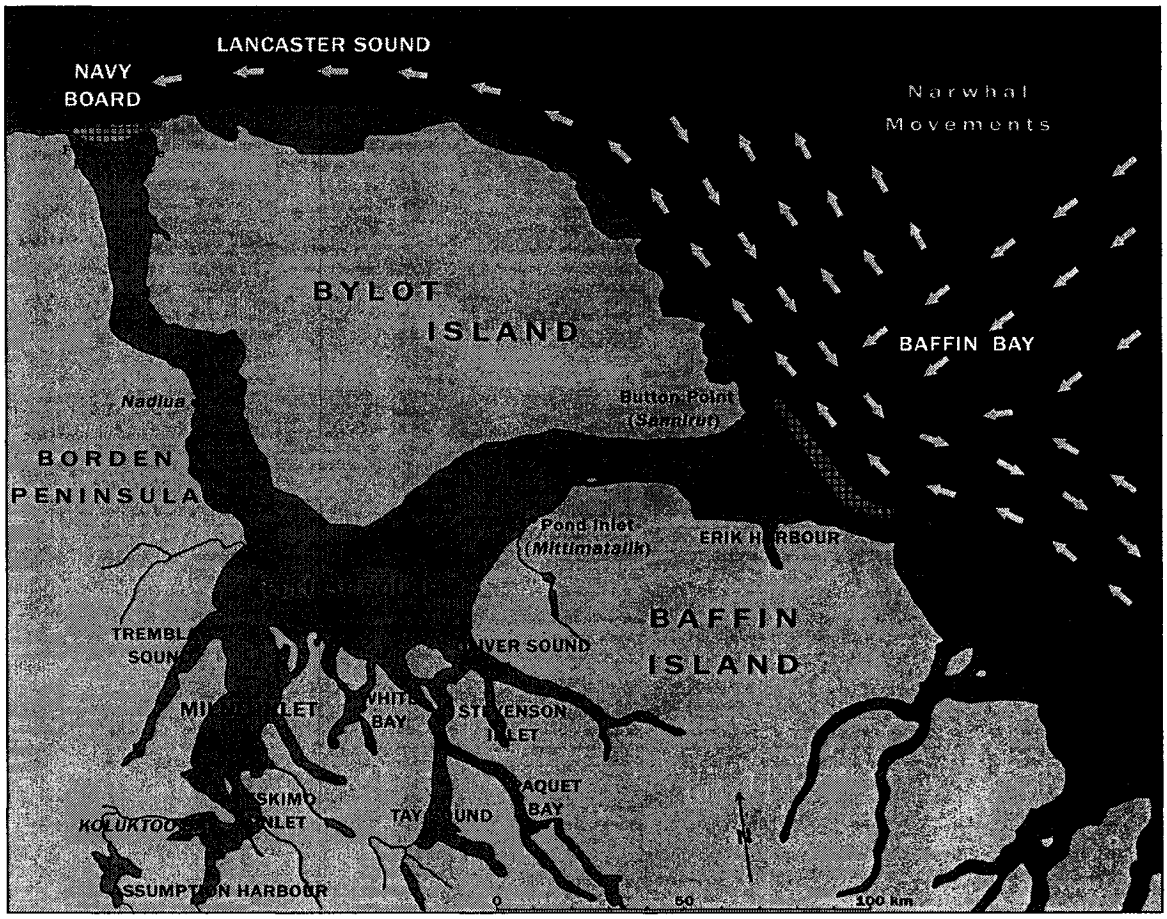

Figure 3. The location of the Pond Inlet and Navy Board Floe Edge Hunting areas.

The Inuit of *Mittimatalik* have historically relied heavily on marine mammals in the spring and winter seasons. Elderly Inuit were noted to hunt narwhals opportunistically by kayak during the summer months while the younger Inuit hunters

traveled inland to hunt caribou (Mary-Rousselière 1984). The period of the Inuit hunt of spring migrating narwhal in the open water environment spans the seasons of *upingua* corresponding to the months of June and July, and *auja* roughly corresponding to the summer months of August and September. The chief feature of *upingua* is marked by the break-up of sea-ice in the northern Baffin Island region. At *Mittimatalik*, during this stage, narwhals are not readily observed from the community as there are still large sea ice floes situated east of the community. Thus hunting is generally conducted at the eastern Pond Inlet-Baffin Bay floe-edge (Lee and Wenzel Forthcoming). As this season progresses into *auja*, open water is prevalent throughout most of the region in northern Baffin and Pond Inlet region with only a few patches of ice. Narwhal may then be observed with higher frequency as they migrate through Pond Inlet to their feeding and summering grounds west and north of the community of Pond Inlet and this presents the first geographical area under study.

The open water environment

Hunting in the summer: Open-water hunting. As spring season progresses into the summer season (*auja*; approximately late June and July), open water becomes more available for narwhals throughout Pond Inlet with patches and floes of ice in the open water. Narwhals are observed to migrate through Pond Inlet to their feeding and summering grounds west and north of the community of *Mittimatalik* (Heide-Jørgensen et al. 2003; Personal observations).

The first open water area that is utilized by Pond Inlet Inuit is located immediately in front of the centralized community of Pond Inlet (local Pond Inlet area). In this local Pond Inlet water, Inuit engage narwhals in small boats (twelve feet or less) during the early part of the season and transfer to larger boats (greater than twelve feet) during the latter phase of the season as the sea-ice deteriorates. Typically, hunters cruise in their boats searching for narwhals, ringed seals, and patches of ice to land their boats. Upon landing upon a piece of ice or a piece of land, hunters would then wait for prey. After a period of time, they would assess whether to move to a different location. If a prey item was detected, they would then assess whether to fire upon and pursue the prey.

The second open water hunting area is located in the eastern region of the northern Baffin Island marine network (Summer camp region; see Figure 1). Hunters

frequently travel to a historical or traditional campsite to deploy a summer camp from which they execute their hunting activities. For example, hunters wait for narwhals to come within assessment and pursuit distance while situated at the summer campsite. If hunters decide to engage narwhals, hunters always pursue narwhals in their boats and attempt to drive narwhals towards the shoreline.

The local Pond Inlet area. The local Pond Inlet area comprises the open water environment situated in close proximity to the community of *Mittimatalik.* All local Pond Inlet water hunting trips took place within a 250 km distance of the community of *Mittimatalik.* Geographically, it encompassed the open water of Pond Inlet from the northern tip of eastern Baffin Island (*Qilulakan*) and northwest Bylot Island to Mount Herodier (*Igarjuak*) and north-eastern Bylot Island (see Figure 1). The actual usage area was dependent upon the sea-ice conditions of Pond Inlet. This is because large sheets of sea-ice (floes) that had constituted the sea ice platform of Pond Inlet and the floe-edge were still present during the early phases of the summer hunting season. The abundance and distribution of these large ice pans and floes through the early stages of the summer hunting season could severely limit access to different areas of open water in Pond Inlet. Consequently, the boats that were utilized in these initial hunting trips were small in size (less than twelve feet) in order to manoeuvre in the open water between ice pans and floes.

As the summer season progressed, local river systems flushed fresh water into Pond Inlet causing an increase in the rate of break-up of both land fast ice and drifting ice in Pond Inlet. By August, most of the sea-ice had melted and there was only open water throughout the region with the exception of large icebergs. Consequently, hunters utilized larger sized boats (greater than twelve feet) during this stage of the season when sea-ice no longer posed a major obstruction to movement for larger sized boats. Hunters continued to use both large and smaller sized boats through the period of break-up and melting of sea-ice in Pond Inlet until freeze-up in autumn.

The summer camp. The summer camp hunting trips consisted of using the area of open water concentrating in and around the north western region of Baffin Island and Navy Board Inlet. Geographically, it includes Navy Board Inlet (*Nalluata imanga*), Oliver Sound (*Kangiqluruluk*), Eclipse Sound (*Tasiuja*) (see Figure 1) and surrounding bays and inlets. Hunters established their summer camps in this area from which they

based their hunting operations. Access to this area was dependent upon the prevailing sea-ice conditions. For example, access to this area was usually not possible until an adequate percentage of the sea-ice of Pond Inlet and neighbouring inlets and bays of the northern Baffin region had melted.

Inuit harvesting studies and human behavioural ecology

Early research on Inuit and narwhal was generally limited to hunt ethnographies (see, for instance, Degerbøl and Freuchen's Fifth Thule Expedition 1935). In contrast, recent anthropological and biological literature has centered on: 1) the culture of the hunt (Mathiassen 1928), 2) the animal's dietary importance (Bissett 1968; Treude 1977) and its socioeconomic value and dynamics (Land 1977; Mary-Rousselière 1984; Matthiasson 1992; Reeves 1992), 3) the animal's place in the modern Inuit subsistence system (Baffin Regional Inuit Association 1982, 1983, 1984, 1985; Donaldson 1988), 4) the technology utilized in hunting narwhal (Finley, Davis and Silverman 1980; Finley and Miller 1982; Roberge and Dunn 1990; Weaver and Walker 1988) and 5) the traditional ecological knowledge component of narwhal hunting (Remnant and Thomas 1992; Thomsen 1993; Stewart et al. 1995).

In general, the research on Inuit hunting has been criticized for lacking substantive theoretical structure necessary to test hypotheses concerning hunter behaviour in particular environments. Thus, in order to improve the understanding of the interaction between hunters-gatherers and their environments, some social scientists have applied several hypotheses based upon optimal foraging theory borrowed from behavioural ecology. Historically, since the mid 1970s, human behavioural ecology studies have applied optimal foraging models to study the subsistence practices of indigenous peoples (see e.g. Hawkes, O'Connell and Blurton Jones 1991; Hawkes and O'Connell 1985; Hawkes, Hill and O'Connell 1982; Hames and Vickers 1982; Hill 1988; Sih and Milton 1985; Smith 1991; Winterhalder 1977, 1983). Optimal foraging models assume that foragers attempt to maximize their immediate energy gains over time (Stephens and Krebs 1986). These are mathematical models where ecological parameters are entered in formulated equations to make testable predictions of foraging behaviour such as diet composition, group size and patch selection among different groups in different habitats. As robust as the optimal foraging approach is in its predictions, it has

received criticism for its lack of descriptive utility and its inability to incorporate the rich qualitative data found in ethnographic studies (e.g. see Smith 1983).

In the present case study of Pond Inlet Inuit open-water hunting behaviour, we address such criticisms by departing from an optimal foraging approach as applied in human behavioural ecology studies; instead, we articulate the search behaviour that Inuit display by describing their foraging mode. In the literature on animal foraging mode, it is observed that some predators attack their prey from ambush, whereas others usually hunt while on the move. Pianka (1966) termed these modes of foraging respectively "sit-and-wait" and "widely-foraging". In the sit-and-wait foraging mode, a forager remains stationary for long periods of time, waiting for a prey item to come within short pursuit or striking distance. In the widely-foraging mode, a forager spends much of its time actively searching for prey (Huey and Pianka 1981). Although this dichotomy can be somewhat artificial, numerous animal and human groups (see Binford 1980) seem to fall into one or the other category. An analysis of the search mode was successfully carried out for the spring floe-edge hunt in a previous study (see Lee n.d.; Lee and Wenzel Forthcoming). The application of foraging mode (see Holling 1959; Kramer 2001) was useful because it described important foraging behaviour Inuit displayed in the floe-edge environment. Furthermore, this methodological approach placed Inuit hunting behaviour in a richer and more realistic context by providing a more descriptive analysis of Inuit search behaviour and the environmental parameters that appeared to influence this behaviour. For example, several ecological factors such as ice physiognomy and narwhal behaviour were important elements of Inuit campsite selection. But also and most importantly, this approach allowed for testable hypotheses.

Thus, in the present study, foraging mode is utilized to study the search behaviour exhibited by Inuit to hunt narwhals in the open water environment. Furthermore, the pursuit behaviour of summer camp hunting trips is also explored in a detailed participant observation trip. The pursuit stage was found to be especially critical for summer camp hunting trips as it was observed to be extremely influential in the successful capture of narwhals.

Methodology

The primary data presented here were collected from 1996 through 1998, utilizing a participant-observation methodology supplemented by directed interviews. In total, almost eleven months were spent accompanying and observing *Mittimatalingmiut* narwhal activities in the floe-edge and open water environments. The open-water hunting component of the research comprised sixteen trips (see Tables 2 and 3).

Table 2. Group information for Summer Camp Hunting Trips.

Trip #	*Date*	*Hunting Party Size (individuals)*	*Travelling Party Size to Summer Camp (groups)*	*Travelling Party Size to Pond Inlet (groups)*	*Camping Party Size (groups)*
1	11-15/08/1996	2	1	2	4
2	01-04/08/1997	3	1	1	1
3	17-18/08/1998	4	1	1	1
4	27-29/08/1998	6	1	1	3
Mean		4	1	1	2

Table 3. The Hunting Party Size for Local Pond Inlet Water Hunting Trips.

Trip #	*Date*	*Hunting Party Size (individuals)*
1	14/07/1996	2
2	23/07/1996	2
3	02/07/1997	2
4	05/97/1997	2
5	08/07/1997	3
6	11/07/1997	2
7	21/07/1997	3
8	24/07/1997	2
9	29/07/1997	3
10	20/07/1998	3
11	26/07/1998	2
12	10/08/1998	3
Mean		2

Recall and post-trip interviews with Pond Inlet elders and active hunters were also employed to supplement this observational data. These observations and interviews formed the basis of the analysis. When possible, information was also collected on other individuals that had accompanied the principal hunting group or other individuals located in close proximity to the individuals of the principal hunting group that the principal investigator had accompanied.

This participatory approach was ideal for recording hunter movements, stops and campsites, while also allowing the observation of contiguous or passing narwhal hunters. Additionally, all search, pursuit, and handling activities were timed and amounts of fuel, ammunition and other expendables used were all recorded. Finally, encountered hazards, camping/resting sites, and narwhal sightings/firing events were recorded.

Results and Discussion

In this section, the search behaviour that was observed for both local Pond Inlet water hunting trips and summer camp hunting trips will be presented and analyzed. These will be compared with each other and the floe-edge hunting trips. The pursuit phase for all three types of trips will also be analyzed.

Search behaviour: Foraging mode

Sit-and-wait foraging for local Pond Inlet area hunting trips. Two major foraging modes were observed for all participant-observation local Pond Inlet area hunting trips. These were sit-and-wait and active foraging. The sit-and-wait foraging mode was classified as when Inuit hunters remained stationary for a period of time while searching for prey. This was usually executed from ice pans or from the shoreline of Bylot Island or northern Baffin Island. During the early summer hunting season (mid June to early July), Inuit selected ice pans and proceeded to wait on them until prey were detected.

As the season progressed (end of July), fewer ice pans were observed to be available to utilize for sit-and-wait hunting. This was because the sea-ice melted as the season progressed. Inuit were then observed to exploit sites on Bylot Island or northern Baffin Island from which they executed sit-and-wait foraging. One preferred location

was *Iglukisat* on Bylot Island which was located northwest of *Mittimatalik* (see Figure 1). Places such as *Iglukisat* were selected because narwhals were observed to migrate near the Bylot Island shoreline and provide hunters with exceptional hunting opportunities.

During all phases of the narwhal hunting season, narwhals migrating through Pond Inlet were observed to travel closer to Bylot Island. Inuit Elders indicated that narwhals had historically travelled along the shoreline of northern Baffin Island and in close proximity to *Mittimatalik.* This is in part supported by the presence of an archaeological site near *Mittimatalik* named *Qilaluqan* whose Inuktitut name means place of narwhals. Both bowhead and narwhal fragments have been uncovered at this location (Mary-Rousselière 1984). Again, Inuit Elders indicated that up until the advent of motorized boats in Pond Inlet, narwhals had traditionally been herded into shallow embayments at this location. During the study period, this site was not used for this purpose as there appeared to be no opportunity to herd narwhals since they no longer travelled near this location (most probably because of the higher noise presence).

During the mid phase of the summer hunting season (approximately July), ice pans still represented the preferred interception places by Inuit narwhal hunters. However, when there was a lot of open water, few narwhals were observed to travel near sit-and-wait locations. This was because each sit-and-wait hunting location covered a relatively small area of open water compared to the amount of open water accessible to narwhals. However, one of the most interesting situations arose when there was a lot of pack ice which limited areas of open water. In this situation, narwhals had limited areas of open water for movement. This provided some of the best narwhal hunting opportunities as hunters could position themselves on ice pans that were located next to areas of accessible open water. Under these conditions, the hunter's interception area covered a higher percentage of open water available to narwhals thereby providing more hunting opportunities. This was observed on several hunting trips.

Inuit hunters were also observed to sit-and-wait for prey items from their boats. In these cases, hunters were observed to drift in their boats for a certain period of time. Drifting was not a frequently observed activity because the currents in Pond inlet would move the boat into non-preferential areas such as areas with high pack ice. In this case hunters were not strictly stationary because the boat was moving through the

environment. However hunters usually did not engage their motors to control their general direction of movement.

Sit-and-wait foraging for summer camp hunting trips. For all summer camp hunting trips, sit-and-wait foraging was the dominant search mode observed. The single most important decision in this environment was the selection of the campsite. This was because the selection of the camp was permanent for the duration of the trip once deployed for most cases, and it also served as the location from which Inuit executed sit-and-wait foraging behaviour.

The selection of camp sites was usually planned prior to departure from the community of Pond Inlet. The camp site was often located on or near previous historical and preferred campsite locations. Historical campsites were geographic locations that Inuit at some point in their history had occupied (Mary-Rousselière 1984). The selection of a campsite usually coincided with access to several desired prey species. For example, the campsite *Iqaluit* located in Tay Sound provided access not only to narwhal but also to Arctic char in nearby river systems and also to caribou that could be hunted inland. The outpost camp *Nadlua* represented a premier narwhal hunting location because of its geographical position. For the participant observed hunting trip to *Nadlua*, narwhals were observed to travel across this location almost twice daily, thereby providing consistent narwhal hunting opportunities. In sharp contrast to the locations of three other summer camp hunting trips, narwhals were not observed or pursued with the same frequency. Therefore, *Nadlua* appeared to be located in a prime migratory area for narwhal. Other key narwhal areas include their summering and feeding areas such as *Koluktoo* Bay, Tay Sound, and Milne Inlet.

Active foraging mode for local Pond Inlet water hunting trips. The active foraging mode behaviour was classified as continuous directed movement through the open water while simultaneously scanning for prey. Active foraging began as soon as hunters entered the local Pond Inlet open water. Upon entering the open water environment, hunters sampled several features of the environment. This included scans for narwhals, ringed seals, sea ice abundance and distribution, open water, currents, and weather conditions. Sampling was particularly important because critical environmental information for travel direction, travel safety and sit-and-wait platform selection was gathered. Movement between ice pans and shoreline stops was also considered as part of

the active foraging mode because hunters engaged in search for narwhal while traveling through the open water.

The active foraging mode was more costly than sit-and-wait foraging in terms of energy expended by hunters and gasoline expenditures. Each hunting trip cost approximately twenty Canadian dollars in gasoline and oil (average price as calculated at the time of study, 1996-1998). It also caused noise disturbance which could drive narwhals from the area.

Active foraging mode for summer camp hunting trips. The first display of active foraging mode for summer camp hunting trips was observed during the travel stage from the community to the campsite location. Therefore, travel to and from the outpost and summer camps was considered part of the active foraging mode. This was because during this travel phase, hunters would engage both ringed seals and narwhals that were sighted or heard.

For the trips to *Nadlua* in Navy Board Inlet, Oliver Sound region, and the Tremblay Sound region, no active foraging events occurred (see Table 4). For the summer camp hunting trips to *Ipiutalik* and *Aulatsivik* located in Milne Inlet, there was only one active search event for narwhal and three active search events respectively. In three summer camp hunting trips, active foraging trips to search for caribou were undertaken (see Table 4).

Table 4. Duration of Sit-and-Wait vs. Active Foraging Activity for Narwhals (in minutes) for Summer Camp Hunting Trips.

Trip #	*Date*	*Trip Time*	*Camp Time*	*Travel Time*	*Sit-and-Wait Time*	*Active Time*
1	11-15/08/1996	5610	4835	775	2980	0
2	01-04/08/1997	4575	4125	450	1905	225
3	17-19/08/1998	1740	1080	660	540	0
4	27-29/08/1998	4440	3450	990	1530	300
Total	*Mean*	4091	3373	719	1739	131

Comparison of foraging mode between local Pond Inlet water and summer camp hunting trips.

First, the time spent engaged in each foraging mode was compared to determine if there was a dominant search mode displayed by Inuit while engaging in open water hunting trips in the local Pond Inlet water. Of the overall 141 hrs spent in the open water, 47.5 percent of the time was spent in active foraging mode, while 39.5 per cent of hunters' time was spent in the sit-and-wait foraging mode (Figure 4; see Table 5). The remaining percentage of camp time was spent in other activities such as hunting of other prey items like caribou and ringed seals, berry picking, and resting.

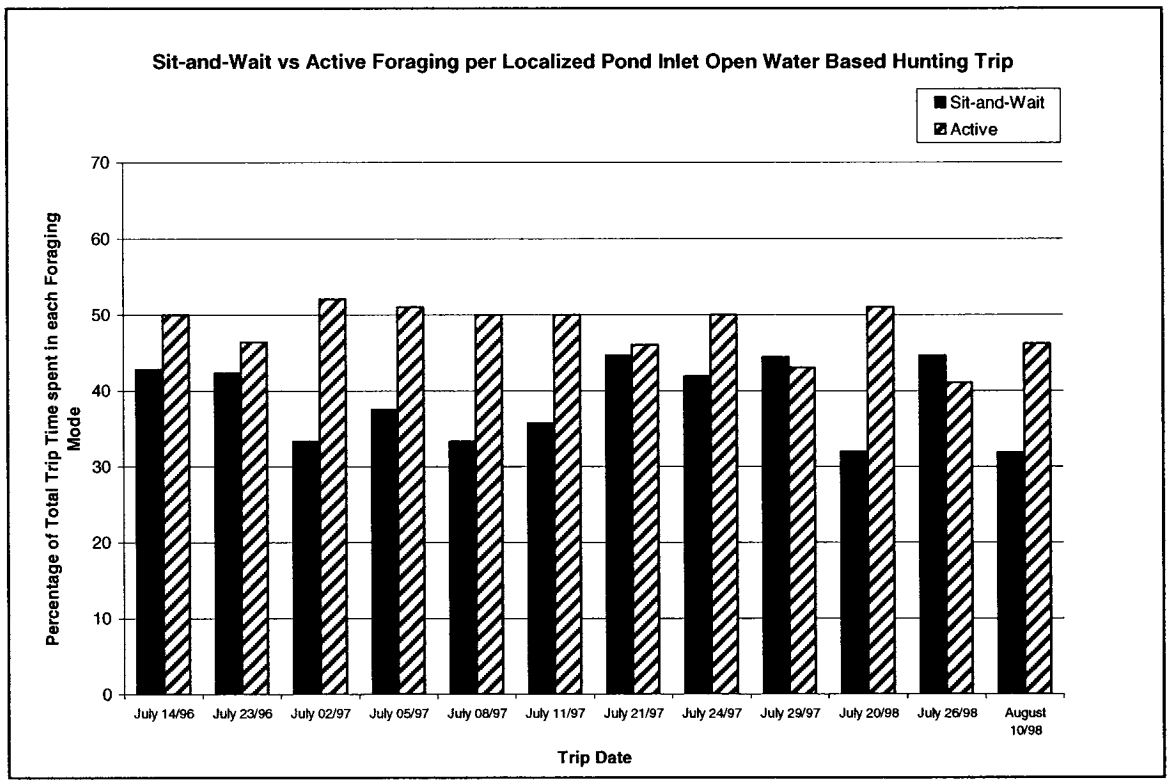

Figure 4. Sit-and-wait (solid bars) and active (cross hatched bars) foraging behavior distributions for each trip relative to total foraging time is presented. The active foraging mode is slightly higher for all participant foraging trips with the exception of two trips.

Table 5. Duration of Sit and Wait vs. Active Foraging Activity for Local Pond Inlet Water Hunting Trips (in minutes).

Trip #	*Date*	*Total Trip Duration*	*Sit-and-Wait Foraging Events*	*Mean Ice Patch Residence Time*	*Mean Cruising Time*	*Total Duration of all Sit-and Wait Foraging Activity*	*Total Duration of All Active Foraging Activity*
1	14/07/1996	420	4	45	53	180	210
2	23/07/1996	980	6	79	57	415	455
1996	*Mean*	700	5	62	55	298	333
3	02/07/1997	480	3	53	63	160	250
4	05/97/1997	480	3	60	61	180	245
5	08/07/1997	660	4	55	66	220	330
6	11/07/1997	420	3	50	53	150	210
7	21/07/1997	1140	5	102	58	510	525
8	24/07/1997	930	4	97.5	93	390	465
9	29/07/1997	720	5	64	62	320	310
1997	*Mean*	690	4	69	65	276	334
10	22-27/06	705	3	75	60	225	360
11	26/07/1998	840	5	75	69	375	345
12	10/08/1998	660	3	70	38	210	305
1998	*Mean*	735	4	73	56	270	337
Total	*Mean*	703	4	69	61	278	334

The amount of time (in hours) that hunters spent foraging was submitted to a 3 (year) x 2 (season: early summer vs. later summer) x 2 (foraging mode: sit-and-wait vs. active) mixed-model ANOVA. Year and season were set as between-subject factors and foraging mode was set as the within-subject factor. The analysis revealed a significant main effect for foraging mode, $F(1, 7) = 8.19$, $p < 0.05$; that is, hunters spent significantly more time in active foraging ($M = 5.6$, $SD = 1.7$) than in sit-and-wait foraging ($M = 4.6$, $SD = 2.0$). Importantly, the interaction between year and foraging mode was not significant, $F(2, 7) = 0.32$, p = NS; that is, the pattern of relatively higher time spent in active foraging was consistent over the three years studied (see Figure 4). Similarly, the interaction between season and foraging mode was not significant, $F(1,7) = .27$, p = NS; that is, the pattern of relatively higher time spent in active foraging is the same for both

seasons. However, there was a significant main effect for season, $F(1,7) = 17.12$, $p < .001$; overall, hunter spent more time foraging in the season of late summer ($M = 5.8$, $SD = 1.8$) than early summer ($M = 3.0$, $SD = 0.4$). This means they spent overall more time altogether engaging in both active and sit-and-wait foraging in the season of late summer.

Second, for summer camp hunting trips, of the total 225 hrs spent in camp, 52 percent of the time was spent in the sit-and-wait foraging mode and only 3.8 percent of hunters' time was spent in active foraging mode (Figure 5; see Table 4). The remaining 44.2 percent of the time was spent in other activities such as active search for caribou, active pursuit of narwhals and caribou, berry picking, ringed seal hunting, handling of prey items, and resting (see Figure 6). Caribou hunting was engaged in three of the four hunting trips and was considered a major objective of the hunting trips. Due to low sample size (only four observations), there was no significant effect found for foraging mode, $F(1, 3) = 2.88$, $p > 0.05$; however, the sit-and-wait foraging mode appears to be the dominant search mode executed by Inuit in this environment (see Figure 5).

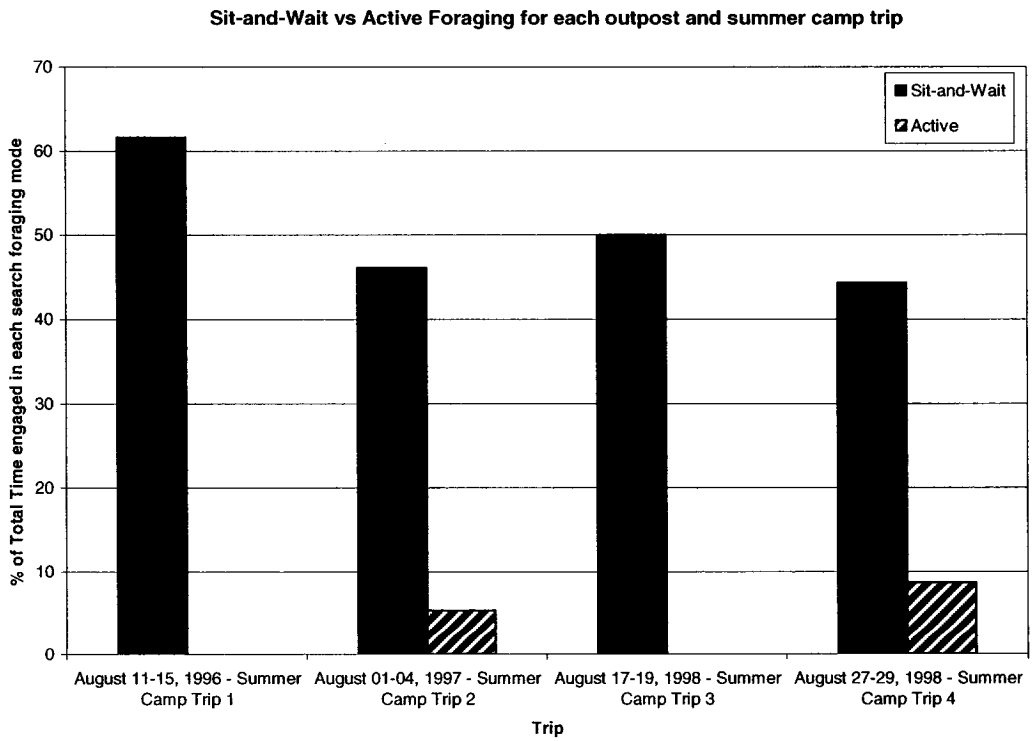

Figure 5. Sit-and-wait (solid bars) and active (cross hatched bars) search behavior distributions for narwhals for each trip relative to total camp time.

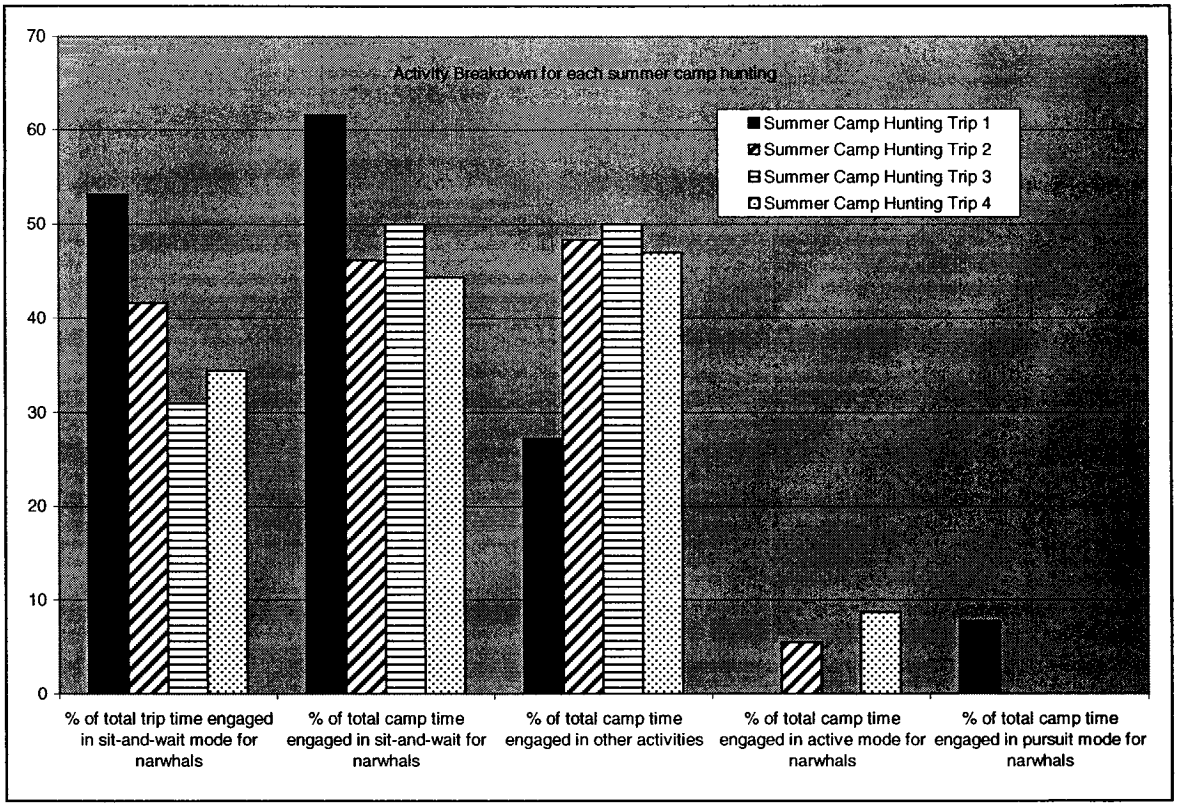

Figure 6. The percentage of total trip and camp time engaged in sit-and-wait foraging mode, active foraging mode, pursuit mode, and other activities. Other activities include berry picking, fishing, caribou hunting, resting, eating, and campsite maintenance.

Pursuit behaviour for local Pond Inlet water and summer camp hunting trips

Local Pond Inlet water and floe-edge environments. The pursuit phase of the hunting trip was initiated when narwhals were first detected and the decision was made to engage them. When narwhals were detected through sightings or sound, Inuit would attempt to locate the narwhals and their bearing. If pursuit was engaged, Inuit would have to make the decision of whether to wait for the narwhals or to move to a different position to intercept the narwhals.

For all participant-observation in the local Pond Inlet water and floe-edge hunting trips, hunters did not actively chase narwhals in boats unless Inuit had fired upon narwhals and there was an attempt to retrieve a floating narwhal (see Table 6). Narwhals were not pursued because they were observed to execute a deep dive when wounded or upon sensing a major noise disturbance such as outboard motors. Deep diving behaviour by narwhals made it extremely difficult to predict their next surface position as they

could be underneath the surface for up to twenty-five minutes (Martin, Kingsley and Ramsay 1994) and could resurface in an area that was beyond the viewing range of the hunter or could not be readily accessible due to obstructing sea-ice.

Table 6. Local Pond Inlet Narwhal and Ringed Seal Sightings and Firing Events.

Trip #	*Date*	*Total Ringed Seal Pursuit Events*	*Narwhal sightings*	*Total Narwhal firing events*	*Narwhal firing events during sit-and wait foraging mode*
1	14/07/1996	1	0	0	0
2	23/07/1996	4	0	0	0
3	02/07/1997	3	0	0	0
4	05/97/1997	2	0	0	0
5	08/07/1997	4	0	0	0
6	11/07/1997	2	0	0	0
7	21/07/1997	3	2	1	1
8	24/07/1997	2	2	1	1
9	29/07/1997	3	2	1	1
10	20/07/1998	3	0	0	0
11	26/07/1998	2	1	1	1
12	10/08/1998	5	0	0	0
Total		34	7	4	4
Mean		2.83	0.58	0.33	0.33

A notable exception that prompted active pursuit by Inuit in the local Pond Inlet water occurred during mass migration narwhal events where several hundred narwhals were observed to travel in one direction together at one time. These events were infrequent and unpredictable. For example, in 1996 and 1997, no mass migration events took place. But in 1998, a mass narwhal migration did occur. A large contingent of Pond Inlet Inuit departed in boats from the community and several Inuit hunt parties successfully captured narwhals during this event. This is because there was a high proportion of the narwhal on the surface of the water that were able to be shot at and harpooned since not all narwhals exhibited deep diving behaviour.

For local Pond Inlet water hunting trips, once a narwhal was detected, Inuit engaged in a pursuit mode that would allow them to engage narwhals from a passive

position. That is, they would not actively pursue narwhals in the water but make a decision of whether to maintain their current position or to move to a different interception position. Movement was highly dependent upon the direction of the narwhal's movement. For example, Inuit were observed to wait for narwhals when narwhals moved towards the hunter's position. However, when narwhals moved away from the hunters' position, hunters would then decide whether to move to a different position for interception. In three hunting trips, when hunters heard or sighted narwhals, they moved their positions to ice pans or other land-based areas where they might be able to intercept migrating narwhals. The interception positions were frequently observed to be situated on ice pans (if available) or on the shore. Hunters also indicated that movement to an interception position was not always based upon the individual or group of narwhal that was first sighted but upon the expectation of other individuals or groups of narwhal to follow (because the noise disturbance caused to move to the interception location often elicited a fright response from that individual or group of narwhals). In most cases, movement was very minimal and hunters continued to wait for narwhal to approach them or another group to pass in close proximity.

Upon mooring the boat on the ice or land, the hunter would then take up a sitting position with rifles and retrieval gear in place and wait for narwhals to close within firing distance (usually less than ten feet and dependent upon the hunter). Once a narwhal came within the preferred firing range of the individual hunter, it was shot upon by rifle, harpooned if possible, and then pursued by boat. In all participant-observed local Pond Inlet water hunting trips, when a narwhal was shot, hunters attempted to harpoon the narwhal as soon as possible in order to track its location. If the narwhal was instantly incapacitated and floating, it could be instantly retrieved. However, if the narwhal had been wounded, it would usually display a dive response to the sound of the shot fired or being hit by the bullet. In this scenario, if the narwhal was not harpooned, relocation and retrieval of the narwhal was observed to be very low. Once and if the narwhal was relocated, it was fired upon again and harpooned with the whaling harpoon and float attached. Harpooning the whale significantly increased the probability of retrieval as the float not only tired the whale significantly but also allowed for the hunter to be able to relocate the whale more readily for capture. Attached to the harpoon was a large red or orange float that could be seen on the surface of the water.

Inuit also exhibited some variation in their firing objectives on narwhals. Hunters expressed different target preferences on the narwhal. For example, some Inuit preferred to target a specific location of the narwhal's spine in order to incapacitate the whale. Inuit indicated that this often prevented it from sinking immediately. Other interviewed hunters preferred to target the blowhole in order to force it to come up for air more frequently after it's initial dive response. Both areas were selected in order to prevent the narwhal from dying from a mortal wound located in another portion of the narwhal body. For local Pond Inlet water trips, hunters did not actively pursue narwhals for great distances once a shot was taken. Any pursuit that was initiated was only in response to a successful shot and an opportunity to retrieve the shot whale.

A brief discussion of the pursuit of ringed seals is presented because all hunters were observed to engage ringed seals when encountered in the local Pond Inlet water environment. There was some variation between the pursuit strategies of hunting parties with respect to ringed seals. For example, a common tactic observed involved keeping the seal under the surface of the water as soon as it was sighted in order to prevent it from breathing. Ultimately, it would be forced to remain on the surface for a longer period to breathe which would provide the hunter with a longer setup time to aim and fire upon the ringed seal. Furthermore, it was more likely that it would be shot with at least some air in its lungs in this scenario unless it was prematurely shot while attempting to keep it down. Because the salinity of the open sea water is significantly decreased from the melting ice, ringed seals were observed to sink rapidly in this environment. Some ringed seals were observed to sink as soon as they were shot making retrieval impossible, while others floated long enough for the pursuers' boat to reach them which was typically less than 30 seconds (Personal observations).

Summer camp hunting region. When narwhals were detected during summer camp hunting trips, hunters always initiated chases and experienced higher hunting opportunities (see Table 7). For all pursuit events observed at *Nadlua*, all hunters successfully retrieved whales that had been shot and harpooned. This success was highly due to the strategy used by Inuit to drive narwhals with their boats towards the shoreline.

Table 7. Summer Camp Narwhal Sightings and Firing Events.

Trip #	*Narwhal sightings*	*Total Narwhal firing events*	*Narwhal firing events during sit-and wait foraging mode*	*Narwhal firing events during active foraging mode*
1	6	6	6	0
2	2	0	0	0
3	2	0	0	0
4	0	0	0	0
Total	10	6	6	0
Mean	2.5	1.5	1.5	0

Accordingly, the general pursuit behaviour displayed by Inuit that was observed was to drive the whale as close to shore as possible with the motorized boat. This allowed hunters to observe the whales continuously because of the shallow water but more importantly it prevented the whales from escaping by not being able to execute a deep dive. Hunters actively chased individual narwhals and groups of narwhals with their boats for extended periods of time (up to thirty minutes) and distances (within a two kilometres radius but back and forth along the coastline). Every pursuit event involved a motorized boat with rifles and harpoon and float for use in kill retrieval. In some cases, a larger boat and engine were employed depending upon the resources of the hunter. Two examples include a twenty foot fibreglass boat with 8-cylinder engine and an eighteen-foot freighter canoe with a 45-horsepower outboard motor. Hunters would simultaneously search for preferred targets on the narwhals and fire shots from a large calibre gun. After firing upon the narwhal, the narwhal was then immediately secured with a hand launched harpoon attached to a sealskin or plastic twenty-five litre jerry can. The float is meant to prevent a dispatched animal from sinking.

After the whale has been secured on shore, it is then processed by the hunter. The skin and meat are cut into transportable, manageable and storable pieces. Some pieces are stored in large dug-up pits that are cached over the summer and autumn and dug up in the winter. Some of the *maktaaq* is transported to the community. In the community, the *maktaaq* is usually distributed throughout the extended family and larger community. Members from the outpost camp almost always sell a large quantity of *maktaaq* to the

local country food market. The *maktaaq* is then repackaged and is sold through the local co-op store to the general community or is shipped to other locations such as *Iqaluit* for resale.

Conclusion

One major finding is the differences and similarities in search strategies that were employed between the floe-edge and open water environments. In contrast to the floe-edge environment, active search behaviour was employed extensively in the local Pond Inlet area. This is most likely due to the dynamic open water environment in which hunters are continuously moving between different ice pans searching for prey while simultaneously sampling the changing environment.

This paper also provided a detailed description of the hunting habitat of the local Pond Inlet area. This habitat represented a highly dynamic environment in which ice floes would continuously move through Pond Inlet during the early stages of the summer season. Narwhal hunting in this area was observed to be highly opportunistic and frequently prompted by sightings from Inuit. Thus, information played an important role as hunting trips in this habitat were frequently prompted by narwhal sightings. Once narwhals were sighted by local residents, the relative position and direction of the narwhals were conveyed to immediate and extended family members through the use of local radio, short-wave radio, in person or by telephone. The interested hunters of the community with access to small boats and means (in terms of necessary equipment and supplies such as outboard motors, rifles, and gasoline and ammunition and, most importantly, time) would then decide whether to engage them.

Another major feature of this hunting habitat was the difficulty in securing narwhals. When narwhals were fired upon and not harpooned immediately, they immediately dived were extremely difficult to relocate. Despite the number of trips observed in the local Pond Inlet area and the large amount of time spent in both modes of foraging, the rate of successful narwhal capture was low. For all participant-observed trips, in which narwhals were sighted and engaged, no narwhals were successfully captured.

A third major finding was the importance of the pursuit phase in open water summer camp hunting trips. Once a narwhal was sighted and the pursuit phase was initiated, hunters were able to strike and retrieve whales successfully by driving them towards the shoreline. All participant-observed pursuits that were initiated at *Nadlua* during the study period ended with successful capture of narwhals.

This study also revealed some major benefits of the summer camp hunting area. The summer camps, especially in Navy Board Inlet and other narwhal summering grounds, provided excellent opportunities to hunt and secure narwhals due to two key factors. The first was related to the regularity of narwhal movements within these particular areas. The second factor was the shallow water near the shore. In this environment, successfully securing a narwhal was significantly higher than the local Pond Inlet area and the floe-edge. However, it should also be noted that travel to these areas required a substantial input of time, energy and economic means as well as other restrictions such as relations that may have limited the capacity for different families to visit and remain in certain summer camps for any extended period of time.

This study describes the significant differences in hunting strategies utilized by Inuit to hunt narwhals in these two open water areas and the floe-edge environment. In local Pond Inlet water foraging trips, pursuit of narwhal in the open water is possible but quite challenging due to the narwhal dive response. In sharp contrast, relentless pursuit of narwhal by boats in the summer and outpost camp environments provided numerous firing and harpooning opportunities that significantly improved retrieval rates.

Lastly, this paper reveals that much like the floe-edge environment, a sound knowledge of the environment was critical to navigate through open water. The open water environment possessed important variables such as weather changes, high winds, fog, and pack ice depending upon the time of the season. Inuit also utilized their geographical knowledge of preferred hunting areas due to changes in narwhal migratory behaviour. For example, hunters selected specific geographical positions such as *Igulikisat* and *Nadlua* for prime narwhal hunting opportunities.

CHAPTER 6: GENERAL CONCLUSION

The present thesis was motivated by the recognition of a significant gap with respect to information specific to Inuit hunting behaviour of narwhals. This gap is addressed by examining the ecological, economic, and social dynamics of narwhal harvesting among a sample of Inuit adults and households in Pond Inlet, Nunavut. The Inuit narwhal hunting process was studied in three distinct environments. They included: 1) the eastern Pond Inlet floe edge during spring, 2) the open water environment in and around Pond Inlet during summer, and 3) the summer camp shore sites located west of the community of Pond Inlet and concentrated in Navy Board Inlet. Participant observation and interview data with regard to Inuit narwhal hunting behaviour were collected in all three of these environments.

Theoretical Implications of the Research

In the first manuscript, I presented the major Inuit narwhal hunting decisions in each of these three environments through the construction of a decision flowchart. The flowchart successfully deconstructed the narwhal hunting process by presenting the major decisions and alternatives that Inuit faced for each environment. It was extremely useful in revealing some of the major geographical and sociocultural factors that were important for these decisions. Furthermore, these factors were elaborated in a cost and benefit analysis. The deconstruction of the foraging process of major hunting decisions provided the necessary background to develop appropriate hypotheses for specific components of the narwhal hunting process. These were tested in the second and third manuscripts.

More precisely, my use of a foraging mode analysis in the second and third manuscript provided a framework to analyze the empirical data presented in the first manuscript. This theoretical line of research aided in the formulation of testable hypotheses with regard to the search and pursuit behaviour of Inuit. Accordingly, the use of foraging mode was found to be an extremely useful approach as it articulated the Inuit search and pursuit behaviour in the floe-edge and open water environments.

For example, in the second manuscript, the study of search behaviour and application of foraging mode revealed the importance of campsite selection and environmental sampling upon arrival at the floe-edge. Also, it was shown that hunters sampled environmental features such as sea-ice physiognomy and narwhal acoustic sensitivity and diving behaviour through active trips.

In the third manuscript, the theoretical approach was furthered by investigating the pursuit phase because it was found to be a critical stage of the hunt process for summer camp hunting trips. It was a critical stage because it directly resulted in higher narwhal capture rates compared to local Pond Inlet water and floe-edge hunting trips.

This approach presents a promising line of inquiry into Inuit narwhal, and other, hunting decisions based on an extension of human behavioural ecology through my application of a mode of foraging analysis. Yet, it is apparent that further research is needed in order to improve our understanding of particular details of Inuit decision and hunting behaviour that were elaborated in this thesis. Although, the first manuscript presented numerous geographic, ecological and social factors for major trip decisions such as the selection of the Pond Inlet floe-edge, group selection, and travel route selection; several factors that were presented to have influenced these decisions remain to be empirically investigated in depth. For example, the use and implementation of information was important during all phases of the hunting trip. Inuit hunters not only acquired information from different sources but also the quality of this information may have been important. Hunters received information from other hunters at Button Point and at the floe-edge. They would also communicate with other hunters or listen for reports of narwhal sightings and activity along the floe edge through short wave radios. This information may have been critical in their decisions regarding active movements such as camp movements. This remains to be further explored.

A second feature that still needs to be studied was the differing skill levels among the hunters. Based upon personal observations and interviews, there were some very skilled narwhal hunters that enjoyed a high success rate and others who were not as experienced but whose skill level showed improvement after numerous trips to the floe-edge over the four-year study period. The difference in skills may provide some insight into the different reactions hunters displayed to different narwhal sighting events. For

example, the behaviour displayed by the narwhal and the distance to the narwhal may have elicited different pursuit responses from differently skilled hunters. Based on participant observation of floe-edge hunting trips, experienced hunters appeared to have displayed more consistency in the conditions upon which they would shoot a narwhal when compared to lesser experienced hunters. For example, non-experienced hunters were observed to fire upon narwhals from greater distances. Furthermore, experienced hunters showed more consistency in the preference for certain targets of the narwhal and a specific narwhal deep diving behaviour to fire upon the narwhal. These aspects should be investigated in further research through interview data and hunting trips to identify which parts of the decision flowchart are cogent and which parts require additional refinements. The entire decision flowchart can be further improved by validating each of the alternatives especially making notice of any absent but important alternatives with more hunters and elders of the community.

On another level, this program of research has also provided important insights into the change that is occurring among Inuit with respect to narwhal hunting. The pattern of narwhal exploitation based from a centralized community setting is a relatively recent development. Historically, elder Inuit mentioned two major groups that traveled to the floe-edge during the early period of centralization. The first group included those Inuit who were intimately familiar with this area and who would normally engage in spring narwhal hunting at the Pond Inlet floe-edge (Mary-Rousselière 1984; Mathiassen 1928). A second group included those Inuit who were dog team owners who hunted narwhals because they used the meat as fodder for their dogs (Mary-Rousselière 1984; Mathiassen 1928; Reeves 1992).

However, as snowmobiles became more accessible and as the population of Inuit in the community increased, the number of Inuit that began to travel to the Pond Inlet floe-edge increased steadily due to its close proximity and accessibility. Consequently, many current Inuit hunters mentioned that they had improved their knowledge of this environment through numerous hunting trips to this area to hunt numerous species of wildlife including narwhal. According to interviews, this knowledge has provided them with a level of ability and security to travel and hunt in this environment. Thus, whereas narwhal hunting previously was only conducted by certain families and for certain

reasons, narwhal hunting has been opened up to a wider range of people. In sum, centralization of Inuit to this community, the geographic position of Pond Inlet, and the availability of snowmobiles and other technologies has provided increased opportunities for Pond Inlet Inuit to hunt narwhals in the floe-edge environment and local Pond Inlet water environments, where historically fewer families would have been engaged in this activity.

Overall, the results of these three studies have significantly enhanced our current understanding of the interactions between Inuit and narwhals in three specific environments of the Canadian Arctic. This research contributes to the cultural ecology approach of subsistence-based societies by studying how Inuit directly interact with their environment with respect to narwhal hunting. Uncovering aspects of the cultural ecological relationship between Pond Inlet Inuit and narwhals has not been addressed in the literature, nor been the focus of many cultural geographers. While extensive work on Baffin Island studies (Boas 1888; Damas 1963; 1984; Mary-Rousselière 1984; Wenzel 1981; 1991) has been conducted on identifying and explicating the relationships between Inuit, their environment and their prey species, not much work has been conducted on Inuit whaling in contemporary society. Contemporary studies of this relationship have often been entirely focused upon the role and effects of Pond Inlet Inuit hunting or the biological and population characteristics of narwhals without any investigation into the interactions between them. One reason that these types of studies may have been lacking is because of the inherent difficultly of engaging in participant observant hunting trips. This is because participating on hunting trips is not only intrusive but also presents potentially dangerous situations for the hunter due to the presence of an inexperienced passenger in highly dynamic environments. This thesis research has met the challenge and provided extensive detail into the actual hunting process and the decision processes by participant observation of actual narwhal hunting trips.

Furthermore, this thesis contends that the cultural ecology approach can be enhanced by the application of behavioural ecology to study Inuit foraging behaviour. To date, relatively few researchers have utilized behavioural ecology to study the hunting behaviour of Inuit with the exception of Smith (1980; 1983). The elucidation of the foraging cycle of hunting narwhals by Inuit and in particular the use of foraging mode to

study Inuit search behaviour has been extremely useful to comprehend how Inuit interact with each of these environments.

Social Implications of the Research

This detailed description of the narwhal hunt, including the technology utilized to hunt narwhals currently and the actual process of ranging and firing upon the narwhals in the floe-edge and open water environments, was discussed with members of the community of Pond Inlet. The Pond Inlet Hunters and Trappers Organization, the Elders Group, the community council and members of the community all expressed concerns with respect to the type of information that would be made available to the public. After I explained my objectives of detailing the narwhal hunting process, these representatives agreed to my project but this did not necessarily mean that every member of the community approved of this research. Inuit were particularly concerned about external perceptions of Inuit and the scrutiny of international organizations such as the International Fund for Animal Welfare (IFAW) and Greenpeace upon their hunting of narwhal. In addition, it was evident that there was a precarious relationship between the Hunters and Trappers Organization, the Department of Renewable Resources, the Department of Fisheries and Oceans and the hunters of the community. There was generally a perception of distrust between the different groups and hunters because of the intrusion of these organizations upon hunters' behaviours. One particularly sensitive issue was the narwhal quota. Narwhal hunting in Pond Inlet is an especially sensitive issue because of its cultural value and long historical relationship with Inuit.

This brings up another very important issue with respect to scientific research in the North. Pond Inlet Inuit expressed concerns over scientific and anthropological research that had been conducted in their community in the past. The major issues appeared to stem from a lack of communication and understanding between researchers and Inuit and finally, a discontent with final products produced by researchers (or foreigners who wrote books on Inuit and Inuit topics). To address such issues, over the four year study period I regularly met with the members of the community, HTO, Hamlet Council, and Elders group to communicate with them the information and status of the

research project. The issue of reporting results to Inuit is becoming more recognized as an important component of northern research as a future conference hosted by the Arctic Institute of North America, University of Calgary, addresses this topic directly. The title and theme of the 14th Annual Inuit Studies Conference is "Bringing Knowledge Home: Communicating Research Results to the Inuit" being held at the University of Calgary, Calgary, Alberta, August 11-14, 2004.

Although this research was reported to members of the community, the capacity of a minority-group community to utilize research framed in a Western academia setting towards a constructive means remains problematic (D. M. Taylor, personal communications). Arguably, these minority communities are not yet equipped with the political or social means to make use of these types of studies. Thus, one important realization may be that although it is important to communicate results with Inuit, scientific researchers should also remain cognizant of the fact that such communities may have a limited capacity to utilize this research in a means that satisfies their interests. This is problematic as it could lead to further frustration on the part of the community and challenges in future research based in and around these communities.

APPENDIX: ETHICS APPROVAL FORM

ETHICS APPROVAL FORM

Research Ethics Review Committee
Department of Geography
McGill University
[Chair - G.W. Wenzel, contact #'s : (tel. 514-398-4346; fax: 514-398-7437]
[e-mail: wenzel@felix.geog.mcgill.ca]

We, the undersigned, being aware of the university and Tri-Council guidelines on the ethical conduct of scholarly research, have reviewed the project (title and applicant below) and consider the procedures and/or methods as outlined by the applicant to be acceptable within these guidelines. Reviewers, if desired, should comment on a separate page.

Project: POND INLET INUIT FORAGERS and NARWHAL

Applicant: David S. Lee

Departmental Reviewers:

1): O. T. Coomes Position: Assistant Professor

Signature: Oliver Coomes Date: 6 May 1997

2): L. MÜLLER-WILLE Position: Assoc. Prof.

Signature: Ludger Müller-Wille Date: 6 MAY 1997

3): Position:

Signature: Date:

External Reviewers:

1): Position:

Signature: Date:

2): Position:

Signature: Date:

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