Inuit spring hunting techniques and local knowledge of the ringed seal in Arctic Bay (Ikpiarjuk), Nunavut

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Inuit hunting techniques used to catch ringed seals (*Phoca hispida*) were observed April–June 1993 on the land-fast ice of Admiralty Inlet, Nunavut, and adjoining fjords and bays. In addition, a survey of hunting techniques and knowledge of ringed seal biology and behaviour was conducted in the community of Arctic Bay (Ikpiarjuk), Nunavut, January–February 1994. A total of 246 seal structures were found in 31 days of hunting and 34 successful kills were observed. An experienced Inuk hunter found subnivean structures by sight, by walking on drifts and by probing snowdrifts with a harpoon (*unaaq*). Most structures were found using subtle visual cues. Breaking through the roof of a lair was the most common hunting technique observed in this study. Pups captured in this manner were subsequently used to lure the mother back into the breathing hole where she was harpooned. Ringed seals were also hunted by a number of other methods that have been described previously in the literature. Respondents in the hunter survey indicated that the ringed seal was the most important animal used by Arctic Bay Inuit. They also reported a variety of biological findings about ringed seals including: size differences among seals in different regions of the pack ice; that adult male ringed seals (*tiggak*) emitted a strong, mustelid-like odour from December until late May or early June. Hunters also reported that males were occasionally caught when coming to retrieve pups. All respondents reported seeing increasing frequencies of liver abnormalities in their ringed seal catches.

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While carrying out research in Nunavut in May 2000, Stuart Innes lost his life in a helicopter accident. He is greatly missed by his colleagues and friends.

Hunting is an integral part of the lifestyle of indigenous people in the Arctic. Wildlife resources provide northern peoples with a substantial portion of their dietary and, in some cases, clothing needs (Donovan 1982; Riewe & Gamble 1988; Kinloch et al. 1992; Jensen et al. 1997; AMAP 1998). Hunting is part of the culture, and the teaching and learning of hunting skills and knowledge of the environment reinforces intergenerational links (Wenzel 1983; Riewe & Gamble 1988; Condon et al. 1995). Aboriginal people in the Arctic have developed extensive knowledge of seasonal distribution, relative abundance, behaviour and biology of their prey through travel, hunting activities and exchange of information between individuals

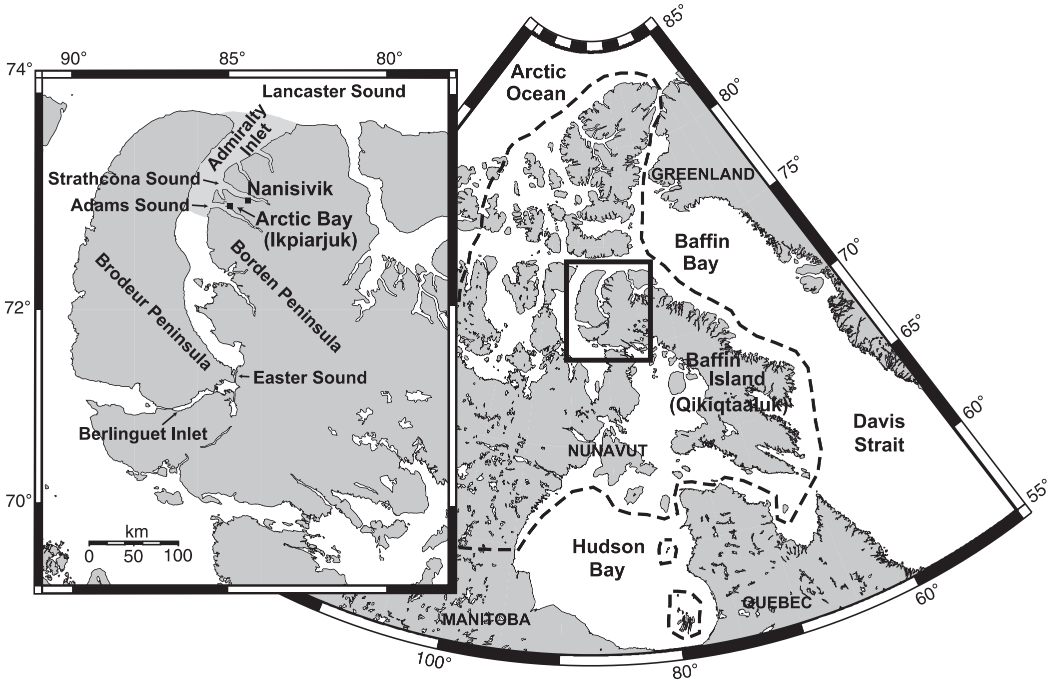

Fig 1. Map of the Canadian Arctic showing the study area. Light grey shaded area in insert shows the specific study area in the land-fast ice of Admiralty Inlet—from Arctic Bay to Lancaster Sound.

(e.g. Gunn et al. 1988; Ferguson et al. 1998). They observe animals while while hunting and travelling, over seasonal and geographical distributions rarely matched by scientists (e.g. Hall 1864; Boas 1888, 1907; Norton et al. 1987; Gunn et al. 1988). Additionally, indigenous people can provide data on specific stocks of animals from knowledge that has been orally transmitted for hundreds of years (e.g. Hall 1864; Boas 1907; Manning 1944; Osherenko 1988). This information can provide knowledge to future generations and complement scientific data sets (Riewe & Amsden 1979; Thomsen 1993; Condon et al. 1995).

Many studies have documented observations of Inuit seal hunting activities (e.g. Hall 1864; Kumlien 1879; Boas 1888, 1907; Murdoch 1893; Degerbøl 1935; Nelson 1969; Riewe & Amsden 1979; Wenzel 1991). However, few investigations have presented such information in association with hunter knowledge or the broader scientific literature regarding the distribution and behaviour of these Arctic marine mammals. This study was initiated at the request of the Arctic Bay Hunters and Trappers Organization (HTO), Arctic Bay (Ikpiarjuk), Canada. At the time of the research, Arctic Bay was included in the area of the Northwest Territories; as of 1999 it is within the boundaries of the new terrirory, Nunavut. The study was conducted concurrently with a study of ringed seal ecology in the region (see Furgal et al. 1996). The objective of this study was to gather local hunters' knowledge on the biology of the ringed seal (*Phoca hispida*) and to directly observe and document Inuit seal hunting techniques during the spring season in the vicinity of Arctic Bay.

Methods

Study site

This study was conducted in and around Arctic Bay (73° 02' N, 85° 10' W), on Baffin Island, Canada. This small Inuit hamlet, located in the north-west quarter of Baffin Island, is home to approximately 540 people (Fig. 1). Historically, Inuit in the Arctic Bay area lived in outposts surrounding nearby Admiralty Inlet, Lancaster Sound and Adams Sound. The Hudson's Bay Company established a post in Arctic Bay in 1926, which closed the following year. It was subsequently re-established in 1936, when Inuit originally from Pangnirtung and Cape Dorset relocated from the unsuccessful post at Dundas Harbour. As was the case for many other Baffin communities, Arctic Bay experienced the introduction of pension plans, government support payments and unemployment insurance in the 1940s and 1950s. Government housing initiatives encouraged Inuit to settle into this, and other, communities in the 1960s (Brody 1976; Oakes 1987; Soublière 1998). The mine at Nanisivik opened in the late 1960s, Pan Arctic oil exploration began in 1971 and associated wage-based employment became a major influence within the community. However, land-based subsistence activities have always been important to Arctic Bay Inuit. Most men, and many women still take part in some form of hunting, fishing and collecting activities at different times of the year. These activities are associated with the various wildlife species in the region, which include caribou (*Rangifer tarandus*), ringed seal, bearded seal (*Erignathus barbatus*), narwhal (*Monodon monocerus*), Arctic fox (*Alopex lagopus*), polar bear (*Ursus maritimus*), Arctic hare (*Lepus arcticus*) and Arctic char (*Salvelinus alpinus*). The ringed seal is still used for clothing (Oakes 1987) and plays an important role in the diet of many north Baffin communities today (Kuhnlein et al. 2000), including Arctic Bay.

Nearby Admiralty Inlet, only some 10 - 20 km away, is a common hunting area for the communities of Arctic Bay and Nanisivik. It has a complex coastline with deep fjords and sounds that freeze each year in late autumn and remain frozen until early July (Lindsay 1977). This land-fast ice is broken and rafted by winds and currents during consolidation. Additionally, persistent cracks occur across the inlet and the openings to deep bays due largely to tidal fluctuations. Ringed seal lairs and breathing holes are often associated with the resultant ice formations, due to snow accumulation at these sites (e.g. McLaren 1958; Smith & Hammill 1981; Lydersen & Gjertz 1986; Lydersen et al. 1990; Lydersen & Ryg 1991; Smith et al. 1991; Furgal et al. 1996). Residents of Arctic Bay and the nearby community of Nanisivik hunt this species the year round.

Hunting observations

Direct observations (by CF) were made of a skilled ringed seal hunter from Arctic Bay on a series of hunting trips between 7 April and 3 June 1993. Hunting expeditions were subdivided into time spent searching and time spent using a specific hunting technique. Seal structures located by the hunter were classified as breathing holes, haul-out lairs, or pup lairs (as in Furgal et al. 1996). Hunting success was documented and prey was classified as being a pup, subadult, adult female or adult male (e.g. McLaren 1958; Smith & Stirling 1975). On a few occasions ($N = 10$) hunting techniques used by other Inuit were also observed, when one or more hunters accompanied the principal hunter, or when other hunters were encountered while out on the land-fast ice.

Data analysis

A Model II one-way analysis of variance (ANOVA) (Sokal & Rohlf 1981) was used to test for differences between structure and habitat characteristics and location and hunting techniques. Assumptions of normality and homogeneity of variance were tested by graphical analysis of the residuals (Sokal & Rohlf 1981). All variables, with the exception of the time spent searching for structures or basking seals and the time spent in a hunting technique, were *ln* transformed to improve normality and homogeneity of variance (Sokal & Rohlf 1981). For statistical analyses the maximum accepted probability for type-1 errors (α) was set at 0.05. Means are shown as $X \pm 1$ s.d. unless otherwise stated.

Hunter knowledge survey

To complement the data obtained through field observations, interviews concerning knowledge of ringed seals were conducted with hunters from Arctic Bay between 31 January and 10 February 1994. Interview topics regarding the general biology and distribution of seals within the land-fast ice, as well as the techniques used to hunt them, were prepared in consultation with the HTO prior to interviews (Table 1). Twenty-three active or experienced seal hunters and community elders were recommended by the HTO as candidates for interviews. These individuals were identified as being experienced or very knowledgeable regarding seals and the techniques used to hunt them in the region. All recommended persons were contacted and willing participants were then interviewed individually in their homes or in the Hamlet Office. The outline, purpose and intent of the study were explained prior to interviews and each participant provided written consent to acknowledge their understanding and involvement in the study. Interview questions were posed in an open-ended manner, and were often followed by suggestions for specification to clarify responses (e.g. Patton 1990; Creswell 1994). Questions were structured to avoid lengthy translation into Inuktitut. They were focused primarily on general ringed seal biology and behaviour, as well as on temporal and spatial trends in body condition, seal distribution, and hunting techniques used by Inuit to catch seals. Interviews were conducted in Inuktitut through sequential translation with the aid of an interpreter. Written notes were taken during interviews and interviews were taped when the participant gave permission to do so. Notes and tapes were reviewed for clarification and participants were contacted again, if necessary, to clarify answers or provide further detail.

A process of iteratively reviewing the textual data and developing groups or categories of similar responses to individual topics discussed (i.e. similar methods and cues used to locate ringed seal structures, similar times when ringed seals are thought to migrate into Admiralty Inlet) was used to organize the data collected in interviews (Miles & Huberman 1984; Marshall & Rossman 1989; Tesch 1990). Once developed, groups or categories were then reviewed, and revised when necessary, to account for all responses given. All interview transcripts were then manually coded using these categories and the information was summarized into tabular form. Although the frequencies of similar responses to interview topics are reported in some cases here, they are used for summary purposes only and are not indicative of statistical significance. Increased frequency of a specific category of information may indicate the prevalence of that view among a group of participants; however, consideration was given for the complete text of all responses.

Table 1. Discussion topics for hunter knowledge survey on ringed seal (*Phoca hispida*) biology and Inuit hunting techniques in Arctic Bay.

1. Temporal changes in ringed seals in Admiralty Inlet and adjoining fjords and bays
   —relative abundances?
   —tissue differences, eg. liver (texture, taste, colour, white spots)?
2. Spatial differences of ringed seals in Admiralty Inlet and adjoining fjords and bays
   —behaviour?
   —size in north and south Admiralty?
   —taste differences?
3. Temporal patterns of ringed seals in Admiralty Inlet and adjoining fjords and bays
   —migration into inlet?
   —when?
4. Ringed seal pups
   —decription of habitat used by pups?
   —behavioural differences observed when hunting? (white pups vs. more yellow-coloured pups?)
   —hunting techniques: how? where? clues to locate?
   —relationship between female and male seal (behavioural and with respect to distance to male used breathing holes and lairs)?
5. Techniques used to hunt basking seals?
6. Male ringed seals (*tiggak*)
   —when do they start “smelling”?
   —how big are they when they do?
   —when is the odour associated with male seals (from when until when)?
7. Uses and importance of seals in Arctic Bay?

Results and discussion

Approximately 80 hours of searching and hunting were observed during 31 hunting days in the spring of 1993. Two hundred and forty-six ringed seal breathing holes or lairs were found and 34 kills were made during the study. A total of 1150 km was travelled in an area of 4115 km^2. An average of 38.1 ± 23.5 km was travelled searching for ringed seals and structures per day. A total of 168 lairs and breathing holes were found and 78 basking seals were sighted at holes (Table 2).

Between 31 January and 10 February 1994, 17 individuals were interviewed to document their knowledge of ringed seal biology and hunting. The duration of the interviews ranged from 40 to 120 min and averaged 1 h. The mean age of respondents was 52 ± 8 years and they had an average of 39 ± 14 years of hunting experience in the Arctic Bay area. Approximately half (8/17) of the respondents had dog teams which they used on an occasional basis but none relied exclusively on them for hunting. Most hunting was performed using snowmobiles.

Ringed seal ecology in Admiralty Inlet

The ringed seal is the smallest and most abundant of the northern phocids (Smith et al. 1991). It is circumpolar in its distribution, occupying areas of stable land-fast and pack ice from 50° N to the

North Pole (Smith & Stirling 1975; Frost & Lowry 1981; King 1983; Heide-Jørgensen & Lydersen 1998). Rough population estimates suggest the North Atlantic and eastern Canadian Arctic population to be 1300 000 animals (NAMMCO 1997). When discussing temporal trends in the ringed seal population in the Arctic Bay area, hunters indicated time periods when ringed seals had been scarce and they suggested various habitat-related, climatic and human-related factors that may have been the cause of these shortages. Several hunters indicated that they had experienced times when ringed seals were so scarce that they went for a period with little or no successful hunting. Hunters reported that these incidences occurred in 1947 in the Cape Strathcona area, in the mid-1950s in the area of Cape Crauford at the north end of Admiralty Inlet, or at times between the early 1950s and early 1960s in various locations within Admiralty Inlet. Some respondents explained these times of short supply as being due to a period of illness among experienced hunters or dogs that hindered seal hunting.

Persistent ridges and cracks in the pack ice are, at least in part, a function of coastal topography (Kingsley et al. 1985). Weather accounts for interannual differences in snow deposition as coastal configuration in an area remains relatively constant (Kelly 1988). The periods of low seal abundance reported might have been due to abnormal weather conditions or other factors that specifically influence local ringed seal population density (e.g. Smith et al. 1978; Lydersen & Ryg 1991; Smith & Lydersen 1991). For example, a February rain that melted much of the snow and created a thick cover of ice over breathing holes was given as an explanation for low availability and catches of ringed seals by one individual interviewed. Documented decreases in local ringed seal densities in the south-eastern Beaufort Sea from 1974–77 have been attributed to very heavy ice conditions in 1974 (Stirling et al. 1982). Fluctuations in seal densities, reproductive rates and body conditions in Amundsen Gulf are reported by Smith (1987). He suggests that differences in ringed seal abundance within this region may be related to annual variations in ice or snow conditions, or to oceanographic features that influence the distribution of seals. The demonstrated potential for ringed seals to migrate long distances and perhaps shift to more favourable wintering and feeding areas in response to unfavourable conditions makes it difficult to document and understand the specific causes of changes in local stocks (Smith 1987).

Ringed seals have evolved in an environment with polar temperatures and, more recently, surface predation (Smith & Stirling 1975; Smith 1976; Lydersen & Smith 1989). Their survival in the high North has been attributed to their ability to construct and maintain breathing holes through

Table 2. Summary of mean time (min) spent, % success, and habitat and structural measurements (m) associated with structures located by one of three location techniques in the 1993 spring fast-ice of Admiralty Inlet and adjoining bays and fjords.

	Location by sight	Walking drift	Probing drift
Investigations	309	29	6
Structures located	163	1	4
Success (%)	52.8	3.4	66.7
Search time (min)	6.5 ± 8.6	3.3 ± 2.5	8.0 ± 3.1
Structural variable measurements (m)			
roof thickness	0.26 ± 1.15	0.37	0.38 ± 0.21
internal height	0.33 ± 0.12	0.58	0.32 ± 0.13
length	2.67 ± 1.15	3.10	2.90 ± 1.56
width	1.54 ± 0.51	1.40	2.15 ± 1.20
breathing hole diameter	0.78 ± 0.30	–	0.64 ± 0.18
Habitat variable measurements (m)			
maximum snow depth	0.58 ± 0.21	0.95	0.70 ± 0.17
distance to nearest ice ridge within 30 m	7.82 ± 6.01	14.00	3.00 ± 2.65
height of nearest ice ridge	0.76 ± 0.36	0.45	0.93 ± 0.12
thickness of largest ice piece in nearest ice ridge	0.30 ± 0.30	0.10	0.62 ± 0.49
distance to nearest seal structure	90.58 ± 196.20	156.09	249.15 ± 323.23

the sea ice throughout the winter. These breathing holes provide access to snow drifts for the construction of subnivean lairs that provide thermal protection and some protection against predation (Smith & Stirling 1975, 1978; Smith & Hammill 1981; Finley et al. 1983; Hammill & Smith 1990). During the winter, seals are distributed in the land-fast and pack ice. Arctic Bay hunters interviewed indicated that persistent cracks appear along the coast of Admiralty Inlet and across the entrances to all adjoining bays and fjords. They also described three areas of late consolidating ice within Admiralty Inlet and one local area that remained ice-free throughout much of the winter. These persistent cracks or ridges, areas of late freezing ice and Easter Sound, which remains more or less ice-free throughout the year, influence the distribution of seals within the land-fast ice of Admiralty Inlet. Penetrated by much more light than ice-covered water, these areas of open water are potentially nutrient-rich pockets in a relatively large land-fast ice habitat and hence tend to be areas where seals aggregate.

Hunters reported distinct differences between seals from various locations in the land-fast ice of Admiralty Inlet and the nearby fjords and bays. They said that seals differed in size between areas and also differed with respect to several conditions or anatomical features. The seals found in the land-fast ice of the inlets and bays were described as the largest ringed seals in the area. The seals in the land-fast ice of Admiralty Inlet were thought to be slightly smaller than those in the adjoining inlets and bays and approximately the same size as those found in Berlinguet Inlet. Seals found at the floe-edge in Lancaster Sound were described as the smallest seals in the area with the exception of those found in the ice-free zone of Easter Sound. Additionally, several morphological or anatomical differences between ringed seals from different localities were suggested. Hunters interviewed indicated that seals found in Berlinguet Inlet had large intestines of distinctly larger diameter and thicker walls than seals from either Admiralty Inlet or Easter Sound. It was also suggested that seals from the different areas within the land-fast ice differed with respect to age and blubber thickness as well as in the taste and texture of their meat. Seals caught in Easter Sound were reported to have an odour and taste similar to Arctic cod (*Boreogadus saida*).

The pattern in ringed seal size differences within areas of the land-fast ice reported here is consistent with a hierarchical age segregation that has been documented by scientists (McLaren 1958; Smith 1973, 1987; Smith & Hammill 1981; Lydersen & Gjertz 1986). Differences in blubber thickness, taste and texture of meat and characteristics of lower intestines may reflect differences in the local diet of seals. It is also possible that this information may be indicative of stock differences in this area at a finer scale than has been reported previously (Kingsley 1990).

From late March until early April females occupy previously constructed haul-out lairs or excavate new lairs in areas of deep snow cover (McLaren 1958; Smith & Stirling 1975; Kingsley 1990) and give birth to a single white-coated pup (McLaren 1958; Smith & Stirling 1975; Smith & Hammill 1981). A number of lairs and breathing holes are often present in the immediate area of the birth lair to provide alternative escape sites in case of attack by a surface predator (Smith & Stirling 1975; Smith & Hammill 1981; Hammill & Smith 1989; Kelly & Quakenbush 1990). During the spring, adult males secrete a strong scented substance from their facial glands which is thought to be used as a territorial marker or an attractant that induces oestrus in females within the territory (Hardy et al. 1991; Ryg et al. 1992). Respondents in this study indicated that adult male seals begin to secrete the characteristic *tiggak* odour shortly after ice consolidation and have it until the seals are seen basking on top of the ice prior to and during the moult in June. This suggests that male seals emit the *tiggak* odour for a longer period than has been reported in the scientific literature in the past (Hardy et al. 1991; Ryg et al. 1992). Late in the spring, as the ice breaks up, younger seals migrate into the inlets and fjords previously covered by land-fast ice. Arctic Bay hunters indicated that seals migrate into Admiralty Inlet in February ($N=3$), March ($N=9$), or April ($N=3$); one individual interviewed believed that the seals did not come into Admiralty Inlet until May.

Temporal changes

All hunters interviewed ($N=17$) believed that ringed seals in the surrounding area had changed since they began to hunt them. Specifically, they reported having seen an increase in the number of ringed seals with abnormal livers. Hunters indicated that in recent years seal livers contained

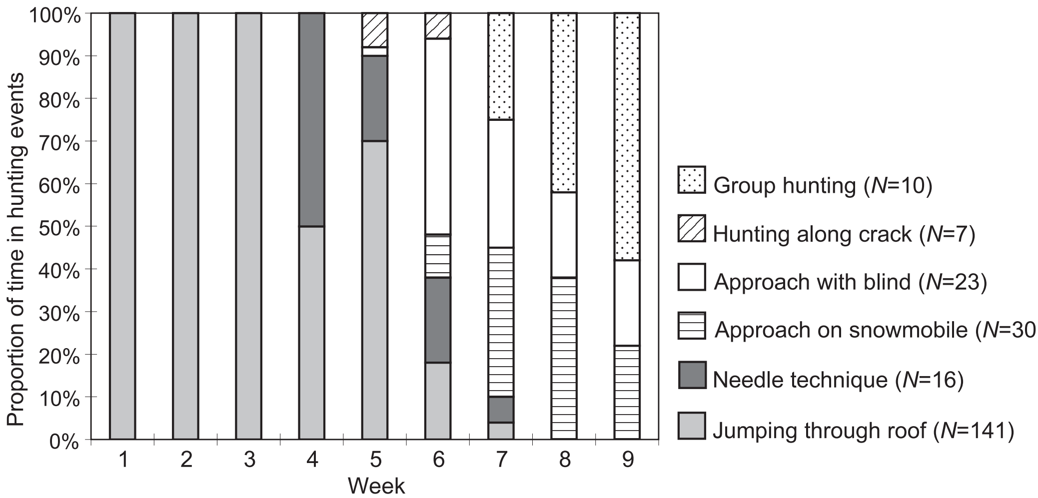

Fig. 2. Plot of proportion of total time spent by an Inuk hunter from Arctic Bay, using each hunting technique, each week, throughout the spring season, 1993.

white spots or nodules or areas of hard and discoloured tissue. Some hunters indicated that these abnormal livers were found more frequently in seals in the land-fast ice of Adams Sound, Strathcona Sound and Arctic Bay, while one hunter indicated this condition was only prevalent in seals found in the area surrounding the Nanisivik mine on Strathcona Sound. Many thought these abnormalities were associated with older seals, and most did not believe there was a correlation between the sex of the seal and the existence of this condition. These results concur with a report on wildlife health in the North Baffin region which documents similar abnormalities in ringed seal livers in this area (QWB & WWF 2000). These small white nodules and lesions may be due to trematode infections (perhaps *Orthosplanchnus arcticus*, L. Measures, pers. comm. 1995). *O. arcticus* is an elongate, slightly flattened trematode found in the liver and gall bladders of bearded seals (*Erignathus barbatus*) and ringed seals of the Canadian and European Arctic (Dawes 1956). Migration of this trematode through liver tissue causes the formation of white nodules and hardened tissue areas; this parasite has been observed previously in ringed seal liver tissue from Arctic Bay (L. Measures, pers. comm. 1995). However, sarcocysts have also been seen in ringed seal livers, and livers with white edges have been seen with no histological pathologies present (T. Smith, pers. comm. 1996).

Inuit seal locating and hunting techniques

During the late winter and spring ringed seals are distributed throughout the land-fast ice and each seal uses a number of breathing holes and lairs. A variety of techniques are employed by Inuit hunters in different habitat types and at different types of seal structures to find and hunt these seals (see also Hall 1864; Kumlein 1879; Boas 1888, 1907; Murdoch 1893; Degerbøl 1935; Nelson 1969; Riewe & Amsden 1979; Wenzel 1991). Inuit hunters use these location and hunting techniques, adjusting them to suit habitat characteristics and seasonal differences in conditions. Observations of hunting methods in this study were divided into techniques used to locate ringed seal breathing holes or lairs and techniques used to catch seals. Three locating techniques and seven hunting techniques were observed (Tables 2, 3).

Locating techniques.—The Inuk hunter travelled along pressure ridges near rafted ice or large multiyear pieces on a snow machine searching drifts that could contain ringed seal lairs. Structures were located when: 1) there was a sag or depression in a snow drift; 2) sunlight reflection off a drift was greater than elsewhere; 3) Arctic fox urine or faeces marked a drift; 4) they had been previously entered by a bear or fox; or 5) the roof had melted through. In interviews on this subject hunters ($N = 15$) indicated that ringed structures were located adjacent to rough or multiyear ice pieces and therefore they searched in these areas. Most individuals reported using the presence of a depression in the surface of the snow to identify the location of ringed seal lairs in drifts (Table 3).

Once a drift thought to contain a ringed seal lair was located, the hunter quickly jumped off the snowmobile and ran to the possible location. If a structure was found a hunting technique was then used. If not, the search of the area continued. Structures were located by these methods throughout the study (7 April to 3 June 1993) (Fig. 2).

The increased temperature in a subnivean lair, due to the body heat of the seal(s) within (Kelly 1988), may begin to melt snow covering the structure and thus cause a depression in the drift over it. This depression in the surface of the snow is more pronounced in areas of less total snow depth andhence it is more easily detected by hunters when these conditions prevail. The roof thickness (Tukey's $P < 0.001$) and total snow depth (Tukey's $P < 0.01$; Table 2) surrounding structures located by sight in this study was significantly less than at structures located using other methods. As the spring season progresses the roofs of all seal structures melt and sag. This depression becomes more prominent late in the season, as the ambient temperature increases. Additionally, partially melting snow may increase the reflectivity of the drift surface above a lair and thus the sun's reflection off a drift, which is seen as a change in the colour of the snow covering a lair.

Arctic foxes may sense that a seal structure is empty and mark it to keep other foxes away or to find it again more easily in the future (Smith 1976; Lydersen & Gjertz 1986). Hunters use visual cues left by foxes to locate ringed seal structures.

Structures were also found when the hunter sighted a drift potentially covering a lair, and jumped off the snowmobile and walked the length of the drift while rotating his heels into the snow. The location of a lair was detected by a low, hollow-toned sound made while walking over the structure in the drift. If a lair was detected an attempt was then made to hunt the seal. This search technique was also used to locate structures throughout the study (Fig. 2).

Breathing holes and lairs were also located by probing drifts with a harpoon. Drifts suspected to contain a lair that was not found by walking the length of the drift were often probed with a harpoon. The location of a structure was indicated by a significant increase in the ease with which the harpoon was pushed through the snow in the drift as the harpoon broke through the ice crust on the roof of the lair into the subnivean chamber. Lairs and breathing holes were found in this study using this technique between 13 April and 8 May (Fig. 2). Most (97%) of the structures found in this study were located by sight (Table 2). Probing drifts with a harpoon served to locate a few

Table 3. Summary of Arctic Bay hunter knowledge survey responses to questions regarding cues used to locate ringed seal structures in the fast-ice and methods used to hunt basking seals ($N_{total} = 17$).

Locating method	Snow drifts suspected of containing seal lairs	Lairs within drifts	Breathing holes	Basking seals
Rough or multiyear ice piece	12	0	11	
Fox markings (scat and paw prints)	0	3	0	
Dip in drift	0	14	0	
Sound of heels on drift	0	12	0	
Differential reflection off drift	0	6	0	
Colour of snow	0	3	0	
Probe with harpoon	0	3	0	
Search along persistent crack	0	0	1	
Don't know	0	2	0	
No response	5	1	5	
Hunting methods for basking seals				
approach on snow machine				10
approach on foot with a blind				5
approach using imitation method				5
no response				5

additional lairs not found by sight or by walking the length of a drift.

In addition to the visual and auditory cues related to lair detection in snow drifts, respondents indicated that structures were found by concentrating searches near rough or multiyear ice pieces (Table 3), and that details of the shape of seal structures often indicated the location of another nearby structure. Individuals ($N=7$) suggested that the side of the breathing hole entering the water on a more vertical slope, often possessing claw marks in its surface, pointed toward another breathing hole. Additionally, they suggested that the opening at the apex of the small ice domes over breathing holes (smaller, simpler structures than lairs) was situated in the direction of a nearby structure. Hunters ($N=7$) also reported that a breathing hole positioned toward one end of a lair indicated another lair was located in the direction of the opposite end of the lair. This relationship between lair shape and the location of another structure in a group of structures randomly selected from all structures found in 1993 did exist statistically (Furgal et al. 1996). The same relationship existed between a structure and the second and third nearest structures in 47% (7/15) and 40% (6/15) of the cases, respectively. However, it is generally believed that lair construction is primarily influenced by snow depth (Lydersen & Gjertz 1986; Hammill & Smith 1989) and perhaps overall drift size (depth × length × width).

Hunting techniques.—Spring hunting in Admiralty Inlet is concentrated in two main areas —along persistent cracks in the land-fast ice and in the open water at the ice edge. Most lairs located in the land-fast ice were found while hunting seals at persistent cracks or while travelling to hunt at the ice edge. Five non-lair hunting methods were observed during this study (Table 4). Descriptions of additional hunting techniques exist in the literature (see Hall 1864; Kumlien 1879; Boas 1888, 1907; Murdoch 1893; Degerbøl 1935; Nelson 1969). The methods observed here that are either self-explanatory by title or have been previously described in the literature are not described in detail but are simply listed in Table 4.

Lair breaking (nunajuk): The hunter entered lairs by jumping on drifts and breaking through the snow covering the structure. Once the roof was broken, the hunter jumped out of the structure and lay on the remaining roof, with his upper torso hanging down into the lair, to look inside (Fig. 3). If a pup was found it was removed from the lair. If the pup was situated in a tunnel off the main chamber the hunter's feet were positioned over the tunnel on the outer surface of the drift. The hunter lifted his upper torso out of the structure and kicked the surface of the drift above the tunnel. When the pup exited the tunnel and moved into the main chamber in an attempt to get into the water the hunter intercepted it. This technique of catching pups is similar to that observed by Riewe & Amsden (1979) in Grise Fiord and by Wenzel (1991) in Clyde River.

Polar bears pounce on structure roofs to gain

Table 4. Summary of (non-lair) ringed seal hunting techniques observed in Admiralty Inlet, 1993.

Hunting technique	Hunting implement	No. of hunters involved	No. of observations	Previous descriptions
Hunting at breathing holes along a persistent crack (*nagutii*)	gun, harpoon, *niksik*	1-2	7	Nelson 1969; Riewe & Amsden 1979; Wenzel 1991
Approaching basking seals with a blind (*taluaqtuut*)	gun	1	23	Hall 1865; Kumlien 1879; Boas 1888, 1907; Murdoch 1893; Degerbøl 1935; Nelson 1969; Riewe & Amsden 1979; Wenzel 1991
Approaching basking seals on a snowmobile	gun	1	30	Kumlien, 1879*; Murdoch, 1893*; Degerbøl 1935*; Wenzel 1991
Group hunting at breathing holes (*aglu*)	gun, harpoon	1+	10	Boas 1888, 1907; Kumlien 1879; Murdoch 1893; Degerbøl 1935; Nelson 1969; Riewe & Amsden 1979; Wenzel 1991
Open water hunting	gun and retrieval hook or grapple	1+	4	Hall 1865; Kumlien 1879; Boas 1888, 1907; Murdoch 1893; Degerbøl & 1935; Nelson 1969; Riewe & Amsden 1979; Wenzel 1991

* These authors do not mention approach on a snowmobile but describe the approach by crawling on the ice or by imitating a seal on the ice to get close enough to harpoon or shoot seals.

Fig. 3. The lair breaking method. Once the a hole has been broken through the roof the hunter quickly searches the lair for the ringed seal pup before it escapes into the water through the breathing hole. Photo: C. Furgal.

access to lairs; snow depth and the size of the bear influence their success (Stirling & Latour 1977). Inuit hunters use similar methods to gain access to pup structures and a similar relationship would therefore be expected. Although hunters took more jumps to enter structures with thicker roofs, there was no evidence to suggest that snow depth alone influenced success. However, greater snow depth and density would be expected to slow the speed of entry by the hunter into the lair, providing the pup more time to escape down the breathing hole and thereby influencing success associated with this method (Riewe & Amsden 1979).

Most lair entries occurred close to the breathing hole. An increase in predation success at subnivean structures was seen when this was the case. The most effective way of trapping a pup was by entering the structure close to the breathing hole and blocking its escape route (Lydersen & Gjertz 1986). Many breathing holes are found near the middle of the lair, where the dip in the surface of the snow roof above is greatest.

When a pup was caught a thin rope was tied to its hind flipper and it was tethered to an object on the snow surface while the breathing hole was prepared to hunt for the pup's mother. A hole was sawed in the lair roof above the breathing hole. The blocks of snow cut from the lair roof were positioned on the surface of the drift outside the lair so as to cast a shadow over the breathing hole. The hunter then prepared the harpoon and tied the end of the rope attached to the harpoon head around his foot, or another hunter held the rope if a second hunter was present. The harpoon was positioned on the drift surface. The pup was then lowered into the water and allowed to swim under the ice approximately 1 m away from the breathing hole. The hunter's feet remained still. When the pup was heard barking in the water the hunter readied the harpoon over the breathing hole. When the hunter felt a strong pull on the rope the pup was slowly pulled toward the surface.

Female ringed seals grasp their pups in their mouths or fore flippers to move them from one place to another. By pulling on the rope attached to a pup the hunter decreased the depth at which the mother–pup pair was swimming. If the pair passed below the breathing hole the female was harpooned. If the strike was successful the pup was quickly removed from the water and put on top of the drift away from the lair. The harpoon shaft (*unaaq*) was removed from the female and the rope attached to the toggle harpoon head (*sakku*) was slowly pulled in with the female attached. When the female surfaced at the breathing hole she was speared through an eye with the harpoon. The female was then removed from the breathing hole with the aid of a hook (*niksik*) attached to a 2 m long wooden shaft. This technique was observed from the start of the study through until 25 May (Fig. 2).

Hunters ($N = 14$) indicated that the colour of a pup influenced the frequency with which the mother came to retrieve it (Table 5). Yellow pups were attended much more closely than white pups. One participant indicated that the female returned more frequently for a pup if its stomach contained large amounts of milk, indicating recent nursing. Additionally, some ($N = 12$) hunters reported personal experience or knowledge of other hunters catching adult male ringed seals when a pup was used as a lure. The lanugo of pups fades from yellow to white during the early

Table 5. Summary of Arctic Bay hunter knowledge survey responses to questions regarding knowledge of ringed seal behaviour.

Sources of knowledge	Mother returns more frequently and quickly for yellow pup	*Tiggak** comes to pup structure and retrieves pup	*Tiggak** structure always near pup structure
Heard from others	7	6	0
Personal experience	7	6	16
None	2	1	1
No response	1	4	0

* Adult male, giving off a characteristic odour.

stages of growth and yellow-coloured pups are therefore very young. It is most likely that adult females remain closer to the pups in the early stages of their development (Hammill et al. 1991) and are therefore more frequently caught returning to a breathing hole to retrieve a young pup. The fact that hunters report catching males using this technique may be the result of male seals investigating a disturbance within the area and consequently being caught by hunters as opposed to some form of paternal response.

When they are young, pups have limited mobility skills and are slow to escape down the breathing hole when the lair roof is entered. This is in contrast to the mothers, who quickly exit the lair into the water when sensing a surface predator. Breaking through the roofs of structures to catch neonate ringed seals was the most frequently used hunting technique in the early to mid-spring once a lair was detected (Fig. 2). While pups are still in the lair, this technique is the only method to hunt them; pups are preferred for human consumption. Although a low success rate was associated with this technique (Table 6), the hunter was able to locate a large number of structures, and potentially have a greater number of hunting attempts in a shorter period of time than when hunting at other types of structures (Table 6). Pup lairs are found closer together than other structure types (Smith et al. 1991; Furgal et al. 1996) as they are concentrated in a small proportion of the land-fast ice with specific and predictable environmental requirements (Smith & Stirling 1975; Smith & Hammill 1981; Furgal et al. 1996). However, the time during which this technique is productive is relatively short, and the area in which these structures exist is a small portion of the total land-fast ice. In previous descriptions of hunting techniques from Clyde River and Grise Fjord, Riewe & Amsden (1979) and Wenzel (1991) have reported that this method accounts for less than 1 % of the annual seal harvests in those communities and because of its highly specialized nature, it is rarely used anymore. Wenzel (1991) reported that the efficiency of this method was approximately 5 h per capture, with a success rate of 20 % of attempts. This study documented that breaking into lairs is labour intensive and less successful than many other techniques observed (Table 6), and it requires skill and experience. Arctic Bay hunters do not commonly use it today.

Needle technique (qivvutaq): When a breathing hole or lair was located and entered and a pup was not caught or when no attempt was made to enter the structure, the *qivvutaq* method was used on some occasions ($N = 16$) (Fig. 4). The breathing hole was located by probing the drift with a harpoon or a long (90 cm) curved metal probe. The centre of the breathing hole was located by inserting and rotating the probe. A fine, long (30 cm) needle was then suspended into the water of the breathing hole through a hole made in the snow roof using the metal probe. The needle was suspended on a piece of thread attached to a small pole inserted into the surface of the snow. The harpoon was prepared and the hunter then positioned himself above the breathing hole. The hunter's feet did not move from this point in time until the end of the hunt. If the seal returned to the breathing hole it pushed the fine needle

Table 6. Summary of mean time (min) (± s.d.) spent searching for ringed seals or structures, mean and total time spent in hunting techniques and their success (%) in Admiralty Inlet, 1993.

	Lair hunting		Approach to basking seals			
	Jump on roof	Needle	Blind	Snow-mobile	Hunting at a crack	Group hunting
Number of observations	141	16	23	30	7	10
Search time (min)	5.9 ± 7.9	4.2 ± 5.3	26.0 ± 22.6	16.2 ± 13.2	28.7 ± 23.8	19.2 ± 20.1
Hunt time (min)	9.4 ± 13.2	15.4 ± 12.1	13.7 ± 4.9	9.4 ± 6.8	12.4 ± 10.9	32.2 ± 14.7
Total time (h)	22.2	4.1	5.3	4.7	1.4	5.4
Pups caught (N)	10	1	1	1	0	1
Adult and subadult females caught (N)	4	0	2	2	3	0
Adult and subadult males caught (N)	0	0	2	4	3	0
Shot but lost	0	0	0	3	0	0
Success (%)	9.9	6.2	21.7	23.3	85.7	10.0
Efficiency (h/seal)	1.6	4.1		0.7	0.2	5.4

Fig. 4. An Inuk hunter inserting the needle suspended on the thread, as described for the needle technique. Inset: Close-up view of pole and thread suspending the needle (*qivvutaq*) into the opening of the breathing hole below the surface of the snow. Photo: C. Furgal.

Fig. 5. Inuk hunter using a blind (*taluaqtuut*) to approach a basking ringed seal, just visible on the ice, to the far right. Photo: C. Furgal.

upward, loosening the tension on the thread. When the thread suspending the needle went slack the hunter harpooned through the snow into the breathing hole. This technique was observed from 27 April until 18 May (Fig. 2).

The needle technique (*qivvutaq*) was employed at lairs late in the spring to catch pups that were swimming independent of their mothers. This technique required a greater amount of time than breaking through the roof of a structure and had a relatively low success rate when compared with other methods observed (Table 6). As the season progresses, ringed seal pups become more mobile (Lydersen & Hammill 1993a, b; Lydersen et al. 1993) and escape through the breathing holes more frequently when structures are attacked (O. Naqitaqvik, pers. comm. 1993). So, although this technique is time consuming, its use results in young-of-the-year seals being caught in mid-spring when they are very difficult to catch by jumping through a lair roof and before they are hauling out on the ice to bask. Catching seals in lairs by this technique is more labour intensive than other methods and hunters must be skilled and experienced to succeed, as is reflected in the relative efficiency and success rates observed in this study (Table 6). Additionally, at this late stage of the season, some pups are already basking on the ice surface and can therefore be hunted by other techniques (see below) that tend to be more efficient and successful (Table 6). Hence, this technique is rarely practiced today (O. Naqitaqvik, pers. comm. 1993).

Approaching (stalking) basking seals: Ringed seals haul-out at breathing holes, leads and ice edges in the late spring to bask and moult (e.g. McLaren 1958; Smith 1973; Finley 1979). When basking seals were sighted on the ice, they were approached on foot behind a blind (*taluaqtuut*) (Fig. 5), or by crawling on the surface of the ice, or by approaching on a snowmobile. These techniques have been previously described in the literature (see Table 4). In the survey, hunters reported that approaching basking seals on a snowmobile was the most common method used to hunt seals, though some reported still using a white blind. Hunters also reported that cautious approaches were used only when the capture of a seal was of great importance. Slow approaches bring the hunter closer to the seal before detection, and therefore increase the chance of success; however, they require more time.

As one would expect, an increase in the proportion of time spent hunting basking seals in this study occurred as the season progressed (Fig. 2). The abundance of seals hauled-out in an area at a specific time is influenced by wind speed and time of day (Finley 1979; Smith & Hammill 1981) as well as by overall seasonal influences (Gjertz et al. 2000). Approaching basking seals on a snowmobile was the most frequently used hunting method in the late spring (Fig. 2). Many hunting attempts were made in a short period of time; however, the risk of losing shot seals into the water was higher than with other methods (pers. observ. CF 1993). The only losses due to sinking that were observed in this study occurred when this method was used (Table 6). Wenzel (1991) observed greater success when hunters approached basking seals on foot as compared to by snowmobile. Although one might expect the use of a blind to increase hunting success, this was not observed to be the case in this study. Hunters had greater success only when a greater period of time was taken to approach basking seals. Greater time spent in approach often resulted in a shorter shooting distance required and therefore greater chance of making a kill.

Hunting at breathing holes along persistent cracks (nagutii): As the season progresses and the snow melts, seals spend less time in lairs; more time is spent by the hunters at breathing structures (*nagutii*) along persistent cracks and at the ice edge hunting seals in the open water. (For descriptions of hunting at breathing holes throughout the fast-ice during the winter see the literature; Table 4.) When sighting basking seals on the ice or surfacing in the open water, the opportunity is taken to rifle hunt. Hunting at breathing holes along cracks takes place for a short period of time, after cracks form in the spring and while seals use breathing holes along them (Kingsley et al. 1985). The hunting methods observed in Arctic Bay at these structures were similar to those described by Wenzel (1991) and others (Table 2). Wenzel (1991) found this to be the most successful hunting method, along with hunting at open breathing holes late in the spring, among Clyde River Inuit. Similarly, this form of hunting appears to be the most successful and efficient method to hunt ringed seals in Admiralty Inlet (Table 6). However, the abundance of such structures in an area and the timing of hunting at these structures influences its efficiency and only a small number of hunts of this type ($N = 7$) were observed during this study.

Fig. 6. Inuk hunter at breathing hole (*aglu*) of ringed seal subnivean lair. Photo: S. Innes.

Other techniques: Cooperative hunting at open breathing holes by several individuals using guns, harpoons or a gaff was also observed (see descriptions in the literature; Table 4). This method was observed on only 10 occasions and was the least successful and least efficient technique used (Table 6). Hunting at the ice edge or along open leads was also observed and was similar to descriptions existing in the literature (Table 4). This technique was observed on very few occasions in this study.

Importance of the ringed seal

Reported uses of ringed seal by Inuit include food for humans and dogs, ropes, clothing (mitts and boots), and innumerable handicraft items, such as rugs, gun cases and toys (e.g. Riewe & Amsden 1979). Uses reported by respondents in this study focussed on items relied upon by the hunters, as well as some popular traditional uses. These included clothing, food (dog and human), fuel, ropes, floats, tarp, kayak skins, tents and dog packs. Additionally, one individual reported that the bones of the fore flippers of ringed seals were still used in a children's game. Items such as two-walled seal skin tents, dog packs, floats for hunting narwhal and beluga, kayak skins and tarps are seldom produced from ringed seal pelts today due to modern replacements and the time and skill required to produce these products. Despite the availability of these alternatives, the ringed seal is still used extensively by the Inuit of the North today (e.g. Riewe & Amsden 1979; Wenzel 1991; AMAP 1998; Kuhnlein et al. 2000). Oakes (1987) reports that ringed seal pelts are still commonly used in the production of kamiks in Arctic Bay. Most hunters interviewed ($N=15/17$) indicated that ringed seals were the most important animal they hunted based on both availability and use. Young ringed seals are preferred for human consumption. The meat of *tiggak* seals is not usually eaten by humans because of its strong taste and odour (Smith 1973; Riewe & Amsden 1979). However, this appears to be a matter of personal taste as some respondents in this study indicated a preference for *tiggak* meat. Kuhnlein et al. (2000) also observed that ringed seals comprise a significant portion of the Inuit diet among three North Baffin communities in terms of its frequency of consumption, wet weight and contribution to total nutrient intake. Dogs are fed almost exclusively on ringed seal, particularly older seals, when seals are plentiful and accessible. Approximately half of the hunters interviewed in this study reported having dog teams, although none of them exclusively used their teams for hunting. The ringed seal still holds a very important place in many aspects of the lives of Arctic Bay Inuit.

Conclusions

In this study we observed an experienced ringed seal hunter from the community of Arctic Bay, Nunavut, during spring hunting trips on the fast-ice of Admiralty Inlet. Additionally, we interviewed experienced hunters and elders from the community regarding their knowledge of ringed seal biology and techniques used by Inuit to hunt them during the spring. Hunters described several aspects of ringed seal ecology also reported in the scientific literature. They indicated that male seals emit the distinctive *tiggak* odour for longer (from the time of ice consolidation until spring break up) than previously reported. All hunters interviewed reported noticing an increasing number of seals with liver abnormalities in the region.

When hunting ringed seals in the spring, Inuit use a number of visual (e.g. depression in drift, fox scat and urine, differential reflection off snow, difference in snow colour) and auditory cues and search for known seal habitat characteristics to locate structures. Hunters catch seals in lairs by breaking through structure roofs or by using the needle (*qivvutaq*) technique. Later in the spring, seals are hunted at breathing holes along persistent cracks, or approached on foot or snowmobile while basking. Seals are also shot at open leads and the ice edge late in the spring. Hunting seals at breathing structures and while basking were the most efficient and successful techniques observed in this study, while breaking through the roofs of lairs was the only method used to catch pups early in the spring. Many of the more traditional techniques (lair breaking and *qivvutaq*) are less commonly used today as they require considerable skill and time, and more modern hunting implements and techniques are becoming more prevalent. The ringed seal is still one of the most important animals used by Arctic Bay Inuit.

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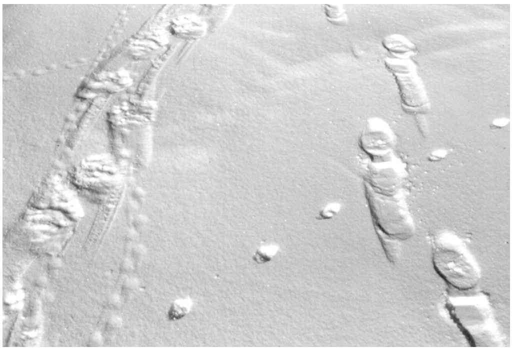

Tracks of the three ringed seal predators discussed in this paper: polar bear (left), Arctic fox (crossing centre), Inuit hunters (right). Photo: C. Furgal.