RINGED SEAL MORTALITY PATTERNS AS AN AID IN THE DETERMINATION OF THULE ESKIMO SUBSISTENCE STRATEGIES

by

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ABSTRACT

Dental annuli analyses were performed on 170 ringed seal (*Phoca hispida*) canines recovered from five Thule semisubterranean houses located at site PaJs-13 at Hazard Inlet, Somerset Island in the central Canadian Arctic. Season of death results indicate greater seal hunting during the spring. Age at death results were used to produce mortality profiles which, when compared with idealized patterns, revealed a prime-dominated pattern indicating the presence of some selective factor in the subsistence strategy. Based on ethnographical studies of traditional seal hunting techniques, conscious selection was eliminated as a factor. Biological studies of ringed seal demonstrate that during the spring, older, sexually mature seals, occupy breeding areas in stable fast ice formations located close to the coast in complex coastal areas. Younger immature seals, on the other hand, occupy areas of unstable pack ice formations either further from the shore in complex coastal areas, or along simple coastlines. The archaeological mortality patterns do not clearly resemble either complex or simple coast modern populations, although a trend toward simple coasts was observed. This observation is consistent with the site location, which allows greater access to pack ice formations. The appearance of selective biological factors affecting random human subsistence strategies indicates that caution must be utilized when interpreting mortality patterns.

RESUME

L'auteur de cette thèse a effectué une série d'analyses sur les anneaux dentaires de cent soixante-dix canines de phoques annelés (*Phoca hispida*). Ces canines ont été découvertes dans cinq maisons semi-souterraines des Thulés au site PaJs-13 à l'anse du Hasard de l'Île de Somerset dans l'océan arctique Canadien central. Les résultats de l'étude de la mortalité saisonnière indiquent une plus grande activité de chasse au phoque au printemps. Les résultats de l'étude de l'âge des phoques au moment de la mort ont servi à établir des profils de mortalité qui, lorsque comparés aux normes idéales, révèlent un pourcentage plus élevé d'animaux sains que la normale, indiquant ainsi la présence d'un facteur de sélection dans la stratégie de subsistance. En nous basant sur les études ethnographiques des techniques de chasse traditionnelles des Inuit, nous avons éliminé la sélection consciente comme facteur. Les études biologiques du phoque annelé démontrent qu'au printemps les phoques, arrivés à la maturité sexuelle, occupent les terrains de reproduction dans les formations de banquise compacte situées près du rivage dans les régions côtières complexes. Par contre, les jeunes phoques, n'ayant pas atteint la maturité sexuelle, occupent les régions de banquise dérivante, soit plus loin du rivage dans les régions côtières complexes, soit le long du littoral simple. Les modèles archéologiques de mortalité ne ressemblent en aucun cas ni aux populations des phoques des régions côtières simples ni à celles des phoques des régions côtières complexes, bien qu'une tendance vers les côtes simples ait été observée. Cette observation s'accorde avec le lieu du site, qui permet meilleur accès aux régions de banquise dérivante. L'apparence de facteurs de sélection biologique affectant les stratégies de subsistance humaine décidées au hasard indique qu'il faut être très prudent lorsqu'on interprète des modèles de mortalité.

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I approached this work on Arctic cultures with all the trepidation of a native Floridian, but came away with a great respect and admiration for the Inuit and their Ancestors. Any errors are mine alone, and should not reflect negatively on these resourceful people nor on anyone previously mentioned.

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CHAPTER 1

INTRODUCTION

In this thesis, Thule Eskimo ringed seal (*Phoca hispida*) hunting techniques will be examined, through the analysis of mortality patterns based on canines recovered from a series of five Thule semisubterranean winter houses. Comparisons of the age profiles of this archaeological seal population with that of modern ringed seal populations in various local habitats will be used to determine the nature of Thule ringed seal hunting practices. Ethnographic records indicate that historic seal hunting practices were "random" and not "selective". These terms will be defined and explained more fully in Chapter 2. "Random" hunting should reveal a close correlation between the archaeological and modern seal populations. Statistically significant deviations between these two populations will be analyzed in terms of seal behavior and ethnographically recorded hunting methods.

The five Thule semisubterranean houses are located at site PaJs-13 at Hazard Inlet, Somerset Island, in the central Canadian Arctic (Figure 1). They are all part of a single winter residential site occupied approximately 1000 - 800 B.P. The houses were excavated by Dr. James Savelle during the 1990 and 1991 field seasons. The canines examined in this thesis were excavated from within individual houses and associated

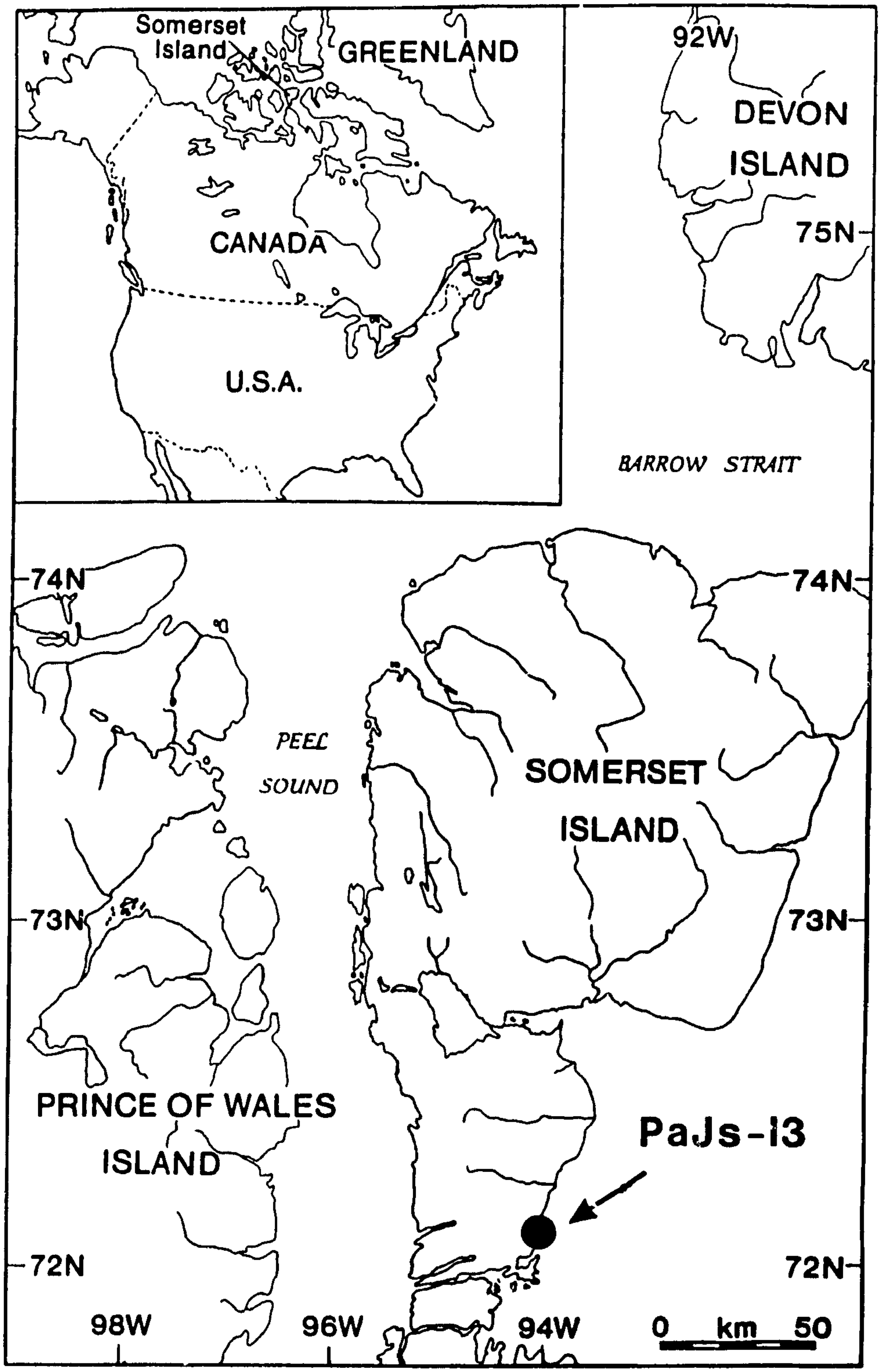


FIGURE 1 MAP OF SOMERSET ISLAND

(From Habu and Savelle n.d.)

middens. This allows an investigation of intrasite variability, in addition to hunting selectivity.

There are a number of reasons for such a study. Thule Eskimo seal hunting patterns are little known and little studied. Indeed, this will be one of the first in-depth studies of Thule Eskimo ringed seal hunting techniques and mortality patterns to integrate modern seal behavior and population compositions with zooarchaeological data. This alone indicates the importance of this investigation for the study of prehistoric diet in the Canadian Arctic.

This thesis comprises nine chapters. Chapter 2 develops the theoretical framework; an ecological approach with particular emphasis on mortality profiles. Chapter 3 outlines the major interpretive studies of ringed seal procurement from the archaeological record that have been completed to date. In addition, it summarizes relevant studies of mortality profiles in order to determine how pinniped behavior may affect mortality profiles. Chapter 4 outlines the primary ethnographical accounts of sealing in the Canadian Arctic by the historic Inuit. Chapter 5 presents the major studies of the biology of the ringed seal with a special emphasis on the behavior of this species, while chapter 6 presents relevant information in the determination of the age structure and seasonality of the archaeological sample. Chapter 7 presents the raw data that resulted from the age and seasonality study. Chapter 8 discusses the nature of the data obtained in relation to behavioral studies as presented in Chapter 4. The various populations discussed are also compared statistically to determine any correlations with observed modern populations. These results will be discussed in light of the ethnographic record as well as relevant previous archaeological studies. Chapter 9 discusses conclusions derived from the comparisons of modern and archaeological ringed seal populations, and discusses the relevance of these data and how they might be utilized to further our knowledge of Thule subsistence.

CHAPTER 2

THEORETICAL FRAMEWORK

This thesis follows an ecological-economic approach frequently utilized in hunter-gatherer studies. The basic premise of this approach is that hunting and butchering behavior is based on rational decisions related to the nature of the economic resources (c.f. Binford 1978).

The Ecological Framework

Within an ecological framework, it is important to determine the value of individual animal species and how this value is demonstrated by cultural behavior with regard to the procurement and processing of these species. In commenting on studies relating to the harvesting of individual species, Jochim (1979:84) states,

> "The value of such studies derives precisely from their narrow scope: by limiting the number of interrelated variables, it is easier to examine their interaction and reaction to change. Such studies can be viewed as building blocks in the construction of an understanding of a total subsistence economy."

Smith (1976) has encouraged the study of faunal remains to move into the realm of ecological studies and away from the use of overly simplistic species lists. According to Smith,

> "The primary research goal of the ecological approach in faunal analysis is to explain, in the form of predictive models, the interface that existed between prehistoric human populations and the faunal section of the biotic community. Such models then can be integrated into more general models concerned with the overall subsistence-settlement strategies of prehistoric human populations."(1976:284)

Smith (1976:284-285) lists five major questions an ecological approach to faunal remains can attempt to answer. These are: 1) the relative importance of various species to the diet, 2) the question of seasonal exploitation of individual species, 3) procurement strategies, 4) selectivity of human predation, and 5) the determination of an overall pattern and strategy of exploitation. Of these, three are important in the context of this thesis; seasonal exploitation, procurement strategies and selectivity of human predation. This thesis is not directly concerned with the relative importance of seal, nor overall patterns of exploitation.

Mortality Profiles

"Random" and "selective" hunting methods have been referred to earlier in this thesis. In this context, "random" hunting is a method in which the hunter selects an animal irregardless of age, sex, or size. A "selective" method is one in which, faced with an option, the hunter will select an animal based on specific age, sex, size, or some similar rationale. When examining mortality patterns, selectivity is fairly simple to observe. However "random" methods may not always be as simple as they might seem. Studies of mortality profiles have suggested ways of approaching this problem.

Stiner (1990) examines various mortality patterns that may be present in an archaeological context. Figure 2 illustrates idealized graphs of the three primary mortality patterns commonly recorded. Graph 1a is a typical mortality pattern referred to as a living-structure or "catastrophic" mortality pattern in which death of individuals is independent of age (c.f. Klein 1982, Klein and Cruz-Uribe 1984, Levine 1983, and Lyman 1987). Natural causes can prove responsible for the creation of a living structure mortality profile through events such as flash floods, volcanic eruptions, or epidemic diseases (Klein and Cruz-Uribe 1984:56). In addition, Stiner notes that, "the cumulative effects of predation may create this pattern, if the predator takes prey on the basis of chance encounter, and individuals are killed more or less in proportion to their natural abundance (1990:314)." Within an archaeological context, this mortality pattern should indicate a truly random hunting method, in which animal behavior, hunting technology, and hunting methods do not favor the selection of certain age categories.

Some studies have rejected the oversimplistic nature of this application of living structure profiles to nonselective hunting techniques. Wilkinson's (1976) study of "random"

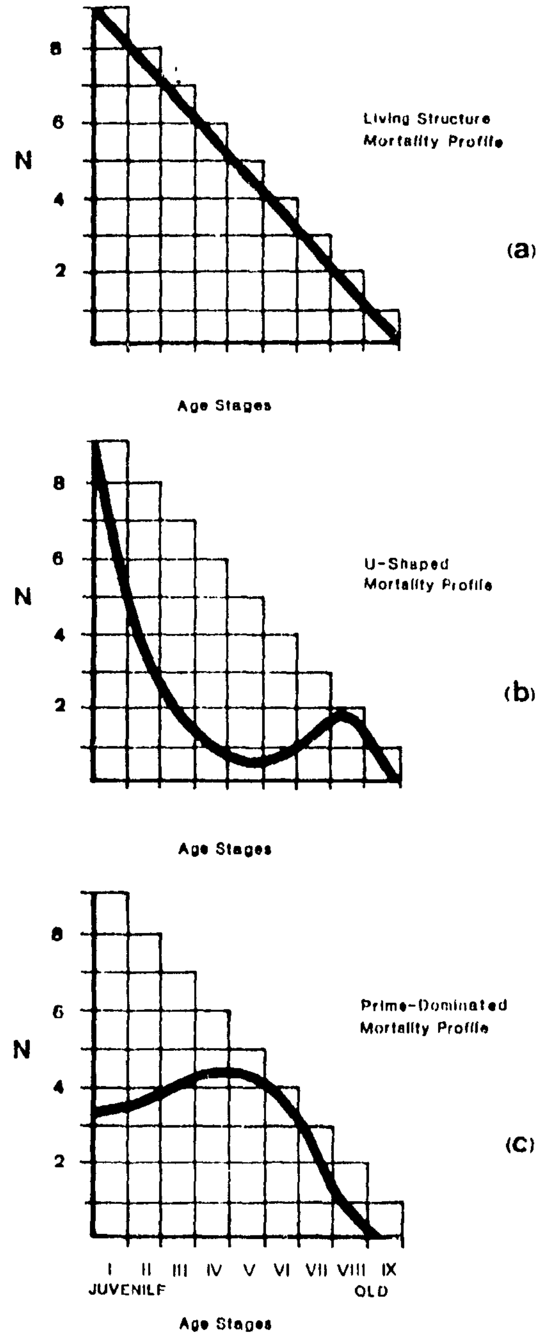


FIGURE 2 IDEALIZED MORTALITY PATTERNS

(From Stiner 1990:310)

hunting of red deer in New Zealand resulted in a wide range of age and sex variations. According to Wilkinson,

> "The data from New Zealand show clearly that non-selective hunting can produce samples of bones that contain an apparently disproportionate percentage of one or more age- and/or sex-groups. Moreover, non-selective hunting in even a small area over a brief period can result in faunal samples that differ radically with respect to the age and sex of the animals that comprise them (1976:325)."

More recently, Hudson (1991) examined nonselective hunting strategies (trapping and netting) among the Aka pygmies of the Central African Republic. The results of netted blue duikers revealed a prime dominated profile instead of the living structure mortality profile that she expected (Hudson 1991:109). This she relates to the behavioral characteristics of young blue duikers to remain quiet and hidden when startled, while older blue duikers try to flee and are captured. She concludes, "to develop more comprehensive models for interpreting nonselective mortality profiles we need to incorporate a knowledge of age specific behavior patterns that characterize the prey species and to consider their potential interaction with particular hunting techniques (Hudson 1991:120)."

Graph 1b exhibits the idealized form of a U-shaped or attritional mortality pattern (c.f. Klein 1982, Klein and Cruz-Uribe 1984, and Levine 1983) . According to Stiner (1990:315), this mortality pattern is the most commonly found in nature, and "can result from any strategy of predation that focuses on the most vulnerable prey; that is aged, very young, and sick individuals." In an archaeological context, this type of mortality pattern may provide evidence for scavenging or a random hunting technique in which the hunting technology or method prevents the procurement of the faster, healthier, prime-aged animals. U-shaped mortality profiles may also be the result of natural factors such as starvation, accidents, predation, and disease (Klein and Cruz-Uribe 1984:56). Klein (1982) examined the nature of catastrophic and attritional mortality profiles on ungulate species from Upper Pleistocene and Holocene sites in South Africa, and was one of the first to use mortality profiles to distinguish between hunting and scavenging. Klein (1984:157) concludes,

> "In an archaeological site, geomorphic/sedimentologic context will usually be adequate for determining whether a species that exhibits a catastrophic mortality profile was scavenged or actively hunted. In most instances, it will probably turn out that the species was hunted. In the case of a species characterized by an attritional profile, scavenging can be distinguished from hunting by the relative proportion of very young individuals. In most instances, it is reasonable to assume that a very high proportion of young individuals reflects active hunting."

Levine (1983:28), in her study of prehistoric horses from French and German Pleistocene deposits, relates coursing, or chasing on foot, and scavenging with an attritional profile and trapping with a living population mortality profile. She also recognized the importance of social groups, and developed mortality patterns for family groups, and bachelor groups, the latter based on the tendency of young male horses to leave the family group when young.

Graph 1c represents a prime-dominated mortality pattern (c.f. Levine 1983). According to Stiner (1990:316-7), "humans appear to be the only agencies that regularly produce prime-biased mortality in prey, making this pattern more specific to cause than other types of death patterns." This mortality pattern would be typical of selective hunting practices. Levine (1983) associated prime-dominated mortality profiles with stalking hunting techniques, if the hunter had the ability to choose the prey. However, Lyman (1991) asserts that random hunting practices, when influenced by animal behavior, may also produce this type of mortality pattern. He compares the remains of harbor seals and Stellar's sea lions on the Northwest coast, and found that identical hunting technology and methods which would be classified as random, exhibited selective mortality patterns as the result of animal behavior.

Problematic Concerns Of Mortality Studies

Wilkinson's (1976) analysis of "random" hunting was one of the earliest studies to warn zooarchaeologists of the danger of oversimplifying nonselective methods of procurement. He stressed the importance of determining the way in which the sample accumulated as a method in dealing with this problem (Wilkinson 1976:327).

Levine (1983:31-4) listed six problems that could potentially be problematic for the valid application of mortality profiles: 1) poor preservation of newborn or juvenile teeth or bones, 2) the abandonment of the skulls of large animals at the kill site, thus losing the highly diagnostic teeth of the older animals, 3) the difficulty in distinguishing whether the site represents multiple or single events, 4) the impact of previous mortality factors (i.e. if a population was highly effected by attritional factors and then destroyed by a catastrophic factor, the result might resemble a prime-dominated mortality profile, 5) the difficulty in determining age, based on eruption or wear, from broken mandibles and loose teeth, and 6) the difficulty of applying mortality patterns when many of the age estimates are age spans. To these Klein and Cruz-Uribe (1984:57) add the potential use of bones and teeth of older animals for artifact manufacture, and the need for knowledge of the site context and associations.

Lyman's (1987) examination of cervids killed in the blast zone of Mount St. Helens, which represented a catastrophic mortality pattern, was an attempt to determine minimum sample size needed for valid results of mortality profiles. He determined that the minimum sample size will vary as life expectancies vary, and noted that the use of age classes can circumvent this problem (Lyman 1987:127-8).

He concludes that, "At the very least, analysis of the Mount St. Helens cervid data suggests that a minimum of 30 individuals is necessary to determine, from age/mortality profile shape, the mortality pattern represented (Lyman 1987:140)."

Frison (1991) emphasizes the use of prey behavior and seasonality in the interpretation of mortality studies aimed at understanding hunting methods. He concludes that,

> "Animal behavior is a diverse and complex topic. Procurement of one species as opposed to another, or particular individuals within a species according to sex or age, may affect hunters' procurement and processing decisions in important ways. The idea that the same hunting strategy can be applied to all prey species is erroneous and results in faulty interpretation (Frison 1991:28)."

Dealing With These Concerns

The analysis of ringed seal remains from an Arctic archaeological context provides solutions to many of the previously mentioned problems. As poor preservation is rarely a problem in the Arctic, tne chances are excellent for the recovery of newborn and juvenile teeth and skeletal remains. As the ringed seal is fairly small, it is unlikely that the skulls would have been abandoned at the kill site. Indeed, ethnographic evidence indicates that typically the entire seal was returned to the residential site for butchering (Van de Velde 1956). The concern of broken mandibles and other factors that might hinder age determination from tooth eruption and wear are not relevant to this study, which relies on dental annuli. Problems related to this aging method will be addressed in Chapter 6. Levine's (1983) concern over the use of age spans is for the most part circumvented by Lyman's (1987) encouragement of the use of age classes and Stiner's (1990) use of a three age history based on major life phases of a taxa. The use of a site from the Arctic minimizes the threats to disturbance of the site and disruption of its context. Whenever possible, Lyman's (1987) minimum sample size of 30 will be used. The impact of prey behavior raised by Frison (1991), Hudson (1991), and Lyman (1991) will be the focus of much of this study and will be addressed in Chapter 5. The concerns regarding previous mortality factors and possible use of teeth for artifact manufacture (in this instance ornamentation) are valid concerns and must be kept in mind during the interpretation of the mortality profiles.

CHAPTER 3

ARCHAEOLOGICAL APPROACHES TO THE STUDY OF SEAL HARVESTING

This thesis will employ an ecological approach by using the techniques outlined by Smith (1976). That is, it combines the use of ethnohistorical records, direct archaeological evidence, and environmental niche reconstruction to arrive at arguments for prehistoric behavior. This chapter examines the archaeology, Chapter 4, the ethnohistorical evidence, and Chapter 5, the environmental and prey behavioral factors.

Seal harvesting has typically been included as a part of general faunal studies. Within this context, those studies most relevant to this thesis are those by Staab (1979), Mohl (1979), Morrison (1983), Stenton (1983), McCullough (1989), Park (1989), and Whitridge (1992), all of which examine seals within broader subsistence studies. Each of these studies will be examined with respect to how they address issues of ringed seal seasonality and mortality.

One study from outside of the Canadian Arctic will be examined, due to its relevance to this thesis. This study, by Lyman (1991), focused on the Oregon coast, and is of central importance because of the application of mortality profiles to marine mammals, in particular pinnipeds. Lyman's conclusions regarding the essential need for understanding prey behavior was seminal to the application of mortality profiles to PaJs-

13 and the interpretation of the resulting data. Because Lyman's study is so pertinent to this thesis, a closer analysis is required.

Studies Of Thule Seal Hunting

Staab's (1979) analysis of the faunal remains from a house and midden from the Silumiut site is an interesting attempted use of increased analytical methods. She was one of the first zooarchaeologists working in the Canadian Arctic to go beyond the simple quantification of the remains. She recorded all seal elements as to whether their epiphyseal sutures were open, closed, or partially closed in an attempt to determine if the sample showed any sign of selectivity of certain age groups during hunting. Unfortunately, very little work has been done with regard to the age of seals based on the epiphyseal union, except to record, as she does (1979:355) that a slow growth rate combined with only slight difference in the size of young and adult seals make age determination based on epiphyseal union practically impossible at this time.

Mohl's (1979) paper examined selected faunal material recovered from the Nugarsuk settlement. Bone counts and ratios of identified species were utilized to determine the function and season of occupation for the site. Mohl recognized the predominant use of ringed seal at the site, as well as the ideal location of the site for seal procurement, as solid evidence for winter occupation. Mohl compared the ratio of recovered small and great seals with Greenlandic Hunting

Statistics, which, he suggested, gives added support to the winter occupation of the settlement. While Mohl seems to discount the presence of caribou, whale, and eider as being better evidence for a fall occupation, his consideration of animal behavior such as breeding, moulting, and migrations in determining the seasonal use of the site is noteworthy.

Stenton's (1983) M.A. thesis provides a thorough analysis of a number of houses within one site. In his faunal analysis, he examines all the animal remains and concludes that seal were the dominant food resource at the site (Stenton 1983:135). In his examination of the seal remains, he utilizes epiphyseal fusion to determine ratio of adult versus immature individuals and applies dental annular studies to the remains. He observes that with the exception of one house (which showed the reverse figures) all of the houses had a ratio of 60% immature and 40% adult seals (Stenton 1983:147) based on epiphyseal fusion.

Stenton's (1983:157) study includes the addition of seal dental annuli studies to the archaeological analysis as a measure of determining both age and season of death. Although Stenton does not precisely define his method, an interpretive photograph resembles that of Morrison (1983). His conclusions are that most of the seals are being caught in the spring and summer with none being caught in the winter, which he interprets as the caching of seals for the winter (Stenton 1983:174). Fven though Stenton (1983:177) recognizes that this is contrary to the ethnographical record he feels the dental annuli evidence is a more reliable source.

Morrison (1983) conducted a study of the Clachan site. He also uses the study of dental annuli to determine the age of archaeologically recovered specimens. He continues, in his study, to attempt to determine not just the season of death but the month of death as well. No satisfactory evidence to date has shown that this may be done, and Morrison's figures (1983:72-3) are not entirely convincing. He analyzes 41 canines and states, "As far as could be determined, they represent 41 individual animals, although in reality there is probably some duplication" (Morrison 1983:71). Thus his sample may represent an MNI of only 11. Morrison arrives at conclusions similar to Stenton. That is, sealing was done in the summer and fall. Because his paper concentrates on season of death more then age, it is difficult to interpret hunting methods in the context of seal behavior and hunting techniques.

McCullough's (1989) study of a number of sites in the Eastern High Arctic is not as extensive as some of the earlier studies. However, she does present a range of data regarding seasonality and mortality. She determined age differences from the degree of epiphyseal union, from which she concludes that, of the elements, 63.7% were from adults, 36.2% from immature seals, and 0.1% were from foetal seals (McCullough 1989:282). McCullough also applied dental annuli studies and came to a conclusion similar to Morrison regarding seal hunting, with fall representing 41.3% out of 63 teeth (McCullough 1989:286). McCullough (1989:285) also presents a mortality profile for her sample, with over half of the individuals representing sexually mature seals. She recognizes that this may indicate breathing hole hunting (McCullough 1989:286), but discounts this hypothesis in favor of the seasonality from the dental annuli study.

Park's (1989) doctoral thesis is one of the most thorough analysis of seals done to date. He analyzes all aspects of the Porden Point site as well as all the fauna, yet still spends a good deal of time focusing on seals in the archaeological record. He utilized dental annuli studies by decalcifying, staining, and mounting 26 teeth. These teeth came only from right mandibles, thus reducing the duplication that most likely occurred in Morrison's (1983) study. Unfortunately, his sample of 26 teeth represent the total number of teeth sectioned from 10 individual houses, with a maximum of 3 sections being made for any one house (Park 1989:185). While the sample size is admittedly too small (c.f. Lyman 1987), he concludes that, "Taken as a group, the results of this thin section analysis are generally consistent with those from other Thule sites that have been studied, in the winter kills are rare and summer kills are the most numerous" (Park 1989:186). Park goes on to identify two different classes of sites based on the seasonality from the dental annuli study and correlated these differences with artifact types. Group A is represented by seals killed in summer and autumn and is associated with lances and bladder float plugs, which Park relates to open water hunting methods (Park 1989:246). Group B is represented by seals killed in the winter and is associated with ice picks, a sealing stool, drag line handles, and a seal scratcher, all of which Park relates to ice hunting (Park 1989:230,246).

Whitridge (1992) analyzed the fauna from a number of sites including house 2 from PaJs-13. Within this broad subsistence study, he included a dental annuli study of right mandibular canines from which he concluded, "Animals whose remains were deposited at the sodhouses were mostly procured between late fall and late spring, although some were probably harvested in late summer and early fall, and cached for winter use" (Whitridge 1992:144). Whitridge (1992:137-139) also included mortality profiles based on broad categories of adult, juvenile, and newborn based on Smith (1987), and consistent with Stiner (1990), but did not elaborate much beyond this.

The present study will be the first to systematically analyze hunting methods and ringed seal exploitation through an in-depth examination of mortality patterns. The archaeological studies that have utilized dental annuli studies have limited their use to discussions of seasonality of the site and what such seasons would mean in practical terms for seal hunters. Although McCullough (1989) and Whitridge (1992) present the foundations of a study involving mortality profiles in an elementary way, they are concerned with a subsistence overview and thus do not take their basic mortality figures to a deeper level of analysis and interpretation.

Review Of Lyman's Oregon Coast Pinniped Study

Lyman (1991) examined seal hunting in the archaeological record with regard to technology from ethnographic records and from archaeological sites as well as seal behavior to assess selectivity for age and sex. By adding seal behavior to the equation, he determined that "random" seal hunting on the Oregon coast would produce a selectivity for Harbor seal pups and adult male sea lions based on escape behaviors (Lyman 1991:196-7). He also notes, "The technology known both from ethnographic accounts and archaeological sites would have sufficed in on-shore (arrows, clubs, harpoons) or off-shore (harpoons) hunting contexts" (Lyman 1991:195). However, on the basis of archaeological data, he discounts the use of off-shore hunting. Although selectivity for age and sex appears in the zooarchaeological record, based on this ethnographical and archaeological evidence, Lyman concludes that prey behavior selected which age/sex groups were most susceptible to on-shore hunting of terrestrial breeding areas.

Summary

Previous zooarchaeological studies of the central Canadian Arctic have focused on the total subsistence economy and the ringed seal's role within that economy. No previous study has concentrated on ringed seal alone. Some of these studies have used dental annuli (e.g. Stenton 1983, Morrison 1983, McCullough 1989, Park 1989, and Whitridge 1992), and a few even began preliminary experimentation with mortality profiles (e.g. McCullough 1989 and Whitridge 1992). Most ringed seal studies have utilized ethnographic parallels and some data on seal behavior.

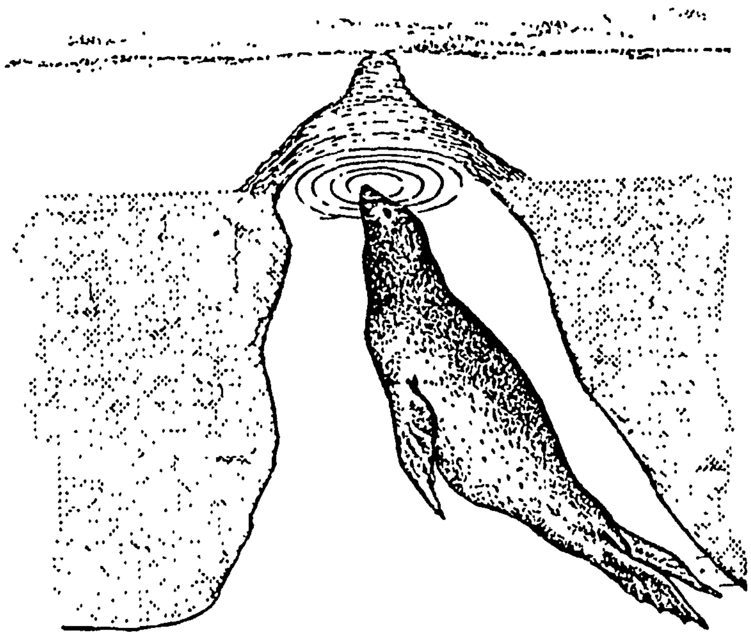
Lyman's (1991) work, which combines *pinniped* behavior, ethnographic records, and archaeological material to explain a zooarchaeological assembledge, is the closest parallel to this thesis; however he does not use dental annuli and his study is focused on the following pinnipeds: harbor seal (*Phoca vitulina*), northern fur seal (*Callorhinus ursinus*), Stellar's sea lion (*Eumetopias jubatus*), and California sea lion (*Zalophus californianus*) on the Northwest coast. While Lyman's primary concern is to explain a faunal assembledge, the application of prey behavioral studies to questions of pinniped harvesting could be useful in the determination of the random or selective nature of hunting techniques utilized to obtain an archaeological assembledge.

CHAPTER 4

ETHNOGRAPHIC ACCOUNTS OF SEAL HARVESTING

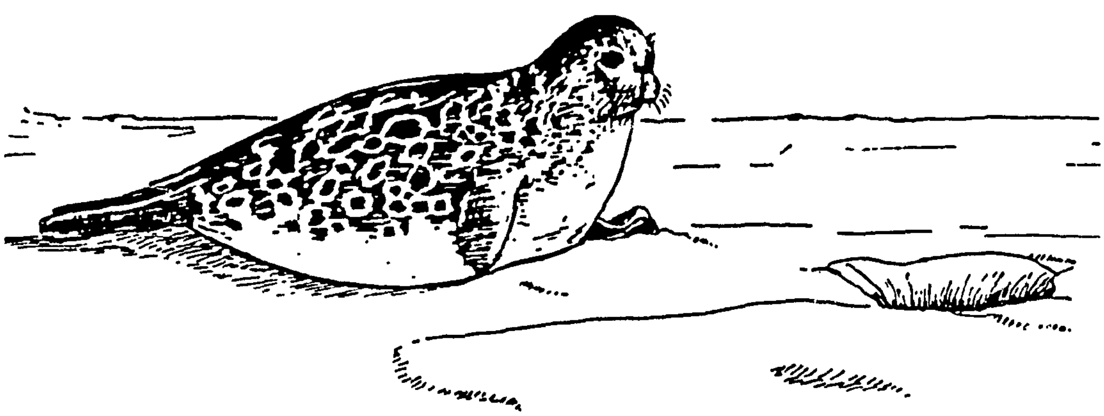
Samik, one of the Netsilik Eskimo men Rasmussen worked with, related the importance of ringed seal to Inuit life this way: "In this country the seal is the only animal that can hinder a famine, for it is the only animal that gives both food and warmth in the snow huts, and only the winter can be a time of need." (Rasmussen 1931:135-6). By focusing specifically on the ethnographic accounts of seal hunting from the central region of the Canadian Arctic, seal hunting techniques that might have been used by the Thule can be examined as to whether hunting techniques common to this cultural area were random or selective. The work among the Netsilik Eskimo groups are probably the most beneficial, as the archaeological sample being used came from the same region, although some sources from other areas have been incorporated. Rasmussen (1931), Boas (1888), and Balikci (1970) provide the primary accounts of sealing methods within the central Canadian Arctic, and their accounts are quite similar with regard to hunting techniques.

Several traditional methods of seal hunting have been documented (Figure 3), including breathing hole hunting, stalking basking seals, snow lair hunting, and open water



(A) SEAL APPROACHING A BREATHING HOLE IN WINTER

(From Balikci 1970:76)



(B) RINGED SEAL BASKING NEAR A BREATHING HOLE IN LATE SPRING

(From Mansfield 1967:20)

FIGURE 3

hunting. Each of these, as well as variations within each category will be discussed in turn.

Breathing Hole Hunting

When seal hunting in winter, it is essential for the hunter to have a dog. The dog can quickly locate a seal breathing hole by the scent of the seal. However, to succeed at breathing hole hunting it must be carried out communally. Because the seal maintains a number of breathing holes, the group of men hunting must spread out and cover as many holes as they can. This increases the likelihood that the hunt will be successful. Rasmussen (1931:153) records that breathing hole hunting usually produces a maximum catch of rarely more then 20-30 seals per hunter for one winter. For example, he noted that at Kuggup Pamiut twelve hunters obtained 150 seals for the entire winter for a camp of thirty-one individuals and thirty dogs.

After the dog locates the breathing hole, all of the hunters race to the area and attempt to locate the hole with their snow probes and the first to find the hole will be stationed at that hole while the others scatter to find additional holes (Balikci 1970:74). Balikci explains the process as follows:

> "Having found a breathing hole, the hunter then prepared for the watch. First he removed his dog from the hunting place and tied him to a block of snow. Then he cut away the upper layer of snow covering the breathing hole with

> the snow knife and leaned down to see and smell whether the breathing hole was still in use or whether it was abandoned and frozen. If the hole was a good one, he broke the hard, ice-like snow on top with the ice pick fixed on his harpoon and removed it with the ice scoop. Then he took the long, curved breathing-hole searcher and examined the contours inside and the curvature of the hole in order to determine the direction in which the harpoon should be thrust. After this the hunter again covered the breathing hole with snow, holding the snow probe straight in the middle of this snow heap, right above the hole and in the proper striking direction. When he lifted the snow probe out, a tiny dark hole of about half an inch remained below in the snow. The down indicator was then prepared for use." (Balikci 1970:74)

The rest of the hunt becomes a waiting game. The hunter stands or sits on a small stool waiting for the down indicator to begin to move, signalling a rising seal. Rasmussen (1931:158) notes that hunters may stand perfectly still for twelve hours at a stretch in temperatures of -50 degrees Celsius. If the harpoon strikes the seal correctly it will only be a matter of time before the seal weakens and the hunter pulls it out, enlarging the breathing hole with his ice pick.

"Maulerktoq" Hunting

One variation of the breathing hole hunting technique is "maulerktoq". Balikci (1970:82) mentions spring sealing, or "maulerktoq", which occurs when the breathing holes have become exposed by melting. These holes are simple to locate without dogs, and women and children join in the hunt by guarding some of the holes. They keep chasing the seals back under the water before they can get a breath to force them up at a hole guarded by a hunter who then harpoons the seal.

Damas (1963) and Wenzel (1981) note that this method of sealing is not restricted to the spring and may be applied to winter breathing hole hunting.

"Sivuliksiroq" Hunting

Balikci (1970:83) records a second variation, "sivuliksiroq", where before midnight a seal would enter the water through an exposed breathing hole and would always return to the ice through that hole in the morning. Thus a single hunter can wait at that hole knowing the seal will return that way, and then harpoon it in the morning, without the use of a communal hunt. There is no biological record for such behavior, indeed seals maintain a number of breathing holes throughout the winter. This method may simply be a way of recording the presence of breathing hole that is being frequently used.

"Itertulerineq" Hunting

Rasmussen (1931:161) records a third variation of breathing hole hunting, called "itertulerineq". This method is used in early spring when the ice begins to melt forming natural cracks along which seals frequently travel. By building a snow hut over the fissure and keeping it completely dark a "false" breathing hole is created. The hunter is stationed inside and when a seal is attracted by the darkness, it is harpooned and quickly removed from the trap to prevent blood from disturbing other seals.

Seal Stalking

A second major seal hunting technique used in the central Canadian Arctic ethnographically is seal stalking. Here the goal is to get as close to a seal as possible as it basks in the sun on the ice in late spring. Balikci (1970:84) describes this technique as follows:

> "After having tested the wind direction, the hunter started his approach, first crouching low and then lying flat on his left side. He slowly dragged himself toward the seal, trying to look like another seal by imitating its movements and sounds. The seal took short naps (a minute or so), after which he lifted up his head, looked around, and occasionally moved his back flippers. The hunter watched every movement of the seal. As soon as the seal put his head down to sleep the hunter crawled a few feet ahead. When the seal's head came up, the hunter at first lay motionless, his head down, pretending he was asleep. Then he raised his head and lifted his right leg, in imitation of the seal's hind flippers. With the snow knife he scratched the ice as if a seal's claws were making the noise and skillfully imitated the deep cry of the seal. Then he advanced a few more feet."

This process continued for over an hour until within fifteen to twenty feet, when the hunter then rushes the seal to harpoon it.

Snow Lair Hunting

Franz Boas (1888:74) recorded another method of hunting, snow lair hunting or birthing lair hunting. Seal pups are born on the ice in lairs located beneath the snow. Here again the lair is located through the use of a dog, only now the hunter must exhibit speed not patience, and break into the lair and hopefully harpoon the mother. If the mother escapes, the hunter may use the seal pup as live bait to lure back the mother.

Open Water Hunting

Balikci has noted, "...the Netsilik could hunt seals only in winter. This was because the Netsilik had no techniques for hunting the seals from the water, and so had to wait until the winter when they could get out on the ice directly above the seals for a kill." (Balikci 1970:23). If this ethnographical account alone was applied to the Thule culture, the archaeological evidence that the Thule society had the ability and technology to hunt whales from the open water would have been ignored. It is not out of the question that the Thule may have hunted seals from open water as well. For analogies of these types of hunting Nelson (1969:221-224) records sealing in Alaska by umiak and kayak as well as by the use of nets. Boas (1888:89-91) also refers to open water hunting from kayaks in the summer.

Summary

Based on these accounts, it can be suggested that with the possible exceptions of birthing lair hunting, which would select for females and newborns, and seal stalking, which may exhibit selection based on size, seal hunting in the central Arctic can be classified as a "random" hunting method. Neither of these methods are as efficient as breathing hole hunting and would be limited to very brief periods of the year. If the Thule were utilizing marine adaptations in hunting seals from the open water, they have no accurate methods of judging and selecting seals to be killed, while in breathing hole hunting the seal is not seen until after it is captured. This suggests that it would be extremely difficult to select which seals are harvested based on any factor of age, sex, or relative size. If this is true, then the harvested population, given a large enough sample size, should accurately reflect the living population at the time these seals were killed.

CHAPTER 5

RINGED SEAL PHYSICAL AND BEHAVIORAL CHARACTERISTICS

In order to understand the predator, some biological and behavioral knowledge of the prey is required. To understand the prey, some knowledge of its environmental niche is necessary. For most of its life, the ringed seal lives in the water in Arctic environments. Its terrestrial experience is limited to the period from birth to the break up of the spring ice, and periods of basking and moulting in the early summer when the seals haul out on the ice edge. Because the ringed seal relies on the ice for reproduction, it is traditionally the major mammal food resource of the historic Central Eskimo during winter. Other mammals that live in large groups migrate south during the harsh winter and spring periods of the Canadian Arctic.

Ringed seals are 65 cm. long at birth, and can reach a maximum adult length of 135 cm. and possibly 168 cm., and may weigh up to 113 kg., although females are typically smaller (McLaren 1958:79). One ringed seal has been caught that was at least 43 years of age, although most ring seals do not live to that age (McLaren 1962:172). Males mature at seven years of age on average, while females may mature slightly earlier (McLaren 1958:80). The rut occurs from sometime in March to mid-May with mating in mid-April. The young are born in winter conditions in snow lairs on the ice at a ratio slightly more in favor of males (McLaren 1958:80). Moulting occurs from mid-May to mid-July with intense fasting in June and early July (McLaren 1958:79). However, Spiess (1976:53) states that the period of fasting and moulting of ringed seals occurs from March through June, based on Smith (1973). McLaren (1958:23) also notes that during this late spring/summer period ringed seals are in their worst condition of the year. He states:

> "In brief, a seal probably maintains a high condition index through the winter, undergoes a gradual decline in blubber thickness through the early spring, and loses condition more rapidly during the intensive basking and fasting period of late spring. The blubber increases with resumed feeding in the early summer until a maximum thickness may be reached in the late fall."(McLaren 1958:23).

<u>Pack Ice And Fast Ice Populations</u>

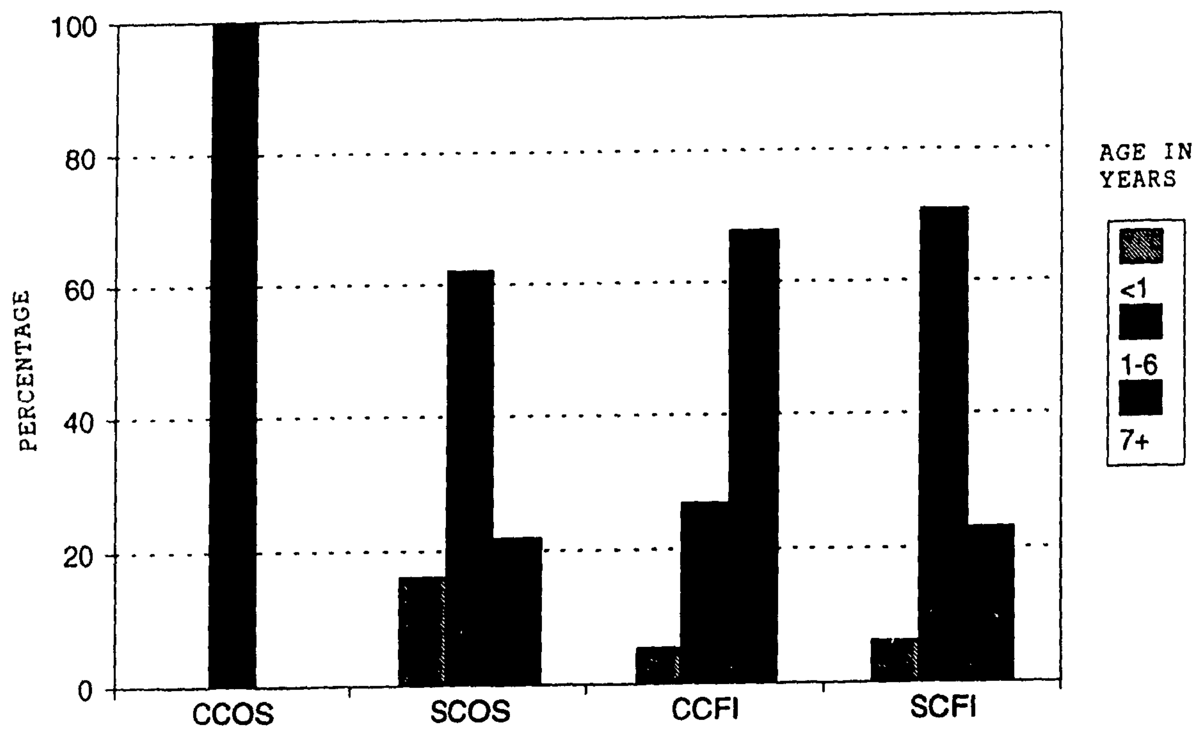
McLaren (1958:70-72) observed that in the fall, as ice begins to form along the coast, the inshore fast ice is occupied largely by sexually mature seals while the immature seals move out into deeper waters as the ice edge moves further from shore. He also noted differences in seal populations age composition between "simple" and "complex" coasts during the winter. In outlining these differences McLaren (1962:171) observed that:

> "In winter, the ringed seals taken in the open water at the edge of the fast ice are exclusively immature in most regions; seals killed in the peripheral ice of complex

> coasts or in the fast ice of adjacent simple coasts are mostly younger adults; those taken at the heads of bays, or well within island-filled regions, and in general in thick, heavily snow-covered ice, are mostly older adults. Increase of experience with age and possible competition for more suitable pupping sites may serve to explain this distribution of adults."

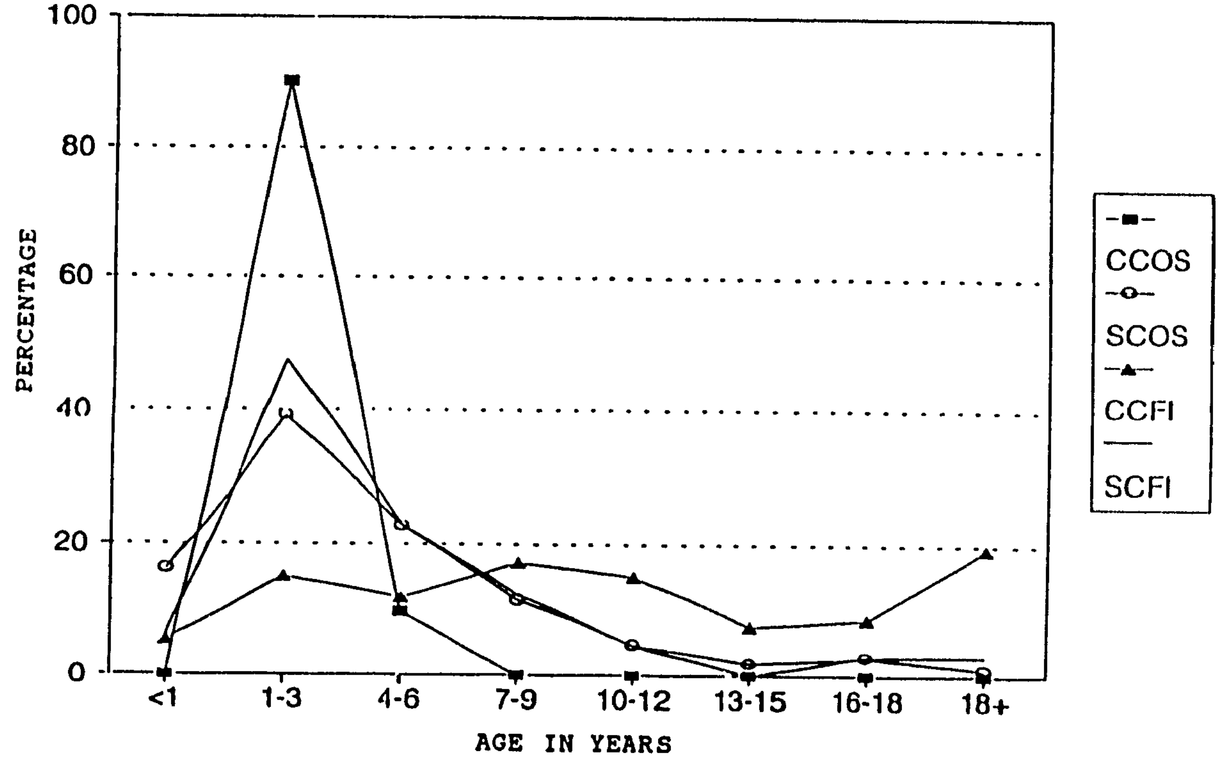
Figures 4-7 are derived from McLaren's data to demonstrate these differences. Figure 4 compares complex coast off-shore populations, simple coast off-shore populations, complex coast fast ice populations, and simple coast fast ice populations with regard to newborn ringed seals (under 1 years old), juveniles (1-6 year olds), and sexually mature seals (7 years old and up). This demonstrates that the most striking differences appear in the fast ice, while the off-shore populations maintain a fairly constant population with a high number of juveniles. Figure 5 demonstrates this comparison within a mortality profile framework expressed in a greater division of ages. Figures 6 and 7 examine the differences between simple and complex coasts separately.

Finley et al. (1983) suggest that this winter distribution of seals based on age is in reality a separate pack ice breeding population. However, their sample size is rather small (45 pack ice seals and only 12 fast ice seals) and their fast ice population still demonstrates a greater percentage of sexually mature adult seals in direct contrast to their pack ice population. These figures actually support McLaren's findings. Finley et al. also do not deal with several key problems raised by McLaren (1962:171-3) including



CCOS= Complex Coast Off Shore
SCOS= Simple Coast Off Shore
CCFI= Complex Coast Fast Ice
SCFI= Simple Coast Fast Ice

FIGURE 4 POPULATION CHARCTERISTICS OF OFF SHORE AND FAST ICE RINGED SEAL POPULATIONS FROM SIMPLE AND COMPLEX COASTAL SYSTEMS (Data From McLaren 1958:76-7)



CCOS= Complex Coast Off Shore
SCOS= Simple Coast Off Shore
CCFI= Complex Coast Fast Ice
SCFI= Simple Coast Fast Ice

FIGURE 5 POPULATION CHARCTERISTICS OF OFF SHORE AND FAST ICE RINGED SEAL POPULATIONS FROM SIMPLE AND COMPLEX COASTAL SYSTEMS (Data From McLaren 1958:76-7)

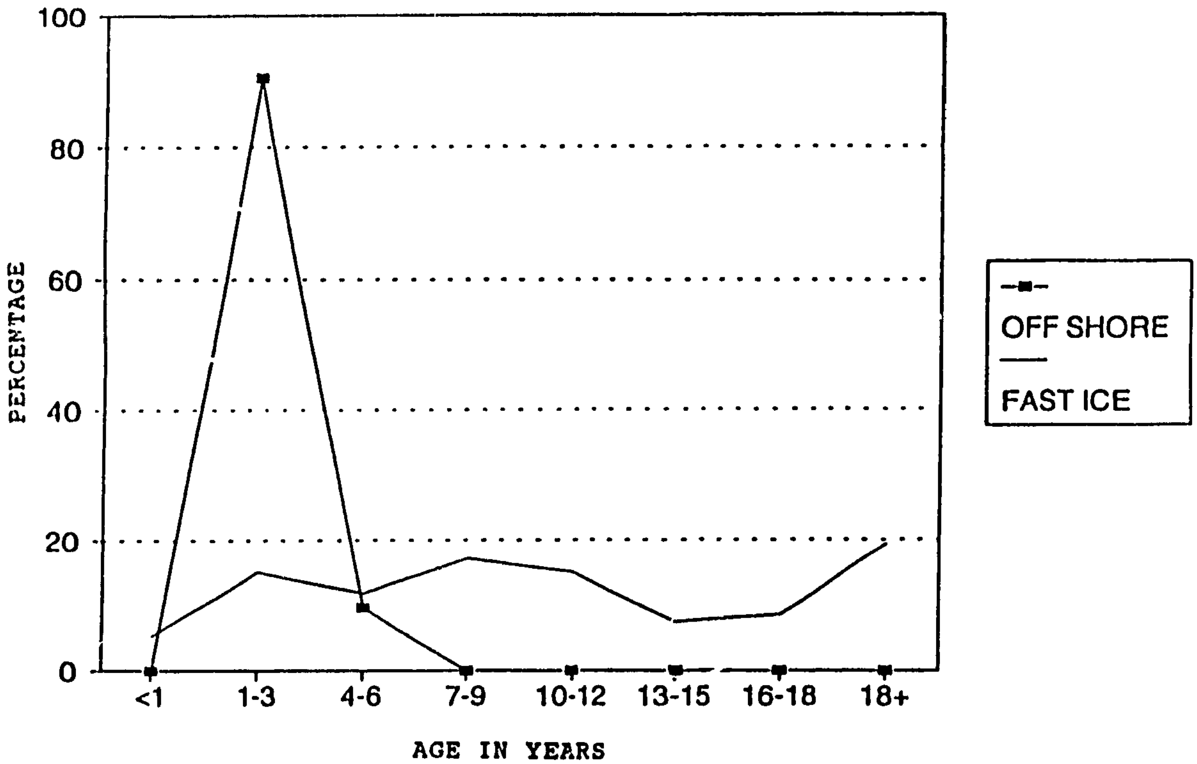


FIGURE 6 COMPARISON OF OFF SHORE AND FAST ICE RINGED SEAL POPULATIONS FROM A COMPLEX COASTAL SYSTEM (Data From McLaren 1958:76-7)

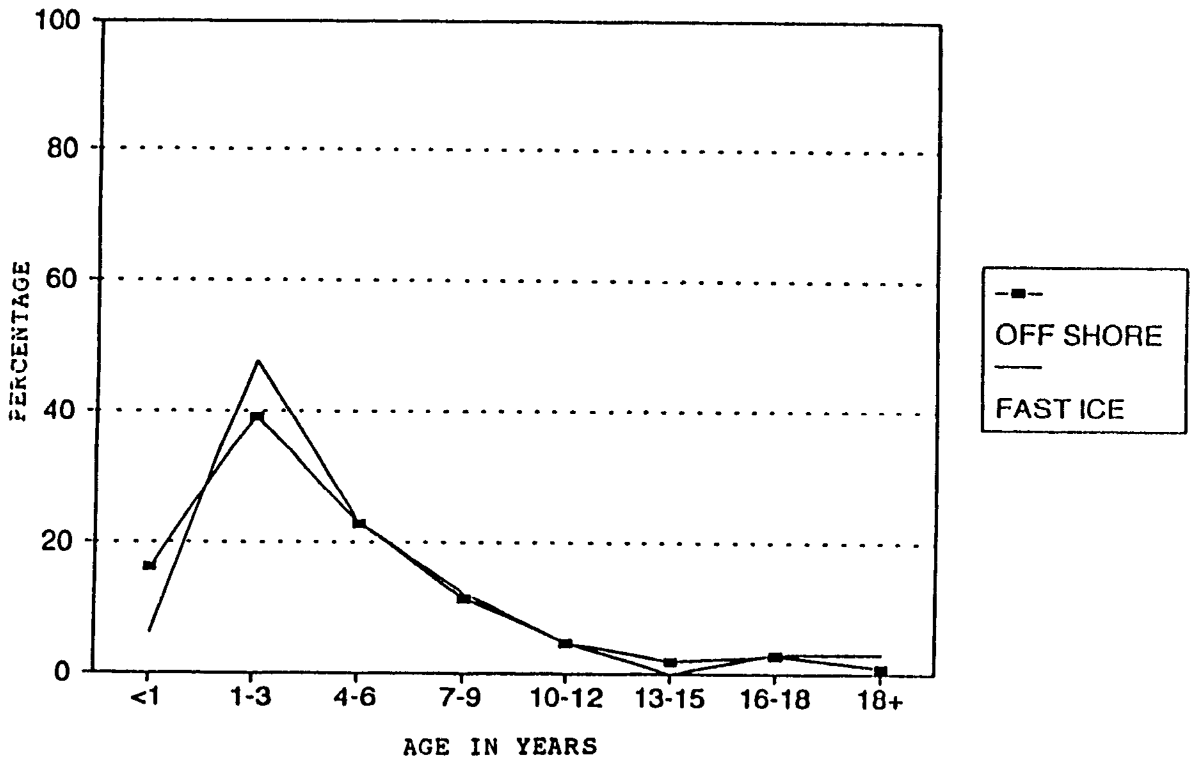


FIGURE 7 COMPARISON OF OFF SHORE AND FAST ICE RINGED SEAL POPULATIONS FROM A SIMPLE COASTAL SYSTEM (Data From McLaren 1958:76-7)

a higher rate of infant and juvenile mortality in the unstable pack ice or "simple" coast situations, and a lack of pregnant females (1 of 128 specimens) in the pack ice.

When the surface of the water begins to freeze the seal must break through the thin ice to breathe. As the ice becomes thicker the seal continues to use the same breathing holes and keep them open. Each seal maintains a number of these holes throughout the winter. These holes occur less frequently in pack ice than in fast ice. Finley et al. (1983:171) argue that this is because pack ice seals "can occupy thin ice that continually forms during the winter and thus probably need not maintain and defend one breathing hole (or small groups of holes) throughout the winter."

Perhaps the best evidence Finley et al. (1983) present to defend their hypothesis of a separate pack ice population is in size differentiation: that is, some ringed seal populations appear more stunted then others. This has been associated with the stability of the ice, with smaller seals being born on the pack ice and thus having less time for weaning and growth prior to break-up. Smith (1987:43) suggests a different possibility:

> "The natural spread in birth dates and apparently restricted time of growth in the first year of life seems to result in a normal distribution of the standard lengths of pups with a slight negative skew. The smallest pups, which are possibly the last born, are also in poor physical condition, with the stunted animals in the oldest classes varying from low to normal condition. This indicates that stunting likely results from poor

> nourishment during the suckling and immediate post weaning period."

As these seals come mostly from the stable coastal ice, the possibility of a separate pack ice seal population seems remote at best.

Seasonal Distribution of Age Groups

Smith (1987) examined the distribution of age groups through different seasons and habitats. He suggests that summer open water ringed seal populations are more consistent with projected living ringed seal populations than samples from other seasons. Figures 8 and 9 illustrate this point using data collected by Smith at Home Bay on the eastern part of Baffin Island during the summers of 1967 and 1970. Figure 8 shows the fairly equal distribution of newborns, juveniles, and sexually mature adults for these periods. Figure 9 demonstrates through the use of a mortality profile that Smith's data does correspond to a living-structure mortality profile. This pattern follows very closely Stiner's idealized living structure mortality profile.

Smith goes on to indicate population frequencies during other periods, but does not provide raw data, and limits his discussion to the frequencies of newborns, juveniles, and sexually mature adults. As Smith only provides the data for these three categories, age categories cannot be redefined to include a broader range of age divisions as was done with his

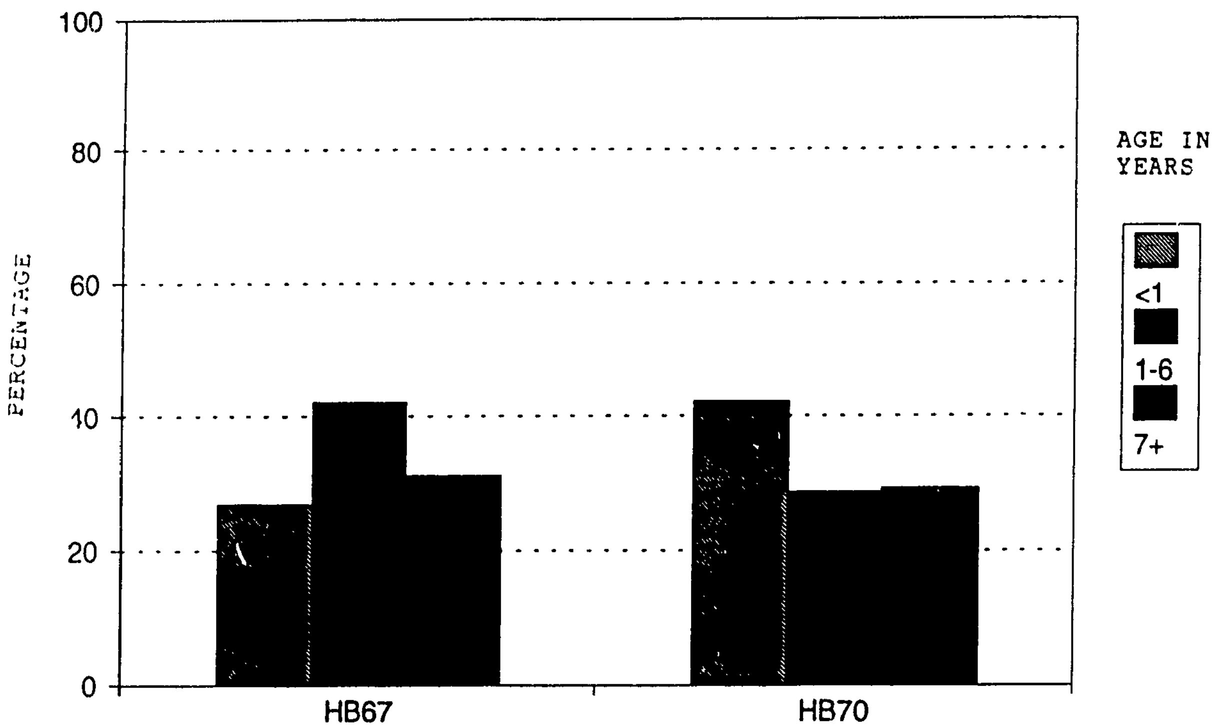


FIGURE 8 COMPARISON OF SUMMER RINGED SEAL POPULATIONS FROM HOME BAY 1967 (HB67) AND 1970 (HB70)

(Data From Smith 1975:285)

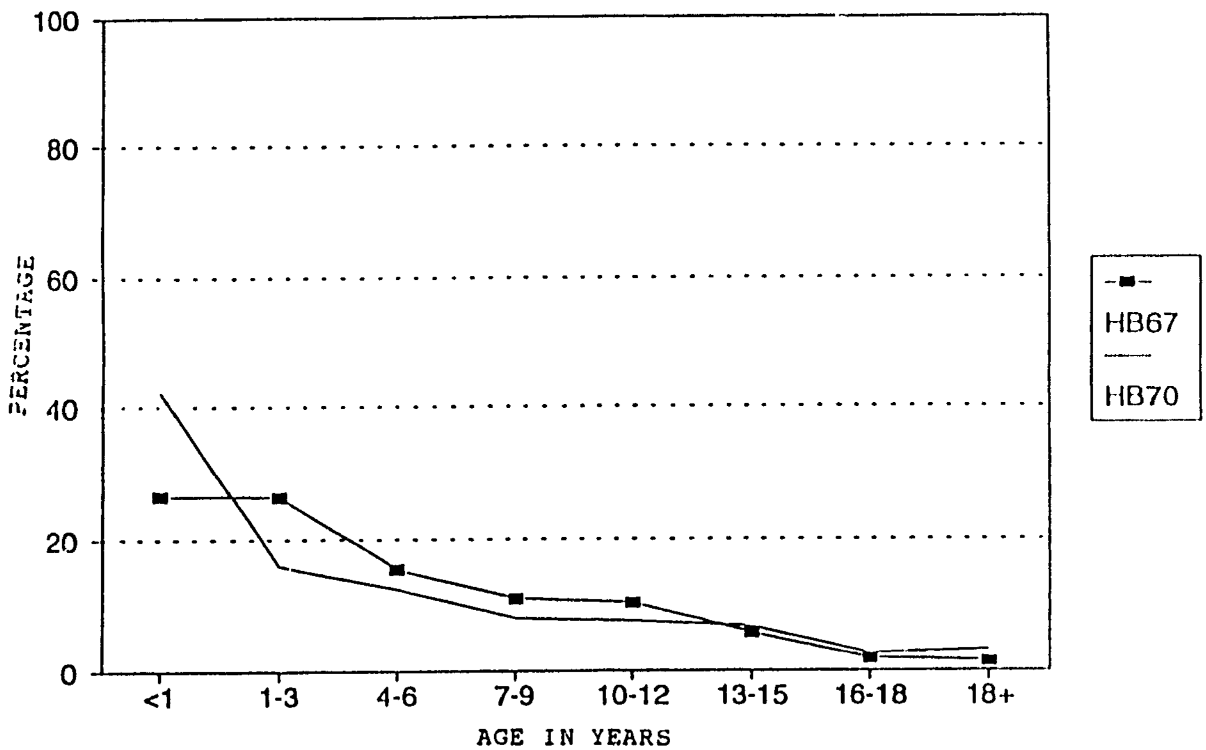


FIGURE 9 COMPARISON OF SUMMER RINGED SEAL POPULATIONS FROM HOME BAY 1967 (HB67) AND 1970 (HB70)

(Data From Smith 1975:285)

two summer populations disscussed previously. Figures 10 and 11 display his data for spring, summer and autumn between samples that were collected within a defined breeding area and samples that were collected from a non-breeding area. The addition of the floe-edge population on figure 10 demonstrates an off-shore population dominated by juveniles. The percentages illustrated in Figures 10 and 11 are composite percentages from several years. In autumn (September 1 to October 15) in open water most of the seals captured were over seven years of age (approximately 63% in 1971 and 90% in 1973) with the younger seal categories (under one year and one to six years of age) each representing under 20%. In the summer (July 1 to August 31) in open water all three categories varied between 20% and 40%. In the spring in a fast ice breeding habitat the resulting figures were similar to the autumn, with seals over seven years of age representing around 55% in 1972 and 90% in 1973, while seals one to six years of age represented 30% in 1972 and 10% in 1973. The population at the floe-edge during March to the end of May 1971 was; 5% under one year, 13% one year old, 26% two years of age, 24% three years of age, 15% four years of age, 12% five years of age, 5% six to seven years of age. This is the age distribution of seals up to seven years of age which represented 70% of the total catch, while seven years old and older represented only 30%.

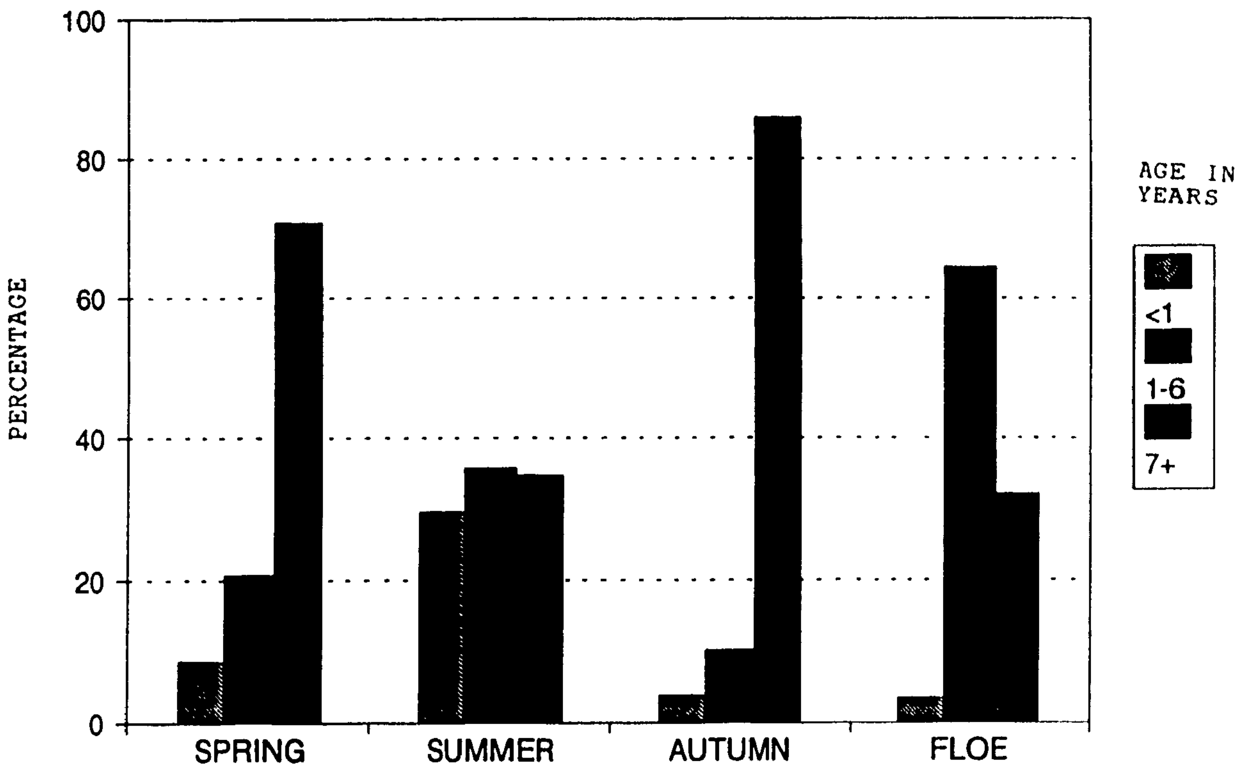


FIGURE 10 POPULATION CHARACTERISTICS OF RINGED SEALS FROM SPRING, SUMMER, AND AUTUMN SEASONS AND THE ICE FLOE EDGE

(Data From Smith 1987:9,11)

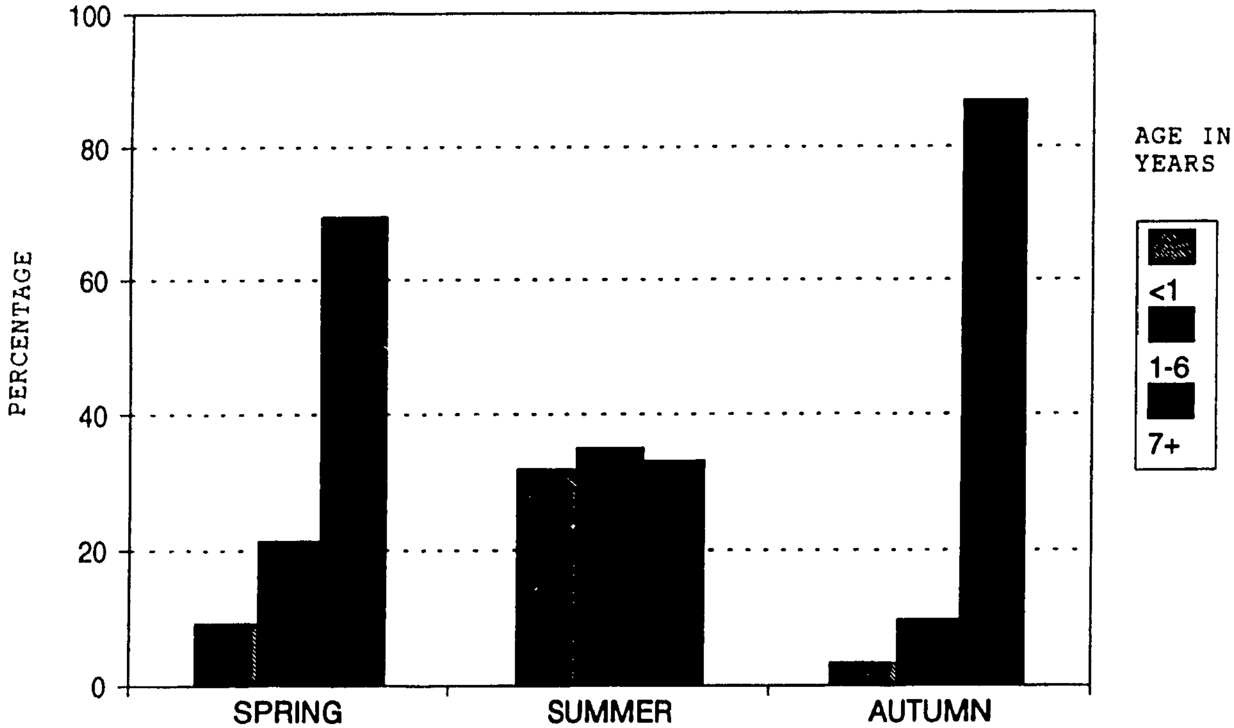


FIGURE 11 POPULATION CHARACTERISTICS OF RINGED SEALS FROM A BREEDING AREA BROKEN DOWN BY SEASON

(Data From Smith 1987:16)

Smith (1987:19) suggests that some active competition may occur during the breeding and birthing periods of winter and spring, which might account for this shift in population frequencies. He notes, "Of the adolescent males with bite marks, three of the five specimens were almost mature at 5 and 6 years of age. Pups were never found to have been bitten and only 8% of adult females showed bite wounds in the hind flippers, which were relatively light and might have been inflicted during courtship chases (Smith 1987:19)."

Summary

While Finley et al. (1983) offer an intriguing alternative of a separate seal population on the pack ice, their evidence is not conclusive enough to supersede the evidence presented by McLaren (1958,1962) and Smith (1987). Therefore, the age distribution of juvenile and sexually mature ringed seals during the winter and spring offer archaeologists the ability to use mortality patterns to determine which type of ice was frequently exploited and possibly which local areas around a site location were more often used.

CHAPTER 6

METHODOLOGY

In order to interpret random or selective harvesting from an archaeological faunal sample, a mortality profile must be generated. If this profile resembles a living structure, the random nature of seal harvesting techniques from the enthnographic records will be supported for the Thule. However, the presence of a prime dominated profile, or any variant of this profile, will indicate selectivity. This could be interpreted as intentional selection, which is not supported by the ethnographic record, or unintentional selection as the result of prey behavior. As the studies of ringed seal behavior show, modern living populations fluctuate from season to season and from one type of ice formation to another, based on periods of mating, birthing, and possible territoriality amongst adult males. If these variables can be accurately identified, an archaeological site can be interpreted in relation to hunting methods most likely practiced at that site, as well as information regarding which areas of the local environment were most often exploited.

To generate a mortality profile from a zooarchaeological sample, a method to determine the age of ringed seals from that sample must be utilized. Dental annuli studies are the best method available at this time, as the previously discussed studies of epiphyseal union allow only general age categories to be determined. Dental annuli studies have the added benefit of allowing the determination of the season of death for individual seals in the sample. This will provide two important types of information: 1) The peak season of seal harvesting among the Thule and 2) The hunting methods most likely to have been utilized during that period.

To provide a basic description of dental annuli studies, it is necessary to review the biological factors of tooth formation. This will be followed by a brief review of sectioning and reading methods used in the study of dental annuli.

Tooth Formation

Teeth consist of four major components; the enamel, the dentine, the cementum (or cement), and the pulp cavity (Figure 12). The enamel caps off the tooth and becomes worn through use. The pulp cavity is the space inside the tooth and is filled through time by layers of dentine. The cementum, laid down in similar layers, is the substance that holds the tooth within the alveolar socket. Because annular rings are deposited in distinct layers with minimal wear, dental "growth ring" studies focus on either the dentine, cementum, or both.

These layers are best defined as transparent and opaque bands, since some confusion has arisen over the interpretation of "dark" and "light" bands. Hillson (1986:158) attributes the

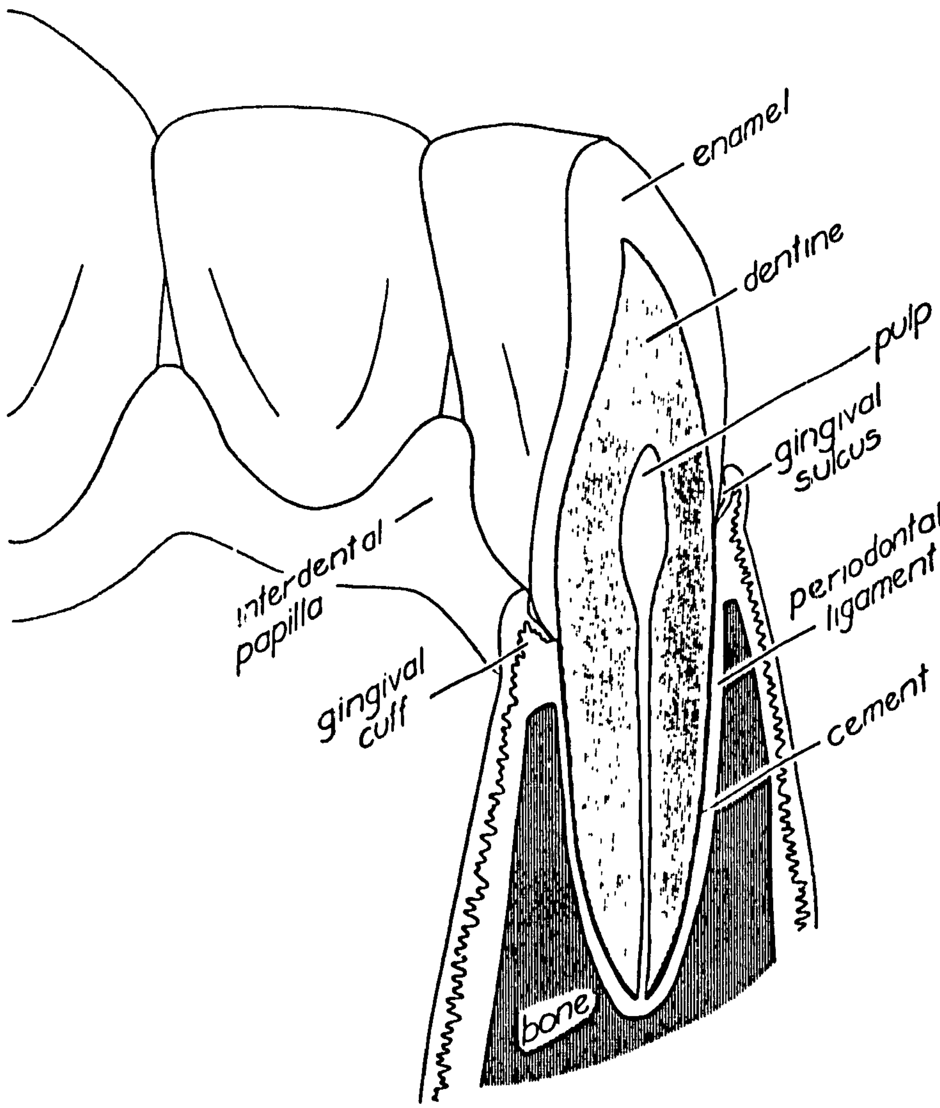


FIGURE 12 TOOTH STRUCTURE

(From Hillson 1986:10)

appearance of these bands as being "due at least in part to changes in the packing of collagen fibrils".

One major difficulty with the use of dental annuli is that no definitive cause of these layers has been determined. It is quite inaccurate to refer to the rings as dental "annuli" per se, since the bands do not necessarily represent one well defined year. Saxon and Higham (1968:306-307), who first introduced dental annuli studies to archaeology, rule out sexual maturity factors (ie. pregnancy, lactation, and the sexual cycle) because of the appearance of bands in immature individuals. They also rule out fluctuations in the availability of food, since their sample included domesticated animals with a reliable and consistent diet. Seasonal factors such as hibernation, fasting during moulting, food stress in the dry season, and distinct periods of rest and activity may influence the formation of dental growth rings (c.f. Klevezal and Kleinenburg 1967, Morris 1972). Grue and Jensen (1979:40-41) conclude in their paper,

> "The main impression gained is that the formation of primary incremental lines is governed to a considerable degree by an internal rhythm, and that it is part of the animal's whole growth and metabolic rhythm. External conditions, and in particular those which directly or indirectly affect growth and physiological condition, can then modify line formation, but only in extreme cases can they obscure the rhythm through the formation of secondary lines, or obliterate it entirely. This is e.g. found in species exposed to different degrees of domestication."

Gordon (1984:2) suggests that the variation of protein intake during different seasons may result in the formation of these different bands. However, the fact remains that two distinct types of bands occur and they provide a good indication of age and season at death.

There do appear to be some difficulties inherent in the use of dentine as an archaeological age determinant. Hillson (1986:156) notes that dentine in teeth recovered from archaeological sites may be softened or brittle. Gordon (1984:2) notes that because dentine slowly fills the pulp cavity, once the cavity is completely filled age determination is impossible.

Cementum also poses several potential problems for the analyst to overcome. Cementum is not confined to the pulp cavity as is dentine. However, variation in deposition due to differences in tooth stress and rate of wear, as well as meandering of the lines at the root and pitting in older animals, can be problematic (Gordon 1984:2). Depending on the species being analyzed, which teeth are being examined, and the preference of the analyst, either dentine or cementum may be used with equally valid results.

The Methodology Of Dental Annuli Studies

In this section more detail will be presented on the actual methods used in conducting dental growth ring studies. Various methods can be used which produce equally valid results, yet each method presents different difficulties that must be overcome. The method of dental annuli analysis utilized depends to a great degree on the research question. The first issue to be faced is what tooth to use. Teeth with simple roots allow the viewer to easily follow and count the rings, and are therefore the most reliable. The larger the tooth, the easier it will be to handle during cutting and viewing. Finally, for the archaeologist, teeth that preserve well and can be easily separated into upper versus lower and right versus left prevent duplication that will affect the age distribution of the site sample.

After the tooth type is selected, the next decision to make, is in regard to how the tooth should be cut. There are basically three methods used; a thin sagittal (longitudinal) section, a thin cross (transverse) section, and to cut the tooth in half and polish the exposed surface.

All of these methods have positive aspects depending on available equipment and the nature of the research problem. Thin sections are convenient for mounting for improved viewing, but with a lack of a thin sectioning saw, a polished half of a tooth will still produce valid results. A sagittal section allows for the analyst to follow the bands completely around the root, however in most cases the thin cross section will serve to determine age and season of death with relative ease.

The next decision to be made, when using thin sections, is whether the tooth should be decalcified or not. If the tooth is to be decalcified, the method might typically employ formic or nitric acid, but must be followed by washing in running water to remove all traces of the acid in order to properly stain the sample (Morris 1972:87-88). When staining, hematoxylin seems to be preferred, as it was used by Saxon and Higham (1968), Morris (1972), and Spiess (1976).

When examining the tooth sample under a microscope, two types of light may be used; transmitted and reflected. Reflected light is usually confined to analyzing polished, undecalcified sections only. The difference in the appearance of bands is extreme, and this has led to the confusion between "dark" and "light" bands previously mentioned. Savelle and Albright (1989) point out these differences. It is more proper to refer to these bands based on optical properties; typically, narrow bands are called translucent bands, while wider bands are called opaque bands.

This information indicates not only the need for careful methodology when dealing with archaeological "growth rings" from one's own site, but also the need for understanding the method on which the interpretation is based. Of equal importance, is knowing what methods were used on other dental annuli studies when comparing results.

Bryan Gordon (1984:3) has also brought up a difficulty that may be problematic to future studies. This is the fact that under normal transmitted and polarized transmitted light a shift in position can occur with regards to the opaque bands. This needs more study to determine what effect this may have, particularly when attempting to determine the season of death from an archaeological specimen.

<u>Ringed Seal Dental Annuli Studies</u>

One of the earliest dental annuli studies was done by Scheffer (1950), when he recognized the possible importance of "growth rings" in Pinnipedia. McLaren (1958:5-1[illegible]) continued the biological use of dental annuli studies, focusing on the ringed seal and noting differences in reflected and transmitted light, because of these differences he began referring to bands as opaque or translucent, based on their optical properties. McLaren (1958:7) also interprets the narrow translucent band as being laid down from mid-March to the beginning of July. Smith (1973:3-9) compares unstained thin sections under both transmitted and reflected light and notes the effect these forms of light have on the interpretation of "dark" and "light" bands. He also refers to bands as translucent and opaque, and defines the narrow "light" band under transmitted light as a translucent band being laid down from the end of March to June.

Spiess (1976:53) applied this technique to ringed seal (<u>Phoca hispida</u>) from an archaeological sample, and using decalcification and staining under transmitted light defined the narrow dark band as being laid from March to June, a period of fasting and moulting. He also noted that seal teeth are simpler to read because the dentine lines may be checked against the cementum lines with relative ease (Spiess:1976:54).

Comparisons With Modern Ringed Seal Populations

Once mortality profiles have been generated from the analysis of dental annuli of the archaeological sample, and the peak season of death has been determined, the profiles will be compared to the idealized mortality profiles from Stiner (1990). Mortality profiles will be generated for each of the houses and the site total. Both Lyman's (1987) use of age classes, although slightly modified to incorporate major life phases, and Stiner's (1990) use of major life phase categories will be utilized. If the archaeological patterns resemble a catastrophic mortality profile, than the indications will be that Thule seal hunting methods were truly random and biological behaviors segregating age classes had little effect on seal harvesting. If the archaeological patterns resemble an attritional mortality profile, than the result will indicate that some factor of Thule hunting techniques or methods prevented the harvesting of prime aged animals. If the archaeological patterns resemble a prime dominated mortality profile, than the age-class based mortality profiles will be compared to fast ice and pack ice populations from Finley et al. (1983), Smith's (1975) summer population as well as complex and simple coasts from McLaren (1958). These profiles will be statistically tested using

Spearman's rho and Kendall's tau B to determine if the comparisons are statistically significant. This treatment will determine if the selective nature of Thule seal harvesting is the result of biological behavior of ringed seals.

Mortality profiles based on major life phases (i.e. newborns, juveniles, and sexually mature adults) will also be generated. This will be for comparative purposes with Smith's (1987) data, as he does not present the raw data necessary to generate the age class mortality patterns previously mentioned.

CHAPTER 7

MATERIAL AND METHODS

The faunal remains from PaJs-13 Houses 1,3,4 and 5 were washed and the ringed seal elements separated from the sample. It was decided that canine teeth would provide an easier sample to analyze due to the size and the fairly simple structure which would limit meandering of the layers. Teeth were initially divided into six groups; right mandibles with canines, left mandibles with canines, right maxilla with canines, left maxilla with canines, and right and left loose canines, based on the curvature of the tooth.

These loose, sided, canines were then classified as mandibular or maxillary as follows: Maxillary teeth were found to exhibit a bulbous formation at the end of the root in most cases, while it was relatively rare, albeit occasionally found, in mandibular canines. Most mandibular canines formed a noticeable groove along the outer edge of the canine root, while this seldom appeared in maxillary canines. Perhaps most diagnostic was the degree of curvature from root end to the tip of the enamel. The maxillary canines in almost all cases exhibited a much more pronounced curve then the mandibular canines. In most of the cases, loose canines were classified into left mandible, right mandible, left maxilla, and right maxilla categories on the basis of at least two of the previously mentioned characteristics. Those that were difficult to categorize were classified as "uncertain" and were excluded from the sample.

The MNI was based on right mandibles for houses 3 and 4, left mandibles for house 1, and right maxillae for house 5 (Tables 1-4). With the exception of house 5, which stands out for its small sample size, the loose canines only augmented the MNI based on the canines recovered from the bone element and did not change the element on which the MNI was based. Because of the small sample size of house 5, it is excluded from intrasite comparisons following Lyman's (1987) minimum sample size of 30. Canine teeth that were clearly from juveniles, because of their very thin tooth walls, were subjected to special treatment that will be discussed below. These teeth and their respective provenience are listed in Appendix 1.

The canines were thin sectioned to a thickness of 40-50 microns. They were left undecalcified and unstained and were mounted on microscope slides and viewed under transmitted light, with a polarizing microscope. The thin juvenile teeth were simply cut in half at a very slow speed and viewed under reflected light. House 2 canines from the left mandibles had previously been cut and read by Whitridge (1992). These were reread and included in the PaJs-13 sample. The results are listed in Tables 5 to 9.

TABLE 1 DETERMINATION OF MNI FOR HOUSE ONE

HOUSE 1	CANINES FOUND IN BONE ELEMENT	LOOSE CANINES	TOTAL NUMBER OF CANINES PER ELEMENT
LEFT MAXILLA	9	6	15
RIGHT MAXILLA	13	1	14
LEFT MANDIBLE	18	7	25
RIGHT MANDIBLE	16	5	21
INDETERMINATE	0	1	1

TABLE 2 DETERMINATION OF MNI FOR HOUSE THREE

HOUSE 3	CANINES FOUND IN BONE ELEMENT	LOOSE CANINES	TOTAL NUMBER OF CANINES PER ELEMENT
LEFT MAXILLA	21	11	32
RIGHT MAXILLA	19	14	33
LEFT MANDIBLE	44	9	53
RIGHT MANDIBLE	46	10	56
INDETERMINATE	0	0	0

TABLE 3 DETERMINATION OF MNI FOR HOUSE FOUR

HOUSE 4	CANINES FOUND IN BONE ELEMENT	LOOSE CANINES	TOTAL NUMBER OF CANINES PER ELEMENT
LEFT MAXILLA	37	3	40
RIGHT MAXILLA	32	7	39
LEFT MANDIBLE	35	8	43
RIGHT MANDIBLE	42	11	53
INDETERMINATE	0	5	5

TABLE 4 DETERMINATION OF MNI FOR HOUSE FIVE

HOUSE 5	CANINES FOUND IN BONE ELEMENT	LOOSE CANINES	TOTAL NUMBER OF CANINES PER ELEMENT
LEFT MAXILLA	4	0	4
RIGHT MAXILLA	2	4	6
LEFT MANDIBLE	3	2	5
RIGHT MANDIBLE	3	1	4
INDETERMINATE	0	1	1

TABLE 5 AGE AND SEASON OF DEATH ESTIMATES FOR HOUSE ONE

MNI = 25

Tooth #	Age	Season of Death
1	4	late summer (early winter?)
2	13	early winter
3	6	mid-summer
4	7	mid-summer
5	4	early summer
6	5	mid to late summer
7	1	late winter
8	4	late winter
9	1	late summer
10	10	mid to late summer
11	4	late summer (early winter?)
12	5	early summer
13	4	late summer
14	9	early summer
15	4	late summer
16	5	late winter to mid-summer
17	5	mid-summer
18	10	mid to late summer
19	10	mid to late summer
20	14	mid to late summer

TABLE 5 CONTINUED

21	9	mid to late summer
22	16 *	uncertain
23	4	mid to late summer
24	5	late summer (early winter?)
25	8	mid to late summer

* Indicates the use of cementum over dentine in determining the age.

TABLE 6 AGE AND SEASON OF DEATH ESTIMATES FOR HOUSE TWO

MNI = 30

Tooth #	Age	Season of Death
1	9	early to mid-summer
2	11	early winter
3	9	late summer
4	9	early winter
5	10	early winter
6	3	mid-summer
7	10	early summer
8	<1	late winter
9	7 (?)	early summer (?)
10	5	late winter to early summer
11	7	mid to late winter
12	10	late summer to early winter
13	2	mid-winter
14	3	mid-summer
15	7	early to mid-summer
16	5	late winter (?)
17	8	early to mid-winter
18	3	mid-summer
19	7	mid to late summer (?)
20	16	late summer to early winter

TABLE 6 CONTINUED

21	9	early to mid-summer
22	<1	uncertain
23	13	early summer
24	3	late winter to early summer
25	2	late winter
26	14 (?)	uncertain
27	14	late winter to early summer
28	2	early summer
29	7	early winter
30	1	mid to late winter

TABLE 7 AGE AND SEASON OF DEATH ESTIMATES FOR HOUSE THREE

MNI = 56

Tooth #	Age	Season of Death
1	5	early summer
2	7	mid to late summer
3	7	early winter
4	16 *	mid-summer (?)
5	20 (?) *	uncertain
6	12	early to mid-summer
7	19-22 *	summer (?)
8	11	early to mid-summer
9	7	early to mid-summer
10	17 *	early winter (?)
11	2	early winter
12	3	early summer
13	3	early winter
14	9	mid to late summer
15	1	late winter
16	19-21 *	uncertain
17	19 *	uncertain
18	18 *	summer (?)
19	14 *	summer
20	4	late summer (early winter?)

TABLE 7 CONTINUED

21	2	early summer
22	3	early winter
23	24 (?) *	uncertain
24	14-17 *	early to mid-summer
25	14-18 *	uncertain
26	5	late summer
27	7	early summer
28	10	late summer (early winter?)
29	9	early summer
30	15	summer (?)
31	6	late summer
32	<1	late summer
33	10	early winter (?)
34	3	late summer (early winter?)
35	8	mid-summer
36	7	mid to late summer
37	2	early summer
38	2	early winter
39	3	late summer (early winter?)
40	11	early winter (?)
41	16 *	uncertain
42	3	late winter to early summer
43	4	mid to late winter

TABLE 7 CONTINUED

44	5	early summer
45	12	early summer
46	5	mid to late summer
47	24-26	summer
48	5	early summer
49	4	late summer
50	19-25 *	uncertain
51	5	early summer
52	12	late summer (early winter?)
53	11	late summer (early winter?)
54	10	mid-summer to early winter
55	13	late summer (early winter?)
56	9	late winter

* Indicates the use of cementum over dentine in determining the age.

TABLE 8 AGE AND SEASON OF DEATH ESTIMATES FOR HOUSE FOUR

MNI = 53

Tooth #	Age	Season of Death
1	10	mid to late summer
2	3	late summer (early winter?)
3	6	early summer
4	7	early summer
5	11	early summer
6	5	early summer
7	2	late winter
8	23-25 *	uncertain
9	21-25 *	uncertain
10	10	mid to late summer
11	9	early to mid-summer
12	12	late summer (early winter?)
13	7	early summer
14	12	early summer
15	12	uncertain
16	26-29 *	uncertain
17	20 (?)	uncertain
18	7	mid to late winter
19	7	late summer
20	14	mid to late winter

TABLE 8 CONTINUED

21	7	late summer (early winter?)
22	14	late winter to early summer
23	13	late summer
24	9	late summer (early winter?)
25	24 *	uncertain
26	2	early summer
27	10	early summer
28	2	late summer
29	9	late winter to early summer
30	10	early summer
31	7	mid to late winter
32	5	early summer
33	8	early to mid-summer
34	7	early to late summer
35	25-27 *	uncertain
36	20-23 *	uncertain
37	16	uncertain
38	23	uncertain
39	9	late winter (early summer?)
40	15 (?)	uncertain
41	22 (?)	uncertain
42	11	mid to late summer
43	14	early summer

TABLE 8 CONTINUED

44	8	early to mid-summer
45	20-24 *	uncertain
46	9	mid to late summer
47	8	early summer
48	7	late winter (early summer?)
49	9	late winter
50	16-17 *	mid to late summer
51	9	late summer (?)
52	2	early winter
53	11	early winter

* Indicates the use of cementum over dentine in determining the age.

TABLE 9 AGE AND SEASON OF DEATH ESTIMATES FOR HOUSE FIVE

MNI = 6

Tooth #	Age	Season of Death
1	4	late summer to early winter
2	4	late summer (early winter?)
3	3	late summer (early winter?)
4	8	early to mid-summer
5	10	mid-summer
6	11	early to mid-summer

Determining age of death was relatively straightforward, while seasonality determinations were more difficult to estimate. Each thin section was analyzed twice with a period of several days occurring between each viewing. If the interpretations differed, the sections were examined a third time.

The seasonal definitions are based on Smith's (1973) study, in which he defines the opaque band as being deposited from July to mid-March, and the translucent band from the end of March to the end of June. Each final band was categorized as "beginning", "partial", or "complete". This resulted in six categories. Biologists frequently utilize spring, summer, autumn, and winter when reporting seasonal population catches as did Smith (1987:8), on which this study's seasonal populations are based. Smith (1987:8) defined "autumn" as the three weeks before the first formation of land fast ice in late September. This category is too narrowly defined for an archaeological study. Therefore, this study utilized three seasons; 1) "winter" from November to mid-March 2) "spring" from late March to June and 3) "open water" from July to October. This results in the following division;

Opaque Band:

"Beginning"	=	July to mid-October (Open Water)
"Partial"	=	mid-October to December (Winter)
"Complete"	=	January to mid-March (Winter)

Translucent Band:

"Beginning" = mid-March to April (Early Spring)

"Partial" = May (Mid-Spring)

"Complete" = June (Late Spring)

Some difficulty arose with regard to when late spring occurs. In the study area, late spring conditions (that is, the presence of stable yet slowly diminishing amounts of fast ice and the gradual breaking up of pack ice) extend well into July (Savelle; personal communication). These conditions were originally classified as open water, based on dates given by Smith (1973), but would be better classified as late spring. Indeed, from a total sample of 170 teeth only 20 were classified as open water, and of those 18 (90%) were clearly from the "beginning" of the opaque band. When these were classified with late spring, the resulting histogram (Figure 13) showed no real difference between the total age distribution for spring as originally defined (Total 1) and the total age distribution for spring including these "early open water" specimens with the late spring specimens (Total 2).

Most seals over 18 years of age were impossible to read for seasonality, and a number were placed in age ranges as it was very difficult to read the crowded incremental lines in these individuals. For this reason, the upper age range that will be utilized in this study is 18 years old and older.

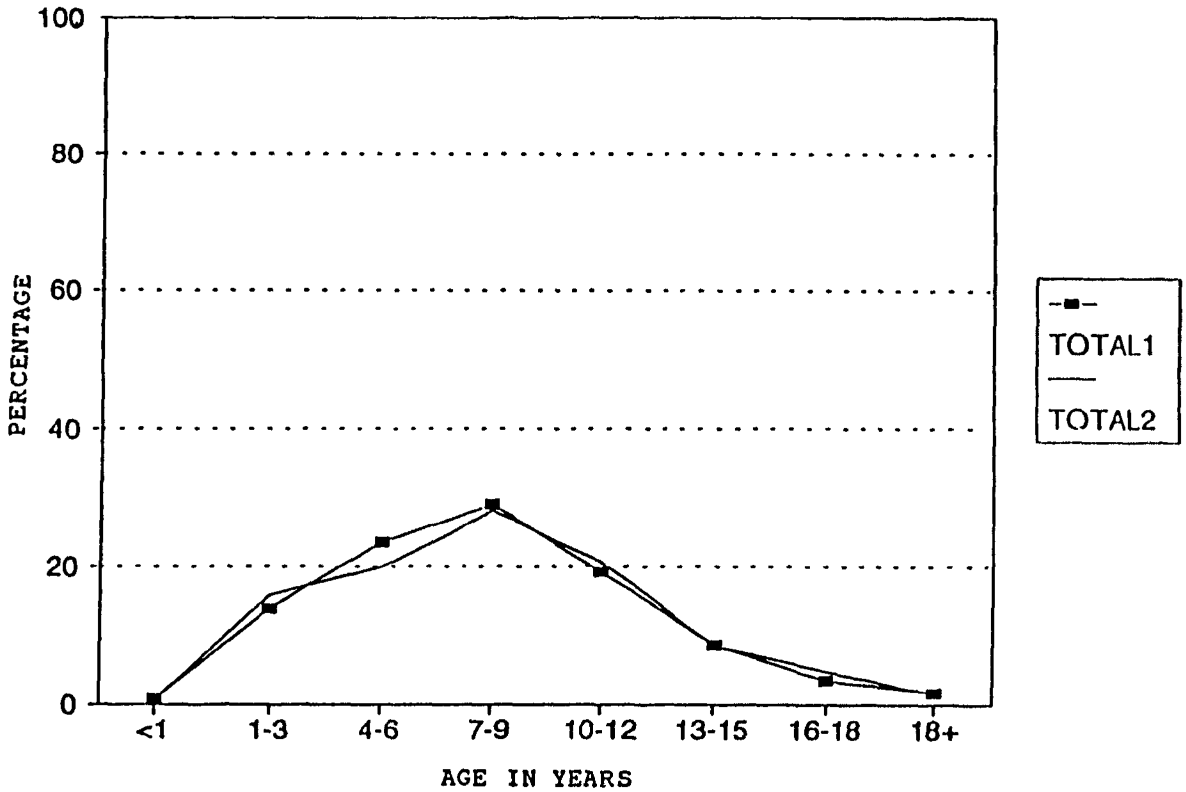


FIGURE 13 COMPARISON OF ORIGINAL SPRING TOTAL (TOTAL 1) AND SPRING TOTAL WITH EARLY OPEN WATER ADDED (TOTAL 2)

CHAPTER 8

DISCUSSION

Comparison Of Season Of Death Estimates

Tables 10 and 11 present the seasonality estimates for teeth from the individual houses and the entire site as originally defined, without combining early open water figures with those of late spring (Total 1)and those with the addition (Total 2). The seasonality estimates are consistent with the classification of the site as a winter site. Interestingly enough, the vast majority of the seals were killed in the spring, which is environmentally similar to winter in the Arctic, with winter kills being underrepresented. This is in contrast to the historic period, for which records indicate a steady reliance on seal in both the winter and spring seasons.

Seasonality data for house 2 compared favorably with that obtained by Whitridge (1992:135) on the same material. He presented a slightly higher winter figure (28.57% to 16.67%), a greater spring figure (61.90% to 50.00%), and a lower summer/fall or open water figure (9.52% to 26.67%). Although figures from this study also allow for an "uncertain" category at 6.67% the basic pattern is evident, and if the early open water category were to be reclassified as late spring the results would be much closer.

TABLE 10 BREAKDOWN OF PAJS-13 BY SEASON

(Based on Total 1 Figures)

	House 1	House 2	House 3	House 4	House 5	PaJs-13
Winter	2 8.00%	5 16.67%	3 5.36%	7 13.21%	0 0.00%	17 10.00%
Spring	21 84.00%	15 50.00%	38 67.86%	31 58.49%	5 83.33%	110 64.71%
Open Water	1 4.00%	8 26.67%	8 14.29%	2 3.77%	1 16.66%	20 11.76%
uncertain	1 4.00%	2 6.67%	7 12.50%	13 24.53%	0 0.00%	23 13.53%
Total	25 100.00%	30 100.01%	56 100.01%	53 100.00%	6 100.00%	170 100.00%

TABLE 11 BREAKDOWN OF PAJS-13 BY SEASON

(Based on Total 2 Figures)

	House 1	House 2	House 3	House 4	House 5	PaJs-13
Winter	2 8.00%	5 16.67%	3 5.36%	7 13.21%	0 0.00%	17 10.00%
Spring	22 88.00%	21 70.00%	46 82.14%	33 62.26%	6 100.00%	128 75.29%
Open Water	0 0.00%	2 6.67%	0 0.00%	0 0.00%	0 0.00%	2 1.18%
uncertain	1 4.00%	2 6.67%	7 12.50%	13 24.53%	0 0.00%	23 13.53%
Total	25 100.00%	30 100.01%	56 100.00%	53 100.00%	6 100.00%	170 100.00%

Tables 12-14 present a division of season of death figures based on the separation of newborns, juveniles, and sexually mature adults (based on Total 2). Table 12 demonstrates that remarkably few newborns are represented in the site. This is unlikely to be due to taphonomic factors, since preservation of the faunal material within the dwellings was very good to excellent (Savelle, personal communication). According to ethnographic accounts of when seal pups were hunted, spring is the ideal period to capture newborns. During the spring birthing and weaning periods seal pups would have been particularly vulnerable. Tables 13 and 14 show that the majority of the juveniles and adults recovered from the site were killed in the spring. This study will concentrate on the spring season, as this is the best represented and indicates the period of occupation of the site when the hunting of ringed seal seems most important.

Comparison Of Age Categories In Spring

The results from the spring season definitely do not follow the living-structure mortality profile as discussed in Chapter 2. In fact the results are much closer to the prime-dominated mortality profile. Chapter 4 demonstrated that this cannot be the result of an unusual living structure among ringed seals, nor is it likely to be the result of intentional selection on the part of the Thule hunters.

TABLE 12 DISTRIBUTION OF NEWBORNS (<1 YEARS OF AGE) BY SEASONS

NEWBORNS (<1)	Winter	Spring	Open Water
House 1	0	0	0
House 2	1	0	0
House 3	0	1	0
House 4	0	0	0
House 5	0	0	0
PaJs-13	1	1	0

TABLE 13 DISTRIBUTION OF JUVENILES (1-6 YEARS OF AGE)

JUVENILES (1-6)	Winter	Spring	Open Water
House 1	2 (3.51%)	13 (22.81%)	0 (0%)
House 2	3 (5.26%)	6 (10.53%)	1 (1.75%)
House 3	2 (3.51%)	15 (26.32%)	4 (7.02%)
House 4	1 (1.75%)	6 (10.53%)	1 (1.75%)
House 5	0 (0%)	2 (3.51%)	1 (1.75%)
PaJs-13	8 (14.04%)	42 (73.68%)	7 (12.28%)

TABLE 14 DISTRIBUTION OF SEXUALLY MATURE ADULTS

(7 YEARS OF AGE AND OLDER)

ADULTS (7+)	Winter	Spring	Open Water
House 1	0 (0%)	8 (9.09%)	1 (1.14%)
House 2	1 (1.14%)	9 (10.23%)	7 (7.95%)
House 3	1 (1.14%)	22 (25.00%)	4 (4.55%)
House 4	6 (6.82%)	25 (28.41%)	1 (1.14%)
House 5	0 (0%)	3 (3.41%)	0 (0%)
PaJs-13	8 (9.09%)	67 (76.14%)	13 (14.77%)

Figures 14-17 present the percentage data for the comparison of houses 1,2,3, and 4. As previously noted, the low sample size recovered from house 5 precluded that sample from individual house comparisons. Figures 14 and 15 compare the percentages of newborn, juvenile, and sexually mature ringed seal both with and without the inclusion of early open water specimens. As has been previously observed, the early open water specimens do not significantly alter the frequency distributions. Houses 2,3, and 4 have a much greater percentage of sexually mature adults then newborns and juveniles. However, the difference is less noticeable in house 3, which also exhibits the only newborns. House 1 presents an inverse relationship with juveniles outnumbering sexually mature adults. Figures 16 and 17 present this same data in terms of mortality profiles. The greatest differences between the four houses occurs during the 4-6 years of age category (i.e. the older juveniles).

A comparison with Whitridge's (1992:137) data again compares favorably with my own. Although Whitridge does not separate the newborn, juvenile, and adult categories by season, the general trend is very similar to my reinterpretation of his house 2 material. He presents 13.33% newborn, 30.00% juvenile, and 56.67% adult as the composite spread for house 2.

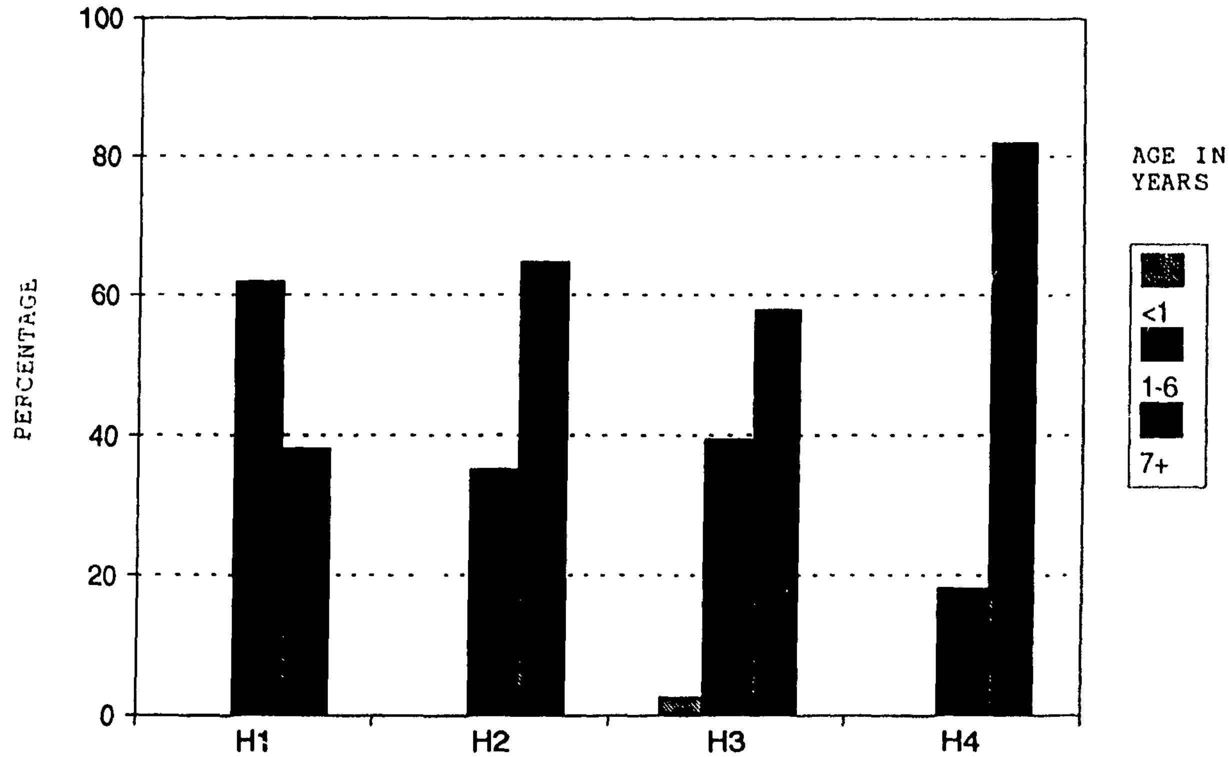


FIGURE 14 POPULATION CHARACTERISTICS OF RINGED SEALS FROM HOUSES 1 (H1), 2 (H2), 3 (H3), AND 4 (H4) BASED ON ORIGINAL SPRING TOTAL WITHOUT EARLY OPEN WATER

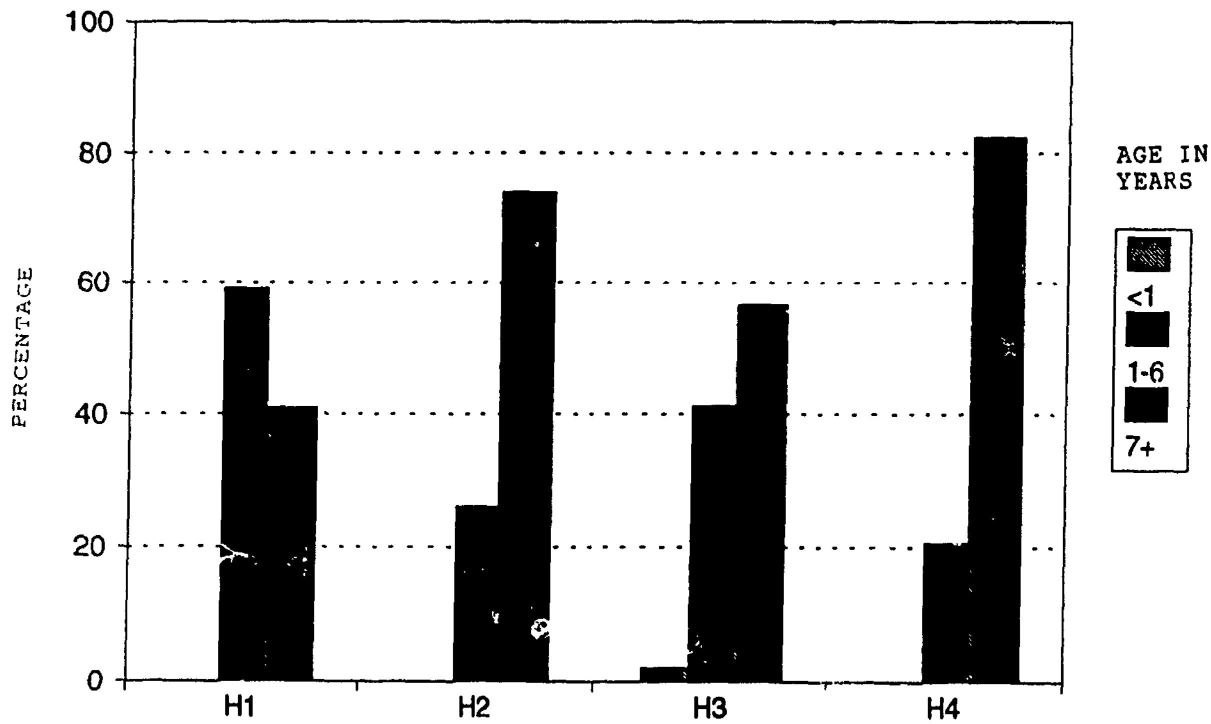


FIGURE 15 POPULATION CHARACTERISTICS OF RINGED SEALS FROM HOUSES 1 (H1), 2 (H2), 3 (H3), AND 4 (H4) BASED ON SPRING TOTAL WITH EARLY OPEN WATER ADDED

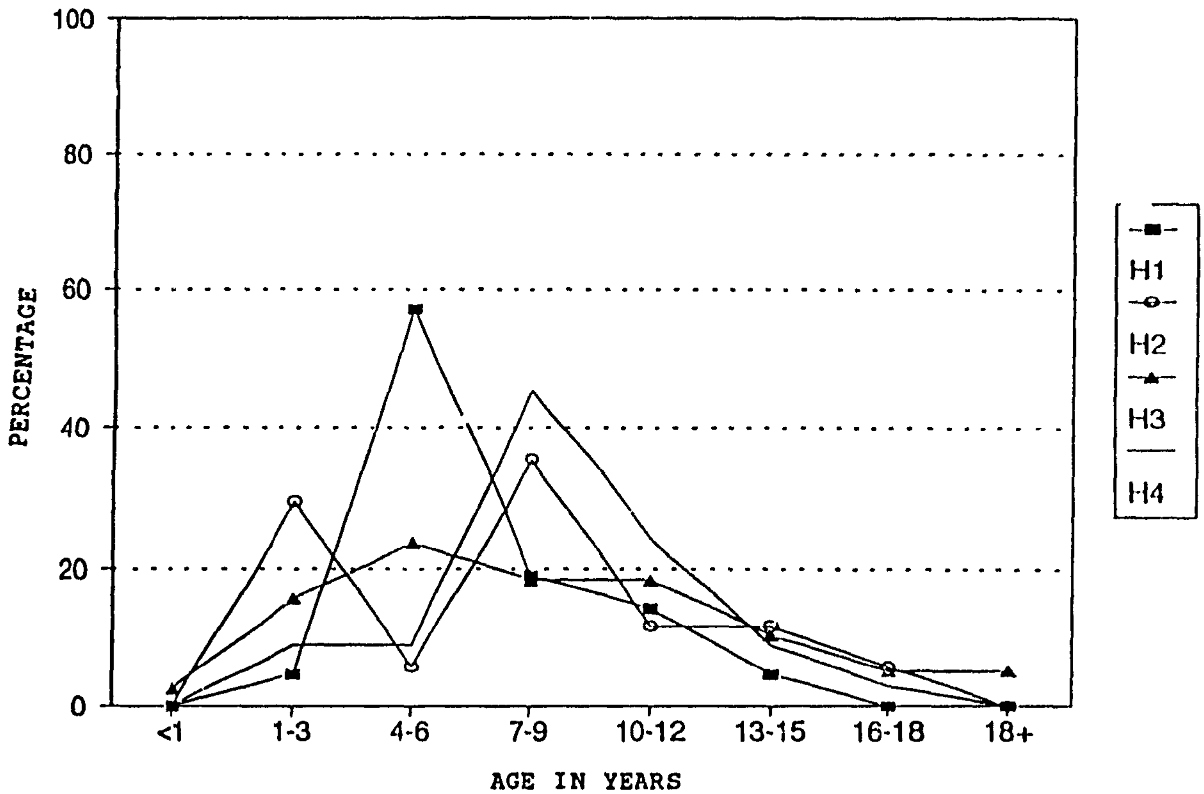


FIGURE 16 POPULATION CHARACTERISTICS OF RINGED SEALS FROM HOUSES 1 (H1), 2 (H2), 3 (H3), AND 4 (H4) BASED ON ORIGINAL SPRING TOTAL WITHOUT EARLY OPEN WATER

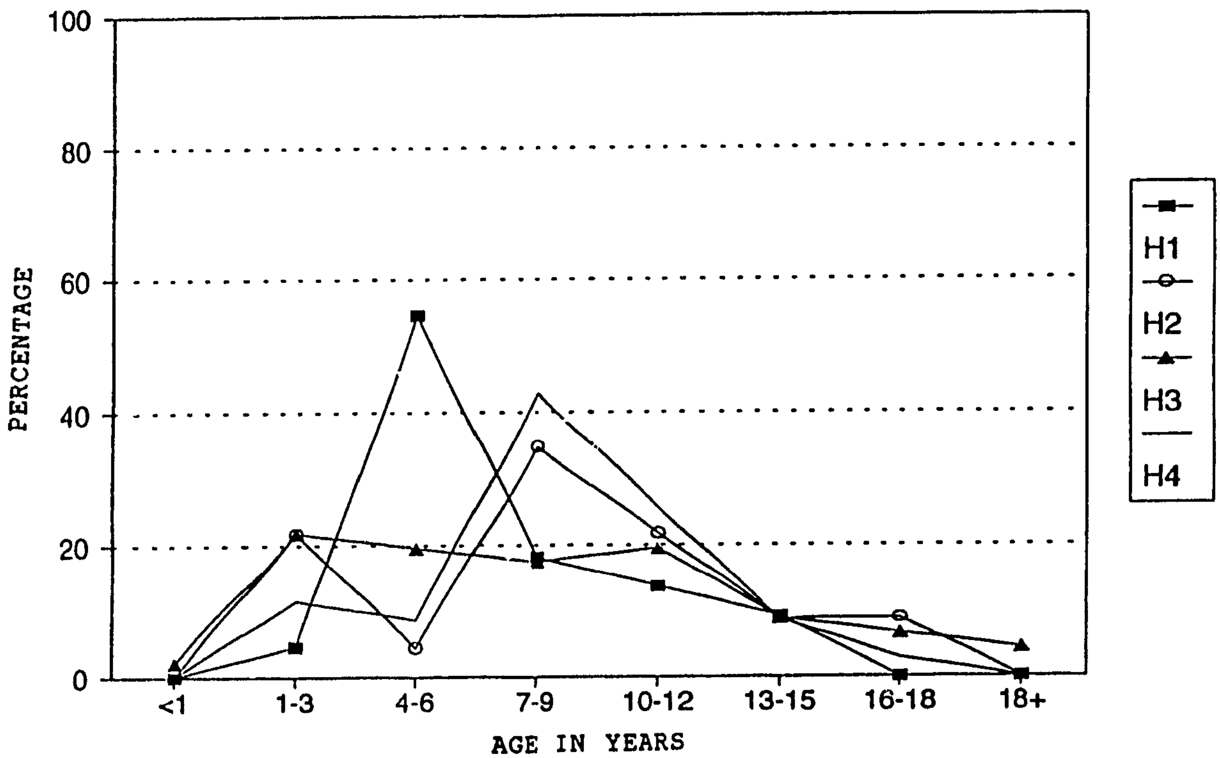


FIGURE 17 POPULATION CHARACTERISTICS OF RINGED SEALS FROM HOUSES 1 (H1), 2 (H2), 3 (H3), AND 4 (H4) BASED ON SPRING TOTAL WITH EARLY OPEN WATER ADDED

Comparison Of Spring Sample With Pack And Fast Ice

As Chapter 5 indicated, ringed seal behavior results in a population split due to the competition of the breeding and birthing period during the spring. This division of the population is based on age, and results in the movement of juveniles to the more distant and/or difficult areas for humans to hunt from. Thus a comparison of the archaeological population with the modern ringed seal populations from fast ice and pack ice is beneficial in explaining the selective mortality profile that resulted from the archaeological sample.

Spearman's rho and Kendall's tau correlation coefficients were run on SAS (Release 6.03 edition) on an IBM personal computer. The individual houses (1,2,3, and 4) were compared with McLaren's (1958) complex and simple coast data presented in Chapter Five, Finley et. al.'s (1983) data on fast ice and pack ice, and Smith's (1987) summer population. Both the total for the site with and without the addition of the early open water specimens were compared with the same data using the same methods. Appendix 2 and 3 list the relevant data used. A statistically significant correlation exists between houses 1 and 3 and Finley's pack ice population, houses 2 and 4 and Finley's fast ice population, as well as between the totals and Finley's pack ice population. Houses 2 and 4, however, also exhibited a close correlation with Finley's pack ice population as well. Tables 15-18 list the correlations.

TABLE 15 SPEARMAN'S CORRELATION COEFFICIENTS FOR SPRING SAMPLE

(Based on Total 1 Figures Without Early Open Water)

(Data on Pack Ice and Fast Ice From Finley et. al. 1983:167)

	Pack Ice	Fast Ice
House One	0.84 (0.01)	0.36 (0.39)
House Two	0.72 (0.05)	0.83 (0.01)
House Three	0.87 (<0.01)	0.43 (0.29)
House Four	0.73 (0.04)	0.78 (0.02)
House Five	0.81 (0.02)	0.45 (0.26)
Site Total	0.86 (0.01)	0.54 (0.16)

The upper number indicates how closely correlated the two samples are, with the greatest positive correlation being 1.0 and the greatest negative correlation being -1.0.

The lower number indicates whether the upper number is statistically significant. If the lower number is less than 0.05 the correlation is significant.

TABLE 16 KENDALL TAU B CORRELATION COEFFICIENTS FOR SPRING SAMPLE

(Based on Total 1 Figures Without Early Open Water)

(Data on Pack Ice and Fast Ice From Finley et. al. 1983:167)

	Pack Ice	Fast Ice
House One	0.76 (0.01)	0.34 (0.28)
House Two	0.63 (0.04)	0.71 (0.02)
House Three	0.77 (0.01)	0.45 (0.15)
House Four	0.64 (0.04)	0.68 (0.03)
House Five	0.66 (0.04)	0.47 (0.16)
Site Total	0.74 (0.01)	0.51 (0.09)

The upper number indicates how closely correlated the two samples are, with the greatest positive correlation being 1.0 and the greatest negative correlation being -1.0.

The lower number indicates whether the upper number is statistically significant. If the lower number is less than 0.05 the correlation is significant.

TABLE 17 SPEARMAN'S CORRELATION COEFFICIENTS FOR SPRING SAMPLE

(Based on Total 2 Figures With Early Open Water)

(Data on Pack Ice and Fast Ice From Finley et. al. 1983:167)

	Pack Ice	Fast Ice
House One	0.75 (0.03)	0.34 (0.40)
House Two	0.14 (0.74)	0.68 (0.06)
House Three	0.87 (0.01)	0.69 (0.06)
House Four	0.46 (0.25)	0.96 (<0.01)
House Five	0.76 (0.03)	-0.14 (0.75)
Site Total	0.77 (0.03)	0.73 (0.04)

The upper number indicates how closely correlated the two samples are, with the greatest positive correlation being 1.0 and the greatest negative correlation being -1.0.

The lower number indicates whether the upper number is statistically significant. If the lower number is less than 0.05 the correlation is significant.

TABLE 18 KENDALL TAU B CORRELATION COEFFICIENTS FOR SPRING SAMPLE

(Based on Total 2 Figures With Early Open Water)

(Data on Pack Ice and Fast Ice From Finley et. al. 1983:167)

	Pack Ice	Fast Ice
House One	0.60 (0.05)	0.34 (0.28)
House Two	0.18 (0.56)	0.59 (0.07)
House Three	0.77 (0.01)	0.61 (0.05)
House Four	0.44 (0.15)	0.89 (<0.01)
House Five	0.65 (0.05)	-0.12 (0.73)
Site Total	0.59 (0.04)	0.67 (0.03)

The upper number indicates how closely correlated the two samples are, with the greatest positive correlation being 1.0 and the greatest negative correlation being -1.0.

The lower number indicates whether the upper number is statistically significant. If the lower number is less than 0.05 the correlation is significant.

Figure 18 compares Finley's pack ice with houses 1 and 3. While house 3 does exhibit a strong similarity with the pack ice population, house 1 seems to differ with regard to the 1-3 and 4-6 years of age categories. Figure 19 compares Finley's fast ice population with houses 2 and 4. The patterns between these samples are very similar indeed. Figures 20 and 21 compare the two totals with Finley's fast ice and pack ice populations. While the overall pattern is similar to the pack ice, the peak in the 7-9 years of age category is significant in that it lies between the peaks of both the fast ice and pack ice population. Figure 22 presents the comparison of the total with the fast ice and pack ice populations for newborns, juveniles, and adults.

Previously, in Chapter Five, a degree of skepticism regarding the use of Finley's fast ice population because of the small sample size of twelve individuals was presented. This may be partially, but not entirely, responsible for the lack of a greater correlation between the totals and the individual houses and the fast ice population. The double peaked mortality profile of the fast ice sample and houses 2 and 4, is extremely interesting. The lower representation of 4-6 year olds, may represent an active aggression against older juvenile males by sexually mature males, which would view the older juveniles as more of a threat than the younger juveniles.

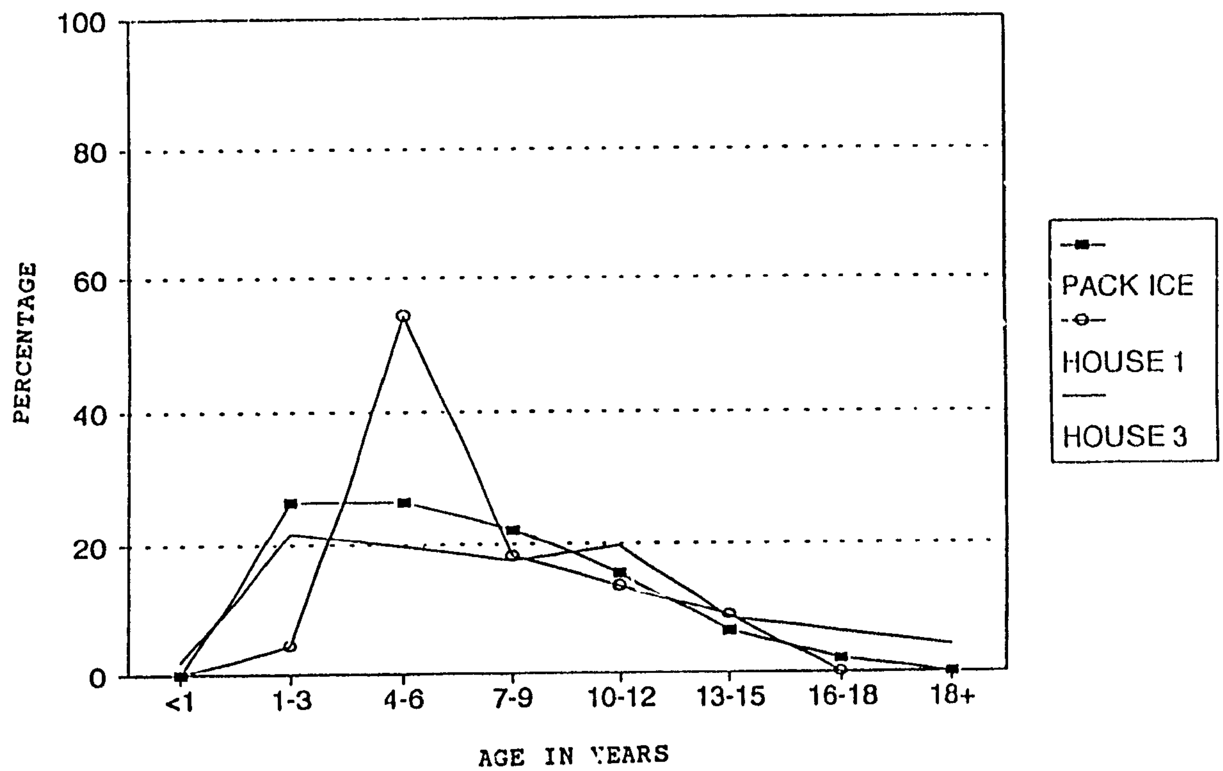


FIGURE 18 COMPARISON OF HOUSE ONE AND THREE

(BASED ON TOTAL 2) WITH PACK ICE

(Data From Finley et al. 1983:167)

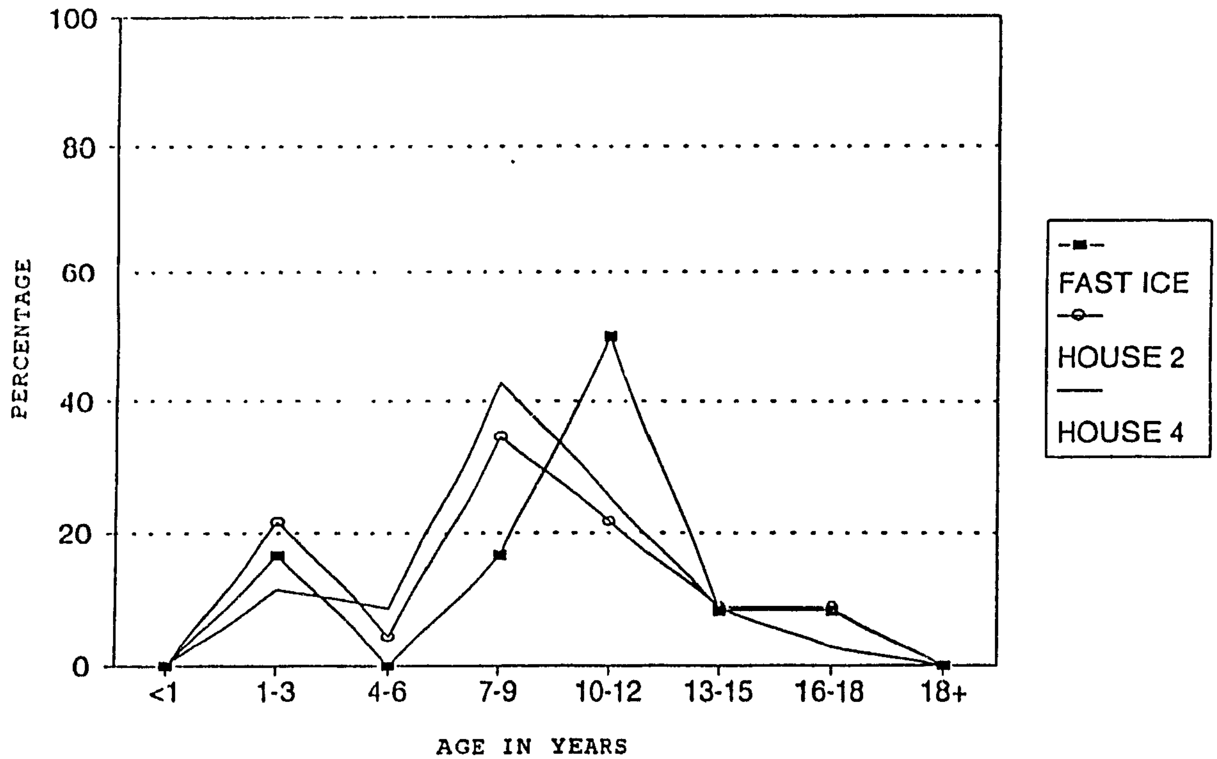


FIGURE 19 COMPARISON OF HOUSE TWO AND FOUR

(BASED ON TOTAL 2) WITH FAST ICE

(Data From Finley et al. 1983:167)

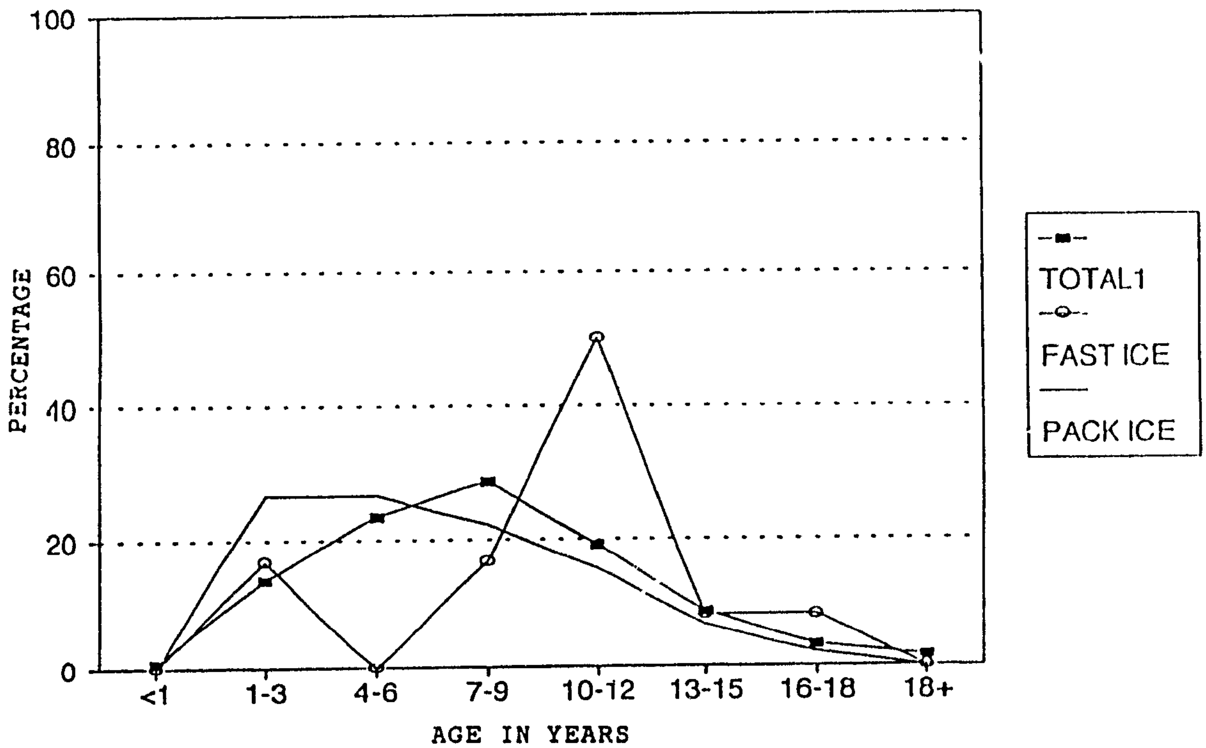


FIGURE 20 COMPARISON OF SPRING TOTAL ONE (WITHOUT EARLY OPEN WATER) WITH FAST AND PACK ICE (Data From Finley et al. 1983:167)

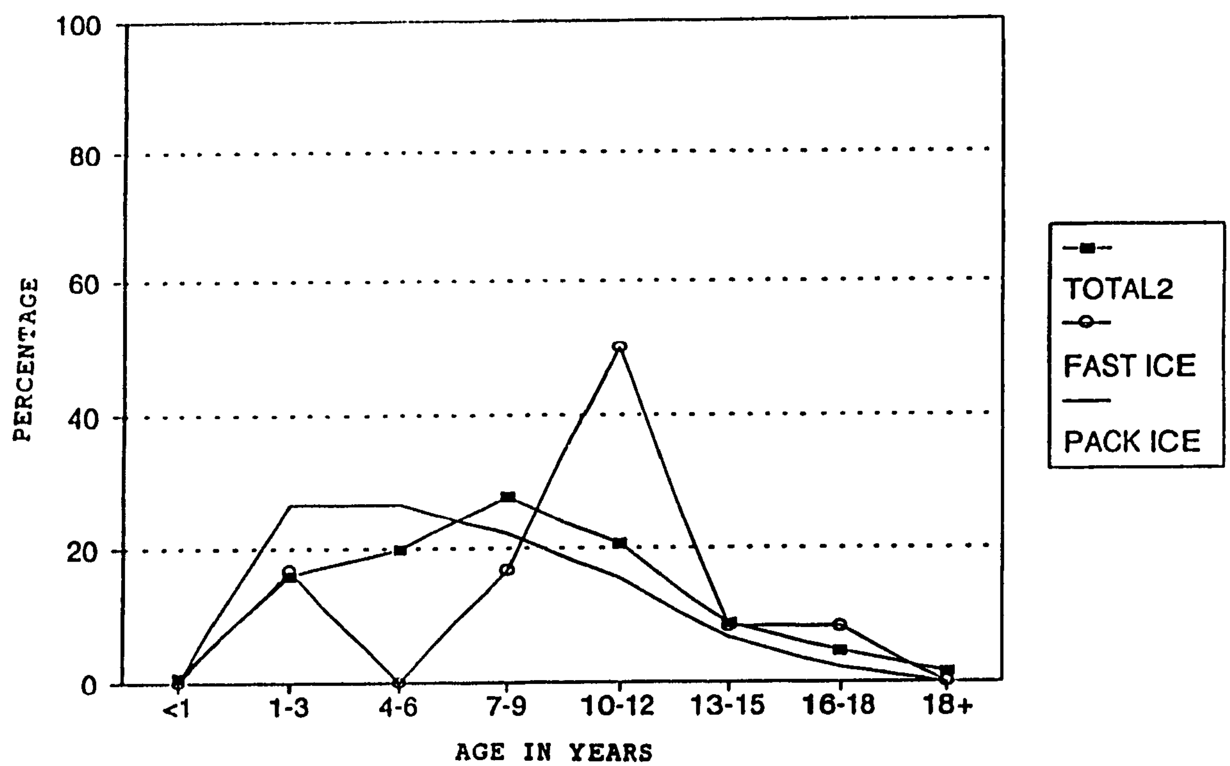


FIGURE 21 COMPARISON OF SPRING TOTAL TWO (WITH EARLY OPEN WATER) WITH FAST AND PACK ICE (Data From Finley et al. 1983:167)

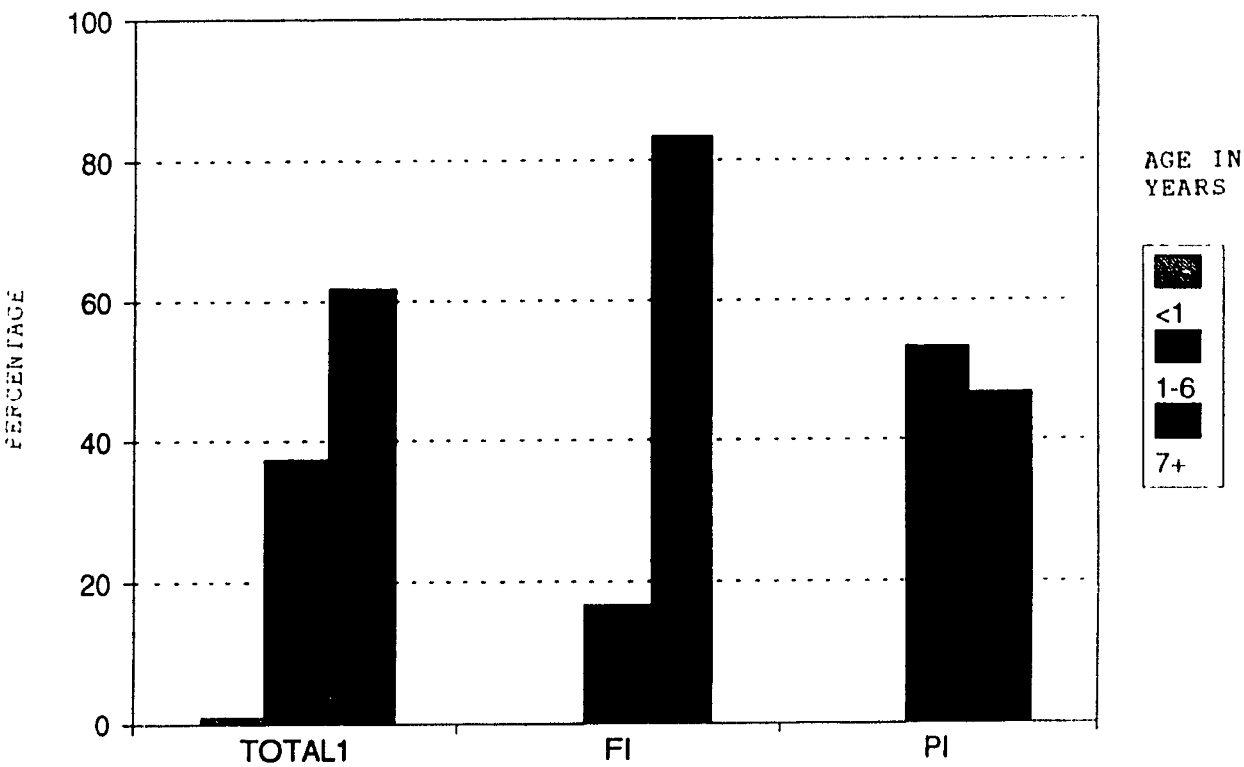


FIGURE 22 POPULATION CHARACTERISTICS OF RINGED SEAL POPULATIONS FROM SPRING TOTAL ONE (WITHOUT EARLY OPEN WATER) AND FAST AND PACK ICE POPULATIONS

(Data From Finley et al. 1983:167)

Discussion Of Hunting Strategies

The peaks in the total figures for the site,as well as Figure 22, suggest that both fast ice and pack ice populations were exploited by the Thule. However 7-9 year olds are represented in greater proportion at the site then any other age group. This would indicate that fast ice is more actively hunted. However house 1 poses a problem in this regard, in that it bears a closer relationship with the floe edge sample presented by Smith (1987). Unfortunately, only the comparison between newborns, juveniles, and adults was available from his study so it was not included in the correlation coefficient study.

The major question remains as to why the archaeological sample seems to emphasize the pack ice environment over the fast ice environment in contrast to historic Inuit harvesting practices. The use of open water hunting techniques can be ruled out, as spring in the Arctic is still a winter environment. If ethnographically documented hunting methods were being utilized, as I believe they were, why are newborns so vastly under represented, and why are winter kills much less then would be expected? Add to this the apparent contradiction of intrasite variability in the site, when ethnographically, seal hunting is communal, not individual.

The answer to many of these questions may lie in the location of the site. PaJs-13 is positioned on what McLaren (1958) would classify as a simple coast. Figures 23-25

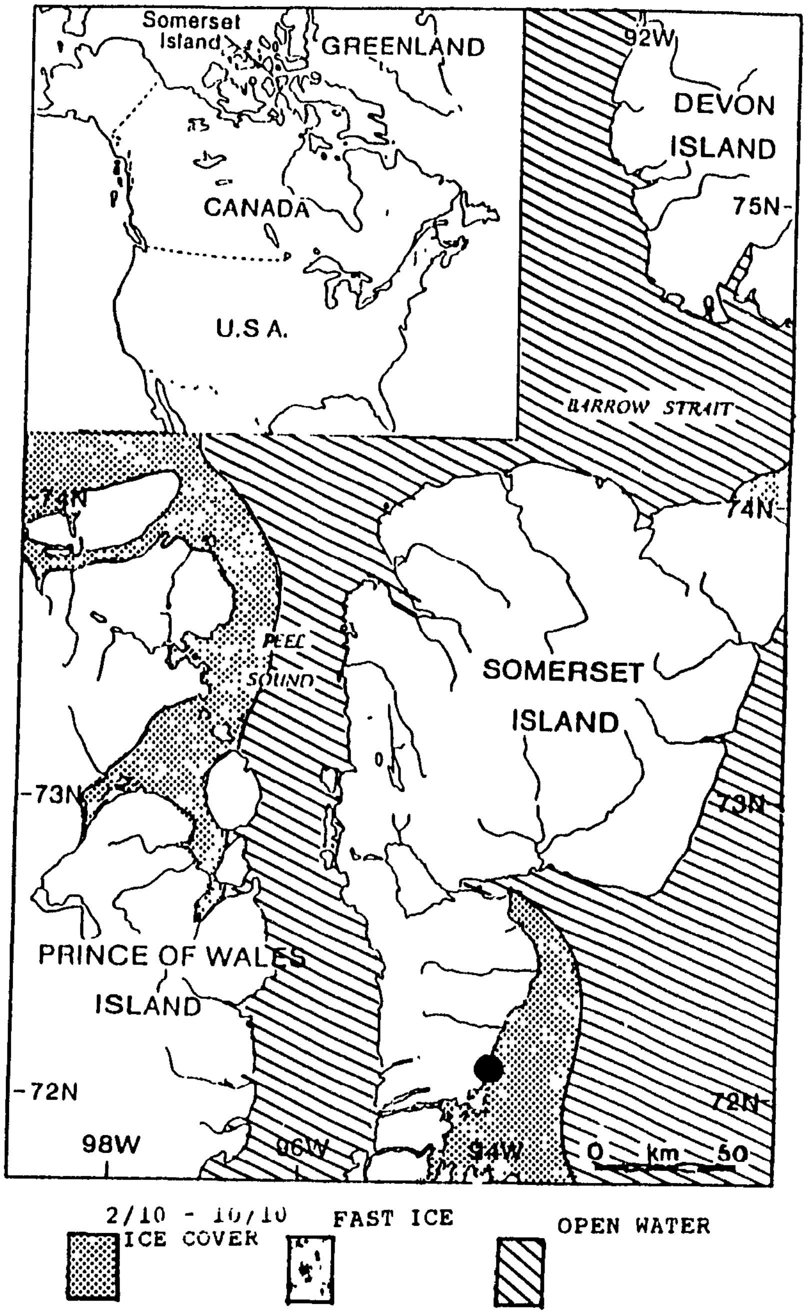


FIGURE 23 MAP OF ICE FORMATIONS AROUND SOMERSET ISLAND FROM SEPTEMBER 15, 1976

(Data From Smith and Rigby 1981:17)

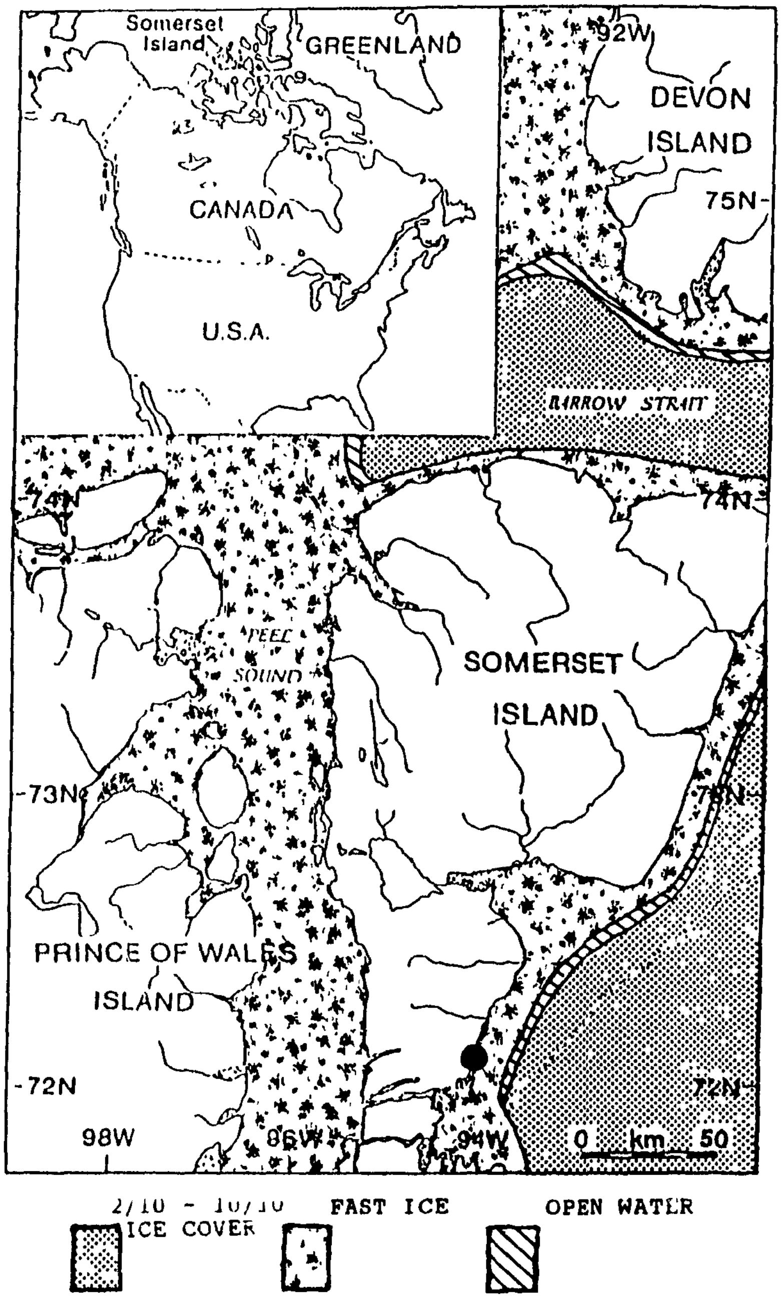


FIGURE 24 MAP OF ICE FORMATIONS AROUND SOMERSET ISLAND

FROM FEBRUARY 15, 1975

(Data From Smith and Rigby 1981:15)

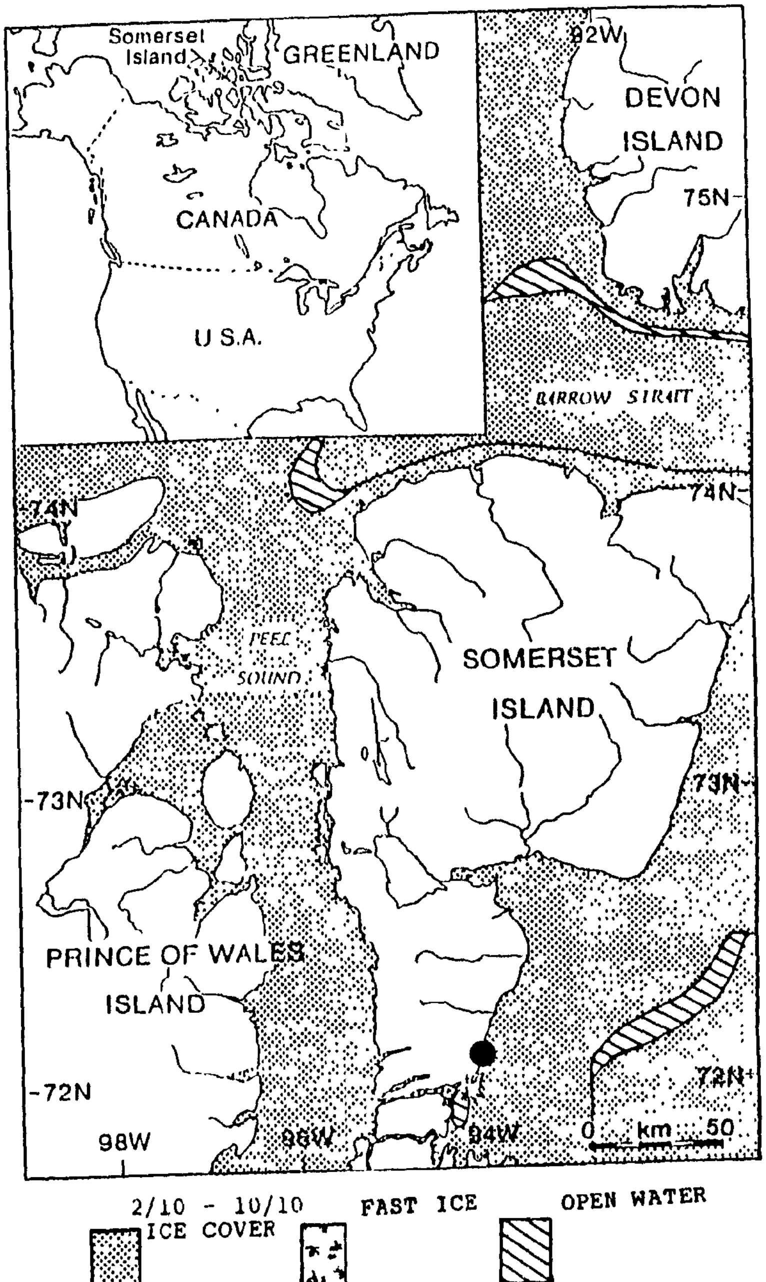


FIGURE 25 MAP OF ICE FORMATIONS AROUND SOMERSET ISLAND FROM APRIL 15, 1976

(Data From Smith and Rigby 1981:17)

indicate the formation of ice throughout the year adjacent to the study area. Fast ice, open water, and intermediate ice cover (indicated as the ratio of ice to open water) are taken from Smith and Rigby (1981:15,17). The closest area of complex coastline with large areas of fast ice is located about six kilometers south of the site. Ice atlas data, together with Savelle's personal observations of the coast adjacent to PaJs-13, indicate that the site is at the periphery of this large fast ice area, so that fast ice represents only a relatively narrow strip of the ice environment (refer to Figure 24). Savelle's observations indicate that the fast ice along the coast is probably much narrower than the ten kilometers shown by Smith and Rigby (1981).

The variability between off-shore and fast ice populations of simple coasts as presented in Chapter 5 is not nearly as noticeable as that from complex coasts. This is probably due to two factors. First, sexually mature adults tend to become year-round residents of areas delimited by fast ice, particularly complex coasts where fast ice forms rapidly and extensively (McLaren 1958:70-73). Second, immature seals find simple coasts easier to occupy as fast ice forms more slowly on these coasts, allowing for a more gradual migration from the shore to remain near areas of open water (McLaren 1959:73). Thus the natural randomness of ethnographic hunting techniques would be more likely to produce slightly different populations such as found at this site. These populations correlate to a certain degree with both fast and pack ice seal populations. However, the ratio of adults to juveniles would be such that even if the smaller area of fast ice were exploited, the sample might very well be more representative of a pack ice population.

The lack of newborns in the archaeological sample may also be directly related to the location of the site on a simple coast. McLaren (1962:171) states,

> "The influence of ice conditions is also reflected in the higher proportion of small pups and the common occurrence of starvelings, the result of premature separation from their mothers, among seals of simple coasts. The offspring of younger, less experienced mothers dwelling on less stable, less snow-covered ice seem generally to be weaned earlier."

The higher occurrence of death among the seal pups is most likely responsible for the smaller number of newborns present in the archaeological record.

The lack of a high percentage of winter kills is also very interesting. It ties in with the use of marine technology and the active fall hunting of bowhead whales. The cultural material evidence, together with faunal evidence, indicates that whaling was a prominent part of Thule culture in this area(Savelle and McCartney 1988, 1991). A reliance on cached supplies of whale meat and blubber could explain the lack of numerous seals killed during the winter. An increased use of ringed seal in the spring may indicate either the depletion of cached whale meat and blubber or the desire for a dietary shift to fresh meat or blubber.

CHAPTER 9

CONCLUSION

This paper has briefly summarized dental "growth ring" studies and their use with regard to the archaeological record. Emphasis has been placed on the role these studies may play in the use of mortality profiles to understand and interpret Thule ringed seal hunting methods.

Ethnographic records emphasize ringed seal as an important species, and demonstrate that seal hunting methods practiced by the historic Inuit can be classified as random, in that no active selection based on age, sex, or size is likely. This allows for the introduction of ringed seal behavior as the primary factor to influence mortality patterns.

Possible competition between sexually mature seals for the best mating and breeding habitats may result in seal populations being distributed in very different age groupings based on the coastal environment and the condition of the ice. The ideal mating and breeding habitats are those along complex coasts and on fast ice If one discounts the likelihood of separate pack ice and fast ice populations, based on the lack of solid evidence for such a situation, then separate archaeological mortality profiles may demonstrate which coastal areas were exploited and possibly what type of ice was most often chosen by Thule hunters. This information, through a close examination of the ethnographic record, will reveal the most likely hunting methods utilized.

An archaeological sample was examined to test this use of mortality profiles. Dental annuli studies provide an accurate method of determining the ages and seasons of death necessary for such a test. Five houses from a Thule semisubterranean house site were examined. One house was deemed too small to represent a valid statistical sample. The other four houses, and the overall total for the site, demonstrated that if ethnographically-documented hunting practices were used, random hunting techniques do not always exhibit a living structure mortality profile, as has often been assumed.

While the resulting mortality patterns showed no definite trend, several interesting characteristics were noted. Birthing lair hunting was not a major hunting technique, as demonstrated by the lack of newborn seals. The season of peak seal hunting at the site is placed without question in the spring, probably due to the use of stored whale supplies during the winter. To determine if the Thule hunters from this site utilized fast ice or pack ice was a more difficult question to answer. The placement of the site on a simple coast may have influenced the results more then was previously expected. When examining broad categories (i.e. newborns, juveniles, and sexually mature adults), faunal material from houses 2, 3, and 4 closely resemble the modern ringed seal populations from the fast ice, while house 1 bears a closer resemblance to modern populations from the pack ice or more likely from the floe edge in winter. In examining the more specific age categories, houses 2 and 4 resembled fast ice populations while houses 1 and 3 resembled pack ice populations. This was probably influenced by the small sample size of the modern fast ice population used for comparison as well as the possible practice of floe edge hunting, which had not been anticipated.

For the continued application of this method to the problem of Thule seal hunting methods and possible indications of hunting territories, further refinements must be made. Archaeological samples from other sites should be examined, particularly on sites located near extensive areas of fast ice and located on complex coasts, to determine if this method can be more precisely applied to Thule sites. More studies, of both a biological and archaeological nature, along simple coasts may reveal ways of interpreting these data. Comparisons between Thule sites and sites of the historic Inuit may be useful to determine changes in hunting methods over time, as well as to test whether the seasonality from this site is directly related to the use of cached whale supplies.

While this use of mortality profiles may have widespread applications for zooarchaeology, it must be remembered that this is a tool which can be extremely misleading unless combined in a holistic approach which examines the behavior of the species in question, the environmental conditions that may influence behavior, the age makeup of the living population, and relevant ethnohistorical accounts. If mortality patterns are applied without regard for prey behavior or the environmental conditions that might influence such behavior, archaeologists may be faced with an increasingly incomplete record of past subsistance strategies.

The practical application of mortality profiles to the archaeological record, through the use of PaJs-13, adds to literature on subsistence strategies. This application of mortality profiles supports a broader methodology that incorporates studies of prey behavior and environmental conditions. The dental annuli analysis confirmed the site as a winter site and provided an age spread of ringed seals from this site, which could ultimately be utilized to obtain a better understanding of harvesting techniques through the use of mortality profiles. This study has demonstrated that whenever mortality profiles are interpreted, the natural habitats and behavioral patterns of the species must be considered.

APPENDIX 1: TEETH RECOVERED AND USED IN THESIS

a) LEFT MANDIBULAR CANINES RECOVERED FROM PAJS 13 HOUSE 1

MNI = 25

Tooth #	Unit
1	8
* 2	8
3	11
* 4	15
* 5	17
6	18
@ 7	18
8	22
@ 9	24
* 10	24
* 11	26
12	26
13	26
14	28
15	29
16	30
17	33
18	34
* 19	36
20	Balk 38

* 21	39
22	39
23	39
24	no unit given
25	no unit givem

* indicates a loose left canine that was sectioned

@ indicates a thin juvenile tooth

b) LEFT MANDIBULAR CANINES RECOVERED FROM PAJS 13 HOUSE 2

MNI = 30

Tooth #	Unit
1	4
2	5
3	5
4	5
5	5
6	6
7	6
@ 8	7 (newborn ?)
9	7
10	8
11	8
12	9
13	10
14	11
15	13
16	13
17	18
18	19
19	19
20	19

21	19
@ 22	20
23	21
24	21
25	21
26	21
27	24
28	24
29	24
30	28

* indicates a loose left canine that was sectioned

@ indicates a thin juvenile tooth

c) RIGHT MANDIBULAR CANINES RECOVERED FROM PAJS 13 HOUSE 3

MNI = 56

Tooth #	Unit
1	1
* 2	1
3	2
4	2
5	2
6	2
7	3
8	5
9	5
10	5
11	5
12	6
13	6
* 14	6
@ 15	6
16	6
17	6
18	7
19	7
* 20	8

* 21	8
22	8
23	8
24	8
25	9
26	9
27	9
28	9
* 29	9
* 30	9
* 31	9
@ 32	9
33	9
34	9
35	9
36	9
@ 37	9
@ 38	9
39	9
40	9
41	9
42	9
43	9

44	9
45	9
46	10
47	11
* 48	11
49	12
50	12
* 51	13
52	13
53	13
54	14
55	14
* 56	15

* indicates a loose right canine that was sectioned

@ indicates a thin juvenile tooth

d) RIGHT MANDIBULAR CANINES RECOVERED FROM PAJS 13 HOUSE 4

MNI = 53

Tooth #	Unit
1	24
* 2	24
3	24
4	25
* 5	25
6	25
*@ 7	26
8	26
9	26
10	26
11	15
* 12	32
13	33
14	33
15	34
16	34
17	36
18	36
19	36
20	36

21	38
* 22	43
23	44
24	45
25	47
@ 26	47
27	47
@ 28	47
29	54
30	55
* 31	65
32	65
33	66
34	66
35	66
36	66
37	67
* 38	76
39	76
40	76
41	76
42	76
43	85

44	86
45	95
46	95
* 47	95
* 48	95
49	105
* 50	105
* 51	105
@ 52	116
53	116

* indicates a loose right canine that was sectioned

@ indicates a thin juvenile tooth

e) RIGHT MAXILLARY CANINES RECOVERED FROM PAJS 13 HOUSE 5

MNI = 6

Tooth #	Unit
* 1	F7
* 2	I8
* 3	I11
4	J11
* 5	K12
6	L7

* indicates a loose right canine that was sectioned

@ indicates a thin juvenile tooth

APPENDIX 2: AGES OF DEATH FOR CANINES FROM PaJs-13

Ages	House 1	House 2	House 3	House 4	House 5
<1	0 (0%)	2 (6.67%)	1 (1.79)	0 (0%)	0 (0%)
1	2 (8%)	1 (3.33%)	1 (1.79%)	0 (0%)	0 (0%)
2	0 (0%)	3 (10%)	4 (7.14%)	4 (7.55%)	0 (0%)
3	0 (0%)	4 (13.33%)	6 (10.71%)	1 (1.89%)	1 (16.66%)
4	7 (28%)	0 (0%)	3 (5.36%)	0 (0%)	2 (33.33%)
5	5 (20%)	2 (6.67%)	6 (10.71%)	2 (3.77%)	0 (0%)
6	1 (4%)	0 (0%)	1 (1.79%)	1 (1.89%)	0 (0%)
7	1 (4%)	5 (16.67%)	5 (8.93%)	8 (15.09%)	0 (0%)
8	1 (4%)	1 (3.33%)	1 (1.79%)	3 (5.66%)	1 (16.66%)
9	2 (8%)	4 (13.33%)	3 (5.36%)	7 (13.21%)	0 (0%)

APPENDIX 2 CONTINUED

Ages	House 1	House 2	House 3	House 4	House 5
10	3 (12%)	3 (10%)	3 (5.36%)	4 (7.55%)	1 (16.66%)
11	0 (0%)	1 (3.33%)	3 (5.36%)	3 (5.66%)	1 (16.66%)
12	0 (0%)	0 (0%)	3 (5.36%)	3 (5.66%)	0 (0%)
13	1 (4%)	1 (3.33%)	1 (1.79%)	1 (1.89%)	0 (0%)
14	1 (4%)	2 (6.67%)	3 (5.36%)	3 (5.66%)	0 (0%)
15	0 (0%)	0 (0%)	1 (1.79%)	1 (1.89%)	0 (0%)
16	1 (4%)	1 (3.33%)	2 (3.57%)	2 (3.77%)	0 (0%)
17	0 (0%)	0 (0%)	1 (1.79%)	0 (0%)	0 (0%)
18+	0 (0%)	0 (0%)	8 (14.29%)	10 (18.87%)	0 (0%)
Total	25 (100%)	30 (99.99%)	56 (100.04%)	53 (100.01%)	6 (99.97%)

APPENDIX 3: AGES OF DEATH FOR RINGED SEAL SAMPLES UTILIZED IN THIS THESIS

Ages	PaJs-13 Total	Fast Ice (Finley)	Pack Ice (Finley)	Home Bay 1967	Home Bay 1970
<1	3 (1.76%)	0 (0%)	0 (0%)	195 (26.79%)	301 (42.33%)
1	4 (2.35%)	0 (0%)	0 (0%)	81 (11.13%)	38 (5.34%)
2	11 (6.47%)	1 (8.33%)	5 (11.11%)	50 (6.87%)	32 (4.50%)
3	12 (7.06%)	1 (8.33%)	7 (15.56%)	63 (8.65%)	44 (6.19%)
4	12 (7.06%)	0 (0%)	5 (11.11%)	43 (5.91%)	31 (4.36%)
5	15 (8.82%)	0 (0%)	6 (13.33%)	40 (5.49%)	35 (4.92%)
6	3 (1.76%)	0 (0%)	1 (2.22%)	30 (4.12%)	23 (3.23%)
7	19 (11.18%)	0 (0%)	1 (2.22%)	26 (3.57%)	19 (2.67%)
8	7 (4.12%)	1 (8.33%)	3 (6.67%)	22 (3.02%)	20 (2.81%)
9	16 (9.41%)	1 (8.33%)	6 (13.33%)	33 (4.53%)	19 (2.67%)

APPENDIX 3 CONTINUED

Ages	PaJs-13 Total	Fast Ice (Finley)	Pack Ice (Finley)	Home Bay 1967	Home Bay 1970
10	14 (8.24%)	3 (25%)	2 (4.44%)	27 (3.71%)	17 (2.39%)
11	8 (4.71%)	1 (8.33%)	4 (8.89%)	23 (3.16%)	23 (3.23%)
12	6 (3.53%)	2 (16.67%)	1 (2.22%)	26 (3.57%)	15 (2.11%)
13	4 (2.35%)	0 (0%)	2 (4.44%)	19 (2.61%)	21 (2.95%)
14	9 (5.29%)	1 (8.33%)	0 (0%)	9 (1.24%)	14 (1.97%)
15	2 (1.18%)	0 (0%)	1 (2.22%)	16 (2.20%)	15 (2.11%)
16	6 (3.53%)	0 (0%)	1 (2.22%)	6 (0.82%)	9 (1.27%)
17	1 (0.59%)	0 (0%)	0 (0%)	6 (0.82%)	5 (0.70%)
18+	18 (10.59%)	1 (8.33%)	0 (0%)	13 (1.79%)	30 (4.22%)
Total	170 (100%)	12 (99.98%)	45 (99.98%)	728 (100%)	711 (99.97%)

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