To freeze or to dry: Seasonal variability in caribou processing and storage in the barrenlands of Northern Canada

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ABSTRACT

This paper presents description and interpretation of 20 caribou bone assemblages from Inuit sites on the Kazan River in northern Canada. A diversity of features including caches, disposal areas, and surface scatters, are quantified in order to understand aspects of butchery, transport, and storage of caribou carcasses. Element distributions are compared to four published indices which quantify bone density, food utility, meat drying, and marrow, in order to understand which factors played important roles in decision-making by Inuit in the region. While several factors are identified as having affected these assemblages, by far the most important factor relates to the season during which the caribou were hunted. During warm seasons, the drying of meat dictated relatively complex division of the carcass for processing and storage. During colder seasons, on the other hand, rapid freezing of meat allowed for greater flexibility, which often simply meant that entire articulated carcasses were cached after skinning and gutting.

KEY WORDS
Arctic, Nunavut, Inuit, archaeozoology, caribou, *Rangifer tarandus*, hunting, storage, dry meat, seasonality

RÉSUMÉ

Congeler ou sécher : variations saisonnières dans le traitement et le stockage du caribou dans les Barren Lands du Canada septentrional.

Vingt assemblages osseux de caribou issus de sites Inuit de la Rivière Kasan, dans le nord du Canada, sont décrits et présentés dans cet article. Une diversité de fonctionnalités, y compris des caches, des zones de rejet et des aires de dispersion, sont quantifiées afin de comprendre les aspects de la boucherie, du transport et du stockage des carcasses de caribou. Les distributions des parties

MOTS CLÉS
Arctique,
Nunavut,
Inuit,
archéozoologie,
caribou,
Rangifer tarandus,
chasse,
stockage,
viande séchée,
saisonnalité.

anatomiques sont comparées à quatre indices publiés, qui quantifient la densité osseuse, l'usage alimentaire, le séchage de la viande et la moelle, afin de comprendre quels facteurs sont importants dans la prise de décision des Inuit de la région. Bien que plusieurs facteurs soient identifiés comme ayant affectés ces assemblages,celui qui, de loin, est le plus important est la saison de chasse des caribous. Pendant les saisons chaudes, le séchage de la viande dicte une division assez complexe de la viande pour le traitement et le stockage. Durant les saisons plus froides, au contraire, la congélation rapide de la viande permet plus de souplesse, ce qui signifie souvent que des carcasses entières et articulées étaient stockées après avoir été dépouillées et éviscérées.

INTRODUCTION

In this paper, we interpret element distributions from a series of caribou (*Rangifer tarandus*) bone assemblages drawn from a variety of seasonal and functional contexts on the Kazan River, northwest of Hudson Bay in northern Canada. This region is inhabited by *Kivallirmiut* Inuit, who were dubbed the "Caribou Inuit" by early anthropologists based on their overwhelming reliance on caribou as a resource. These assemblages are significant because of the unusually good condition of the bones, and the fact that the archaeological record can be understood in the context of extensive Inuit oral histories recorded in the area (e.g., Stewart *et al.* 2000; Friesen and Stewart 2004). Our ultimate goal is to understand seasonal differences in decisions relating to caribou butchery, transport, and storage. To that end, the assemblages are broken into two groups (summer-fall and spring), and element frequencies are assessed against zooarchaeological indices for bone density, food utility, meat drying, and unsaturated marrow content.

BACKGROUND

The Harvaqtuuq: Geography of the lower Kazan River

During much of the nineteenth and twentieth centuries, the *Kivallirmiut* or Caribou Inuit lived in the southern barrenlands of Canada west of Hudson Bay (Fig. 1). Among Inuit cultures across the Arctic, the Caribou Inuit are known for their distinctive way of life, characterized by year-round inland settlement and subsistence focused primarily on hunting and extensive use of caribou (Anoee 1982, Birket-Smith 1929, Burch 1986), comparable to the Nunamiut of northern Alaska (Binford 1978). By the late nineteenth century, at least five regionally distinct societies of Caribou Inuit with a total population of about 1400 were living in the interior barrenlands north of the boreal forest in what is now the southeastern Kivalliq Region of Nunavut (Csonka 1995; Burch 1986). We focus on one of these societies, the Harvaqtuurmiut, who lived for much of the year along the lower Kazan River, known to them as the Harvaqtuuq.

Draining an area of 70,000 km^2, the 850-km-long Kazan River flows from the edge of the boreal forest through several large lakes on the subarctic tundra into Baker Lake, which empties through Chesterfield Inlet into Hudson Bay. The Kazan River, following fault lines in the bedrock, abruptly changes direction several times, flowing alternately north and east. The Harvaqtuuq begins at the outlet of Yathkyed Lake (Fig. 1). The linear reach that flows east, forming in part Thirty Mile Lake, is relatively well-documented and was the focus for archaeological and oral history research reported on here (Fig. 1).

This lake has an extensively convoluted shoreline along its north and south sides and many bedrock islands (Fig. 2). Islands and peninsulas combine to form three narrows in the lake. Ground next to the shore of the lake, particularly near the narrows, is a

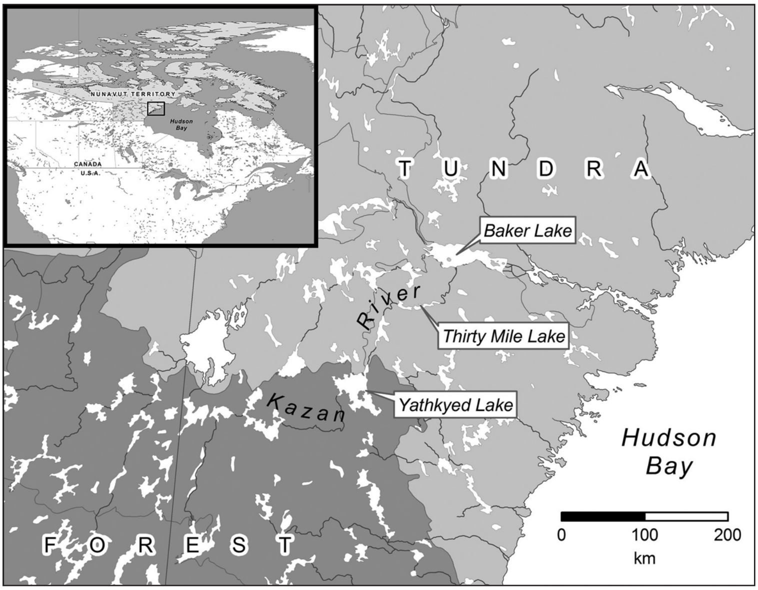

FIG. 1. — Location of Thirty Mile Lake on the lower Kazan River, Nunavut Territory, Canada.

low till plain containing a patchwork of mudboils surrounded by higher areas of peat supporting grasses, shrubs and mosses (Aylsworth, Cunningham and Shilts 1989). At the end of Thirty Mile Lake, the river narrows and turns north, flowing through a 1500-metre-long rapids at Itimniq before resuming an easterly course along a 2-km-wide channel (Fig. 2). Over the next 20 km, two more channel constrictions occur, each with very short northward twists that interrupt the eastward direction of flow. The course of the river downstream from each of these constrictions progressively narrows – from about 2 km to about 700 m at the first constriction (next to a former camp called Piqqiarjuk), to about 300 m at the second constriction (next to a former camp called Piqqiq; Fig. 2). A sharp northwestward bend then takes the channel, now wider in places, another 10 km to Kazan Falls. Along this eastward course within the study area, the land rises to hills that are dominated by bedrock outcrops on both sides of the river. The land rises more steeply, and to a higher elevation, on the south side, and moreso as one travels downriver from Thirty Mile Lake.

The climate for this region is best reconstructed from weather records from the town of Baker Lake, located 70 km north of the study area. The regional climate is harsh, with extreme seasonal variation in temperature and light conditions. The record of climate normals for Baker Lake during the period 1971-2000 shows daily averages of 11 for July and -32 for January (degrees Celsius) and 27 cm of precipitation per year (Environment Canada 2012). Summer temperatures are particularly important for the interpretation that follows, given that warm temperatures can cause rapid spoilage of meat. In that connection, July daily maximums average 16.7, and occasional very hot periods have resulted in temperatures as high as 33.6 degrees Celsius (ibid).

Archaeological Survey and Oral History in the Harvaqtuuq

The Harvaqtuuq contains extensive evidence for Inuit occupation and land use. This was noted in an earlier archaeological survey (Friesen and Stewart 1994; Stewart 1991, 1994) and recalled by Harvaqtuurmiut elders in drawings (Tulurialik & Pelly 1986) and verbal narratives (Mannik 1998). The community of Baker Lake worked with Parks Canada to designate part of this area as a national historic site (Fall Caribou Crossing National Historic

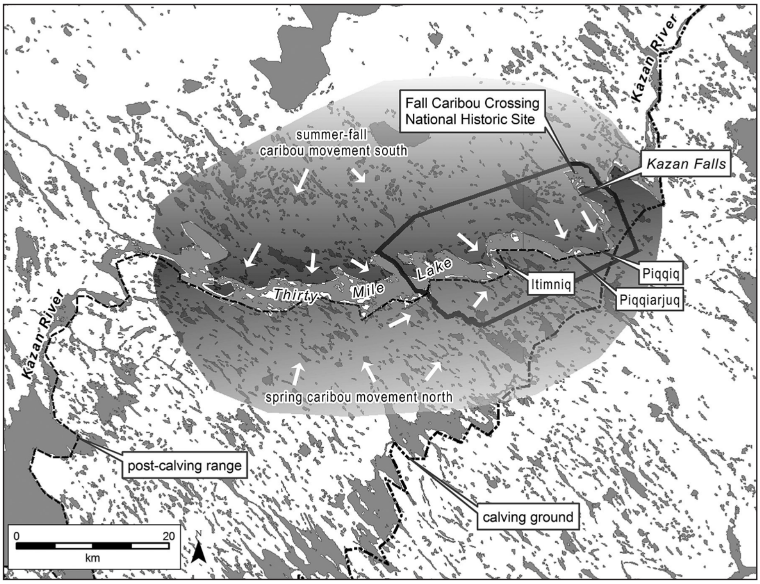

Fig. 2. — Study area on Thirty Mile Lake, showing some locations mentioned in text, the western boundaries of the Qamanirjuaq caribou herd calving ground and post-calving range based on observations from 1993 to 2004 (Beverly and Qamanirjuaq Caribou Management Board 2004), and caribou seasonal movements (schematic) around Thirty Mile Lake based on oral accounts recorded in the 1990s.

Site; Fig. 2) in 1997. Leading up to and supporting this designation was a programme of archaeological and oral history research, carried out between 1993 and 1997, focused on Harvaqtuurmiut camps and way of life along a proposed designated reach of the lower Kazan River (Keith 2000, 2004; Friesen and Stewart 2004, Stewart *et al.* 2000, Stewart *et al.* 2004).

In the course of archaeological survey in 1996 and 1997, the locations of about 1500 surface features, primarily boulder structures and clusters of artifacts and bones, were recorded by Differential Global Positioning System (Stewart *et al.* 2000). Many of the features were clustered into what had been seasonally- and repeatedly-occupied camps, some of which were located on the shoreline, and others overlooking the river from higher ground on slopes or hilltops slightly further inland. Information about some of these camps, including place-names, names of individuals or families associated with camps and seasonal activities or events that occurred there, was recorded in the oral history during this field work. Summer-fall camps are better represented in the oral accounts than spring sites. Our understanding of the seasonal caribou hunting cycle and the use of these camps, outlined in the next section, leads to the conclusion that summer-fall camps are mainly found along the river, while the higher camps further inland were occupied mainly in the spring.

Caribou, Camps and Seasons of Occupation

According to biological survey data collected in the 1990s and early 2000s, the traditional spring calving grounds of the Qamanirjuaq herd of the migratory barrenground caribou are located between the study area and the coast of Hudson Bay, about 250 km to the east. The post-calving (summer) range includes this core area plus an area extending west along the length of Thirty Mile Lake (Beverly and Qamanirjuaq Caribou Management Board 2004), in agreement with earlier studies (Gates 1989, Parker 1972) and with the oral history for this area, which attests to land use in both spring (May-June) and summer-fall (July, August and September) (Keith 2000, 2004; Fig. 2). Historical accounts from the

1920s also show that Harvaqtuurmiut had camps in this area during spring, when hunters and their families would intercept northward-migrating caribou (Rasmussen 1930:15). This area along the lower Kazan River was, therefore, a productive area for caribou from May to September, though not consistently from year to year.

According to oral history recorded in the 1990s (Keith 2000, 2004), caribou arriving from the south to cross the still-frozen Kazan River between April and June were generally spotted from camps located on hills, where snowmelt occurred more quickly, on the south side of the river. In some years, early ice break-up on the river served to constrain the movement of caribou (i.e., from crossing to the north side), giving hunters more time to intercept them (Fig. 2). Meat was dried and marrow stored at or near these camps. Beginning in July, caribou would start to drift south, crossing the river from the north side. Hunters, in their kayaks, could then spear caribou in the water at river-crossings. The warm weather, bringing flies, meant that meat had to be dried as soon as possible before spoiling. This requirement limited the number of caribou that could be practically harvested. Only in mid-August was the weather cold enough for meat to be cached without it having to be dried first, allowing more animals to be taken, faster. By then, caribou hair was starting to grow longer. By September, when it was long enough to make into winter clothing, a major effort was made to harvest caribou for both skins and meat at the water-crossings. The specific crossings where people chose to wait for caribou each year depended on information available to predict their points of crossing. Some of the meat obtained at the crossings was carried inland to locations that would be closer to anticipated winter camps. By early November, ponds froze and snow would accumulate on the downwind side of lakes and hills, enabling people to build and move into iglus (snow houses). Winter lasted from early November to April; during this season people lived away from the river in iglus on lakes.

There are at least four summer-fall caribou crossings at narrows identified in the oral history record between the west end of Thirty Mile Lake and Kazan Falls. Three of these crossings (Piqqiq, Piqqiarjuk, and Itimniq) occur in the national historic site study area and have abundant archaeological evidence of settlement along the shoreline on the south side of the river (Fig. 2). Caribou bone was collected from Piqqiq and Itimniq, as well as from features on the north shore at Nuillak (opposite Piqqiq) and 145X (opposite Piqqiarjuk). Both Piqqiq and Piqqiarjuq are large sites that are located across from a series of stone cairns (inuksuit) placed on the north side of the river (Fig. 3). At each site, inuksuit are arranged in lines that form what appear to be caribou drives leading towards each of the two river-crossings (Stewart *et al.* 2004:198). Many fewer features were found on the north side of the river and a high proportion of them were inuksuit, compared to the regional average.

Three places on elevated ground on the south side of the river were explicitly identified by elders as spring camps, all with archaeological evidence of settlement (Stewart *et al.* 2000:269). Caribou bone was collected and analysed from features at two of these sites, Auksiivik and Pipqa'naaqtalik, both located south of Itimniq (Fig. 4). Note that while oral histories indicate that Pipqa'naaqtalik was occupied in both the spring and summer/fall seasons, the specific bone assemblage discussed below represents spring activities, based on faunal seasonality indicators. Bones were also collected from two additional spring contexts: Akunni'tuaq, a high inland locale with a variety of feature types located between Piqqiq and Piqqiarjuk, and 143X, a spring site west of Piqqiarjuk. Most (but not all) winter camps are assumed to be located on inland lakes, away from the river, and are not addressed further here.

This record of seasonal behavior from the oral accounts suggests that a shift in settlement occurred in late June or early July, from elevated spring locations to river-shoreline summer and fall locations. Our analysis of archaeological feature distributions at spring and fall sites, as identified in the oral record and by their location in the landscape, suggests that the proportion of certain features (particularly kayak stands, caches, inuksuit, and hearths) distinguishes seasons of occupation (Stewart *et al.* 2000). Sites with more caches and other 'minor' categories of features, and fewer inuksuit, hearths and kayak

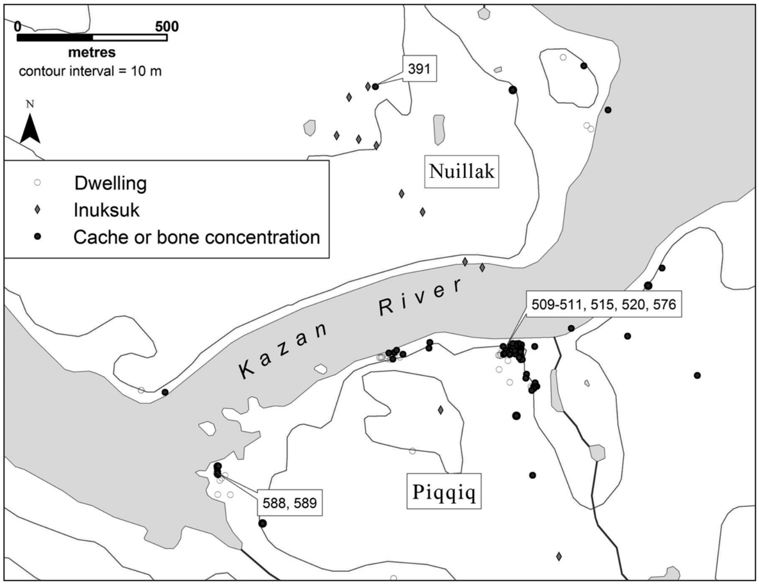

FIG. 3. — The caribou crossing site of Piqqiq, and its north shore counterpart Nuillak, showing locations of bone-bearing features in this study.

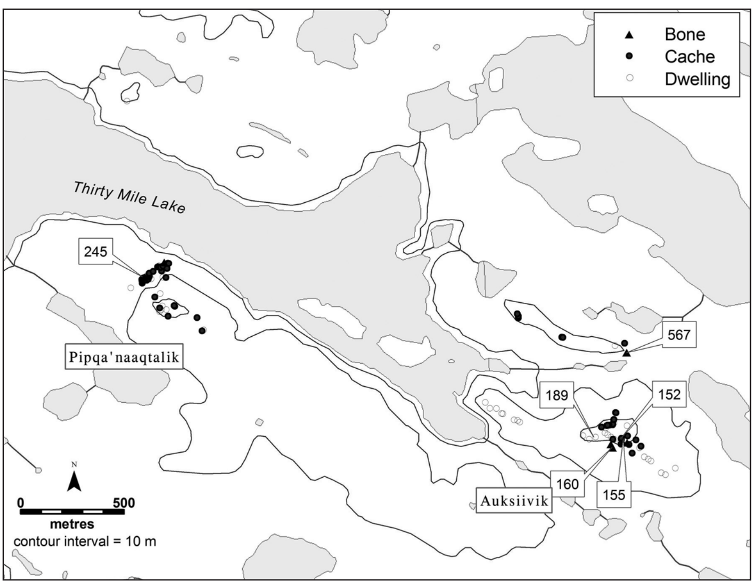

FIG. 4. — The sites of Pipqa'naaqtalik and Auksiivik, showing locations of bone-bearing features in this study.

Table 1. — Faunal samples in this study.

Site No.	Site name	Feature No.	Season	Caribou NISP	Description
145X	unnamed	196	Summer/Fall	193	Cache - one articulated individual missing several portions
145X	unnamed	201	Summer/Fall	148	Cache - one complete articulated caribou
149X	Nuillak	391	Summer/Fall	200	Cache - one complete articulated caribou
150X	Piqqiq	509	Summer/Fall	333	Cache or disposal area
150X	Piqqiq	510	Summer/Fall	59	Cache or disposal area
150X	Piqqiq	511	Summer/Fall	24	Disposal area
150X	Piqqiq	515	Summer/Fall	106	Cache - small - one articulated individual missing several portions
150X	Piqqiq	520	Summer/Fall	515	Cache - two complete articulated caribou
150X	Piqqiq	576	Summer/Fall	153	Cache - one articulated individual missing several portions
150X	Piqqiq	588	Summer/Fall	556	Midden / disposal area under boulder (F9 in Friesen and Stewart 2004)
150X	Piqqiq	589	Summer/Fall	89	Midden / disposal area under boulder (F10 in Friesen and Stewart 2004)
178X	Itimniq	64	Summer/Fall	56	Cache - small - one incomplete caribou
143X	unnamed	50	Spring	33	Small carefully constructed mandible deposit
148X	Akunni'tuaq	316	Spring	199	Surface scatter near probable hunting blind
173X	Pipqa’naaqtalik	245	Spring & Summer/Fall	2425	Cache - large and well made; Feature 245 constructed in spring or summer
174X	Auksiivviq	152	Spring	465	Cache - high numbers of cervical vertebrae and sternal segments
174X	Auksiivviq	155	Spring	278	Cache - primarily long bones
174X	Auksiivviq	160	Spring	612	Cache - primarily skulls and mandibles
174X	Auksiivviq	189	Spring	1234	Surface scatter in vicinity of tent ring - does not represent a single event
174X	Auksiivviq	567	Spring	791	Surface scatter - marrow processing area

stands are associated with fall occupation, whereas sites with more kayak stands are associated with spring occupation.

MATERIALS AND METHODS

During surveys, bones were encountered in a wide range of contexts, and were collected from 30 features. This number includes the ten contexts at the “Itiminiq-Muskox Area” which have been previously reported (Friesen and Stewart 2004); these will not be described further in the present study because they appear to represent an earlier, and somewhat different settlement pattern than the later Caribou Inuit lifeways represented by the remainder of this paper. The remaining 20 assemblages, collected from boulder features or surface scatters, form the basis of the current study (Table 1). Selection of features from which to collect bones was largely judgmental, and was based on degree of preservation and an attempt to collect from a broad range of feature types. As such, these 20 features cannot be considered a random sample, however we are confident that in total they reflect much of the variability in the region.

In the case of caches, we collected primarily from those which appeared to have never been opened and were therefore still full of bones, in order to allow more detailed interpretation of storage activities. The fact that the caches were still full of bones is unusual, given that they were originally intended to be opened, and emptied, when the meat they contained was collected for consumption. We speculate that in some cases the caches may have been forgotten, and in other cases they may have been abandoned when their builders moved into the town of Baker Lake in the late 1950s.

Table 2. — Four indices used in this study. See text for published sources and further discussion.

	Density Index	Food Utility Index	Meat Drying Index	Unsaturated Marrow Index
Cranium		235	1.9	
Mandible	1.07	590	56.2	
Atlas/Axis	0.62	524	88.2	
Cervical 3-7	0.45	1905	186.7	
Thoracic	0.53	2433	311.3	
Lumbar	0.51	1706	205.8	
Rib	0.96	2650	745.4	
Sternum		3422	195.2	
Scapula	1.04	2295	89.5	
Humerus	1.12	1891	18.5	22.8
Radius/Ulna	1.09	1323	16.4	26.3
Metacarpal	1.1	795	15.5	19.6
Innominate	1.02	2531	196.8	
Femur	1.15	5139	17	34
Tibia	1.13	3225	13	51.1
Metatarsal	1.1	1903	11.2	46.5
Phalanx	0.92	998	67.3	2.1

Bones were collected by hand, and were not screened. In most cases, bones were not surrounded by soil or other matrix; they were simply sitting loose on cobble surfaces; thus recovery levels were generally high, though occasionally small bones, bone fragments, or loose teeth may have been missed. Many bones appeared very "fresh", occasionally with small amounts of soft tissue still attached. While a few of these contexts included bones of other species, all were overwhelmingly dominated by caribou, and a majority contained exclusively caribou bones.

The purpose of this paper is to understand seasonal differences in the treatment of caribou carcasses, in relation to butchery, transport, storage, and destruction. As such, the analysis below deals exclusively with element (body part) distributions. Quantification methods are intended to allow comparison between features, and interpretation of the relationships between element frequencies and various indices (Lyman 2008:232 ff.; cf., Binford 1978, 1984). Thus, all element frequencies are expressed as Minimum Animal Units (MAU), a measure which allows the analyst to scale element frequencies to the variable numbers of elements in a complete skeleton. In order to calculate this value, for each feature all complete and fragmentary specimens were sorted by element and side, after which the Minimum Number of Elements (MNE) in each anatomical category (e.g., femur) was calculated. MNE calculations incorporated age; for example a juvenile proximal left femur and an adult distal left femur would be recorded as an MNE of 2. The total number of each element category (disregarding side) was then divided by the number in a complete skeleton to determine the MAU. For example, if all tibia fragments from a feature were determined to represent an MNE of 5 left and 2 right tibiae; the total, 7 tibiae, was divided by the number of tibiae in a skeleton (2), to result in an MAU of 3.5. Similarly, if a feature contained an MNE of 8 lumbar vertebrae, this number was divided by the number in an average complete skeleton (5), to yield an MAU of 1.6. Only a select set of 17 element categories are presented, since it is this group which will be compared to the various indices described below.

Indices for the Interpretation of Element Distributions

Zooarchaeologists have developed a number of quantitative tools for the interpretation of variable element distributions, particularly as they pertain to animals with larger body sizes. These are usually presented as indices, which provide a numerical scale against which to evaluate different elements or groups of elements (Table 2). Typically, these indices are compared to element distributions from archaeological sites in one of two ways: 1) by generating a scatter plot of index value and element frequency, which is then interpreted; and 2) by statistically assessing their correlation, usually through Spearman's rank order correlation coefficients. We will base most of our interpretations on this latter method.

The most broadly applicable index measure is the variability in bone density across the skeleton of a particular taxon. All else being equal, the density of a particular element, or part of an element, will play a major role in determining how resistant it is to destruction by a host of taphonomic agents, including carnivore gnawing, trampling, chemical diagenesis, and human activities such as marrow

TABLE 3. — Rank order correlation coefficients indicating relationships between four indices. *For cases with fewer than 10 pairs, significance at the .05 level is based on a table of critical values for r_s.

	Food Utility	Unsaturated Marrow	Meat Drying
Density	r_s= 0.24; P=0.39	r_s=0.61; not significant*	r_s=-0.79; P=<0.001
Meat Drying	r_s=0.36; P=0.16	r_s=-0.71; not significant*	
Unsaturated Marrow	r_s=0.82; significant*		

breakage (Lyman 1984, 1994). In assemblages which have seen significant destruction, positive correlation is expected between density and element frequency; in other words, the denser the element, the more frequently it should occur since it is more resistant to destruction. For the present research, we use a density index (DI) based on the mean shape-adjusted density values from four *Rangifer tarandus* individuals (Lam *et al.* 1999; see also Lam *et al.* 2003). For present purposes, we use the version incorporating "BMD_2" values which are more accurate since they adjust for medullary cavity shape (Lam *et al.* 1999:357). For each element category, we use the highest (densest) value in cases where a given element or group of elements has had density measured in more than one location ("scan site").

A second category of indices is more specific to human activities such as transport, butchery, storage, and consumption. Most of these indices are ultimately derived from Binford's (1978) pioneering study of Nunamiut activities in relation to caribou in northern Alaska, although they have for the most part been refined over time. In this paper, we will refer to three of these indices. First is the Food Utility Index (FUI), which measures the total amount of edible material (meat, fat, marrow, and bone grease) associated with each element category (Metcalfe and Jones 1988). It is similar to Binford's (1978) Modified General Utility Index, and its interpretation is based on the assumption that when people transport carcass portions, they will favour those with more edible material, including meat, marrow, and bone grease, attached. Thus, elements with lower FUI values are expected to remain at kill sites, while elements with higher FUI values are expected to be transported to occupation sites. Second, is the Meat Drying Index (MDI) (Friesen 2001). This index, similar to Binford's (1978) Drying Utility Index, is based on the more complex process which accompanies decisions relating to storage of meat by drying. It is based on the total amount of meat attached to the bone, the weight of bone in relation to meat weight of the portion (which is a proxy for surface area), and the amount of marrow and brain associated with the element. Elements with high MDI values are expected to be dried for storage more frequently, while those with lower values will be consumed immediately, discarded, or otherwise treated in a manner different from dried meat. The third of these indices is the Unsaturated Marrow Index (UMI) (Morin 2007), similar to Binford's (1978) Marrow Index. This index takes into account the volume of the marrow cavity of particular elements, and the percentage of desirable unsaturated fatty acids in the marrow. It is used to predict which elements will be preferred for processing for marrow.

Although these indices are all ultimately based on aspects of caribou biology, they should be considered relatively crude measures which may predict butchery, transport, and storage under ideal circumstances, but which are unlikely to capture the full complexity of past decision-making. Furthermore, they are interdependent to varying degrees. Table 3 presents rank order correlation coefficients calculated for each potential pair of published indices, using the 17 element categories presented in Table 2. The degree of correlation, negative or positive, varies from slight to strong; however in two cases the correlation is both strong and significant. The relationship between the FUI and the UMI is positive and significant. This must reflect the fact that marrow cavity volume is a part of the FUI calculation. A strong, and significant, negative relationship is seen between the DI and the MDI. This negative relationship means that carcass portions which are likely to be selected

Fig. 5. — Site 143X Feature 26, a small cache containing caribou mandibles, likely representing a ritual deposit. Covering stones have been removed.

for drying tend to be low in density, and vice versa. The reasons for this relationship are not completely clear, but probably relate primarily to 1) the fact that body parts suitable for drying tend to be those with a thin layer of meat over large surface areas of bone, thus they often correlate to relatively "thin", and less dense elements; and 2) the fact that long bones rank low in the MDI due to the presence of marrow; and these same longbones tend to be among the densest elements in the skeleton. Whatever the cause, this relationship presents challenges to interpretation, since it means that bone assemblages which have been exposed to destructive agents and are therefore biased towards denser bones, will appear to have a negative drying profile.

Regional Taphonomic Issues

Before proceeding to a discussion of the bones, it is important to give a brief overview of taphonomic conditions in the study region. Caribou carcasses and bones in this region are subject to the impacts of carnivore, rodent, and artiodactyl gnawing, as well as ice breakup on the river, trampling, and other minor impacts. However, by far the most important factor relates to whether bones were covered or not. Based on our observation of bones on known-age historic sites on the Kazan River and elsewhere in the Kivalliq Region, it is clear that bones left on the surface, and therefore subject to direct sunlight, wind, and precipitation, begin the weathering process immediately, and in most cases even the densest elements are completely destroyed within 100 years, or less. On the other hand, carcass portions or bones deposited under rocks, whether intentionally or accidentally, are preserved much better, with bones in these contexts often retaining very delicate tissues such as costal cartilage. This is particularly true of covered bones resting on well-ventilated cobble and boulder beds, as is the case in well-constructed caches. Most of the 20 assemblages described below were recovered from boulder or cobble-covered contexts, and therefore have resisted the worst impacts of weathering and diagenesis.

A second set of factors which affected bone frequencies relates to ideologically-based ritual practices. These bone accumulations occurred within the context of a complex Inuit lifeway conceptually built around an understanding of the world in which caribou played a major role. People were expected to interact with caribou in particular ways to ensure that animals would return in later years. The treatment of caribou and their remains was subject to a variety of proscriptions. For example, in 1997 elder Elizabeth Tunnuq told us that after processing, bones were carefully cleaned away, and placed either in cracks in the rock or under large stones where they wouldn't be disturbed. During our surveys, we came across a number of contexts which may represent this sort of intentional disposal, including cracks in the bedrock that appeared to be full of bone, though the possibility that some of these deposits were caches must also be considered. The clearest example was a small cache consisting of ten mandibles from a minimum of six individual caribou (Fig. 5). These mandibles had already been processed for marrow, and their presence here probably reflects ritual rather than economic activities. These types of actions can clearly have an impact on the archaeological record, potentially creating features which mimic caches, and also potentially removing particular element classes from other feature types. However, we currently have no way to quantify that impact.

RESULTS

We will present our results in terms of the two seasonal categories described earlier: summer-fall and spring. For reasons outlined above, our seasonality designations are quite secure, since they are based primarily on interviews with Inuit elders who either had direct experience in living at a particular site, or who indicated logical reasons why certain sites were occupied in different seasons. As discussed previously, summer and fall occupations are concentrated on the south bank of the river at a few well-known water crossings, with some related activities occurring on the north side of the river. Spring occupations, on the other hand, are located on high, well-drained slopes from which snow melts earliest in spring time, thus making a dry surface on which to pitch tents. Wherever it has been possible to use zooarchaeological measures of seasonality, including tooth eruption and analysis of tooth thin-sections, these have agreed with the elders' accounts (Hazell 2004). Most of these assemblages are difficult to date, since they are composed exclusively of bone, and are assumed to be too recent to date with radiocarbon methods. The region as a whole was relatively intensively occupied until the 1950s, and nineteenth and twentieth century manufactured trade goods were noted throughout the area. Thus, we assume that most of the assemblages date to the early to mid 20th Century, and represent a mix of hunting techniques including lancing from kayaks, hunting with bows and arrows, and hunting with rifles. While the precise methods of hunting are important, they do not significantly alter the constraints on seasonal storage which play an important role in our discussion below.

Summer-Fall Sites

To begin with samples associated with the summer-fall season, this stretch of river contains three major caribou crossings, Itimniq, Piqqiarjuk, and Piqqiq. Each of these crossings is associated with complex sites, including stone cairns on the north side intended to drive caribou toward the crossings, and dwellings on the south side occupied during the migration. Most of the actual hunt occurred from kayaks on the river.

We collected bones from 12 summer-fall contexts (Table 4); with nine belonging to the major caribou crossings of Piqqiq (150X; eight samples) and Itimniq (178X; one sample). The remaining three contexts were from caches on the north side of the river just across from major crossing sites, Nuillak (149X; one sample) and an unnamed site (145X; two samples). Four of these 12 contexts (F64, F510, F511 and F589) yielded very small sample sizes, with Numbers of Identified Specimens (NISP) for caribou below 100. Most of these contain highly fragmented scraps of bones from under rocks in poorly drained areas. They

TABLE 4. — Caribou element frequencies, expressed as Minimum Animal Units (MAU), for summer-fall contexts.

	145X F196	145X F201	149X F391	150X F509	150X F510	150X F511	150X F515	150X F520	150X F576	150X F588	150X F589	178X F64
Cranium		1	1	1				2		1	1	
Mandible		1	1					1.5			1	0.5
Atlas/Axis		1	1					2		5	0.5	
Cervical 3-7	0.2	1	1	1.2				1.8	0.4	2.2		
Thoracic	0.71	1	1	0.71	0.07		0.71	2	0.64	1.71	0.07	0.57
Lumbar	1	1	0.8	0.8	0.8		1	2	0.8	0.6		
Rib	0.82	1	1	0.82	0.07	0.07	0.89	1.86	0.93	1.75	0.39	0.5
Sternum	0.57	1	0.86				1	1	1			0.28
Scapula		1	1	0.5	0.5		1	2	0.5	2	1.5	
Humerus	0.5	1	1	2	2		1	2.5	0.5	4	1.5	
Radius	1	1	1	1.5	1	0.5		1	0.5	5	1.5	
Metacarpal	1	0.5	1	5.5				1	1	3.5	1	
Innominate		1	1	1			0.5	2	1	1		
Femur	1	1	1	1		0.5	1	1.5	1	3.5	1	
Tibia	1	0.5	1	1		0.5		2	0.5	2.5	2	
Metatarsal	0.5	1	1	4.5				2		1.5	1.5	
Phalanx	0.75	0.08	0.96	0.04	0.08			1.58		0.7	0.04	

TABLE 5. — Caribou element frequencies, expressed as Minimum Animal Units (MAU), for spring contexts.

	143X F26	148X F316	173X F245	174X F189	174X F567	174X F152	174X F155	174X F160	174X combined
Cranium			4					7	7
Mandible	5	1	2.5	2				11	13
Atlas/Axis		6	13.5	14		14		4.5	32.5
Cervical 3-7		5	12.4	5.6		11.8		4.8	22.2
Thoracic		0.14	17.7	1.5		1.86	1	0.36	4.72
Lumbar		0.8	13	1.6		1.8	0.4	1.2	5
Rib		0.04	3.89	0.11		1.21	0.43	0.21	1.96
Sternum			16			8.86	5		13.86
Scapula		0.5	11.5	6				4	10
Humerus		2	12	28.5			5.5		34
Radius		1.5	8.5	8.5	9.5		2.5	4	24.5
Metacarpal		2	9.5	8	0.5	0.5	2	4.5	15.5
Innominate			20	4.5		1			5.5
Femur			2.5	8.5	1		5		14.5
Tibia		1	5.5	10	17.5		4.5	1	33
Metatarsal		1	7.5	10	12.5		4	5	31.5
Phalanx			7.04	0.21	0.04	0.08	0.46	1.54	2.33

are interpreted as disposal areas, in some cases serving to keep the bones away from dogs and other carnivores, and will not be discussed further.

Of the eight remaining summer/fall contexts, six separate caches were found to contain either one or two virtually complete caribou skeletons, with the carcasses fully or partially articulated (F196, F201, F391, F515, F520, F576; Fig. 6). These carcasses appear to have been cached after skinning and gutting, and in three of the six the skulls were missing.

The final two samples, both at Piqqiq (150X), indicate some variability in caching and disposal activities. The first of these features, F509, was a larger cache-like structure containing a mix of disarticulated bones. Many specimens were buried, and preservation appeared to be relatively poor.

Fig. 6. — Piqqiq 150X F520, cache containing two individuals (one adult, one juvenile). Covering stones have been removed.

Element distributions from this feature are not strongly correlated with the FUI or UMI, but are positively but weakly correlated with the DI (r_s = 0.48; P = 0.09); and are significantly and negatively correlated with the Meat Drying Index (r_s -0.56; P = 0.04). As outlined above, the fact that the DI and the MDI are inversely correlated with each other is expected to lead to more than one potential interpretation. In the present case, we have no direct evidence based on the bones themselves for the seasonality of this feature, so cannot be sure if it represents a summer or fall accumulation. If summer, the negative relationship with the MDI could indicate it results from drying activities, in which case top-ranked body portions would have been removed for drying, leaving the lower ranked elements behind. However, it is also possible that this feature represents a density-mediated assemblage, leading to the correlation with the DI. This issue must remain unresolved. The second of these final two samples is an assemblage of bones recovered from under a large boulder (F588, previously reported as "Piqqiq F9" in Friesen and Stewart 2004). No clear patterns are evident, and this assemblage is not significantly correlated with any index.

Spring Sites

We will now turn to camps occupied during spring, which occur mainly on well-drained higher ground south of the Kazan River. When encountered during fieldwork, it was immediately evident that caribou element distributions from these contexts were more variable, and in some cases more enigmatic, than their summer-fall counterparts (Table 5). At one extreme, at site 143X, the context F50 yielded the small, extraordinary cache described above containing exclusively caribou mandibles, which was almost certainly a ritual deposit. At the opposite extreme is a surface scatter of bones from the site Akunni'tuaq (148X F316) which does not exhibit any strong patterning or correlation with any index. However, the remaining six spring contexts are worth a more detailed description. Table 6 presents the results of rank order correlation between the four

Fig. 7. — Pipqa'naaqtalik 173X Feature 245; a very large cache. Covering stones have been removed.

indices described earlier, and the caribou element frequencies from these six contexts.

The site of Pipqa'naaqtalik (173X) has more complex seasonal associations than the other sites. Oral histories indicate that different parts of the site were occupied during spring, summer, and fall. At this site, we noted a number of features which contained some bone, but collected from only one, F245, which was the largest cache encountered during the entire project (Fig. 7). This cache was carefully constructed, with a bed of cobbles to allow air circulation under the meat, and larger cobbles and small boulders covering it. Clearly part of the same structure, but slightly separated, was a smaller area containing five caribou mandibles and only a few other bone scraps; this may be a ritually differentiated area similar to the mandible cache at 143X F50. Seasonality estimates based on tooth cementum analysis indicate that this was a spring or summer cache (Hazell 2004). It contained 2,425 specimens, representing a minimum of 22 individual caribou. For this cache, there is significant negative correlation between element frequency and the DI, and significant positive correlation between element frequency and the MDI. Negative correlation with the DI has no interpretative value in terms of taphonomy: there is no natural process which destroys or removes bones of greater density in greater quantities than those of lesser density. Thus, meat drying is the most likely process leading to the formation of this assemblage. Given the spring or summer date of this caching activity, this assemblage is interpreted as one in which large quantities of meat were dried and then cached.

The remaining five spring assemblages were all recovered from Auksiivik (174X), a large site identified in the oral historical record as having been occupied exclusively during the spring. This site contained 122 features in total, including 29 tent rings and 27 caches. One of these contexts, F189, is a surface scatter consisting of 1,234 specimens recovered from a relatively large area within and around a tent ring.

FIG. 8. — Auksiivik 174X Feature 567, a marrow cracking area. Note anvil and hammer stones near centre of photo.

TABLE 6. — Rank order correlation coefficients relating element distributions from six spring contexts to four indices. Bold font indicates coefficients significant at the .05 level. *For cases with fewer than 10 pairs, significance at the .05 level is based on a table of critical values for r_s.

	173X F245	174X F189	174X F567	174X F152	174X F155	174X F160	174X combined
Density	**r_s = -0.57, P = 0.03**	**r_s = 0.60, P = 0.02**	r_s = 0.46, not sig.*	r_s = -0.69, not sig.*	**r_s = 0.89, P = <0.001**	r_s = 0.16, P = 0.62	**r_s = 0.51, P = 0.05**
Food Utility	r_s = 0.10, P = 0.70	r_s = -0.09, P = 0.74	r_s = 0.60, not sig.*	r_s = 0.05, not sig.*	r_s = 0.45, P = 0.16	**r_s = -0.70, P = 0.008**	r_s = -0.07, P = 0.78
Meat Drying	**r_s = 0.52, P = 0.03**	**r_s = -0.70, P = 0.004**	r_s = -0.77, not sig.*	r_s = 0.17, not sig.*	r_s = -0.48, P = 0.14	**r_s = -0.59, P = 0.03**	**r_s = -0.59, P = 0.01**
Unsaturated Marrow	r_s = -0.46, not sig.*	r_s = 0.62, not sig.*	**r_s = 0.94, sig.***	insufficient pairs	r_s = 0.54, not sig.*	r_s = -0.10, not sig.*	r_s = 0.50, not sig.*

This is not a homogeneous assemblage, and is not assumed to represent a single activity; rather, the bones appear to represent a combination of processing areas and elements discarded following consumption. Because these bones were recovered on the surface, it is reasonable to assume that they are density mediated. In fact, when the element frequencies are arrayed against the DI, the rank-order correlation is positive and significant. It is likely, therefore, that some destruction of less dense bones has occurred. However, a stronger, and significant, negative correlation exists with the MDI. Thus, it appears that this sample reflects, in part, the production of dry meat, with the dried portions having been removed to a different location, and the remainder being consumed or processed at or near the tent.

Fig. 9. — Auksiivik 174X Feature 152, a cache. Covering stones have been removed.

The second context from Auksiivik is F567, which consisted of a surface scatter dominated by broken longbone fragments (Fig. 8). Tibiae, metatarsals, and radii are well represented, and are all broken, while all other element classes are absent or rare. For this feature, the element frequencies are positively and significantly correlated with the UMI, which takes into account both marrow cavity volume and the quality of marrow as measured in unsaturated fatty acids, confirming that this is a specialized marrow processing area.

The final three contexts from Auksiivik are all caches that are located relatively close to each other. Each displayed a distinctive element profile. First is F152, which consists primarily of cervical vertebrae and sterna, with much lower frequencies of additional, primarily axial, elements (Fig. 9). The degree of element selection here is remarkable. This feature is difficult to interpret in isolation; it is not correlated with any index. Second is F155, which consists mainly of longbones and sterna (Fig. 10). Noteworthy here is the fact that many of the longbones are unbroken; this is exceedingly rare in this region where longbones are almost always broken for marrow. Element frequencies for this feature are significantly and positively correlated with the DI, however contextual information indicates that this is highly unlikely to be a density-mediated accumulation, given the extremely "fresh" appearance of the bones. Third is F160, which is dominated by skulls, mandibles, and cervical vertebrae, as well as many longbones, but no sterna (Fig. 11). These element frequencies are negatively and significantly correlated with both the FUI and MDI, indicating that on either scale this cache contains relatively undesirable body portions.

These five contexts from Auksiivik present a highly variable range of element frequencies, which must result from multiple factors relating to both Inuit activities at the site and taphonomic issues. F189 likely represents post-consumption disposal of bones, F567 represents specialized

FIG. 10. — Auksiivik 174X Feature 155, a cache. Covering stones have been removed.

processing for marrow, and the other three represent intentional caching activities. In Figure 12, the five element distributions have all been expressed as percent MAU (each context is scaled to its highest MAU value) so that they can be compared visually. While the diversity of the assemblages is immediately apparent, perhaps the clearest aspect of this pattern is seen in the elements which are consistently rare, and which *never* make up a large proportion of any of these spring assemblages. In the case of the absence of phalanges, this likely results at least in part from initial butchery and skinning, with phalanges left at the butchery site or attached to skins which are processed elsewhere. However, particularly noteworthy is the lack of thoracic and lumbar vertebrae, ribs, and innominates.

In order to explore this pattern, the MAUs from all five features were added together, and assessed against the four zooarchaeological indices (included in Tables 5 and 6 as "174X combined"). Importantly, this combined element profile is presented simply as an expedient way to suggest broad patterns; since not all bone from the site was collected, it cannot be considered to be an unbiased sample of spring activities. The combined element frequencies are negatively and significantly correlated with the MDI, and positively and significantly correlated with the DI, though not as strongly. Thus, this overall, combined element profile suggests that dried meat was produced at and removed from the site, leaving harder-to-dry body portions behind. Density mediation likely played a role as well, though the inverse relationship between the DI and the MDI makes its relative importance difficult to assess. Thoracic and lumbar vertebrae, ribs, and innominates are in fact the four top-ranked elements in terms of the MDI; therefore their absence, as noted here, is expected if meat was dried and transported elsewhere. A particularly important aspect of the interpretation of the Auksiivik assemblages is that several of the features are difficult to interpret in

FIG. 11. — Auksiivik 174X Feature 160, a cache. Covering stones have been removed.

isolation, but when viewed together they conform to comprehensible patterns.

DISCUSSION

The diverse array of caribou element frequencies from a variety of contexts indicates just how complex and systematic the butchery and storage process was at these Inuit sites on the Kazan River. The complexity of the system is seen in the fact that different assemblages are interpretable only with reference to multiple indices, including bone density, marrow, and meat drying.

The clearest results relate to differences in seasonal constraints among these contexts. In particular, the fall hunt is characterized by caribou in peak physical condition, and also by cold or even freezing temperatures which allow preservation of meat without much effort. Under these conditions, caribou can be cached with minimal field butchery, as seen in the several caches containing complete or nearly complete carcasses, some of which have been further field butchered into body portions. It is quite likely that other decisions made in the fall would be based on ease of butchery and the amount of meat and fat attached to each carcass part (as reflected in the FUI), however none of the contexts we encountered are unequivocally correlated with the FUI.

Spring, however, is a completely different story. Due to warm temperatures, and the promise of the heat of summer to come, caribou meat must generally be dried for optimal storage. Under these circumstances, it is not only the amount of meat associated with a particular element which determines its suitability for storage, but also the ease with which it can be processed into thin strips, and the amount of marrow or brain associated (Binford 1978; Friesen 2001). Furthermore, in many cases, and especially with females, caribou are at a nutritionally difficult phase in the spring. Thus, fat content of different body portions, and marrow quality, is more

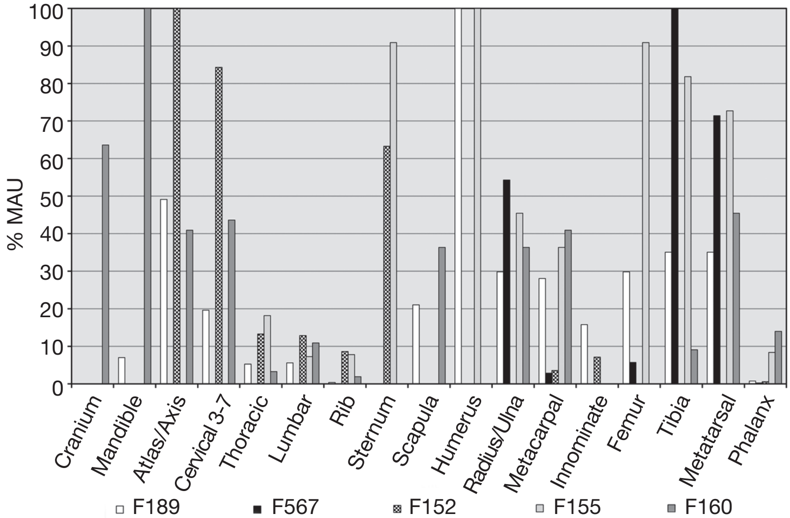

Fig. 12. — Element frequencies, expressed as %MAU, for five contexts at Auksiivik 174X.

variable, and this is acted upon by Inuit butchers. This may explain the high level of selectivity in the marrow processing area F567 at Auksiivik (174X), which is dominated by large numbers of only three longbone categories: radii, tibiae, and metatarsals. Three caches at Auksiivik, F152, F155, and F160, each emphasize only a few specific body parts, with one cache emphasizing necks and sterna, a second unbroken longbones, and a third heads. Presumably, these body parts were differentiated so that they could be retrieved later, in a ranked order.

When taken as a group, however, these spring element distributions at Auksiivik are significantly negatively correlated with the Meat Drying Index. Thus, they likely represent meat portions left behind and/or consumed on site, while dried meat was prepared and eventually transported or consumed elsewhere. We found no evidence for the consumption of dried meat, and assume that it in some cases it may have been transported to sites outside of the study area. Interestingly, another spring site, Pipqa'naaqtalik, yielded a very large cache (173X F245) containing element frequencies which are significantly *positively* correlated with the MDI. In this case, it appears that dry meat was cached, rather than being transported elsewhere.

In fact, the seasonal signatures in the element profiles are so robust that they can aid in the interpretation of particular sites. For example, elders indicated that Piqqiq was occupied during the summer or fall; however the results of these analyses suggest that fall activities dominated. This is due to the prevalence of entire carcasses being cached, and no good evidence for drying. A second example is the site of Pipqa'naaqtalik, which oral histories suggested could have been occupied in spring, summer or fall. However, our analyses of the caribou remains from F245 indicate that dry meat was stored there, thereby confirming that this portion of the site was definitely occupied in spring or summer. Ultimately, while many factors influence these bone assemblages, those relating to season, and therefore temperature, are by far the most important.

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