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RESEARCH REPORT

The Seasonality of Prehistoric Caribou Hunting in Northeastern North America

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ABSTRACT
It is widely accepted that caribou were an important resource for Paleoindian economies and lifeways in northeastern North America. The existence of large aggregation sites, such as Bull Brook, further suggests that hunters employed mass capture communal hunting methods for caribou exploitation during their seasonal migrations. As zooarchaeological remains are scarce in this region of acidic soils, site interpretations must often rely on historic or ethnographic analogs to determine the seasonality of these hunts, and on this basis, often predict that communal hunting of caribou took place in the fall. In contrast, new data from underwater sites in Lake Huron provide empirical archaeological evidence for communal hunting and social aggregation in the spring. It is suggested that this divergent pattern of seasonal exploitation is due to distinct paleoenvironment and larger populations of caribou at the end of the Pleistocene – resulting in unique hunting and social strategies seen only in the past.

KEYWORDS
Paleoindian; underwater archaeology; Pleistocene; caribou; northeastern; Great Lakes

1. Introduction

It is widely accepted that caribou exploitation was a major feature of Paleoindian adaptations in northeastern North America (broadly defined here to include the western Great Lakes) (e.g., Cannon and Meltzer 2004; Johnson 1996; Lothrop et al. 2016; Simons 1997). Caribou would have been an abundant resource for human exploitation during this time and one with the potential for mass capture by communal hunting. These mass captures would have made seasonal aggregations of human population possible, well beyond those normally associated with Paleoindian adaptations. The existence of large aggregation sites in the American Northeast, such as Bull Brook (Robinson et al. 2009), seems to confirm that the potential offered by collective caribou hunting was in fact realized.

Caribou are particularly useful for archaeological analysis. These animals have been extensively studied by wildlife biologists and have a well-established seasonal structure of movement, reproduction, and biology. They also exhibit behavioral traits, such as curiosity and line-following, that have been exploited by caribou hunters and reindeer herders alike for millennia (Lemke 2016). Ethnographic and historical sources are rife with descriptions of constructed drive lines and hunting blinds which take advantage of these behavioral quirks (e.g., Birket-Smith 1924; Boas 1888; Freuchen 1912; Holm 1914; Mathiassen 1927; Stefansson 1914; see also Lemke 2016, table 5.7).

Given the opportunity for mass capture and its importance for understanding large and significant Paleoindian aggregation sites, determining the season of hunting has taken on great importance. Unfortunately, the acidic forest soils of the Northeast rarely allow for good preservation of the zooarchaeological data that would normally be used to determine kill seasonality (see Lemke 2015a). As such, most efforts at determining the season of occupation and exploitation are by necessity indirect and inferential (e.g., Ellis 2011; Gramly 1982, 1988; Jackson 1990, 1997; Johnson 1996; Newby et al. 2005; Robinson et al. 2009; Roosa 1977; Simons 1997).

While heroic efforts to identify proxy measures for seasonality have been offered, most modeling of the Paleoindian economic behaviors in the Northeast ultimately rely on historical and ethnographic analogs to infer seasonality of caribou hunting. These analogies, coupled with knowledge of herd movement, reproduction, and condition, produce inferred models that closely resemble ethnographic accounts of caribou hunting (e.g., Freisen 2004; Robinson et al. 2009; Spiess, Curran, and Grimes 1985; see also Levine 1997).

1.1. So what's wrong with what we think we know?

While some may argue that this process of merging ethnographic analogies with regularities of animal behavior

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is a normal and necessary archaeological practice, there are good reasons to be skeptical of such models. First and foremost, the late Pleistocene/early Holocene was a very different time and setting than the historic environments from which ethnographic cases derive. For example, despite natural boom and bust cycles which characterize caribou populations (e.g., Burch 1972; Couturier et al. 1990), the size and density of caribou herds were much larger and higher at the end of the Pleistocene (Cohen 1997, 246; Geist 1998, 335). Even given the species' natural population fluctuation, prehistoric herds were larger, particularly when compared to the systematic reduction in caribou since the historic introduction of firearms and other technologies, i.e., snowmobiles, planes, etc. (e.g., Manning 1960). In addition, the social context of caribou hunting has also dramatically changed since the last ice age, forcing historic era and ethnographic hunters to pursue diminished herds within increasingly circumscribed (and often externally imposed) territorial boundaries, particularly post-contact (e.g., Gillespie 1975, 1976; Hearne 1958; see also Sharp and Sharp 2015). While ethnographic examples provide useful case studies, it seems clear that they should not be uncritically imposed upon the prehistoric past (*sensu* Wobst 1978; see also Lemke, forthcoming). What is needed is empirical evidence directly linked to prehistoric exploitation that can anchor our modeling efforts.

1.2. Contributions of submerged site archaeology

It is to the need for empirical evidence of prehistoric exploitation that submerged site archaeology can make a contribution. Similar to global changes in sea level that exposed large portions of the continental shelf, water levels in the late Pleistocene/early Holocene Northeast likewise fluctuated. The most extreme of these oscillations in the western Great Lakes was the Lake Stanley stage in Lake Huron, which saw a drop of as much as 140 m below modern lake levels, exposing over 250,000 ha of land for human and animal exploitation between ~11,500 and 8300 cal yr BP (Lewis and Anderson 2012; Lewis, Blasco, and Gareau 2005). This time period encapsulates the late Paleoindian – early Archaic periods from the terrestrial archaeological record.

This submerged context presents many potential advantages. Most important is the fact that archaeological sites, including stone-constructed caribou hunting structures, have remained in place during the region's re-inundation at the end of Lake Stanley; and unlike contemporary sites on land, those underwater are not disturbed by subsequent human activities and development. In addition to the preservation of archaeological sites and structures, paleoenvironmental data have been preserved including intact rooted trees and other environmental indicators such as pollen and testate amoebae (Sonnenburg 2015), enabling a detailed reconstruction of the prehistoric environmental context of caribou hunting (Sonnenburg and O'Shea 2017). Finally, as the timing of the drop and subsequent rise in lake levels is well established through absolute dating, and the Lake Stanley stage represents a relatively short time span, there is tight chronological control. Overall, the preservation provided underwater offers enormous data potential in areas of chronology, environmental reconstruction, and the structure of archaeological sites. Underwater archaeological investigations of caribou hunting sites on a submerged landform in the middle of Lake Huron offer just such unique data to address the seasonality of prehistoric caribou hunting in the Northeast.

2. Case study

The Alpena-Amberley Ridge (AAR) is a formation of limestone and dolomite that resisted the thrust of glacial ice and survives as a rocky structure on the modern lake bottom linking northeast lower Michigan and southcentral Ontario (Hough 1958; Thomas, Kemp, and Lewis 1973, 232). Currently 80–130 ft underwater, during Lake Stanley times it would have existed as a dry land corridor (averaging about 15 km in width) dividing the modern basin into two distinct lakes (Figure 1).

2.1. Paleoenvironment

Paleoenvironmental reconstructions of the late Pleistocene/early Holocene Great Lakes are extremely complicated, due both to the nature of the environments themselves as well as the limited data from which they are inferred. For example, pollen cores from sites which are few and far between on the landscape indicate a mosaic of environments at 9000 cal yr BP, including patches of tundra, lichen woodlands, boreal forest, deciduous areas, and zones of boreal/aspen parkland transitions (e.g., Julig and Beaton 2015, figure 5.1).

More locally, cold water preservation and intact ancient sediments, as well as micro- and macro-botanical remains, indicate that the AAR was a cold, subarctic, periglacial environment characterized as spruce parkland with numerous lakes and marshes (McCarthy, McAndrews, and Papangelakis 2015; Sonnenburg 2015; Sonnenburg and O'Shea 2017). Radiocarbon dates from several preserved pieces of wood, rooted trees, and charcoal from archaeological sites on the AAR

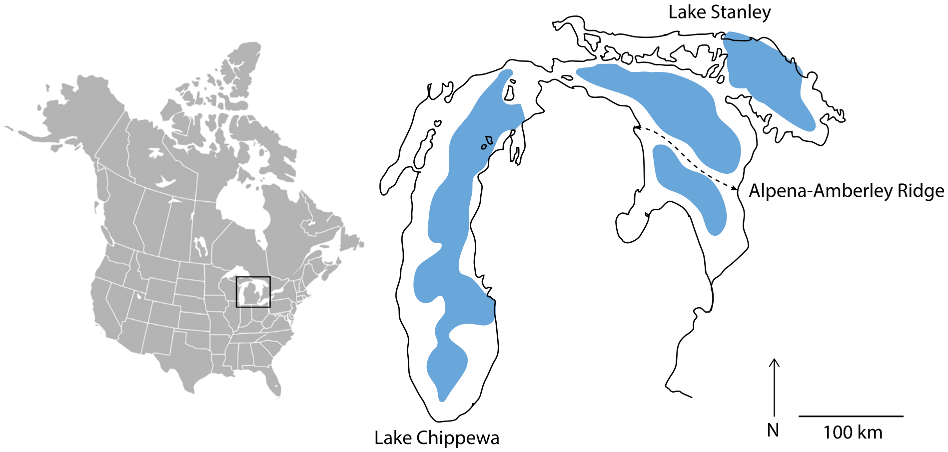

Figure 1 Map showing the geographic location of the Great Lakes, and lower water levels of Lakes Chippewa (in the modern Lake Michigan basin) and Lake Stanley (in the modern Lake Huron basin). AAR is indicated by dashed, arrowed line.

closely date the dry land occupation between 9125 and 8542 cal yr BP (see O'Shea et al. 2014, table S2). The climate remained cold throughout Lake Stanley, and patterns of forest succession lagged behind changes on the mainland of either Michigan or Ontario (McCarthy, McAndrews, and Papangelakis 2015). Therefore, environments on either side of the ridge were densely forested while the AAR remained more open. Overall, the AAR appears to have acted as a cold climate refugium (Lemke 2015a; Lemke and O'Shea, forthcoming) that likely retained an array of late Pleistocene flora and fauna (including caribou) longer than the adjacent mainland.

2.2. Inferred seasonal movements of caribou

Late Pleistocene/early Holocene Great Lakes paleoenvironments were likely attractive to long-distance migratory caribou herds (see Storck and Spiess 1994). Both paleontological and archaeological remains of caribou indicate their presence on the landscape at this time (Lemke 2015a). Similar to caribou today, it is likely that prehistoric herds participated in semi-annual (fall and spring) migrations. Such migrations can be generally characterized by herds moving south in the fall to wintering grounds, and north in the spring to sheltered calving grounds. Such latitudinal migration is most likely given paleoclimates in the region as well as topography, i.e., shorter distance migrations between higher and lower elevations characteristic of some modern caribou is not possible on the flat, glacial landscape of the Great Lakes.

Given the environmental reconstruction of the AAR, this landform would have presented an ideal region for caribou with forage, fresh water, and probably fewer insects than the mainland due to significant winds across the ridge from water on either side (McCarthy, McAndrews, and Papangelakis 2015; O'Shea et al. 2014, table S1). It is hypothesized that the AAR would have served as a natural route for the semi-annual migration of caribou herds, and that this in turn attracted human predation. Running northwest to southeast, the AAR would have provided an ideal migration route.

Computer simulation has been used to better understand the inferred movement of caribou across the AAR. This simulation draws on environmental reconstruction and a topographic map of the AAR provided by sonar surveys to create an agent-based simulation of herd movements during bi-annual migrations (see Fogarty et al. 2015; O'Shea et al. 2014; Reynolds et al. 2013). Many of the archaeological sites identified on the AAR fall along these simulated routes of movement. Importantly, the AAR, or at least its more northerly and southerly ends, may have been used by caribou at other times of the year as well. For instance, the open nature of the ridge may have offered preferred calving grounds. Further work with the computer simulation will incorporate ecological and biological studies of modern caribou to test these predictions.

2.3. Archaeological patterns

Archaeological research on the AAR is beginning to fulfill the promise of submerged site archaeology. Work to date has identified more than 60 hunting features constructed from local stone boulders, potential habitation areas, storage facilities, as well as stone tools and debitage (e.g., Lemke 2015b, 2016; O'Shea et al. 2014; Sonnenburg, Lemke, and O'Shea 2015). These lithic artifacts include a thumbnail scraper, characteristic of Paleoindian occupations, but no culturally diagnostic artifacts have been recovered. Two distinct varieties of hunting structures are observed. First, there are relatively simple structures such as hunting blinds that could only accommodate a few individuals. These are typically situated to take advantage of larger, natural landscape features that would channel the movement of caribou toward such hunting sites – such as a topographic bottleneck or glacial esker. The second type, termed complex, is much more elaborate, involving larger, built structures with multiple hunting blinds and other features (such as drive lines and cairns) functioning together. These complex structures would have required a substantially larger number of individuals to operate, and would have been capable of producing a much greater yield of animals (see O'Shea, Lemke, and Reynolds 2013; O'Shea et al. 2014) (Figure 2).

As research has progressed, efforts have focused on two research areas (Areas 1 and 3) to begin to understand the spatial distribution of hunting sites across the landscape, the relationships between hunting features, and the seasonal organization of hunting activities. Particularly relevant to the latter question is the fit between the orientation of hunting features and the inferred seasonal direction of semi-annual caribou migrations. For example, since many of the hunting features exhibit "directional dependence" (O'Shea, Lemke, and Reynolds 2013; O'Shea et al. 2014), meaning that they will only function if the animals are moving in a specific direction, these hunting sites can be linked to a specific season of use (Figure 3).

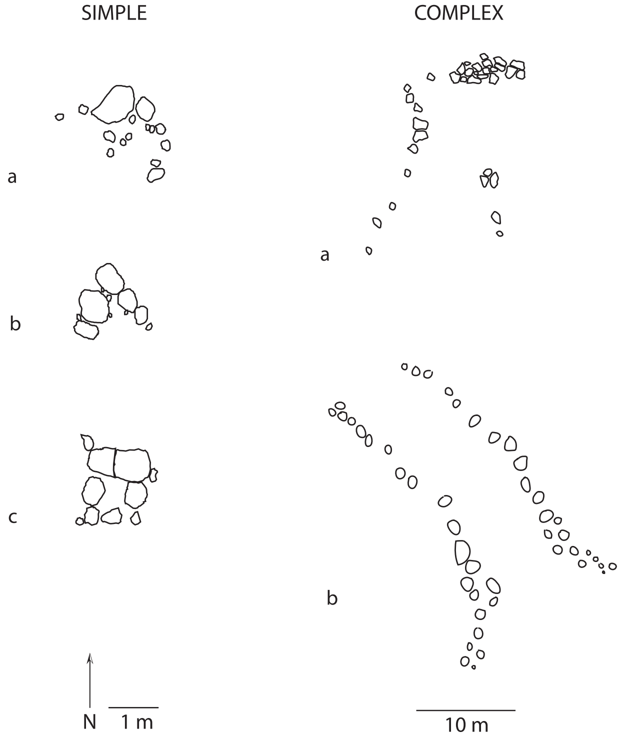

Figure 2 Examples of the two types of structures found on the AAR. Simple structures: (a) Ash-Gap V hunting blind, depth 105 ft; (b) V-Structure hunting blind, depth 105 ft; (c) Rectangular cache structure, depth 116 ft. Complex structures: (a) Funnel site, composed of drive lines, walls, and hunting blinds, depth 82 ft; (b) Drop 45 site, composed of drive lines, hunting blinds, and natural cul-de-sac, depth 120 ft.

Given the inferred movement of caribou during semi-annual migrations across the AAR, structures oriented to the north/northwest are arranged to intercept caribou during their fall migration; while vice versa, structures oriented to the south/southeast are made to intercept the animals during their spring migration. A sample of structures on the AAR (n = 12), have been the primary focus of archaeological investigation to date with measurable orientations (i.e., circular structures are not considered), three structures are complex and include drive lines, hunting blinds, and other features operating together, and nine are simple structures, including hunting blinds and single lines. All three of the complex structures are oriented southeast, and six of the simple structures are oriented north. The three remaining simple structures have east, northeast, and north–south orientations (Table 1). When these observations of structure type (i.e., simple or complex) and orientation are combined, distinct patterns of seasonal exploitation can be inferred.

2.4. Modeling seasonal patterns of caribou exploitation

2.4.1. Fall

In the autumn, we propose that small groups of hunters (probably including their extended families) assembled at key sites along the AAR where they had constructed simple hunting blinds in locations where landscape

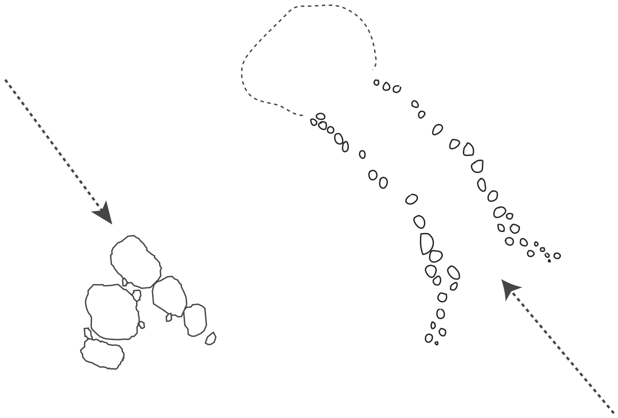

Figure 3 Schematic of directional dependency. Many structures on the AAR would only work if the animals were coming from one specific direction. Animal movement depicted by dashed, arrowed lines.

Table 1 Archaeological structures on the AAR and inferred season of use.

Site name	Research area	Orientation	Corresponding season
Complex structures			
Dragon	1	~Southeast	Spring
Funnel	1	Southeast	Spring
Drop 45	3	Southeast	Spring
Simple structures			
V-Structure	3	North	Fall
Ash-Gap V	3	North	Fall
V with rectangular structure	3	North	Fall
Overlook V Blinds (n = 3)	1	North	Fall (n = 3)
Overlook Blind	1	East	Non-migration
T-V Blind	3	Northeast	Non-migration
New Gap Line	3	North–south	Fall and spring

features would tend naturally to channel the migrating herds of caribou. The blinds are most commonly simple V-shaped structures with their apex facing towards the north (n = 6), the direction from which the animals would be coming. Given the simple nature of these hunting blinds and the absence of complex drive lanes, these structures do not indicate active drives such as a bison jump, per se, nor any indication that the animals were panicked or otherwise actively directed towards the blind (see O'Shea, Lemke, and Reynolds 2013). Instead, we infer that the hunters waited, concealed by these blinds, until they were surrounded by animals. In some cases, as at the New Gap locality (O'Shea 2015, 122–125), the blinds were located sequentially down a channel formed by glacial eskers which formed a topographic bottleneck along a likely migration route. For such a strategy to work, a large number of passing animals must have been present.

A focus on autumn hunting is not surprising as caribou are in prime condition during their autumn migration and are valued not just for their meat but also for their hides and sinew (Blehr 1990; Enloe 2003; Reimers and Ringberg 1983; Stefansson 1951). An additional outcome of autumn hunting on the AAR was likely the storage of meat for the winter. It appears that limited processing of the carcasses took place close to the hunting sites, as rectangular structures, often identified as caches in the ethnoarchaeological literature (cf. Stewart 2014), are located nearby (e.g., V with rectangular structure site, Table 1). To date, all caches identified on the AAR are associated with simple hunting structures indicative of a relatively small band taking and processing animals in proportion to their numbers and anticipated needs (see Table 2).

2.4.2. Spring

The spring hunt, by contrast, presents a very different profile. While one of the simple structures may be oriented for both fall and spring migrations (e.g., New Gap Line, Table 1), all of the complex hunting structures (n = 3) are oriented with their openings to the south and east – specifically designed for spring migration hunting. As described previously, these structures were much more elaborate than the simple structures, and they incorporated multiple constructed drive lines, hunting blinds, and upright or stacked stones to help channel the movement of animals into a kill zone. These features would have required a large number of hunters to operate and probably also utilized additional personnel to drive or direct the animals into the structure. The take anticipated in these complex hunting structures would have been large, and would have required a proportional number of people to process.

Unlike the autumn, during the spring caribou are not in prime condition, and storing meat in frozen caches would not be an option. Cache structures, to date, have not been found in association with the complex hunting features – supporting this assertion. As such, it seems most probable that the goal of this spring hunt was immediate consumption, as hunters emerge from a long, hungry winter. Therefore the mass kill of animals, and the limited ability to preserve frozen meat during the spring, presents the opportunity for a large number of people to aggregate. As such, population aggregation can be seen as both a necessary condition for the operation of complex hunting features, and a benefit deriving from them (Carlson and Bement 2013; Smith 2013; Wilke 2013) (see Table 2 and discussion below).

2.4.3. Winter and summer

Two simple structures may hint at non-migration hunting on the AAR. Neither the Overlook Blind nor T-V Blind (Table 1) are oriented for fall or spring movements of animals – perhaps these structures were designed for hunting caribou in the "off season". Certain aspects of the AAR paleoenvironment suggest it could have functioned as a calving ground for caribou, given its more open environment, likely fewer insects, and perhaps fewer predators (see above). These structures may have been utilized during these times. Further archaeological and paleoenvironmental research will analyze the mirco-settings of these and other structures on the AAR to determine if they were

Table 2 Archaeological observations concerning seasonality of caribou hunting.

Season	Structure type	Primary orientation	Labor requirements	Storage facilities present
Autumn	Simple	North/northwest	Low	Yes
Spring	Complex	South/southeast	High	No

placed next to grazing areas, fresh water, or other topographic opportunities for ambush hunting.

We need to look beyond submerged hunting structures to fill in the remainder of the annual cycle. At this point, these represent testable expectations rather than empirically demonstrated facts. Climatic reconstructions make it appear very unlikely that hunters would remain on the AAR during the cold, harsh winters. Instead, we would expect the local populations to move west to the more sheltered tree line areas in Michigan. We can imagine these small family or extended family groups living in dispersed winter camps with occasional hunting and trapping forays. They also very likely moved across the frozen "near" lake (see Figure 1) to access stores that had been cached and frozen on the AAR. It is most likely that the lower elevation winter camps are now submerged beneath Lake Huron and buried under nearshore coastal sediments, but hunting trips to higher ground (which were dry land during Lake Stanley and remain dry today) should result in the preservation of small hunting camps in the terrestrial archaeological record. Activities and movements during the summer are the most difficult to ascertain or infer. Did the communities stay on the AAR to fish or hunt birds or non-migratory mammals? Did they move inland? There is simply not evidence at present to say.

An important caveat to these inferred seasonal patterns is that the archaeological sites and structures on the AAR are contemporary. However, given that variation in depth on the AAR is related to the step-wise rise in lake levels which occurred over the course of the Lake Stanley stage and that both types of hunting structures occur in both deeper and shallower settings, it seem unlikely that the differences could be attributed to change over time. Radiocarbon assays from wood and charcoal at several sites across the AAR have a span of less than 1000 years (given a two sigma range, see above). It is our assumption that these sites were likely re-used over time and that variability in structures is indicative of different, essentially contemporary economic strategies rather than change over time.

3. Discussion

The submerged prehistoric record on the AAR presents evidence for distinctive patterns of hunting in the autumn and the spring. These patterns have important implications both for understanding the organization of human activities during this time period, and also for the size and behavior of caribou herds at the end of the Pleistocene. While the seasonal pattern of caribou exploitation on the AAR makes logical sense, it does run counter to most ethnographic and historical accounts of caribou hunting. For example, many sources agree that caribou are in their most desirable condition in the autumn (Blehr 1990; Enloe 2003; Reimers and Ringberg 1983; Stefansson 1951), so why should the emphasis on mass capture take place in the spring on the AAR?

The answer to this question returns us to a consideration of the unique circumstances at the end of the Pleistocene in northeastern North America, and how they contrast with conditions during the post-contact era. Firstly, it is important to remember that the caribou herds roaming across the Northeast at the end of the Pleistocene were likely many times larger than those observed during the historic period. Indeed, Lorenzen et al. (2011) suggest that global *Rangifer* (caribou and reindeer) decreased by 84 per cent from the end of the Pleistocene, and that these decreases were particularly dramatic during the 17th through 19th centuries (e.g., Bergerud, Luttich, and Camps 2008; Cuyler 2007; Simeone 2007, 318); but why should the absolute number of animals make a difference?

The simple answer is that there are fewer animals available to kill during the historic/ethnographic era, which drastically affected economic and social strategies. As herds decrease in size, their movements become less constrained by available forage, meaning their routes of movement are less predictable. This is the time reflected in *In a Hungry Country* (Campbell 2004) and others (Mowat 1962; Tester and Kulchyski 1994) where hunters relentlessly seek, and often fail, to locate the life sustaining animals. It is a time of hunger and starvation and desperate measures. Spiess (1979, 118) has commented that as caribou become scarcer, more elaborate structures tend to be constructed for their capture. This may be effective for capturing relatively stationary groups of grazing animals, but if the focus of hunting is on migrating animals and the routes become less predictable, the risk associated with building structures in fixed locations would be great. This suggests that the relatively large human population aggregations we see archaeologically, which were tied to complex structures and mass capture of animals during the spring migration, are reflecting the specific and local conditions of the late Pleistocene/early Holocene era.

The special circumstances of the AAR provide a vivid contrast. The cold refugium appears to have attracted cold adapted species, such as caribou, at the end of the Pleistocene, and the constricted character of the landform (i.e., a narrow land bridge) would have produced a high level of predictability to animal movements and increased hunting success. Given larger herds and a confined landform, even individuals in less preferred hunting venues on the AAR would still have a good chance for a successful hunt.

This may well be the factor responsible for the different seasonal hunting patterns observed on the AAR, with multiple small and scattered hunting sites in the autumn and large cooperative hunting structures in the spring. In this case, the predictability of hunting success allowed small dispersed groups to efficiently process and make winter stores, while the large cooperative structures were not built to entrap a diminishing resource as envisioned by Spiess, but rather to ensure a large take of migrating animals to feed an aggregated population at the end of the lean season.

Overall, the AAR data, specifically communal hunting in the spring, suggest that historic and ethnographic analogs are constrained by their context. That is, such cases are specific reactions to reduced herd sizes of the modern era and need not reflect herd sizes or hunting behavior prior to historic population collapse.

4. Conclusion

While the seasonal pattern of caribou exploitation on the AAR is clear, it need not represent a global pattern, nor should it necessarily be expected to hold across the Northeast. The conditions on the AAR were unique and reflect an equally distinct adaptation to these conditions. We should expect equivalently unique settings and responses by ancient caribou hunters throughout the region.

Historical and ethnographic accounts are foundational for our understanding of prehistoric caribou hunting, but we should not expect these models to necessarily be replicated in the distant past, nor should we be surprised when archaeological data indicate patterns of exploitation or seasonality that differ from the ethnographic norm. Instead, underwater research provides a useful alternative model which can be compared and contrasted with other regions and as new indicators of seasonality are obtained.

Overall, submerged site research in the Northeast will continue to present unique data and alternative models to supplement the terrestrial archaeological record. The landscapes over which Paleoindian populations were living and hunting were drastically different than those in the region today – our best chance for understanding hunter-gatherer lifeways in this region is to connect the submerged and terrestrial archaeological records for an integrated view of the prehistoric past.

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