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Exploratory Models of Social Organization and Adaptive Responses to Risk in Subarctic Alaska

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ABSTRACT. Cultural stability and change in subarctic Alaska are often couched in terms of archaeological constructs derived from lithic typologies, migration, and (to a lesser extent) diffusion. Major problems explaining material-culture continuity and transitions remain largely unresolved. To address these problems, models of resource management strategies (RMS) are developed for the two major cultural systems: a Late Pleistocene / Early Holocene (LP/EH) RMS (12,500–6000 cal BP) and Middle Holocene (MH) RMS (6000–1000 cal BP). This allows a first approximation of social organization and an investigation of the systemic relationships among demography, habitat use, mobility, storage, economy, and technology as constraints on exchange, group size, territory, and social interaction. These elements of both RMS are inferred or estimated through archaeological proxies, and ethnographic data, or both. Results indicate that the MH RMS resembles recent subarctic Dene hunter-gatherers, while the LP/EH RMS is substantially different in social organization, more similar to early Paleo-Indian complexes. The two RMS yield different predictions with respect to responses to risk, and these are assessed by examining several periods of hypothetically increased risk. The LP/EH RMS managed substantial climate change during and after the Younger Dryas without major technological or land-use changes, due in part to flexible social organization, mobility, and economic strategies. Mid-Holocene vegetation changes connected to decreasing bison and wapiti populations led to a collapse of this system.

Keywords: subarctic Alaska; archaeology; resource management strategies; risk; Denali tradition; Northern Archaic tradition

RÉSUMÉ. Dans l'Alaska subarctique, la stabilité culturelle et le changement sont souvent décrits à partir de concepts archéologiques dérivés des typologies lithiques, de la migration et, dans une moindre mesure, de la diffusion. Des problèmes majeurs expliquant la continuité de la culture matérielle et les transitions restent en grande partie sans réponses. Pour remédier à ces problèmes, des modèles de stratégies de gestion des ressources (SGR) ont été élaborés pour les deux grands systèmes culturels. Un modèle de SGR couvre le Pléistocène tardif et l'Holocène précoce (PT-HP) (de 12 500 à 6 000 ans cal. BP) et l'autre couvre l'Holocène moyen (HM) (de 6000 à 1000 ans cal. BP). Ces modèles ont permis d'obtenir une première approximation de l'organisation sociale et de faire une enquête sur les liens systémiques existant entre la démographie, l'utilisation de l'habitat, la mobilité, l'entreposage, l'économie et la technologie en tant que contraintes sur les échanges, la taille des groupes, le territoire et les interactions sociales. Ces éléments tirés des deux SGR ont été déduits ou estimés à l'aide de calculs archéologiques par approximation de données ethnographiques, ou les deux. Ils révèlent que la SGR de l'HM ressemble à celle des chasseurs-cueilleurs dénés récents du subarctique, tandis que la SGR du PT-HP diffère considérablement sur le plan de l'organisation sociale, qui se rapproche plutôt des complexes du début du Paléoindien. Les deux SGR ont produit des prévisions différentes sur la réaction au risque, lesquelles sont évaluées au moyen de l'examen de plusieurs périodes hypothétiques de risque accru. La SGR du PT-HP a fait face à un changement climatique majeur pendant et après le Dryas récent, sans avoir subi de profonds bouleversements technologiques ou de modifications de l'utilisation des terres. Cela est en partie attribuable à l'organisation sociale flexible, à la mobilité et aux stratégies économiques. Les changements en matière de végétation de l'Holocène moyen, en lien avec la diminution des populations de bisons et de wapitis, ont entraîné l'effondrement de ce système.

Mots-clés : Alaska subarctique; archéologie; stratégies de gestion des ressources; risque; tradition du Denali; tradition archaïque nordique

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INTRODUCTION

Many current interpretations of subarctic Alaska prehistory tend to rely on techno-typological analyses of lithic assemblages, often in the context of individual components within a single site (e.g., Bever, 2001; Clark, 2001; Hoffecker, 2011; Graf et al., 2017; Graf et al., 2020). Concomitant advances in our understanding of social organization, particularly interactions and relationships among technology, economy, habitat use, exchange systems, and group and territory sizes, however, remain underconceptualized (Potter, 2008a, 2011; Shott, 2013). Detailed explications for major archaeological transitions and for extended periods of stability remain lacking for interior Alaska, and most explanations tend toward migration and diffusion (Clark, 1994; Bever, 2001; Esdale, 2008; Goebel and Potter, 2016; Potter, 2016). An alternate analytical strategy was developed and employed effectively in adjacent Northwest Coast regions by Chatters and Prentiss (2005), who defined an analytical category—a socioeconomic blueprint they termed resource management strategy (RMS). RMSs are a holistic suite of shared behaviours incorporating subsistence economy, technology, resource scheduling and habitat use, labour management, and exchange that enable groups to survive in their specific environmental contexts. These RMSs are similar to adaptive systems, a term widely used in other regions to model ancient hunter-gatherer behaviours (described in Binford,1962, 1965; see discussion in Bettinger et al., 2015). These RMSs have advantages over the archaeological constructs used in the Arctic or subarctic: techno-complex or cultural tradition. These latter units are primarily summaries of descriptions of specific stone-making techniques with little or no explicit connections to other important variables and cultural subsystems such as economy and habitat use (Trigger, 1995; Binford, 2001). Thus, RMSs provide a more realistic framework for examining archaeological problems such as complex behavioural adaptations to environmental changes on multiple scales. Specifically, this approach leads to holistic predictions of how the RMS subsystems should behave with respect to external environmental changes, integrating shifts that must occur when one element of the strategy changes.

The northern subarctic archaeological record could be conceived as comprising primarily high-mobility foragers/collectors who show relatively little technological changes for many millennia (Workman, 1978; Holmes, 2001, 2008; Holmes et al., 2023). However, because of patterned differences between Early Holocene and Middle – Late Holocene hunter-gatherers, this record can be used to explore variation within the high-mobility forager adaptive system (or RMS) category (Potter, 2008a, 2016).

This article focuses on integrating proxies for social organization, human ecology, and risk-management strategies in eastern Beringia/subarctic Alaska from 12,500 to 1000 cal BP (Fig. 1). Investigations from 2008 to 2024 have focused on elucidating patterning among elements that can condition assemblage variability, particularly by influencing technological and economic choices made by ancient populations interacting with changing environments (Potter, 2008a – c, 2011, 2023; Potter et al., 2013; Lanoë et al., 2018; Halffman et al., 2020; Doering, 2021). These elements—primarily faunal, lithic, and organic technology and features and geospatial variation at both intrasite and intersite scales—provide important controls for understanding settlement strategies and landscape use (Potter et al., 2013; Potter et al., 2017; Doering, 2021). More importantly, these data allow exploration of social organizational properties that are tractable from the archaeological record.

Given the coarseness of the Alaskan archaeological record, I identified the most substantial transitions in cultural traditions, as measured by technological and economic change (Dixon, 1985; Potter, 2008a – c). While the record in eastern Beringia is complex, and there is no firm consensus on the delineation of archaeological groups from approximately 14,200 to 12,000 years ago, the later record is less controversial (Holmes, 2001; Bever, 2006; Potter, 2011). The Denali (or Paleo-Arctic) tradition was widespread throughout subarctic Alaska from approximately 12,500 to 6000 cal BP (West, 1967, 1996); it was replaced by the Northern Archaic tradition, dating from approximately 6000 to 1000 cal BP (Anderson, 1968; Dixon, 1985; Esdale, 2008; Potter, 2008a). These two traditions are internally homogeneous and geographically isomorphic, with broad similarities across interior subarctic Alaska (Fig. 1, Fig. 2). The archaeogenetic record strongly suggests that Northern Archaic tradition peoples were direct Dene ancestors, while Denali tradition peoples represent another branch of Native Americans, termed Ancient Beringians, that were absorbed or replaced by incoming Dene peoples (Rasmussen et al., 2014; Verdu et al., 2014; Moreno-Mayar et al., 2018a, 2018b). For the purposes of this paper, the Chindadn complex (Holmes, 2001), which persisted from 13,300 to 12,000 cal BP in this region, is included with the Denali complex, given the similarities in subsistence and land-use strategies (Potter, 2008a, 2011; Doering, 2021). The two adaptive systems, or RMS, developed here are as follows:

- Late Pleistocene / Early Holocene RMS (13,300 – 6000 cal BP; Chindadn and Denali)
- Middle Holocene RMS (6000 – 1000 cal BP; Northern Archaic)

A third Late Holocene RMS (1000 cal BP to historic contact), a Dene tradition, has long been interpreted to be associated with ethnographically attested behaviours recorded for Dene peoples in subarctic Alaska (McKennan, 1969; Workman, 1977; Dixon, 1985).

This modelling approach estimates paleodemography, habitat use, mobility, subsistence, and technology for each RMS from (1) paleoenvironmental reconstructions that include resource abundance, diversity, and patch structure; and (2) multiple archaeological proxies. A more speculative

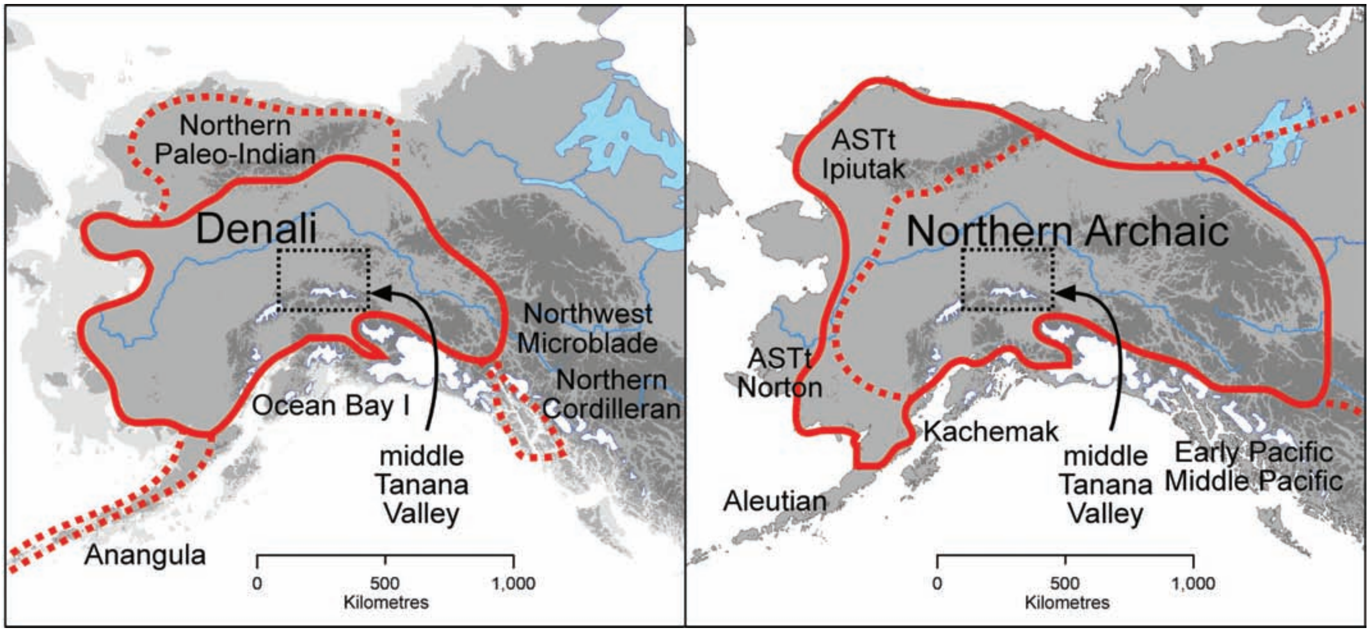

FIG. 1. The geographic extent of the Denali complex (solid line: 12,500–9000 cal BP, dashed line: 9000–6000 cal BP), the Northern Archaic tradition (solid line 6000–4500 cal BP, dashed line, 4500–1000 cal BP), and surrounding archaeological cultures. Site data derived from the middle Tanana Valley.

series of models of social organization are constructed from archaeological and ethnographic datasets, including estimates for exchange and other social interactions, territory size, group size, reciprocity, foraging strategies, and expected responses to risk (Halstead and O'Shea, 1989; Bousman, 1993, 2005; Bamforth and Bleed, 1997; Holly, 2018). These RMS models are then used to evaluate human responses to the Younger Dryas (12,800–11,600 cal BP) and the Middle Holocene cultural transition (at approximately 6000 cal BP). Finally, this paper addresses why cultural traditions were mostly stable and conservative for thousands of years in the context of integrated cultural systems.

METHODS

Recent synthetic analyses of the archaeological record of interior Alaska that yielded data on site locations, chronological controls, faunal analyses, and limited technological analyses were used as a basis for this modelling effort (Potter, 2008a–c, 2011; Potter et al., 2013; Doering, 2021). Analyses in Potter, 2008a–c were based on 167 dated archaeological components in interior Alaska. This present analysis includes 107 components that were newly discovered or dated since the 2008 research, yielding a database of 274 directly dated components (data summaries in Potter, 2008a–c; Potter et al., 2013, 2018; summaries in Doering, 2021). Basic patterns used to construct the models in this present database follow earlier studies (Potter, 2008a–c) and are briefly described here.

Analyses focused on identifying periods of stability and change in the material culture record by examining technological, subsistence, and habitat patterning at thousand-year intervals. Space- and time-averaging archaeological components in this way allowed for the detection of periods of stability and marked change (see Lyman, 2003). Results indicated remarkable technological continuity between 12,500 and 1000 years ago but marked changes at 6000 and 1000 cal BP. These coincide with specific archaeological cultural traditions established through typological analyses of lithic industries, of, for example, Denali, Northern Archaic, and Dene traditions (Dixon, 1985).

The data presented in these studies were used to define three major adaptive systems (or RMS), labelled here Late Pleistocene / Early Holocene (LP/EH; 13,300–6000 cal BP), Middle Holocene (MH; 6000–1000 cal BP), and Late Holocene (LH; < 1000 cal BP). Model elements were developed through two methods. First, archaeological and paleoenvironmental data provided independent data to evaluate differences in resource abundance, diversity, and patch size and structure. These data, along with radiocarbon date distributions, site types, storage facilities, zooarchaeological data, and techno-typological data, were then used to infer constraints on technology, demography, economy, and mobility. Second, ethnographic data from Binford (2001) and Hamilton et al. (2018) were used to provide general parameter estimates on high-latitude, subarctic hunter-gatherer mobility and group size. The Hamilton et al. (2018) study used 11 ethnographic groups from a widespread geographic area with different environments yet with a relatively narrow range of values; these data are useful as a baseline for generalized hunter-gatherer group sizes. Two items are of particular importance: (1) the relatively narrow range of hunter-gatherer mean co-residing group sizes, number of household features, individuals per feature, camp area, and residence times (Hamilton et al., 2018); and (2) the

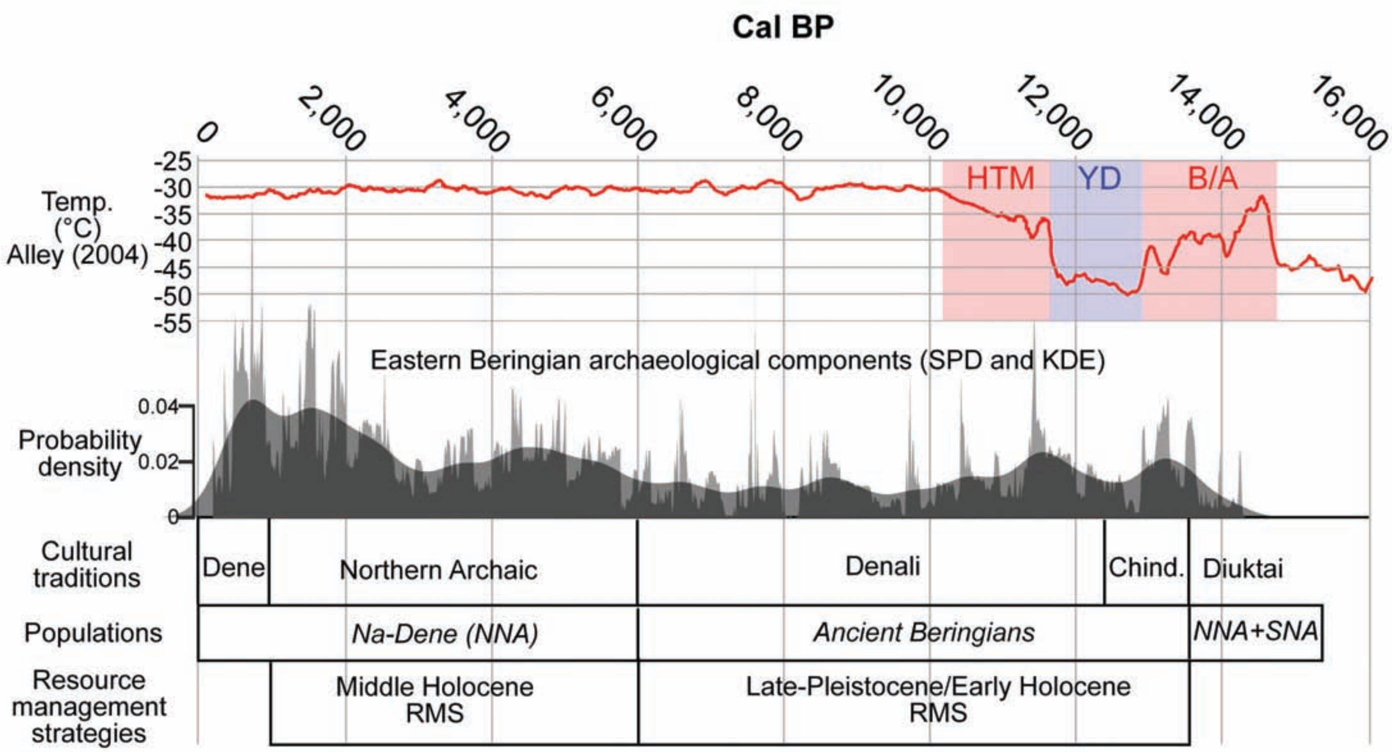

FIG. 2. Eastern Beringian and northwestern subarctic climate variation (HTM = Holocene Thermal Maximum), YD = Younger Dryas, B/A = Bølling-Allerød), population proxy (SPD = summed radiocarbon date probability distributions, KDE = kernel density model), cultural traditions (Dene = Dene tradition, Chind. = Chindadn complex), genetic populations (NNA + SNA = Northern and Southern Native Americans), and resource management strategies.

relatively narrow range of demographic and mobility values for subarctic hunter-gatherers with limited plant resources (Binford, 2001). These recent boreal forest hunter-gatherer data are important proxies for the MH RMS, as both groups inhabited the same region, and both the paleoenvironmental and zooarchaeological data show broad similarities and continuity in vegetation regime and available animal and plant resources.

Paleoenvironmental studies provided baselines on resource availability, general habitat, vegetation communities, and overall patch size and structure. Regional zooarchaeological records provided proxies for resource abundance and diversity for each site location (Potter, 2008a–c; Lanoë et al., 2018; Doering, 2021). Given the general lack of detailed faunal analyses for each recorded site, faunal ubiquity was measured as a percentage of dated components per adaptive system with at least 1 MNI (minimum number of individuals) per taxon. For modern resources, ethnographic data provided patterns of seasonal exploitation structured by specific resource scheduling and settlement pattern.

Resource abundance, diversity, and patch structure should condition the adaptive systems modelled here (Chatters and Prentiss, 2005). Some elements of the RMS have archaeological proxies, such as demography, technology, economy, and mobility, while others are more difficult to discern with limited archaeological data—exchange systems and social interactions, territory size, group size, food sharing, and overall foraging strategy, for example.

Demography was estimated by component densities (evaluated as number of components per 100 years for each period) and summed probability distributions (SPD) and kernel density models (KDE) of radiocarbon dates from the same dataset. The SPD was based on averaged radiocarbon dates per archaeological component. The KDE method smooths out random sampling error and calibration interference present in the SPD distribution. I calculated the SPD and KDE by calibration using the IntCal20 radiocarbon calibration curve with Oxcal software program (Bronk Ramsey, 2017; Reimer et al., 2020).

Mobility was primarily inferred from the presence and absence of specific site and feature types. Most site types are shared by both Denali and Northern Archaic cultural traditions, but the latter (Ackerman, 2004; Wilson and Rasic, 2008) additionally contains caribou drivelines and associated corrals (tended facilities). One of these corrals was associated with aggregate residential base camps used for communal caribou hunting (Wilson and Rasi, 2008). Cache pits that were used to store seasonally abundant resources occur only during the Northern Archaic and succeeding Dene traditions (Potter, 2017, Potter et al., 2007). Broad economic and technological patterns were summarized from published syntheses (Potter, 2008a–c), consistent with later research (Doering, 2021).

We estimated additional social variables based on the conditioning and constraints of the differences in habitat use, technology, economy, mobility, and demography. We estimated territory sizes and co-residing group sizes for both RMS from ethnographic data for subarctic and other hunter-gatherers (Binford, 2001; Hamilton et al., 2018). Because of the similarity of environments of the MH RMS and recent Dene, these ethnographic data become more relevant. Exchange systems and social interactions were inferred from the previously established constraints and from economic and technological differences with neighbouring cultural groups for each adaptive system. From all of these data and social variable estimates, we inferred overall foraging strategies.

RESULTS

Model Development

Paleoclimate and Paleoenvironments: Paleoenvironmental patterns in interior Alaska are generally established through palynological and other analyses of lake cores (Bartlein et al., 1991; Hu et al., 2006; Wooller et al., 2012; Bigelow, 2013; Kaufman et al., 2016; Clarke et al., 2024) and more recently through terrestrial sediments (Kielhofer et al., 2023) and fauna (Lanoë et al., 2020). While details remain debated, the general trends are well-established. During the LP/EH RMS, climate change effects appear to be stronger and more abrupt than during the MH RMS. This includes the global temperature oscillations denoted as the Bølling-Allerød Interstadial, Younger Dryas, and Holocene Thermal Maximum (regionally expressed at ~11,000 cal BP or later) (Kaufman et al., 2004; Kaufman et al., 2016; Wooller et al., 2018). Pollen records indicate widespread shrub tundra dominated by *Betula* (birch) with substantial sedge (Cyperaceae) and willow (*Salix* sp.), through the 13,000 – 11,000 cal BP period (Bigelow and Powers, 2001). Between 11,000 and 9000 cal BP, *Populus* (poplar and aspen) and *Picea* (white spruce) expanded as gallery forests along broad river valleys (Bigelow and Powers, 2001; Hu et al., 1996). Early Holocene vegetation (9000 – 6000 cal BP) was dominated by mixed coniferous-broadleaf gallery forests (Edwards et al., 1991). After 6000 cal BP, black spruce increased, and the modern boreal forest continued to the present without major compositional changes (Lynch et al., 2002). Grasses and sedges became rare (< 2% of pollen sum for this later period). The widespread development of waterlogged soils (paludification) accompanied this shift from gallery forests to black-spruce-dominated boreal forests of the Middle – Late Holocene (Hu et al., 1996; Mann et al., 2002; Jones and Yu 2010).

These records permit an evaluation of landscape evolution and patch sizes and structures (Table 1). During the LP/EH RMS, climate change effects appear to be stronger and more abrupt. High-ranked ungulates were common; they used the sedge meadows and grassy understories of the emerging gallery forests. Guthrie (2006) documented substantial quantities of bison between 13,500 and 11,000 cal BP, persisting to later than 9000 cal BP, while Stephenson et al. (2001) identified Holocene bison persisting in interior Alaska. Late Pleistocene and Holocene bison in interior Alaska appear to have been concentrated in interior bottomlands and lowlands, consistent with expectations of the ecological literature (Stephenson et al., 2001). Wapiti showed a great increase around 13,500, at the onset of the LP/EH RMS (Guthrie, 2006), and Potter (2005) identified wapiti presence in archaeological and paleontological contexts in eastern Beringia from 13,300 until approximately 3000 cal BP. Zooarchaeological analyses indicate the predominance of bison and wapiti in LP/EH RMS sites along with a near absence in MH RMS sites (Potter, 2007; 2008a – c). In sum, high-ranked resources (particularly bison and wapiti) were relatively more abundant and diverse in the earlier period.

Resource patches for bison and wapiti were larger and more relatively homogeneous in the early period (Guthrie, 2001; 2013), with both species commonly found together in early archaeological sites such as Broken Mammoth (Yesner, 1996) and Gerstle River (Potter, 2005). Over 75% of the archaeological bison and wapiti were found in lowland sites, near large, braided rivers, and few were found in upland or montane settings (Potter, 2008a). Collectively, these data suggest more open landscapes with high visibility, aiding human exploitation of large gregarious herbivores such as bison and wapiti, which dominated the earlier period faunal assemblages.

In contrast, during the MH RMS, climate change was less pronounced and more gradual, with few fundamental vegetation shifts (Table 1). As muskeg bogs dominated by black spruce and sphagnum increased at the expense of sedge meadows, bison and wapiti habitat would have been reduced, evident in the relative rapid decline of bison and wapiti in zooarchaeological assemblages (Potter, 2008a – c). Resource patches were predicted to be smaller, more heterogeneous, and spaced farther apart as relatively unproductive wetlands expanded. Resource patches used by recent Dene hunter-gatherers were principally structured by seasonally abundant resources, particularly salmon accumulations in rivers and caribou aggregations in migration corridors in the spring and fall (see summaries in Helm, 1981). These differences in resource patch size and structure required more specialized approaches to exploit them. Landscapes became more heavily forested (with closed canopies) and increasingly paludified, leading to more difficult hunting conditions, particularly in lowland regions. Resource abundance and diversity were greatly reduced with the loss of bison and wapiti, two high-ranked resources most commonly hunted in the earlier period (Potter, 2008a – c).

These patterns suggest that we should expect relatively lower nutritional stress in the early period and higher resource stress in the later period. Independent faunal evidence supports this hypothesis, as faunal analysis at Gerstle River has shown that medium- and low-marrow-yield bones were not processed (Potter, 2007), in contrast to the widespread occurrence of bone grease rendering

TABLE 1. Environmental summary.

Environmental variable	LP/EH RMS	MH RMS
Climate change	Very strong	Moderate–low
Tempo of climate change	Abrupt, oscillations	Gradual
Resource abundance	Variable (high)	More variable (low)
Resource diversity	High (more high-ranked)	Low (less high-ranked)
Patch structure	Larger, homogeneous patches	Smaller, heterogeneous, seasonally structured patches
Terrain / visibility	Open, high visibility	Closed, low visibility
Resource stress	Lower	Higher

TABLE 2. Demographic summary.

Demographic variable	LP/EH RMS	MH RMS
Population (component density)	Low (expanding) 13.9 components/1000 years	Higher (stable) 24.8 components/1000 years
Carrying capacity (storage, seasonal exploitation)	Low	Low–moderate
Population pressure	Lower	Higher
Habitat use	Lowland areas (62%) with some upland use (38%)	Lowland areas (39%) with much more upland use (61%)

in the Northern Archaic and the later ethnographically attested Dene record in the region (Yesner, 1989; papers in Helm, 1981).

Demography and Habitat Use: Demographic shifts and changes in habitat use may be expected in light of these different environmental conditions for each adaptive system (Table 2). Figure 2 illustrates SPD and KDE for the project area. Broad paleodemographic trends include an initial increase from ~ 14,000 cal BP through the Bølling-Allerød, a decrease at the onset of the Younger Dryas chronozone (~ 12,800 cal BP), an increase during the later stages of the Younger Dryas (after 12,000 cal BP), peaking during the initial Holocene (~ 11,500 cal BP), followed by relatively stable populations until about 6000 cal BP. The Northern Archaic tradition (and MH RMS) distributions indicate higher population levels, with increases at about 5000 cal BP and after 3000 cal BP. Broadly, LP/EH RMS data indicate lower overall populations than the MH RMS. Doering (2021) analyzed the SPD (but not KDE) of sites in the region, revealing a dip in population at the onset of the Younger Dryas (though not statistically significant) and an increase during the later Younger Dryas that was significant, similar to these results and those of Potter (2008a).

For the early period, populations appear to fluctuate and are more punctuated, with decreases at the onset of the Younger Dryas (~ 12,800 cal BP) and again at 9000 cal BP, perhaps associated with the expansion of white spruce forests. This suggests high residential mobility, and perhaps recurrent abandonment of the region more broadly. Expansion and diversification of the Denali complex after 10,000 cal BP is evident in Pacific drainages (Copper River, Susitna River), Southcentral and Southwest Alaska, and the Aleutian Islands (Ackerman, 1996; Wygal and Goebel, 2012; Coutouly, 2015). Population peaks are evident at about 13,000 cal BP, concurrent with the early manifestation of the Chindadn complex. Later Chindadn points are found with the next population peak, at approximately 11,000 cal BP, suggesting overall continuity. In contrast, the MH RMS populations were generally higher than the preceding adaptive system, populations appear more stable, and there is no evidence of Northern Archaic expansions after they were established (Esdale, 2008).

Carrying capacity is difficult to estimate given the lack of specific knowledge of these ancient societies, however storage often acts to minimize the risk of seasonal shortages and increased population densities (Binford, 2001). MH RMS has evidence of increased food storage. Thus, an increase in local populations during the MH RMS could be connected to the appearance of cache pits. In this case, in response to shifts in resource diversity and seasonal abundance, the new MH RMS land-use strategy led to increased carrying capacity and relatively larger populations, even during a period of increased nutritional stress. These populations apparently adapted not to generalized hunting success (a strategy expected in the earlier period with homogeneous and large patches associated with gregarious high-ranked herbivores) but to increasingly localized ecologies with smaller, seasonally structured patches dominated by caribou and fish.

Habitat use is operationalized based on the broadest levels of ecological and physiographic divisions in interior Alaska (Table 2). Elevation broadly segregates the modern boreal forest in lowlands and bottomlands that are associated with broad, generally east-west trending river systems from upland and montane regions associated with alpine tundra (Wahrhaftig, 1965; Gallant et al., 1995). For brevity, these are distinguished as lowland and upland (or highland) areas, respectively. Zooarchaeological data on taxonomic abundance show distinctly patterned presence/absence of generally upland fauna (about 70% ubiquity of caribou, sheep) and lowland fauna (83%–85% ubiquity of bison, wapiti, moose, fish, birds) (Potter, 2008a–c).

LP/EH RMS sites predominantly (62%) occur in lowland settings (interior bottomland and forested lowland and upland ecoregions), while 38% of sites occur

TABLE 3. Mobility summary.

Mobility variable	LP/EH RMS	MH RMS
Site types	Residential base camps Logistical hunting camps Transitory camps Quarries/workshops	Residential base camps Logistical hunting camps Transitory camps Quarries/workshops Tended facilities (drivelines) Food caches Aggregate base camps
Storage	Low / none	High
Residential mobility	Very high > 16 moves/year > 400 km total/year	Moderately high ~ 16 moves/year ~ 400 km total/year
Logistical mobility	Moderate	Very high
Long-term (territorial) mobility	Higher	Lower
Permanent migration	Likely/common	Unlikely/rare
Mobility strategy	High-tech forager/traveller	Collector

at higher elevations (Alaska Range and interior highlands ecoregions). In contrast, MH RMS sites predominantly occur in upland settings (61%) and less (39%) in lowlands (Potter, 2008b). Average site elevations are significantly different: 424 m asl vs. 522 m asl (t-test for independent samples, t = −2.42, df = 25, p = 0.017) (Potter, 2008a). While not a direct measure of increased logistical mobility, riverbank and lakeshore locations are more commonly used in the MH RMS (10%) than in the earlier LP/EH RMS (3%), while positive landform locations are reduced from 97% in the LP/EH RMS to 90% in the MH RMS (Potter, 2008b).

Mobility: Aspects of mobility can be inferred (Table 3) from presence and absence of specific site types (Binford, 1979, 1980; Kelly, 1992). Many site types are shared by both cultural traditions, including short-term logistical hunting camps, residential base camps, and lithic workshops. The MH RMS contains new site types such as tended facilities (caribou drivelines and associated corrals), cache pits to store seasonally abundant resources, and aggregate base camps, probably used in the context of communal caribou hunting (Potter et al., 2007; Wilson and Rasic, 2008).

Given the presence of storage facilities and communal hunting stations for exploitation of seasonally overabundant resources in the latter period, residential mobility should be relatively lower. Some logistical mobility was present in both periods, but logistical mobility should increase as groups focus on extracting the maximum amount from smaller resource patches in the later MH RMS period. Thus, the later period tended toward stationary facilities and associated aggregate base camps, and food caches indicate increased focus on specific resources (caribou, salmon), further implying more planning depth relating to seasonal resource exploitation. Longer term (territorial) mobility (Kelly, 1992), the LP/EH RMS should be higher than the MH RMS. With respect to permanent migration as a mobility strategy, this may be more feasible within the overall LP/EH RMS, while being unlikely for the MH RMS. These predictions are in line with demographic estimates and cultural distinctions and are connected to different economic bases as discussed below.

Characterization of the overall mobility strategies of these two systems, which were probably internally variable and flexible, is difficult to estimate. However, as a first approximation, the earlier LP/EH RMS appear more like high-tech foragers (originally defined as a set of technological responses) due to large territories and low population density associated with early Paleo-Indian groups (Kelly and Todd, 1988; Bamforth, 2002). However, in this case, the lightweight microblade-dominated industries were apparently preferred over bifacial cores (West, 1996). The LP/EH RMS also have some traits associated with travellers, practising a generalized subsistence strategy focused on large high-ranked prey and high residential mobility (Bettinger and Baumhoff, 1982). The traveller strategy also facilitated movement or migration into uncolonized areas by mapping onto the large-game behaviours, particularly bison and wapiti.

In contrast, MH RMS mobility strategies are more similar to modern Dene boreal forest hunter-gatherers, characterized as collectors (Binford, 1980) though with forager-like tendencies, with respect to high residential mobility (but lower than LP/EH RMS mobility). The MH RMS would be generally inconsistent with processor characters, which include far less mobility and use a wider diversity of resources, particularly plant foods (Kelly, 1992). In fact, Northern Archaic groups tend to have a narrower diet breadth than earlier Beringian groups because of the local extirpation of high-ranked taxa and the increasing focus on caribou and salmon.

Turning to ethnographic data on modern boreal forest hunter-gatherers (Binford, 2001), some estimates can be examined with respect to prehistoric mobility in several areas. Binford (2001) calculated the average number of residential moves and total distance of moves (per year). Specific patterns are apparent, primarily based on his SUBSP1 variable, defined as the food category supplying the majority of calories. For the western subarctic boreal forest hunter-gatherers considered here (n = 8), four were identified as primarily hunters (Dinjii Zhuu, Koyukon, Dän k'í, Tłı̨chǫ) or fishers (Dena'ina, Nabesna, Deg Xit'an, Doogh Hit'an), though they are overall relatively similar (63% hunting, 34% fishing, 3% gathering for the first group,

TABLE 4. Subsistence economy summary.

Economic variable	LP/EH RMS	MH RMS
Resource categories	> 63% hunting < 33% fishing ~ 3% gathering	~ 63% hunting ~ 34% fishing ~ 3% gathering
Diet breadth	Variable (wider)	Variable (narrower)
Diet evenness	Even distribution	Uneven distribution (caribou, salmon dominate)
Hunting strategies	Encounter Disadvantage Intercept	Intercept/pursuit Disadvantage Mass-kill (drivelines) Encounter
Land-use strategy	Generalized, opportunistic, extensive use	Specialized, intensive local use
Adaptive strategy	Flexibility, adaptability	Mapping onto local resources

and 43% hunting, 55% fishing, and 3% gathering for the second group) (Binford, 2001). The hunter group averaged 16 ± 3 residential moves per year, with a total distance of 425 ± 50 km, compared with the fisher group that averaged 5 ± 6 residential moves per year, with a total distance of 105 ± 146 km (Binford, 2001). Given that we have no evidence of fish camps or intensive salmon exploitation in the Northern Archaic, it is reasonable to posit that the MH RMS was similar to the hunter group, with approximately 16 residential moves and total distance of about 400 km. The LP/EH RMS would be expected to have higher residential mobility and more extensive (less seasonal) land-use practices focused on bison and wapiti. This, in turn, implies plausible values for the number of residential moves to be substantially higher than 16 per year and total distances of greater than 400 km.

Obsidian sourcing data are consistent with these expectations of high mobility. There are regular occurrences of Wiki Peak obsidian (the nearest known source) at locations over 400 km away in multiple Tanana Valley sites (Reuther et al., 2011; Coutouly, 2017), and evidence of Hoodoo Mountain obsidian (about 600 km away) at Upward Sun River, as well as evidence of embedded procurement (Little, 2013; Potter, 2005; Potter et al., 2018).

Mean residence time for hunter-gatherers analyzed by Hamilton et al. (2018) was 7.9 days, with a 95% and the confidence interval of 3.6 – 17.7 days. Binford's (2001) model for interior Alaskan hunter-gatherers implies an MH RMS mean residence time of 23 days, most similar to Aka, Efe, and Kua Peoples (African), and considerably longer than the Nunamiut (6.6 days) hunter-gatherers in the Hamilton et al. (2018) study. Given the site and feature types present in the MH RMS, this was probably unevenly divided by season and local resource patch, including winter versus summer camps and transitory camps. LP/EH RMS values of perhaps 20 – 24 moves/year imply a mean residence time of 15 – 18 days, which may have been more evenly dispersed through the seasons given reliance on resources that were available year-round.

Subsistence Economy: The interior Alaskan zooarchaeological record provides direct evidence of exploited taxa. Faunal syntheses show that most mammal, bird, and fish resources available in the present (and regularly exploited based on the ethnographic record) were available throughout the periods considered here (Potter, 2008a – c). However, different foci are evident for the two RMS, yielding different predictions with respect to risk (Bousman, 2005). The primary changes in available taxa are reductions: the extinctions of mammoth and horse at about 12,000 cal BP (Krasinski and Haynes, 2010) and the local extirpation of bison and wapiti from about 3000 cal BP to 1000 cal BP (Holmes, 2001; Stephenson et al., 2001; Farnell et al., 2004; Potter, 2005; Potter et al., 2018). The principal subsistence economic shifts occurred at about 6000 cal BP, at which time bison and wapiti almost completely disappeared, and caribou became the dominant large-mammal prey (Potter, 2008a).

The resource base, patch size and structure, and mobility indicators discussed above allow for predictions about broader economic strategies (Table 4). Diet breadth and evenness should vary given paleoenvironmental conditions. For the LP/EH RMS, there should be wider diet breadth and even resource distributions. In the MH RMS, there should be narrower diet breadth and more uneven resource distributions, reflecting increased focus on seasonally abundant prey. The large-mammal record supports this prediction. The MH RMS faunal record indicates a less diverse and more uneven large-mammal resource base than the LP/EH RMS record (Shannon Entropy H(nat) of 0.758 versus 1.583, Simpson Dominance SD of 54.1% versus 21.1%, and Diversity (1D) of 2.1 versus 4.9 for the MH and LP/EH RMS respectively). With fewer high-ranked large/very large mammals in the MH RMS, we should expect more reliance on lower-ranked buffer foods (e.g., small mammals, fish). Faunal data supports this prediction, as does the increased ubiquity of hare, beaver, and fish from 10% – 16% to 23% – 27% (data from 19 LP/EH and 26 MH faunal assemblages; Potter, 2008a). More broadly, only 32% of LP/EH sites with fauna contain small mammals, compared with 50% of MH sites.

Hunting strategies should vary in predictable ways as well. The LP/EH RMS predicts generalized encounter, opportunistic, and perhaps disadvantage techniques in lakes, especially for larger, more dangerous prey (bison, wapiti, moose) in primarily lowland environments. The MH RMS predicts a shift from encounter to more intercept or pursuit and mass-kill practices as a result of different land-use strategies (incorporating more upland hunting of

TABLE 5. Technology summary.

Technology variable	LP/EH RMS	MH RMS
Toolkits	Generalized	More specialized
	Curated and expedient	Curated and expedient
	Fewer configurations	More configurations
	Fewer point types	Many point types
Toolstone procurement	Embedded, direct	Direct, embedded, long-distance exchange
Production time	Transport unfinished	Transport finished
Planning depth	Lower	Higher

caribou) and increased planning depth (derived in part from more seasonally structured resource patches). Overall, early period land-use strategies could be modelled as generalized and opportunistic, focused on extensive use of the best (highest-ranked) resources. This can only sustain very small, highly mobile populations (Kelly and Todd, 1988). For the later period, land use was more specialized, focused on intensive use of more restricted local patches requiring more specific local knowledge that was less transferable to new areas.

These zooarchaeological patterns and expected economic strategies can help elucidate broader conditioning factors on the larger-scale expansion of these populations (Table 4). For the LP/EH RMS, these factors include flexibility and adaptability, which readily facilitate expansion into new regions, particularly uncolonized areas, through generalized foraging strategies focused on high-ranked prey within larger megapatches. For the MH RMS, these involved mapping onto more localized resources, reflecting the importance of local landscape knowledge, and (perhaps) population pressure that the earlier groups did not face given the reduction in high-ranked prey abundance and diversity. This MH strategy focusing on local mapping-on strategies would act to constrain expansions of populations into areas with different ecological characteristics that were increasingly inhabited by different cultures with different economic subsistence bases.

Technology: Overall, the technologies of the Denali and Northern Archaic cultures are relatively similar: both rely on chipped-stone industries with many overlapping artifact classes, including microblade technology, bifacial projectile points, various unifacial implements, and burins (Esdale, 2008; Potter, 2008a). The transition between later Denali (~ 7000 cal BP) and early Northern Archaic (~ 6000 cal BP) is debated (Dumond, 1969; Workman, 1978; Dumond, 1987; Clark, 1994; Holmes, 2008). No major new technologies or industries were introduced during the Denali—Northern Archaic transition (Esdale, 2008), except notched cobbles, argued to represent net sinkers and more intensive fishing (Anderson, 1988; but see also Esdale, 2008).

These types of mobility and land-use patterns discussed above should affect technological organization (Table 5). In the LP/EH RMS, toolkits should be more generalized, with fewer configurations, as populations focused on a traveller strategy, employing frequent residential mobility, a generalized strategy of large-game predation (primarily bison and wapiti), and use of small game, birds, and fish. There should be fewer extraction implement types (e.g., projectile points). Toolstone procurement should be largely embedded (and planning depth should be shorter), acquired through their overall subsistence annual rounds with limited need for exchange with other groups. Tool production should be consistent with these strategies, and unfinished items should be transported because of the shorter planning depth.

In contrast, later-period toolkits should be more specialized, with more configurations, particularly relating to systematic seasonal-exploitation strategies (e.g., fishing vs. caribou hunting). The MH RMS predicts increased numbers of more specialized sites with activity areas composed of fewer tool types (e.g., hide processing) or specific hunting toolkits (sheep hunting in upland settings vs. bison hunting in lowland settings). There should be a greater variety of extraction implements (e.g., more projectile point types). Toolstone procurement should be more varied, including direct access and long-distance exchange, as territories become more circumscribed. Tool production should be different—more gearing-up sessions and transport of finished tools and less ad hoc production as planning depth increases (Bousman, 1993).

It is difficult to fully test these expectations at present, but generally there is less variability in Denali bifacial projectile points and more variation in Northern Archaic bifacial projectile points (Esdale, 2008). Analyses at Delta River Overlook (DRO), with seven Denali and six Northern Archaic components respectively, broadly support these models (details from Potter et al., 2018). Denali material-type richness is high and distributions are even, with many materials shared among components, suggesting shared, embedded procurement strategies. Overall, tool types and proportions were similar, including redundant hearth-centred activity areas surrounded by smaller activity areas. Denali site types at DRO were restricted to hunting camps and hunting stations (Potter et al., 2018).

In contrast, Northern Archaic material-type richness is low and uneven, and materials are not shared among components, suggesting different and perhaps more direct procurement strategies for each component. Northern Archaic behaviours vary more widely, with no clear modes evident among the components, with distinct (and smaller) toolkits left at specific components, reflecting specialized and perhaps seasonal land use. Obsidian in Denali components was almost all derived from the nearest source (Wiki Peak), which is consistent with embedded procurement

TABLE 6. Social organization summary.

Social variable	LP/EH RMS	MH RMS
Exchange: geographic extent	Local	Local and long distance
Exchange: needs	Marriage partners Information	Marriage partners Information Toolstone Non-local resources
Social interaction	Local bands Similar groups (Anangula, Ocean Bay I)	Local bands Macrobands Different groups (ASTt, Norton, Kachemak)
Band territory size	Very large (> 2,000 km^2) (unrestricted, unbounded) < 0.035 persons/km^2	Smaller (~ 2,000 km^2) (restricted, bounded) ~ 0.035 persons/km^2
Co-residing group size and territory (aggregated)	Low (local band) ~ 20–30 individuals ~ 714 km^2 territory	High (macroband) ~ 60–100 individuals ~ 541–775 km^2 territory
Co-residing group size and territory (dispersed)	Very low ~ 10–20 individuals ~ 425 km^2 territory	Variable (low) ~ 20 individuals ~ 155 km^2 territory
Food sharing	Intragroup	Intragroup Intergroup
Foraging strategy	Resource maximization	Risk minimization

and generalized foraging strategies. Northern Archaic components utilized more sources, including more distant ones such as Batza Tena and Ringling, but had relatively lower frequencies of obsidian per component, suggesting more long-distance trade. Northern Archaic site types at DRO reflected a wider range of behaviours, including hunting camps, transient flaking stations, a lithic cache, and perhaps a residential base camp (Potter et al., 2018).

Social Organization: Given the patterning detailed above, social organization properties for the two systems can be hypothesized, focusing on exchange, territory size, group size, reciprocity, and foraging goals (Table 6). Different configurations of these elements can lead to different responses to risk (Bousman, 2005).

Given mobility, economy, and technological constraints, exchange needs and the systems developed to meet these needs should be different. For the LP/EH RMS, exchange needs should be relatively lower, and the geographic extent of exchange was probably local (neighbouring groups). Local was likely larger in geographic extent than in the later period, given the overall higher residential mobility and lower absolute population size (at the band level, considering the absence of macroband aggregation). Social interaction should be limited to groups that had similar cultures. Given the high mobility, most of their immediate needs were probably met with embedded procurement, so exchange was probably limited to information and perhaps marriage partners (Anderson, 1995; Anderson and Gillam, 2001; Meltzer, 2021). The archaeological record is consistent with these predictions. Contemporaneous cultures adjacent to Denali tradition cultures (Fig. 1) include Ocean Bay I (after 7500 cal BP) and Anangula tradition (after 9000 cal BP) in the Aleutian Islands, both derived from the earlier Denali tradition (Dumond, 2001; Coutouly, 2015).

For the MH RMS, exchange systems and needs should be different because residential mobility was reduced. Social interaction during the later period should be more complex, as these groups were trading with people focused on different local resources. These groups include Kachemak, ASTt, Norton, and Ipiutak in coastal northern and western Alaska (Fig. 1). The social boundary between the Northern Archaic and these coastal groups persists for millennia. There was thus more potential for the development of stable systems of exchange of resources beyond toolstone, such as non-local food and other resources (e.g., caribou hides, antlers, seal oil, and ivory). Increased longer distance exchange, incorporating higher-quality toolstone (and perhaps other resources) should be present. In sum, exchange-system dynamics, extent, complexity, and number of traded items change from the early to the later period, in ways that can help further model ancient social dynamics. These predictions have yet to be tested.

Co-residing group sizes should be different for both periods. For the LP/EH RMS, there were probably more limited differences in group size relating to foraging success given their overall land-use strategies and the lack of both storage and macroband aggregations. Overall, co-residing group sizes should be very low, probably varying between local bands and nuclear families. For the later MH RMS, different group-formation principles operated. During periods or seasons when groups maximized local resources, group sizes could be high, with macroband aggregation to exploit caribou-using tended facilities. During other periods, group size could be variable but would probably be higher than during the earlier period. The potential for more complex social interactions (e.g., potlatching, raiding) would be greater for the later period given the greater fluctuations between low and high co-residing group sizes.

Quantifying co-residing group sizes is difficult, but a recent study indicates relatively narrow ranges of these values among widely different environments (Hamilton et al., 2018). According to this study, the number of forager-camp occupants averaged 19.2 ± 1.6 (ranging from 15 to 25). Binford (2001) summarized multiple group-size variables for subarctic hunter-gatherers. Group 1 reflects population at the most dispersed (or local bands) whereas Group 2 reflects population at more aggregated situations (roughly equivalent to regional bands). For hunting groups, Group 1 averages 21 ± 8 persons and Group 2 averages 59 ± 16 persons. For three of the four predominantly hunting groups, a third category, Group 3, denotes periodic multi-group encampments, and averages 119 ± 90 persons (ranging from 105 to 210 individuals). These estimates are probably useful for a first approximation of MH RMS group sizes. In comparison, LP/EH RMS co-residing group sizes should be limited to about 20 individuals. Upward Sun River, an early residential site, has a number of evenly spaced hearth areas and possibly three residential features, consistent with an estimated occupation of about 20 individuals (Potter et al., 2014; Choy et al., 2016). In contrast, Gerstle River C3, a logistical hunting camp, has a site-occupant estimate of 8–12 individuals (Potter, 2005).

Band territory size should be quite different for each RMS. Given the environmental and social factors considered above, LP/EH RMS territories should be larger than the later MH RMS. Annual territories should be relatively unrestricted by limited resource patches and unbounded by other neighbouring groups. Territory edges should be connected with other similar social groups who shared material culture, and should be permeable (through intermarriage, etc.), similar to early Paleo-Indian expectations (see Meltzer, 2021).

The relatively more intensive habitat-use focus of the later MH RMS suggests smaller band territories that were restricted or bounded by the edges of natural resource concentrations in a more marginal environment, as well as bounded by adjacent cultures that were very different, as they also adapted to different local conditions and environments. Because of the smaller territories and the different economies, more complex social interaction with neighbouring groups was possible. The presence of communal hunting and aggregate base camps also suggests more internally complex social interactions. Estimates of western subarctic boreal hunter-gatherer territory size, population, and density vary by percent fishing (SUBSP1) (Binford, 2001). Territories (of multiple bands speaking the same language and broadly sharing material culture) are for 2029 ± 563 km^2 for hunters and 510 ± 356 km^2 for fishers. Fishers have about twice the densities as hunters in adjacent areas of the boreal forest (Binford, 2001: Table 5.01). Keeley (1988: Table 1) summarizes population densities for interior Dene hunter-gatherers: averaging 0.035 persons/km^2 and 0.129 persons/km^2 for hunters and fishers respectively.

Given the similarities of the MH RMS to recent Dene hunters, estimates for Northern Archaic multi-band groups connected by kinship and language may be greater than 1000 individuals inhabiting a multi-annual territory of about 2000 km^2, and a density of about 0.035 persons/km^2. While absolute territory size and population density of LP/EH RMS populations are difficult to estimate, relative to the later MH system the populations should be smaller, multi-annual territory should be larger, and population density should be lower, less than 0.035 persons/km^2. Assuming a relatively stable multi-annual territory of 2000 km^2 and co-residing group size estimates, these estimates suggest a population of 70 Denali tradition hunter-gatherers, comprising 4–5 local bands (most dispersed) and between two and three regional bands compared with 258 Northern Archaic tradition hunter-gatherers, comprising almost 13 local bands (most dispersed) and roughly 3–4 macrobands (most aggregated) inhabiting the same area. Using these numbers, the LP/EH RMS local and regional-band territory sizes are estimated at 425 km^2 and 714 km^2 respectively, and MH RMS local and regional-band territory sizes are estimated at 155 km^2 and from about 541 to 775 km^2, respectively.

Reciprocity in the context of resource sharing may be different between these RMSs. For the LP/EH RMS, food sharing should occur almost exclusively within the local group or band. This could take the form of related families sharing locally captured resources to buffer temporary shortfalls (see Lee and Daly, 1999). For the later MH RMS, this local food sharing could be coupled with more intergroup food sharing, particularly as overall resource stress was greater and neighbouring cultures captured different locally available resources. In addition, the presence of caribou drivelines and associated aggregate base camps indicates communal hunting and food sharing above the level of local bands.

Given the patterns described above, overall foraging strategies are different. The LP/EH RMS appears geared for resource maximization. In an environment with generally high resource abundance and diversity and spatial homogeneity of patches, groups should work to maximize overall net return (Kelly, 2013). This would be best achieved by an extensive land-use strategy focused on the highest-ranked prey, and a generalized technology through multiple seasons using high residential and logistical mobility. For the later MH RMS, simple resource maximization would not work, as resource patches become restricted, seasonal differences increase, and overall abundance of high-ranked prey declines. These hunter-gatherers should shift to a risk-minimization goal, where success lies in buffering the most unpredictable time of the year and organizing the rest of the seasonal round relative to that. In subarctic Alaska, the riskiest time was the spring when, in ethnographic times, Dene often depleted their winter storage of salmon and caribou before waterfowl and salmon were available. Managing this situation requires more specialization, local landscape knowledge, and extensive food storage. As storage is present, limited surpluses could be used to buffer risk both within bands and among related bands. MH RMS food sharing might be expected in broader contexts than in the earlier RMS.

These strategies also relate to how hunter-gatherer bands deal with stress at multiple levels. In the LP/EH RMS, as travellers practicing a generalized subsistence strategy focusing on large game could successfully move to new

TABLE 7. Possible responses to risk.

Response to risk	LP/EH RMS	MH RMS
Prevention of loss	Move to new local area Economic diversification Change labour organization More information exchange Change mobility patterns	Same (but more limited options)
Resource pooling	Food sharing (local groups)	Co-operative hunting Interband food sharing
Storage	Limited/none	Intensive
Transfer loss	Limited/none	Potlatches, raiding?
Abandonment	Common	Last resort, temporary

areas if those taxa were present. This is more feasible in homogeneous environments with large patches supporting high-ranked, gregarious, grazing megafauna, and low human populations (see Kelly and Todd, 1988). Collectors, such as those within MH RMS, typically respond by mapping onto local resources, intensifying exploitation of seasonally abundant resources, resource scheduling, and increasing reliance on storage (Kelly, 2013). All of this implies increased planning depth in the later period.

Testing Responses to Risk

Given the development of these two models, we can explore the responses of the RMSs to periods of increased risk. Archaeologists have developed expectations for hunter-gatherer responses to periods of increased risk (e.g., Bamforth and Bleed, 1997; Bousman, 2005). Two parts of risk include the likelihood of the loss of a resource and the relative cost of that loss (see discussion in Bousman, 1993). Table 7 lists a series of choices hunter-gatherers can make to respond to risk (derived from Weissner, 1982; Butzer, 1988; Bousman, 1993). The two RMSs modelled above should lead to very different responses that can be evaluated with extant archaeological data.

In a generalized economic system focusing on multiple high-ranked resources in a homogeneous environment (LP/EH RMS), the loss of any one resource can be buffered by a shift or expansion to other resources. In this early system, responses should include economic diversification, widening of diet breadth, and potential abandonment and expansion/migration into new areas. Resource pooling may be less successful, and lack of storage limits the potential for buffering temporary shortfalls.

In contrast, in the MH RMS (a more specialized economy), the loss of a key resource (e.g., caribou or salmon) increases the cost of that loss. Risk-minimizers such as the Northern Archaic (and the ethnographically known Dene hunter-gatherers) had more limited options to prevent the loss, as there were fewer available high-ranked taxa. Since these traditions already practised intensive, local resource exploitation, a mapped-on strategy, more intensification of storage could be feasible. Resource pooling would be more likely, particularly more co-operative hunting and interband food sharing. Loss transfers, such as raiding, may have been practised. Finally, abandonment would probably have been a last resort, given surrounding social groups with different technological and economic systems.

With these basic expectations in mind, variation within these systems can be explored. What responses (if any) did populations make in the context of the deteriorating climate conditions known as the Younger Dryas interstadial (~12,800 – 11,600 cal BP), which occurred in the middle of this early adaptive system? While the regional effects of the Younger Dryas are ambiguous (Kokorowski, 2008; Meyer et al., 2010), it does reflect an abrupt shift to the colder and more arid conditions temporally situated between the Bølling-Allerød Interstadial (approximately 12,800 cal BP) and the warmer and more mesic Early Holocene (with the Holocene Thermal Maximum dated regionally at approximately 11,000 cal BP; Kaufman et al., 2004). Ameliorating climatic conditions associated with the earlier Bølling-Allerød Interstadial is associated with the entry of humans into eastern Beringia (Goebel et al., 2008; Wooller et al., 2018), suggesting a reversal of these conditions may hypothetically reflect local adverse conditions and increased risk for local hunter-gatherers. In addition, there are almost no sites of any kind recorded for the first half (12,800 – 12,200 cal BP), suggesting that the Younger Dryas did have an adverse impact on Beringian population density. Previous research based on a handful of sites suggests that pre-Younger Dryas sites in lowlands were Nenana complex, Younger Dryas-aged Denali complex sites in the uplands were more variable, Nenana complex sites continued in the lowlands, and post-Younger Dryas sites reflect Denali complex materials in lowland sites (Graf and Bigelow, 2011). A more nuanced analysis by Doering (2020) focused on three coarse-grained variables (site size, elevation, and slope) showed no significant differences at the onset of the Younger Dryas or with the Pleistocene/Holocene transition.

Archaeological data to evaluate adaptive responses are composed of 40 components directly dated to between approximately 14,000 and 9000 cal BP in the middle Tanana Valley, Alaska (Potter et al., 2013). Technological responses to the Younger Dryas should be minimal. There are little substantial differences in both technology and typology in this region during the Allerød Interstadial and Younger Dryas. Chindadn point types and microblades are found in the first two periods, at Bølling-Allerød sites such

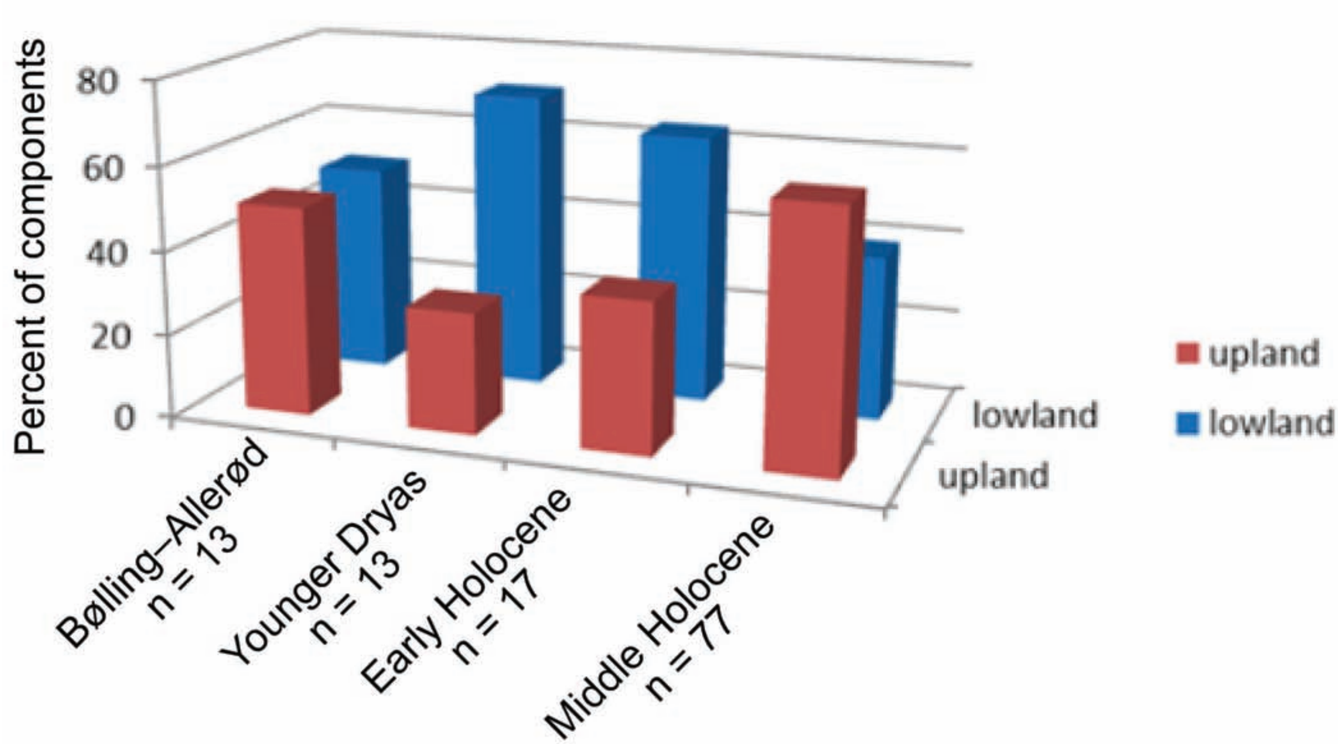

FIG. 3. Habitat use by climate period within the LP/EH RMS and MH RMS based on Gallant et al. (1995) and archaeological data from Potter (2008a), Potter et al. (2013), and Doering (2021).

as Mead CZ4, Linda's Point, and Healy Lake Village, and Younger Dryas-aged sites such as Broken Mammoth CZ3, Swan Point CZ3, and Mead CZ3 (Holmes, 1996; Holmes et al., 1996; Potter et al., 2013; Younie and Gillispie, 2016), though microblades appear to have been less commonly used (cf. Graf and Bigelow, 2011). Procurement of raw materials appears similar before and during the Younger Dryas given controls for location and site function; onsite and embedded procurement predominate at Mead CZ4 and CZ3, for instance, with nearly identical non-local obsidian patterns (Little, 2013). These data suggest that climate change did not cause local hunter-gatherers to significantly modify their technological system.

Habitat use is operationalized as site occurrence in broad ecoregions (Gallant et al., 1995). There is no statistical difference between Bølling-Allerød (n = 21), Younger Dryas (n = 19), or Early Holocene components (n = 29) (c^2 test for independent samples: Bølling-Allerød versus Younger Dryas, $p = 0.890$, Younger Dryas versus Early Holocene, $p = 0.191$). All three periods show more intensive occupation of lowland areas compared with later MH RMS patterns (Fig. 3). By this measure, early interior Beringian hunter-gatherers did not change their overall land-use patterns as a response to the Younger Dryas.

There should be expected differences in subsistence economy with respect to diversity and diet breadth. Taxonomic ubiquity through each period was compared, based on data in Potter, 2008a and Potter et al., 2013 (Fig. 4). There are several clear patterns in faunal exploitation in the context of the Younger Dryas and ameliorated periods before and after. All periods exhibit a similar distribution of higher-ranked large mammals. This is expected in the context of a resource-maximizing strategy. Bison is the most abundant taxon before, during, and after the Younger Dryas within the same sites (Easton et al., 2011; Potter et al., 2013). A second clear pattern is the differential exploitation of fish. All four components with fish date to the latter half of the Younger Dryas. The recent study of all known fish remains in the Tanana Valley (Potter et al., 2023) showed an even greater reliance on fish during the Younger Dryas chronozone. Of the 10 components with fish between 14,000 and 6000 years ago, all but one (90%) lie within the Younger Dryas.

The most important economic pattern is a dramatic increase in utilization of small game such as hare and ground squirrel in the Younger Dryas in both ecological zones. Using these coarse-grained data as proxies for diet breadth, there is evidence for an increase in diet breadth during the Younger Dryas, specifically incorporation of more small-mammal and fish taxa. This may represent an adaptive response to increased aridity and decreased temperature, resulting in loss of mesic habitat for waterfowl, which, while important in the Bølling-Allerød, are poorly represented in the Younger Dryas. Even when controlling for site function and season, this pattern is replicated at residential base camps at Broken Mammoth, Mead, and Upward Sun River.

Another pattern is an apparent narrowing of diet breadth during the Early Holocene, a reduction from 13 to 7 of the taxonomic groupings used here (Fig. 4). This corresponds

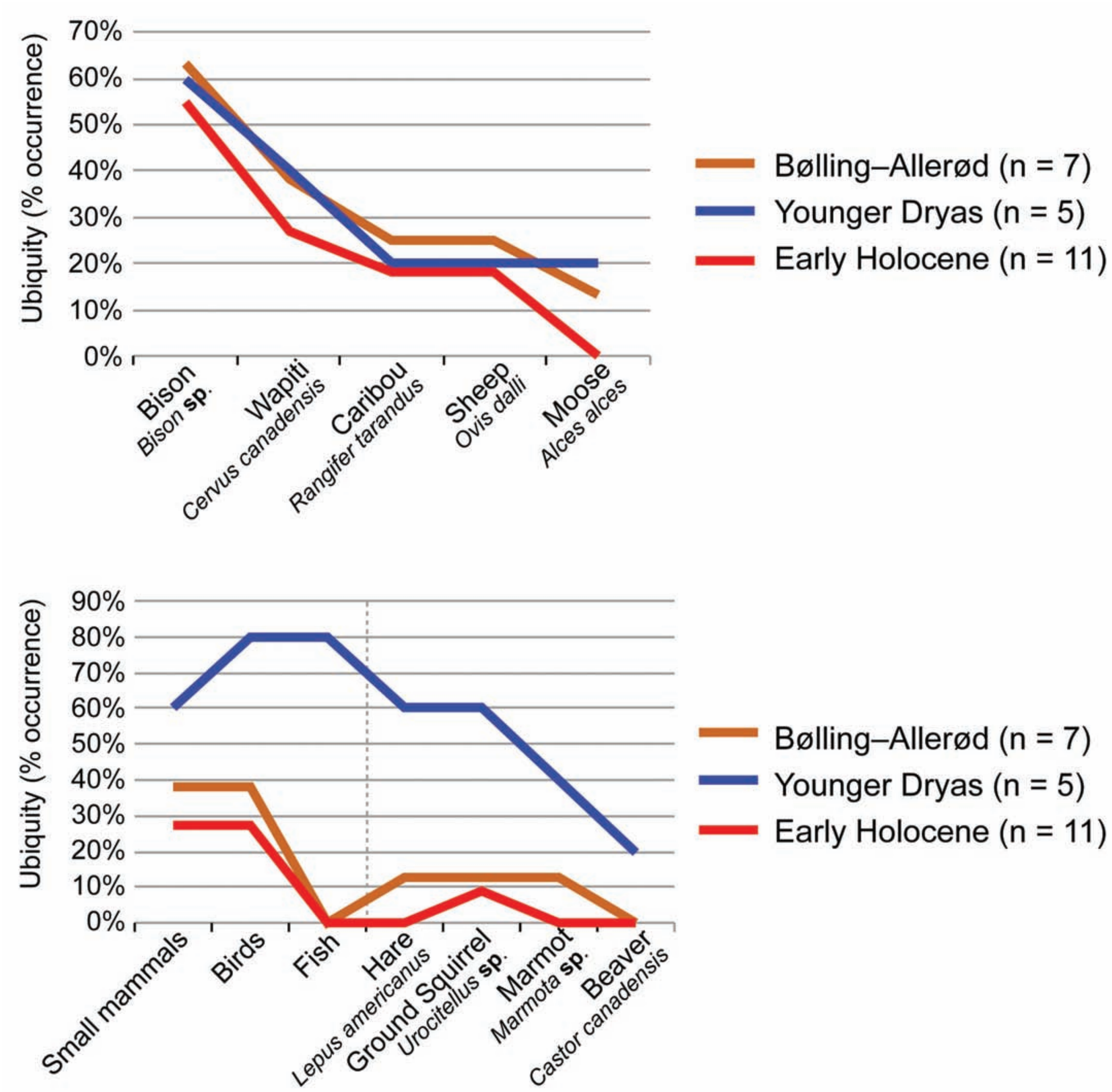

FIG. 4. Faunal ubiquity by climatic period in central Alaska. Top: large and very large mammals; bottom: small mammals, birds, and fish (n = 23 components) (data from Potter et al., 2013: see Table 5.7).

to the period of widespread (perhaps risk-averse) Denali complex present throughout the region and could reflect a response to more abundant high-ranked resources such as bison and wapiti in the earliest Holocene.

In sum, the most robust pattern is of widening diet breadth, basically incorporating more lower-ranked foods along with continued generalized hunting of high-ranked prey. These patterns indicate that local land-use patterns are embedded in local ecology, and the components that share a similar patch (interior bottomlands) yield very different signatures in terms of suites of animals taken and processed. Variation among these assemblages appears largely structured by site function, social groups represented at the site and their associated foraging activities, distance from large-game kill and processing sites, and seasonality (see discussion in Potter et al., 2013).

One additional expectation for this early LP/EH RMS is expansion into new (or uncolonized) areas using a generalized adaptive system. Summed radiocarbon probability distributions for central Alaska and other adjacent regions are illustrated in Figure 5. At the onset of the Younger Dryas, there were locally lower populations in

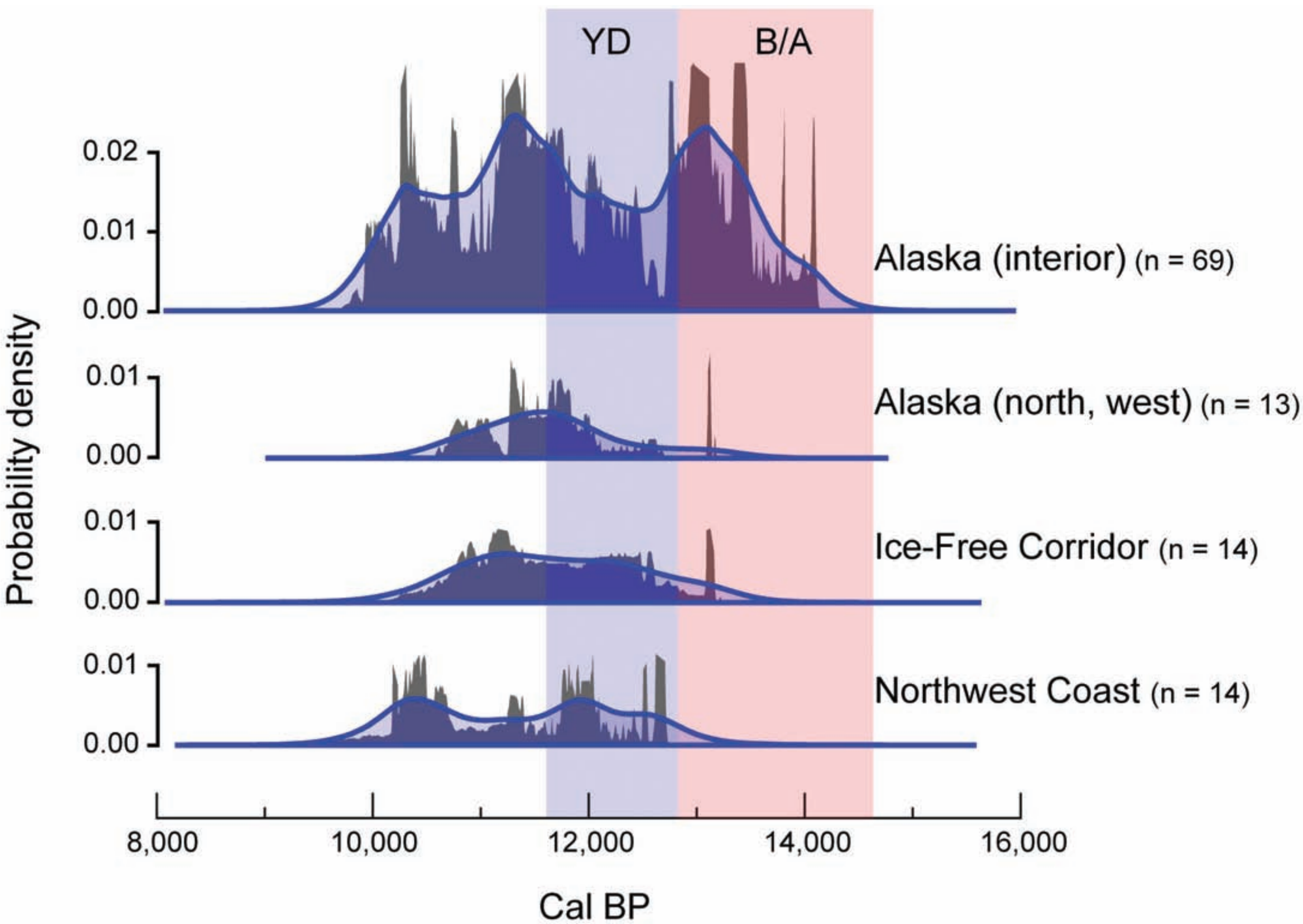

FIG. 5. Summed probability distributions (SPD, gray) and kernel density models (KDE, blue) for sites > 10,000 cal yr BP from central Alaska and adjacent regions (data from Potter, 2008a; Potter et al., 2013; Doering, 2021). Each component is represented by one averaged date. Microblades are associated with the expansions in the ice-free-corridor, north and west Alaska.

central Alaska and, concurrently, renewed occupations in the ice-free corridor, northwestern Alaska, and the earliest occupations in Southwest Alaska and the northern Pacific Northwest. Most of these expansions are associated with the first microblade technologies, probably derived from earlier Denali complex industries. Colonization of these areas may be related to risk-management strategies of interior Beringians.

While major environmental changes described above did not fundamentally alter the RMS practised by Ancient Beringians in interior Alaska, this system was replaced by the MH RMS, associated with the Northern Archaic tradition, approximately 6000 cal BP (Esdale, 2008; Potter, 2008b). The paleoenvironmental changes in the Middle Holocene probably had a major impact on gregarious grazers such as bison and wapiti through habitat reduction, as they decline in abundance and disappear from archaeological contexts. The reliance on generalized resource-maximization strategies associated with lowland bison and wapiti predation could not be sustained in the face of the loss of these high-ranked prey. The genetic data and archaeological data converge in support of a hypothesis of decline of Ancient Beringian populations using Denali tradition material culture, the LP/EH RMS described above, and a later in-migration of a new population (ancestral to Dene peoples that inhabit the region now, associated with the Northern Archaic–tradition material culture and the MH RMS). If these latter populations expanded north from interior northern British Columbia, they would have been already familiar with caribou and salmon exploitation strategies.

DISCUSSION

While the technological and typological material culture traits between the Early and Middle Holocene in interior Alaska have many elements of continuity, and both groups (Denali and Northern Archaic traditions) could be considered subarctic hunter-gatherers with collector-like tendencies, this study has elucidated a number of important differences in social organization, primarily conditioned by different environments, resource diversity and abundance, patch structure, and basic economic responses.

First-approximation estimates of social variables such as co-residing group size, territory size, social interaction, and exchange for both traditions allow for a more nuanced exploration of prehistoric behaviours. These models facilitate the exploration of Beringian and subarctic hunter-gatherer responses to periods of increased risk during different environmental conditions with different social configurations. Both environmental change and cultural responses played a role in subsequent configurations. Situational responses were complex and interacting parts influenced each other in subtle ways.

In the LP/EH RMS, substantial climate change was managed without major changes in the technological, economic, and land-use systems. This was partially due to social organization—small co-residing group sizes, larger territories, high residential mobility, and exchange with local groups. The Younger Dryas stadial was associated with relatively limited cultural responses visible in the archaeological record. The LP/EH RMS was sufficiently flexible and resilient to manage climate, vegetation, and resource abundance changes. Cultural responses were primarily evident in widening diet breadth and movement into adjacent regions. This social configuration also explains population expansions in the greater eastern Beringian area after 12,000 cal BP, which contrast with the relatively stable cultural boundaries of the succeeding MH RMS.

The LP/EH RMS, stable for 6500 years, became untenable as resources and patch structure changed at approximately 6000 cal BP. Genetic data suggest that the Ancient Beringian populations, present from approximately 12,500 cal BP to perhaps 6000 cal BP, did not admix with recent Dene populations or their ancestors (Moreno-Mayar et al., 2018a; Moreno-Mayar et al., 2018b). However, archaeologists must still explain the differences in lifeways in the same region. The transition between the LP/EH RMS and MH RMS appears to be related to lower amplitude climatic stressors, primarily related to increasing paludification and the spread of black-spruce-dominated forests and muskegs at the expense of sedge meadows with a concurrent reduction in bison and wapiti habitat. The MH RMS was more focused on seasonally restricted patches (primarily caribou) using a mapping-on strategy of local resources. Compared to the LP/EH RMS, while the MH RMS contained similar material cultural types and technologies, it exhibited system-wide differences, including the appearance of communal hunting, storage, more logistical behaviours, and possibly increased social interaction.

The specializations enabling the Northern Archaic (MH RMS) to cope with risk in the subarctic boreal forest also made them susceptible to local resource crashes, when those key resources were more critical. Abandonment and migration were less likely, given the Holocene fragmentation of local ecologies and resource bases. Resource stress was likely to be greater, and their risk-minimization strategies facilitated increased social interactions with neighbouring groups who were increasingly dissimilar to themselves.

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REFERENCES

Ackerman, R.E. 1996. Early maritime culture complexes of the northern Northwest Coast. In: Carlson, R.L., and Dalla, L., eds. Early human occupation in British Columbia. Vancouver: UBC Press. 123–132.
https://doi.org/10.59962/9780774853637

———. 2004. The Northern Archaic tradition in southwestern Alaska. Arctic Anthropology 41(2):153–162.
https://doi.org/10.1353/arc.2011.0074

Alley, R.B. 2004. GISP2 ice core temperature and accumulation data. IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series 2004-013.

Anderson, D.D. 1968. A stone age campsite at the gateway to America. Scientific American 218(6):24–33.
https://www.jstor.org/stable/24926252

———. 1988. Onion Portage: An archaeological site on the Kobuk River, northwestern Alaska. Anthropological Papers of the University of Alaska Fairbanks 22(1-2).

Anderson, D.G. 1995. Paleoindian interaction networks in the eastern woodlands. In: Nassaney, M.S., and Sassaman, K.E., eds. Native American interaction: Multiscalar analyses and interpretations in the Eastern Woodlands. Knoxville: University of Tennessee Press. 1–26.

Anderson, D.G., and Gillam, J.C. 2001. Paleoindian interaction and mating networks: Reply to Moore and Moseley. American Antiquity 66(3):530–535.
http://doi.org/10.2307/2694251

Bamforth, D.B. 2002. High-tech foragers? Folsom and Later Paleoindian technology on the Great Plains. Journal of World Prehistory 16(1):55–98.
https://doi.org/10.1023/A:1014567313865

Bamforth, D.B., and Bleed, P. 1997. Technology, flaked stone technology, and risk. Archaeological Papers of the American Anthropological Association 7(1):109–139.
http://doi.org/10.1525/ap3a.1997.7.1.109

Bartlein, P.J., Anderson, P.M., Edwards, M.E., and McDowell, P.F. 1991. A framework for interpreting paleoclimatic variations in eastern Beringia. Quaternary International 10:73–83.
https://doi.org/10.1016/1040-6182(91)90041-L

Bettinger, R.L., and Baumhoff, M. 1982. The Numic spread: Great Basin cultures in competition. American Antiquity 47:485–503.
http://doi.org/10.2307/280231

Bettinger, R.L., Garvey, R., and Tushingham, S. 2015. Hunter-gatherers as optimal foragers. In: Bettinger, R.L., Garvey, R., and Tushingham, S., eds. Hunter-Gatherers: Archaeological and evolutionary theory. Boston: Springer. 91–138.
https://doi.org/10.1007/978-1-4899-7581-2

Bever, M.R. 2001. An overview of Alaskan Late Pleistocene archaeology: Historical themes and current perspectives. Journal of World Prehistory 15(2):125–191.
https://doi.org/10.1023/A:1012571931711

———. 2006. Too little, too late? The radiocarbon chronology of Alaska and the peopling of the New World. American Antiquity 71(4):595–620.
https://doi.org/10.2307/40035881

Bigelow, N.H. 2013. Pollen records, Late Pleistocene, northern North America. In: Elias, S., ed. Encyclopedia of Quaternary Science, 2nd ed. New York: Elsevier. 39–51.
https://doi.org/10.1016/c2021-1-00296-6

Bigelow, N.H., and Powers, W.R. 2001. Climate, vegetation, and archaeology 14,000–9000 cal BP in central Alaska. Arctic Anthropology:171–195.
https://www.jstor.org/stable/40316729

Binford, L.R. 1962. Archaeology as anthropology. American Antiquity 28(2):217–225.
http://doi.org/10.2307/278380

———. 1965. Archaeological systematics and the study of culture process 1. American Antiquity 31 (2 Part1):203–210.
https://doi.org/10.2307/2693985

———. 1979. Organization and formation processes: Looking at curated technologies. Journal of Anthropological Research 35(3):255–273.
http://doi.org/10.1086/jar.35.3.3629902

———. 1980. Willow smoke and dogs' tails: Hunter-gatherer settlement systems and archaeological site formation. American Antiquity 45(1):4–20.
https://doi.org/10.2307/279653

———. 2001. Constructing frames of reference: An analytical method for archaeological theory building using ethnographic and environmental data sets. Berkley: University of California Press.

Bousman, C.B. 1993. Hunter-gatherer adaptations, economic risk and tool design. Lithic Technology 18(1-2):59–86.
http://doi.org/10.1080/01977261.1993.11720897

———. 2005. Coping with risk: Later stone age technological strategies at Blydefontein Rock Shelter, South Africa. Journal of Anthropological Archaeology 24(3):193–226.
https://doi.org/10.1016/j.jaa.2005.05.001

Bronk Ramsey, C. 2017. Methods for summarizing radiocarbon datasets. Radiocarbon 59(2):1809–1833.
https://doi.org/10.1017/RDC.2017.108

Butzer, K.W. 1988. A "marginality" model to explain major spatial and temporal gaps in the Old and New World Pleistocene settlement records. Geoarchaeology 3:193–203.
http://doi.org/10.1002/gea.3340030303

Chatters, J.C., and Prentiss, W.C. 2005. A Darwinian macro-evolutionary perspective on the development of hunter-gatherer systems in northwestern North America. World Archaeology 37(1):46–65.
https://doi.org/10.1080/0043824042000329568

Choy, K., Potter, B.A., McKinney, H.J., Reuther, J.D., Wang, S.W., and Wooller, M.J. 2016. Chemical profiling of ancient hearths reveals recurrent salmon use in Ice Age Beringia. Proceedings of the National Academy of Sciences 113(35):9757–9762.
https://doi.org/10.1073/pnas.1606219113

Clark, C.L., Bigelow, N.H., Heintzman, P.D., Lammers, Y., Monteath, A.J., Reuther, J.D., Potter, B.A., Alsos, I.G., and Edward, M.E. 2024. Steppe-tundra composition and deglacial floristic turnover in interior Alaska revealed by sedimentary ancient DNA (sedaDNA). Quaternary Science Reviews 334: 108672.
https://doi.org/10.1016/j.quascirev.2024.108672

Clark, D.W. 1994. The Archaic in the extreme northwest of North America. Revista de Arqueologia Americana 5:71–99.

———. 2001. Microblade-culture systematics in the far interior Northwest. Arctic Anthropology 38(2):64–80.
https://www.jstor.org/stable/40316723

Coutouly, Y.A.G. 2015. Anangula—A major pressure-microblade site in the Aleutian Islands, Alaska: Reevaluating its lithic component. Arctic Anthropology 52(1):23–59.
https://doi.org/10.3368/aa.52.1.23

———. 2017. A technological approach to obsidian circulation in prehistoric central Alaska. Journal of Archaeological Science: Reports 16:157–169.
https://doi.org/10.1016/j.jasrep.2017.10.001

Dixon, E.J. 1985. Cultural chronology of central interior Alaska. Arctic Anthropology 22(1): 47–66.
https://www.jstor.org/stable/40316079

Doering, B.N. 2021. Subarctic landscape adaptations and paleodemography: A 14,000-year history of climate change and human settlement in central Alaska and Yukon. Quaternary Science Reviews 268: 107139.
https://doi.org/10.1016/j.quascirev.2021.107139

Dumond, D.E. 1969. Toward a prehistory of the Na-Dene, with a general comment on population movements among nomadic hunters. American Anthropologist 71(5):857–863.
https://doi.org/10.1525/aa.1969.71.5.02a00050

———. 1987. The Eskimos and Aleuts. London: Thames and Hudson.

———. 2001. The archaeology of eastern Beringia: Some contrasts and connections. Arctic Anthropology 38(2):196–205.
https://www.jstor.org/stable/40316730

Easton, N.A., Mackay, G.R., Young, P.B., Schnurr, P., and Yesner, D.R. 2011. Chindadn in Canada? Emergent evidence of the Pleistocene transition in southeast Beringia as revealed by the Little John Site, Yukon. In: Goebel, T.E., and Buvit, I., eds. From the Yenisei to the Yukon: Interpreting lithic assemblage variability in Late Pleistocene/Early Holocene Beringia. College Station: Texas A&M Press. 289–307.

Edwards, M.E., Dawe, J.C., and Armbruster, W.S. 1991. Pollen size of *Betula* in northern Alaska and the interpretation of late Quaternary vegetation records. Canadian Journal of Botany 69(8):1666–1672.
https://doi.org/10.1139/b91-211

Esdale, J.A. 2008. A current synthesis of the Northern Archaic. Arctic Anthropology 45(2):3–38.
https://doi.org/10.1353/arc.0.0006

Farnell, R., Hare, P.G., Blake, E., Bowyer, V., Schweger, C., Greer, S., and Gotthardt, R. 2004. Multidisciplinary investigations of alpine ice patches in southwest Yukon, Canada: Paleoenvironmental and paleobiological investigations. Arctic 57(3):247–259.
https://doi.org/10.14430/arctic502

Gallant, A.L., Binnian, E.F., Omernik, J.M., Shasby, M.B. 1995. Ecoregions of Alaska. Professional Paper (No. 1567). US Government Printing Office.
https://doi.org/10.3133/pp1567

Goebel, T., and Potter, B.A. 2016. First traces. In: Friesen, M., and Mason, O., eds. The Oxford handbook of the prehistoric Arctic. Oxford: Oxford University Press. 223–252.
https://doi.org/10.1093/oxfordhb/9780199766956.013.17

Goebel, T., Waters, M.R., and O'Rourke, D.H. 2008. The Late Pleistocene dispersal of modern humans in the Americas. Science 319(5869):1497–1502.
http://doi.org/10.1126/science.1153569

Graf, K.E., DiPietro, L.M., Krasinski, K.E., Gore, A.K., Smith, H.L., Culleton, B.J., Kennett, D.J., and Rhode, D. 2017. Dry Creek revisited: New excavations, radiocarbon dates, and site formation inform on the peopling of eastern Beringia. American Antiquity 80(4):671–694.
https://doi.org/10.7183/0002-7316.80.4.671

Graf, K.E., Gore, A., Melton, J.A., Marks, T., DiPietro, L., Goebel, T., Waters, M.R., and Rhode, D. 2020. Recent excavations at Owl Ridge, interior Alaska: Site stratigraphy, chronology, and site formation and implications for Late Pleistocene archaeology and peopling of eastern Beringia. Geoarchaeology 35(1):3–26.
https://doi.org/10.1002/gea.21754

Guthrie, R.D. 2001. Origin and causes of the mammoth steppe: A story of cloud cover, woolly mammal tooth pits, buckles, and inside-out Beringia. Quaternary Science Reviews 20(1-3):549–574.
https://doi.org/10.1016/S0277-3791(00)00099-8

———. 2006. New carbon dates link climatic change with human colonization and Pleistocene extinctions. Nature 441(7090): 207–209. https://doi.org/10.1038/nature04604

———. 2013. Frozen fauna of the mammoth steppe: The story of Blue Babe. Chicago: University of Chicago Press.

Halffman, C.M., Potter, B.A., McKinney, H.J., Tsutaya, T., Finney, B.P., Kemp, B.M., Bartelink, E.J., et al. 2020. Ancient Beringian paleodiets revealed through multiproxy stable isotope analyses. Science Advances 6(36): eabc1968. https://doi.org/10.1126/sciadv.abc1968

Halstead, P., and O'Shea, J. 1989. Bad year economics. In: Halstead, P., and O'Shea, J., eds. Introduction: Cultural responses to risk. Cambridge: Cambridge University Press. 1–7.

Hamilton, M.J., Buchanan, B., and Walker, R.S. 2018. Scaling the size, structure, and dynamics of residential mobile hunter-gatherer camps. American Antiquity 83(4):701–720. https://www.cambridge.org/core/journals/american-antiquity/article/abs/scaling-the-size-structure-and-dynamics-of-residentially-mobile-huntergatherer-camps/3A1BC468ED01A37BA8FFCE003D1C7B44

Helm, J. 1981. Subarctic. Handbook of North American Indians, Vol.6. Washington, DC: Smithsonian Institution.

Hoffecker, J.F. 2011. Assemblage variability in Beringia: The mesa factor. In: Goebel, T.E., and Buvit, I., eds. From the Yenisei to the Yukon: Interpreting lithic assemblage variability in Late Pleistocene/Early Holocene Beringia. College Station: Texas A&M Press. 165–178. https://www.cambridge.org/core/books/bad-year-economics/2249365CCA983DAC9E902E08D7990E48

Holly, D.H. Jr., Prince, P., and Erwin, J.C. 2018. Bad year economics at Birchy Lake. Journal of Anthropological Research 74(2):201–231. https://www.journals.uchicago.edu/doi/10.1086/697151

Holmes, C.E. 1996. Broken Mammoth. In: West, F.H., ed. American beginnings: The prehistory and palaeoecology of Beringia. Chicago: University of Chicago Press. 312–318.

———. 2001. Tanana River Valley archaeology circa 14,000 to 9000 BP. Arctic Anthropology 38(2):154–170. https://www.jstor.org/stable/i40013112

———. 2008. The Taiga period: Holocene archaeology of the northern boreal forest, Alaska. Alaska Journal of Anthropology 6(1–2)69–81. https://www.alaskaanthropology.org/wp-content/uploads/2017/08/akanth-articles_264_v6_n12_Holmes.pdf

Holmes, C.E., VanderHoek, R., and Dilley, T.E. 1996. Swan Point. In: West, F.H., ed. American beginnings: The prehistory and palaeoecology of Beringia. Chicago: University of Chicago Press. 319–323.

Holmes, C.E., Potter, B.A., and Reuther, J.D. 2023. An updated synthesis for the cultural sequence in the Tanana Valley, Alaska. Paper presented at the 88th Society for American Archaeology Meetings, Portland, Oregon.

Hu, F.S., Brubaker, L.B., and Anderson, P.M. 1996. Boreal ecosystem development in the northwestern Alaska range since 11,000 yr BP. Quaternary Research 45(2):188–201. https://doi.org/10.1006/qres.1996.0019

Hu, F.S., Brubaker, L.B., Gavin, D.G., Higuera, P.E., Lynch, J.A., Rupp, T.S., and Tinner, W. 2006. How climate and vegetation influence the fire regime of the Alaskan boreal biome: The Holocene perspective. Mitigation and Adaptation Strategies for Global Change 11:829–846. https://doi.org/10.1007/s11027-005-9015-4

Jones, M.C., and Yu, Z. 2010. Rapid deglacial and early Holocene expansion of peatlands in Alaska. Proceedings of the National Academy of Sciences 107(16):7347–7352. https://doi.org/10.1073/pnas.0911387107

Kaufman, D.S., Ager, T.A., Anderson, N.J., Anderson, P.M., Andrews, J.T., Bartlein, P.J., Brubaker, L.B., et al. 2004. Holocene thermal maximum in the western Arctic (0–180 W). Quaternary Science Reviews 23(5-6):529–560. https://doi.org/10.1016/j.quascirev.2003.09.007

Kaufman, D.S., Axford, Y.L., Henderson, A.C., McKay, N.P., Oswald, W.W., Saenger, C., Anderson, R.S., et al. 2016. Holocene climate changes in eastern Beringia—A systematic review of multi-proxy evidence. Quaternary Science Reviews 147(1):312–339. https://doi.org/10.1016/j.quascirev.2015.10.021

Keeley, L.H. 1988. Hunter-gatherer economic complexity and "population pressure": A cross-cultural analysis. Journal of Anthropological Archaeology 7(4):373–411. https://doi.org/10.1016/0278-4165(88)90003-7

Kelly, R.L. 1992. Mobility/sedentism: Concepts, archaeological measures, and effects. Annual Review of Anthropology 21:43–66. https://doi.org/10.1146/annurev.an.21.100192.000355

———. 2013. The lifeways of hunter-gatherers: The foraging spectrum. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139176132

Kelly, R.L., and Todd, L.C. 1988. Coming into the country: Early Paleoindian hunting and mobility. American Antiquity 53(2):231–244. https://doi.org/10.2307/281017

Kielhofer, J.R., Tierney, J.E., Reuther, J.D., Potter, B.A., Holmes, C.E., Lanoë, F.B., Esdale, J.A., Wooller, M.J., and Bigelow, N.H. 2023. BrGDGT temperature reconstruction from interior Alaska: Assessing 14,000 years of deglacial to Holocene temperature variability and potential effects on early human settlement. Quaternary Science Reviews 303(1): 107979.
https://doi.org/10.1016/j.quascirev.2023.107979

Kokorowski, H.D., Anderson, P.M., Mock, C.J., and Lozhkin, A.V. 2008. A re-evaluation and spatial analysis of evidence for a Younger Dryas climatic reversal in Beringia. Quaternary Science Reviews 27(17-18):1710–1722.
https://doi.org/10.1016/j.quascirev.2008.06.010

Krasinski, K.E., and Haynes, G. 2010. The eastern Beringian chronology of quaternary extinctions: A methodological approach to radiocarbon evaluation. Alaska Journal of Anthropology 8(1):39–60.
https://www.alaskaanthropology.org/wp-content/uploads/2017/08/akanth-articles_327_v8_n1_Krasinski-Haynes.pdf

Lanoë, F.B., Reuther, J.D., and Holmes, C.E. 2018. Task-specific sites and Paleoindian landscape use in the Shaw Creek Flats, Alaska. Journal of Archaeological Method and Theory 25:818–838.
https://doi.org/10.1007/s10816-017-9360-0

Lanoë, F.B., Reuther, J.D., Holmes, C.E., and Potter, B.A. 2020. Small mammals and paleovironmental context of the Terminal Pleistocene and Early Holocene human occupation of central Alaska. Geoarchaeology 35(2):164–176.
https://doi.org/10.1002/gea.21768

Lee, R.B., and Daly, R. 1999. Introduction. Foragers and others. In: Lee, R.B., and Daly, R.H. eds. The Cambridge encyclopedia of hunters and gatherers. Cambridge: Cambridge University Press.

Little, A.A. 2013. Lithic analysis at the Mead site, central Alaska. Masters Thesis. University of Alaska Fairbanks.
https://scholarworks.alaska.edu/handle/11122/4598

Lyman, R.L. 2003. The influence of time averaging and space averaging on the application of foraging theory in zooarchaeology. Journal of Archaeological Science 30(5):595–610.
https://doi.org/10.1016/S0305-4403(02)00236-4

Lynch, J.A., Colark, J.S., Bigelow, N.H., Edwards, M.E., and Finney, B.P. 2002. Geographic and temporal variations in fire history in boreal ecosystems of Alaska. Journal of Geophysical Research 108:1–18.
https://doi.org/10.1029/2001JD000332

Mann, D.H., Peteet, D.M., Reanier, R.E., and Kunz, M.L. 2002. Responses of an Arctic landscape to late glacial and early Holocene climatic changes: The importance of moisture. Quaternary Science Reviews 21(8-9):997–1021.
https://digitalcommons.unl.edu/cgi/viewcontent.cgi?params=/context/nasapub/article/1019/&path_info=Peteet_QSR_2002_Responses_arctic.pdf

McKennan, R.A. 1969. Athapaskan groups of central Alaska at the time of white contact. Ethnohistory 16(4):335–343.
https://doi.org/10.2307/480968

Meltzer, D.J. 2021. First peoples in a new world: Colonizing ice age America. Cambridge: Cambridge University Press.
https://doi.org/10.1017/9781108632867

Meyer, H., Schirrmeister, L., Yoshikawa, K., Opel, T., Wetterich, S., Hubberten, H.-W., and Brown, J. 2010. Permafrost evidence for severe winter cooling during the Younger Dryas in northern Alaska. Geophysical Research Letters 37(3).
https://doi.org/10.1029/2009GL041013

Moreno-Mayar, J.V., Potter, B.A., Vinner, L., Steinrücken, M., Rasmussen, S., Terhorst, J., Kamm, J.A., et al. 2018a. Terminal Pleistocene Alaskan genome reveals first founding population of Native Americans. Nature 553(7687):203–207.
https://doi.org/10.1038/nature25173

Moreno-Mayar, J.V., Vinner, L., de Barros Damgaard, P., de la Fuente, C., Chan, J., Spence, J.P., Allentoft, M.E., et al. 2018b. Early human dispersals within the Americas. Science 362(6419): eaav2621.
https://doi.org/10.1126/science.aav2621

Potter, B.A. 2005. Site structure and organization in central Alaska: Archaeological investigations at Gerstle River. Ph.D. dissertation, University of Alaska Fairbanks.

———. 2007. Models of faunal processing and economy in Early Holocene interior Alaska. Environmental Archaeology 12(1):3–23.
https://doi.org/10.1179/174963107x172714

———. 2008a. Radiocarbon chronology of central Alaska: Technological continuity and economic change. Radiocarbon 50(2):181–204.
https://doi.org/10.1017/S0033822200033518

———. 2008b. A first approximation of Holocene inter-assemblage variability in central Alaska. Arctic Anthropology 45(2):88–113.
https://doi.org/10.1353/arc.0.0013

———. 2008c. Exploratory models of intersite variability in Mid to Late Holocene central Alaska. Arctic 61(4):407–425.
https://doi.org/10.14430/arctic49

———. 2011. Late Pleistocene and Early Holocene assemblage variability in Central Alaska. In: Goebel, T.E. and Buvit, I., eds. From the Yenisei to the Yukon: Interpreting lithic assemblage variability in Late Pleistocene/Early Holocene Beringia. College Station: Texas A&M Press. 215–233.

———. 2016. Holocene prehistory of the northwestern subarctic. In: Friesen, M., and Mason, O., eds. The Oxford handbook of the prehistoric Arctic. Oxford: Oxford University Press. 531–555.
https://doi.org/10.1093/oxfordhb/9780199766956.013.54

———. 2017. Archaeology at the Mead Site: Subarctic human adaptation and social organization. Invited paper presented at the 44th Annual Alaska Anthropological Association Meetings, Sitka, Alaska. AAA Program 44.

———. 2023. Integrating ancient genetic and archaeological patterns for the peopling of northeast Asia and the Americas. Anthropological Papers of the University of Alaska, New Series Volume 7(1-2):41–62.
https://www.uaf.edu/apua/

Potter, B.A., Bowers, P.M., Reuther, J.D., and Mason, O.K., 2007. Holocene assemblage variability in the Tanana Basin: NLUR Archaeological Research, 1994–2004. Alaska Journal of Anthropology 5(1):23–42.

Potter, B.A., Holmes, C.E., and Yesner, D.R. 2013. Technology and economy among the earliest prehistoric foragers in interior eastern Beringia. In: Graf, K.E., Ketron, C.V., and Waters, M.R., eds. Paleoamerican odyssey. College Station: Texas A&M Press. 81–103.

Potter, B.A., Irish, J.D., Reuther, J.D., and McKinney, H.J. 2014. New insights into Eastern Beringian mortuary behavior: A terminal Pleistocene double infant burial at Upward Sun River. Proceedings of the National Academy of Sciences 111(48):17060–17065.
https://doi.org/10.1073/pnas.1413131111

Potter, B.A., Reuther, J.D., Holliday, V.T., Holmes, C.E., Miller, S., and Schmuck, N. 2017. Early colonization of Beringia and northern North America: Chronology, routes, and adaptive strategies. Quaternary International 444(b):36–55.
https://doi.org/10.1016/j.quaint.2017.02.034

Potter, B.A., Esdale, J., Reuther, J.D., McKinney, H.J., Holmes, C.E., Holloway, C., and Glassburn, C. 2018. Archaeological investigations at Delta River Overlook, central Alaska. Archaeology GIS Laboratory Report #7. University of Alaska Fairbanks.
https://www.uaf.edu/anthro/

Potter, B.A., Halffman, C.M., McKinney, H.J., Reuther, J.D., Finney, B.P., Lanoë, F.B., Lopez, J.A., et al. 2023. Freshwater and anadromous fishing in Ice Age Beringia. Science Advances 9(22): eadg6802.
https://doi.org/10.1126/sciadv.adg6802

Rasmussen, M., Anzick, S.L., Waters, M.R., Skoglund, P.L., DeGiorgio, M., Stafford, W., Rasmussen, S., et al. 2014. The genome of a Late Pleistocene human from a Clovis burial site in western Montana. Nature 506:225–229.
https://doi.org/10.1038/nature13025

Reimer, P., Austin, W., Bard, E., Bayliss, A., Blackwell, P.G., Ramsey, C.B., Butzin, M., et al. 2020. The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). Radiocarbon 62(4):725–757.
https://doi.org/10.1017/RDC.2020.41

Reuther, J.D., Slobodina, N.S., Rasic, J.T., Cook, J.P., and Speakman, R.J. 2011. Gaining momentum: Late Pleistocene and Early Holocene archaeological obsidian source studies in interior and northeastern Beringia. In: Goebel, T.E., and Buvit, I., eds. From the Yenisei to the Yukon: Interpreting lithic assemblage variability in Late Pleistocene/Early Holocene Beringia. College Station: Texas A&M Press. 270–286.

Shott, M.J. 2013. Human colonization and Late Pleistocene lithic industries of the Americas. Quaternary International 285:150–160.
https://doi.org/10.1016/j.quaint.2010.12.034

Stephenson, R.O., Gerlach, S.C., Guthrie, R.D., Harington, C.R., Mills, R.O., and Hare, G. 2001. Wood bison in Late Holocene Alaska and adjacent Canada: Paleontological, archaeological and historical records. In: Gerlach, S.C., and Murray, M.S., eds. People of wildlife in northern North America: Essays in honor of R. Dale Guthrie. Bar International Series 944:124–158.
https://doi.org/10.30861/9781841712369

Trigger, B.G. 1995. Expanding middle-range theory. Antiquity 69(264):449–458.
https://www.cambridge.org/core/journals/antiquity/article/abs/expanding-middlerange-theory/F6B7857AF921EE54F77395EB4E9F2227

Verdu, P., Pemberton, T.J., Laurent, R., Kemp, B.M., Gonzalez-Olivier, A., Gorodezky, C., Hughes, C.E., et al. 2014. Patterns of admixture and population structure in Native populations of northwest North Americans. PLOS Genetics 10: e1004530.
https://doi.org/10.1371/journal.pgen.1004530

Wahrhaftig, C. 1965. Physiographic divisions of Alaska. U.S.G.S. Professional Paper 482, Washington D.C.
https://doi.org/10.3133/pp482.

West, F.H. 1967. The Donnelly Ridge site and the definition of an early core and blade complex in central Alaska. American Antiquity 32(3):360–382.
https://doi.org/10.2307/2694665

———. 1996. Beringia and New World origins. II. The archaeological evidence. In: West, F.H., ed. American beginnings: The prehistory and palaeoecology of Beringia. Chicago: University of Chicago Press. 537–559.

Wilson, A.K., and Rasic, J.T. 2008. Northern Archaic settlement and subsistence patterns at Agiak Lake, Brooks Range, Alaska. Arctic Anthropology 45(2):128–145.
https://doi.org/10.1353/arc.0.0007

Wooller, M.J., Kurek, J., Gaglioti, B.V., Cwynar, L.C., Bigelow, N., Reuther, J.D., Gelvin-Reymiller, C., and Smol, J.P. 2012. An ~ 11,200 year paleolimnological perspective for emerging archaeological findings at Quartz Lake, Alaska. Journal of Paleolimnology 48:83–99.
https://doi.org/10.1007/s10933-012-9610-9

Wooller, M.J., Saulnier-Talbot, É., Potter, B.A., Belmecheri, S., Bigelow, N., Choy, K., Cwynar, L.C., et al. 2018. A new terrestrial palaeoenvironmental record from the Bering Land Bridge and context for human dispersal. Royal Society Open Science 5(6): 180145.
https://doi.org/10.1098/rsos.180145

Workman, W. 1977. Ahtna archaeology: A preliminary statement. In: Helmer, J.W., Van Dyke, S., and Kense, W., eds. Problems in the prehistory of the North American Subarctic: The Athapaskan question. Calgary: University of Calgary Archaeological Association. 22–39.
https://archive.org/details/problemsinprehis0000unse/page/n5/mode/2up

———. 1978. Prehistory of the Aishihik-Kluane area, southwest Yukon Territory. Musée National de l'Homme. Collection Mercure. Commission Archéologique du Canada. Publications d'Archéologie. Dossier 74. Ottawa.
https://doi.org/10.2307/j.ctv16s1t

Wygal, B.T., and Goebel, T. 2012. Early prehistoric archaeology of the middle Susitna Valley, Alaska. Arctic Anthropology 49(1):45–67.
https://doi.org/10.1353/arc.2012.0014

Yesner, D.R. 1989. Moose hunters of the boreal forest? A re-examination of subsistence patterns in the western subarctic. Arctic 52(2):97–108.
https://doi.org/10.14430/arctic1646

———. 1996. Human adaptation at the Pleistocene—Holocene boundary (circa 13,000 to 8,000 BP) in eastern Beringia. In: Staus, L.G., Eriksen, B.V., Erlandson, J.M., and Yesner, D.R., eds. Humans at the end of the Ice Age. Boston: Springer. 255–276.
https://doi.org/10.1007/978-1-4613-1145-4_13

Younie, A.M., and Gillispie, T.E. 2016. Lithic technology at Linda's Point, Healy Lake, Alaska. Arctic 69(1):79–98.
https://doi.org/10.14430/arctic4550